Corrosion

User Tutorial for the Corrosion Test Bench and Tool

May 2, 2014

1.0 Purpose

The purpose of this tool is to provide a galvanic corrosion analysis of the welds and bolted joins in the design. When discussing galvanic corrosion, the metal, or "species", that corrodes is referred to as the "anode" and the non-corroding species is called the "cathode". The corrosion tool evaluates joins involving two metals and computes a "thickness loss percentage" for the anode, the corroding species. The tool computes this thickness loss percentage by calculating the thickness of the material, as obtained from meshing the design for a blast computation, and dividing it by the galvanic corrosion rate (in Mils Per Year) to obtain a percentage of the part thickness that can be expected to corrode in one year. Thickness loss rates of 10% or higher are considered very bad. An overall thickness loss metric for the design is computed by summing all the thickness loss percentages that are greater than or equal to 10%. A corrosion score for the design, between 0 and 100, is then computed according to the following formula:

```
Corrosion Score = max( 0, 100*(1-Thickness_Loss_Metric) )
```

NOTE:
The majority of the time required to perform the corrosion analysis is spent building the mesh of the vehicle in order to obtain proximity & connectivity information, as well as part thicknesses. For this reason, it is highly recommended to simply include the "Corrosion_Thickness_Loss_Metric" and "Corrosion_Score" metrics in all Blast testbenches that are tier 2 or higher. In this way, the corrosion is automatically calculated as a small additional computation.

1.1 Requirements Tested

Corrosion resistance for the design.

1.2 Required Components

There must be at least two components in the design and they must be touching.

2.0 Procedures

Given the high degree of overlap between blast and corrosion analysis, the corrosion tool is integrated in the blast analysis and is executed during every blast analysis that is tier 2 or higher.

2.1 Tool Installation

The Corrosion tool is provided with the SwRI AVM Tools installer.

2.2 Use

2.2.1 Corrosion Test Bench

The following tutorial describes how to set up and run a corrosion test bench using the META/CyPhy toolchain.

2.2.2 Step 1: Set Up Test Folder

- In the GME Browswer, insert a "Testing" subfolder in your testing folder.
- Insert a new test bench to this subfolder, and name it "Corrosion".

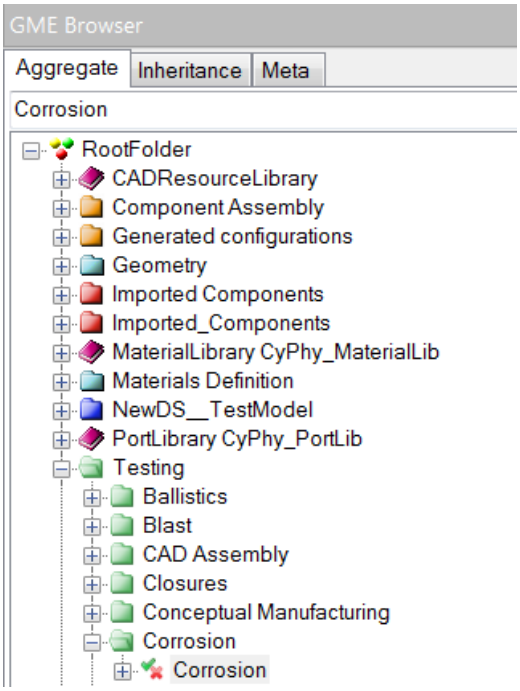

Figure 1

2.2.3 Step 2: Insert Design Space or Component Assembly Reference

- Double click on "Corrosion" to open test bench window.
- Copy/Paste As Reference your desired design space or component assembly.
- When the dialog box appears, select "TopLevelSystemUnderTest".

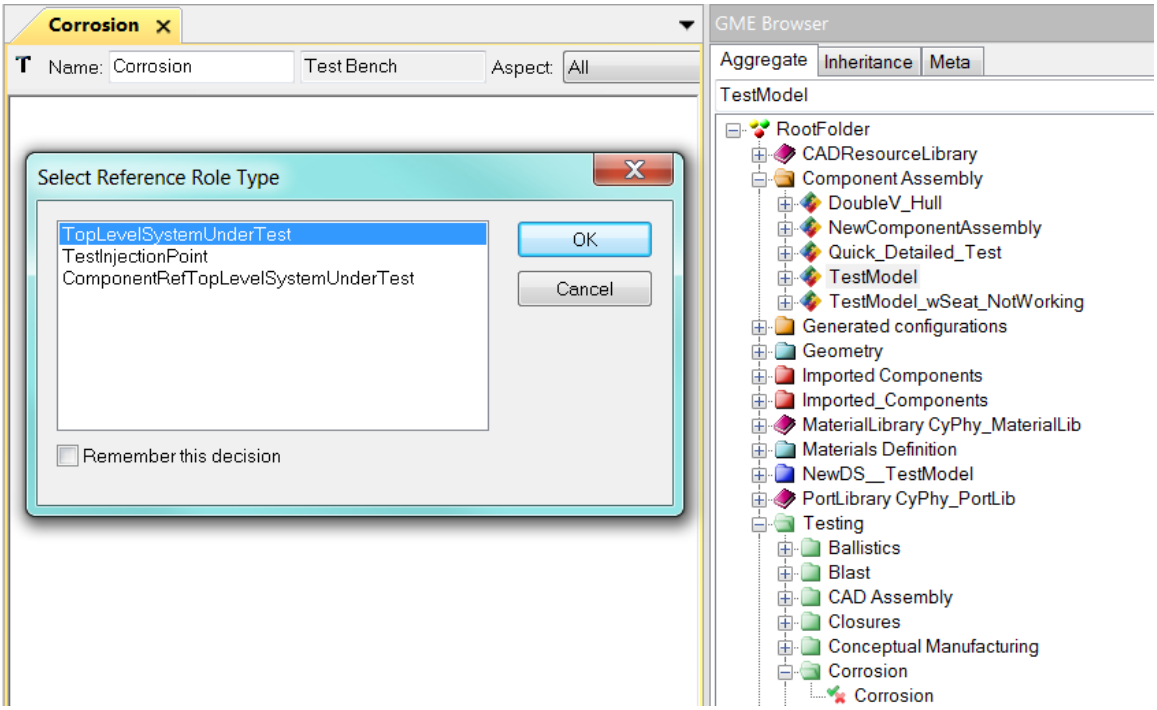

Figure 2

2.2.4 Step 3: Corrosion Test Bench Requirements

The Corrosion test bench has three (3) components:

- Assembly Under Test
- CyPhyCADAnalysis Workflow
- Metric

2.2.7 Step 3a: Workflow

- In the GME Browser, add a workflow definition folder in your testing folder.
- Add a workflow to this folder, and call it Corrosion.

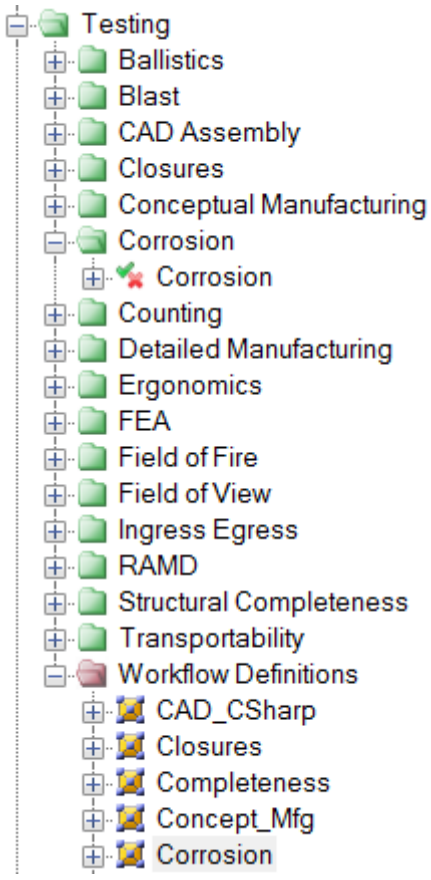

Figure 3

- Open the workflow, and drag in a task from the part browser.

- Select CyPhyCADAnalysis from the list.
- Double-click on the task and select "corrosion" from the drop-down menu. Select the red X in the top-right corner to save your selection.

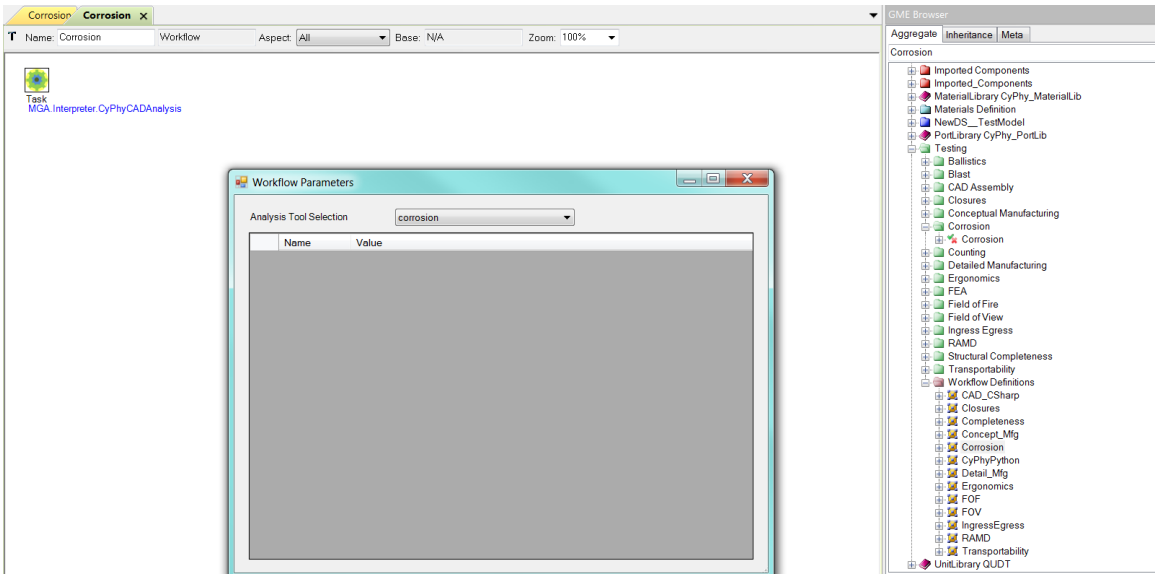

Figure 4

- Copy/Paste as Reference the workflow into the Corrosion test bench window.

2.2.8 Step 3b: Metric

- Drag two metric components from the Part Browser into the test bench window, and name them "Corrosion_Score" and "Corrosion_Thickness_Loss_Metric".

Your screen should now resemble Figure 5:

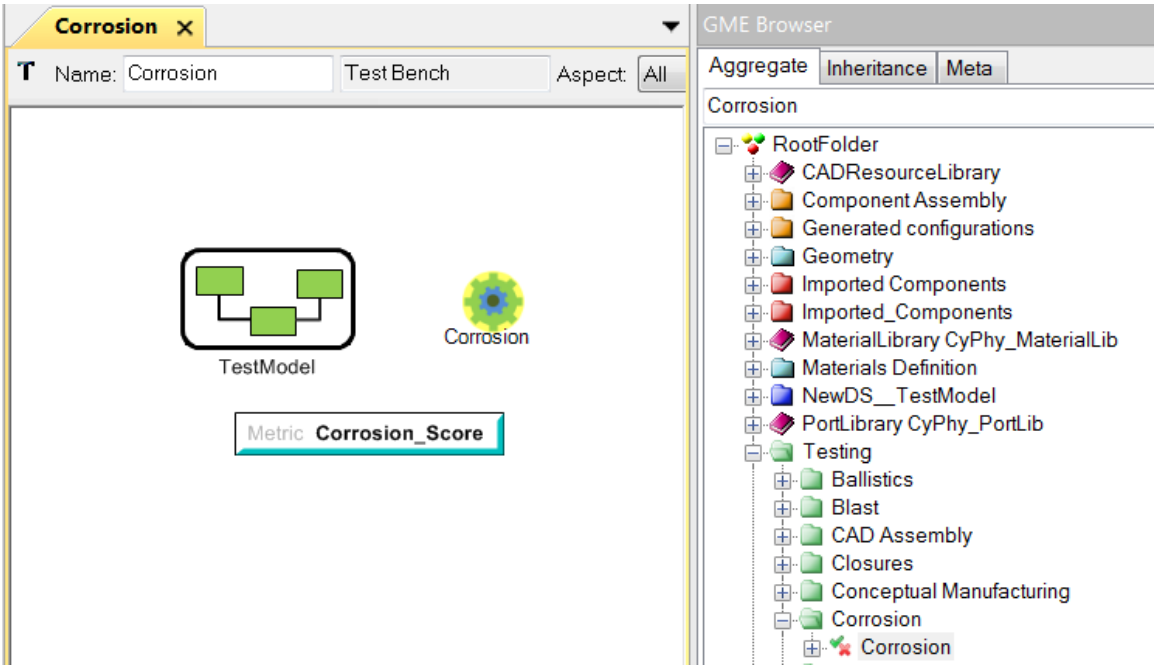

Figure 5

2.2.9 Step 4: Run DESERT (if using a design space)

- Run DESERT as usual, applying all constraints and exporting all configurations.

2.2.10 Step 5: Running the interpreter

- From the META tool bar, select the Master Interpreter.

Figure 6

Select the design configurations you would like to run the test on, select "Post to Job Manager", and click OK.
At the next dialog box:

- If applicable, choose the location of the Creo part files that make up the assembly.
- Make sure that "AP203_E2_Single_File", "AP203_E2_Separate_Part_Files", and "Use Project Manifest" are checked.

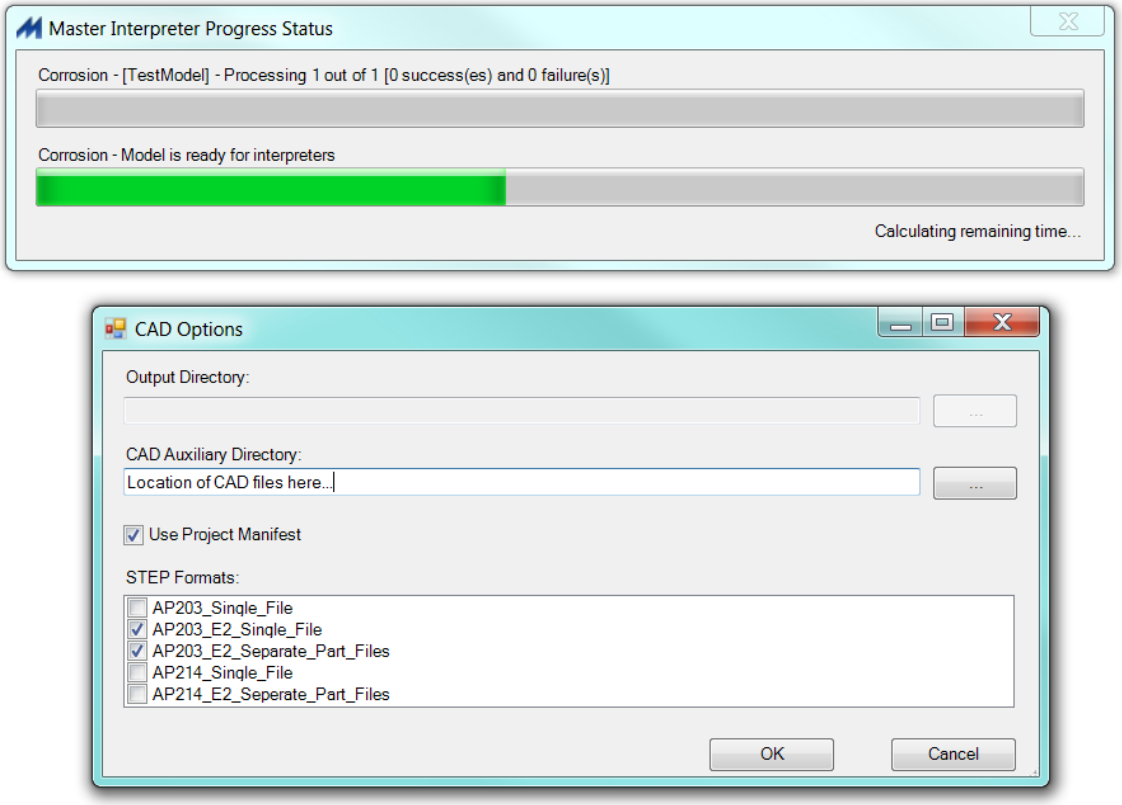

Figure 7

- Select OK.

- Make sure to run the job locally by deselecting the remote execution box in the job manager configuration box.

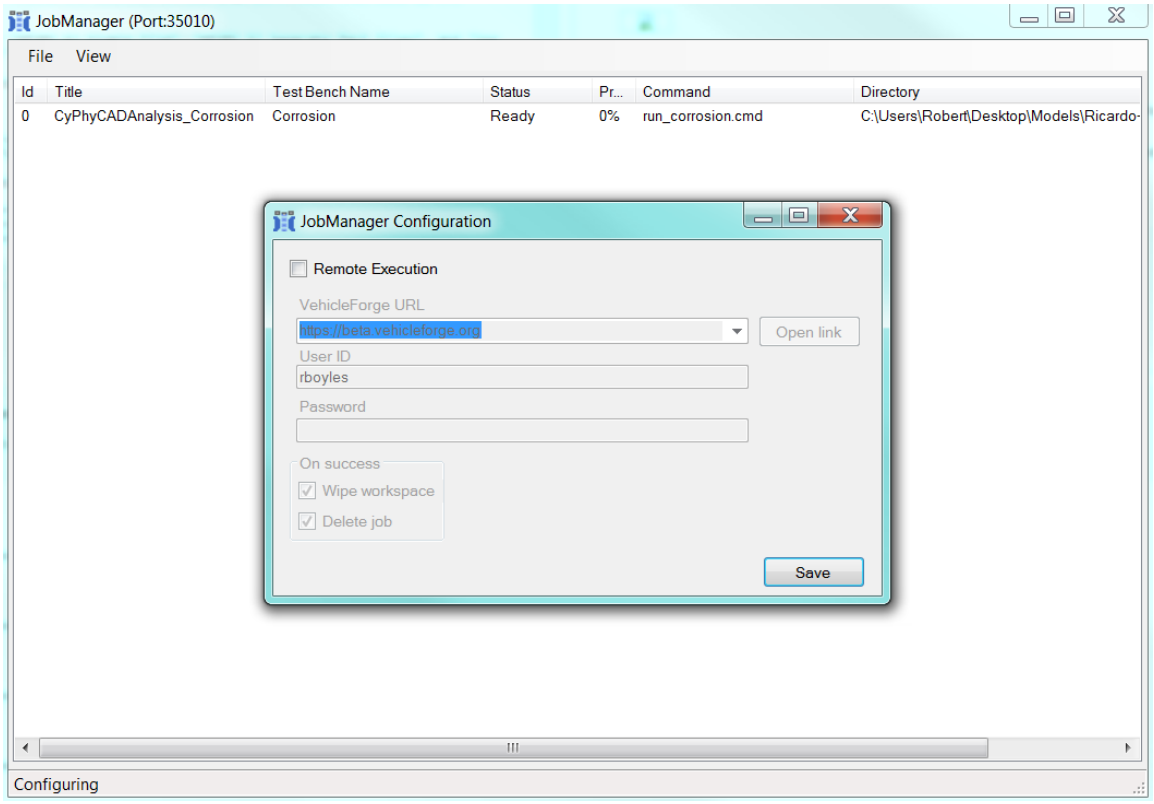

Figure 8

- If the test bench was correctly set up after the analysis is completed, a corrosion.log file should be in the same directory where the files were exported. This is a detailed results file for the corrosion analysis.

2.3 Results

Detailed results of the corrosion analysis are given in the "corrosion_report.json". In addition, a log of the process, including error, warning, and informational messages are given in the "corrosion.log" file. The metrics for this analysis are "Corrosion Score" and "Corrosion Thickness Loss Metric". These values are computed by the corrosion tool as follows:

1. Calculate the thickness loss for each join in the design (weld, bolted join, etc.)
   a) This is done by analyzing all welds and bolted joins in the design to determine the rate of galvanic corrosion for the join, generally expressed in Mils per Year.
   b) Determine the thickness of the corroding part in the join.
   c) Calculate a percentage of the part thickness that will corrode in one year (aka thickness loss).
2. Sum the thickness loss values for all parts with a thickness loss greater than or equal to 10% to arrive at the Corrosion Thickness Loss Metric.

The Corrosion Score or utility is calculated as follows:

```
Corrosion Score (utility) = max(0, (1-Corrosion_Thickness_Loss_Metric)*100)
```

The thickness loss values for each analyzed join is given in the "corrosion_report.json" file so that the user can focus attention on the worst offenders.

2.4 Release Notes

The corrosion analysis is automatically included with any tier 2 or higher blast analysis starting with R30 of the SwRI AVM Tools. Starting with R31 of the tools, a command-line option for running only the corrosion analysis ("--only-corrosion") was added to blast.exe.