RAMD

User Tutorial for RAMD (Reliability, Accessibility, and Maintainability) Test Bench and Tool

May 2, 2014

1.0 Purpose

The purpose of the RAMD test bench and tool is to assess a given design for reliability, accessibility, and maintainability. These aspects are critical in a fully functional and affordable design because components fail and need to be replaced. In addition, routine maintenance should not be so burdensome in terms of accessibility that it reduces the vehicle's ability to be on station, i.e. poses a significant negative affect on the operational availability.

2.0 Procedures

The instructions in this manual assume that the user has installed the latest version of GME/CyPhy and has access to Creo, either locally or via the remote server. Additionally, the user must download and install the RAMD analysis codes.

2.1 Installation

First, download the latest RAMD installer from VehicleForge. Next, run the installer. Ensure the files are installed to the C:\PSU-RAMD-Tools folder.

2.2 Tool

The RAMD Test Bench is the test bench in GME that the designer will use to interface with the RAMD analysis tool. The RAMD analysis tool interrogates the design and calculates three values: reliability, accessibility, and maintainability. Reliability measures the reliability of components included in the design. Accessibility determines how accessible known maintenance items are for reach and access. Lastly, maintainability checks the feasibility of the removal and replacement of known maintenance items.
The reliability portion of the tool is a very high-level analysis of the components integrated in the design to gain an understanding of the reliability of the entire vehicle. This reliability estimate improves as the number of components decreases. More complex analysis tools are being created under the AVM program for detailed fault identifications and the compounding effects of poor reliability.

Accessibility and Maintainability will be assessed by identifying known maintenance items within the design and analyzing the feasibility of reaching those items (engine oil dipstick) or the ability to remove the item(s) and replace them (starter motor). These analyses will be performed using design information contained in GME/CyPhy design. Geometric reasoning will be performed to determine feasible reach, access and removal paths. Because of this, the testbench will require some time to complete. However, the testbench will have the ability to run both locally and through the use of the remote server.

3.0 Requirements Tested

- **RAMD (percentage between 0 and 100:** Reliability, Accessibility, and Maintainability of a given design.

4.0 Required Components

When setting up the testbench, you will typically Copy as Reference the entire vehicle design into the RAMD testbench. RAMD expects there to be an engine and transmission contained within the design.

5.0 Theory of Operation

The system (design) is assembled into a 3D CAD representation, including the customization / generation of any parameterized components. Data about the design compilation and integration is generated for analysis within this test bench. This information is analyzed to estimate the feasibility of RAMD.
It is intended that the designer will use this test bench during and after designing hull penetrations and cut-outs as a check to ensure that the hatches are sized appropriately. In addition, it is envisioned that this test bench will be utilized in the latter stages of design to fully comprehend the capabilities of the design as it pertains to RAMD.

6.0 Test Bench Structure

This test bench contains a system under test that is to be assembled and analyzed for reliability, accessibility, and maintainability.
The RAMD test bench is installed by a standalone installer downloaded from VehicleForge. Once installed, please follow these steps to instantiate the test bench within GME/CyPhy.

Steps 1-6 below show how to instantiate the test bench if the designer would like to re-create the test bench. Steps 7-8 discuss running the test bench and viewing the output from the tool.

Step 1

In the GME Browser, within the "Testing" Test Bench folder insert a new Test Bench subfolder ("RAMD"). Then insert a new Test Bench model ("RAMD"). Figure 1 shows the new test bench and model.

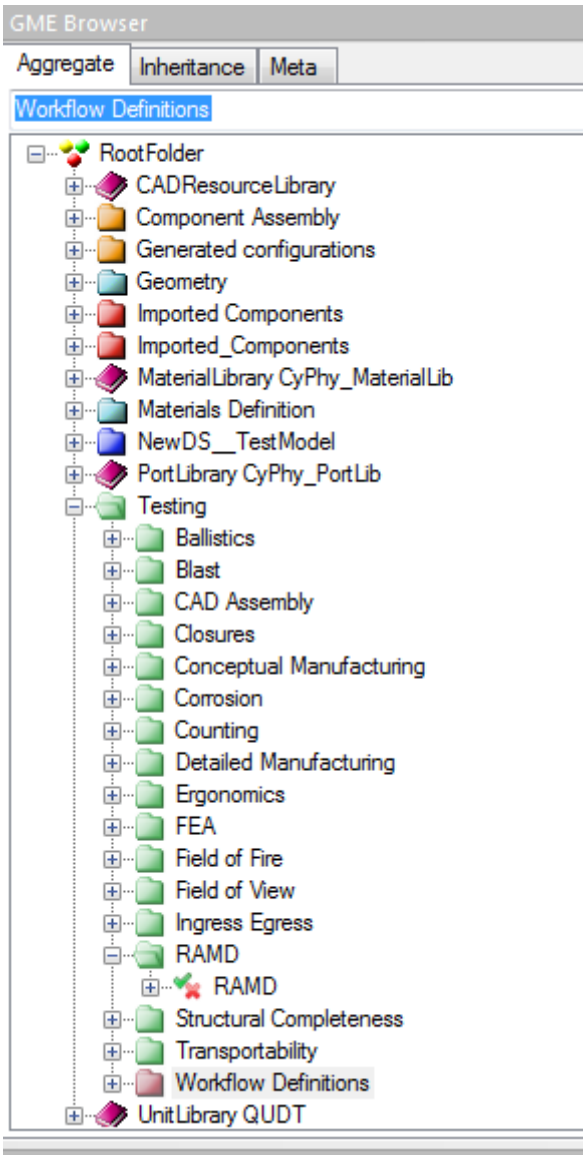

Figure 1: RAMD Test Bench and Model (highlighted).

Step 2

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

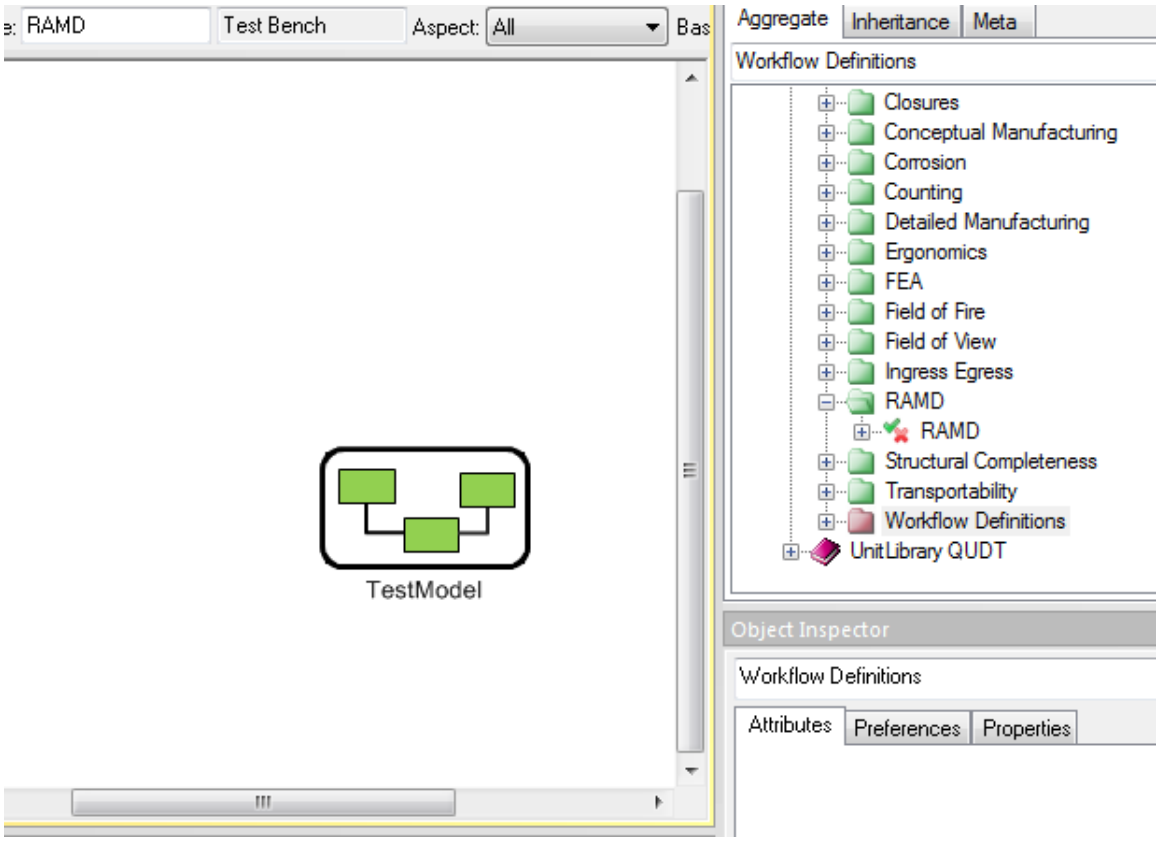

Figure 2: Copy/Paste…as Reference the Design Assembly.

Step 3

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

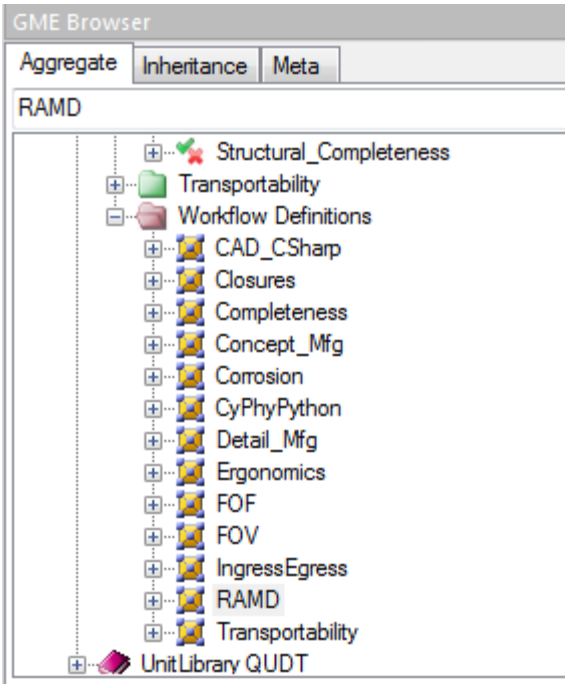

Figure 3: Workflow Definition (highlighted).

Step 4

Open the “RAMD” 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 " RAMD " as analysis tool. The RAMD Workflow Model is shown in Figure 4.

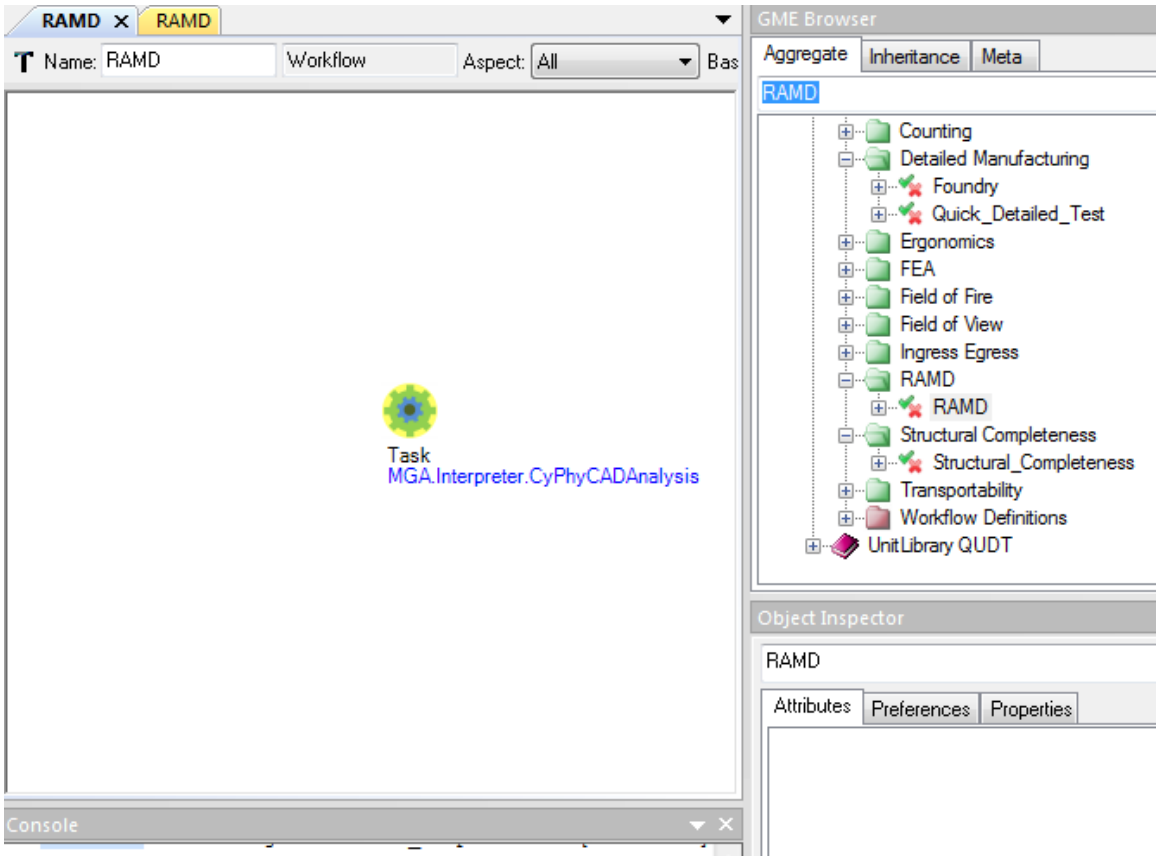

Figure 4: RAMD Workflow Model with Task.

Step 5

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

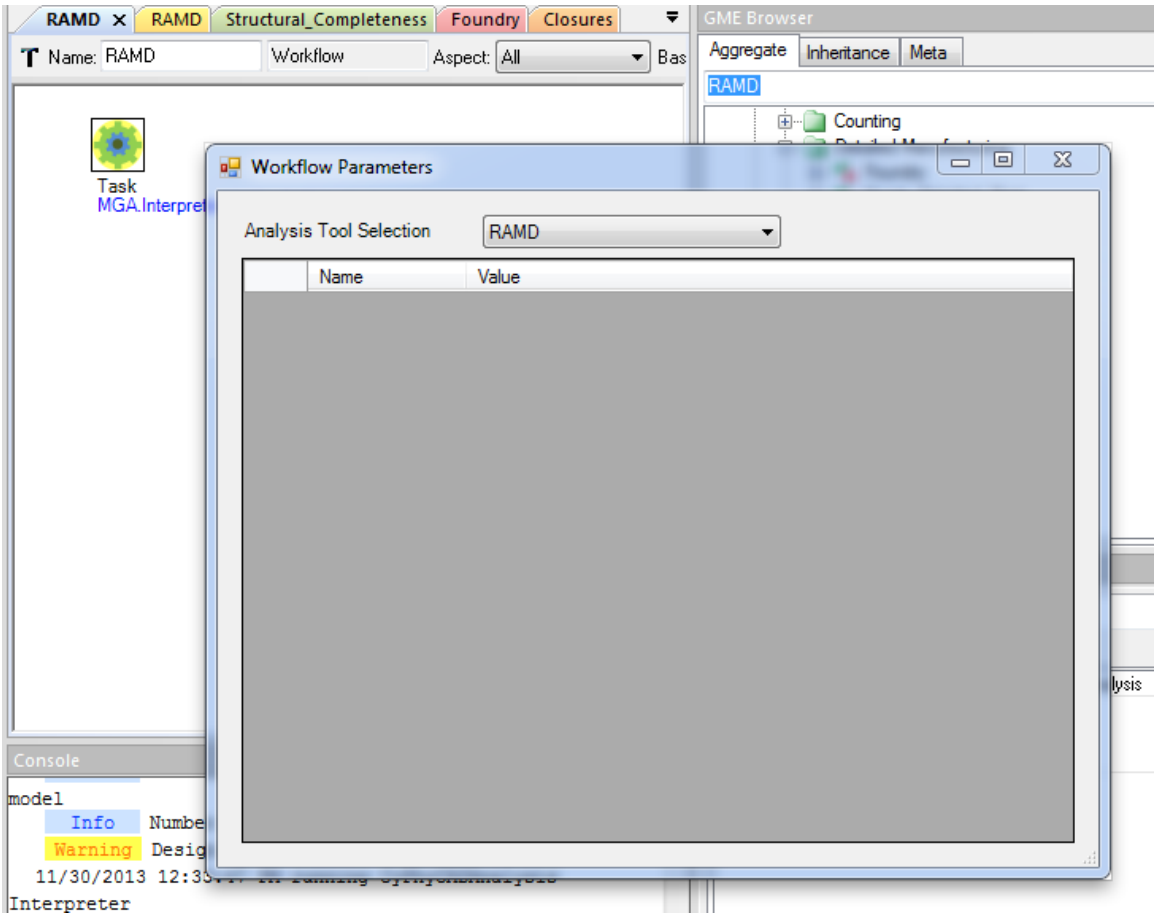

Figure 5: Setting up the Metrics.

Step 6

Now open the “RAMD” test bench and drag/drop the “RAMD” workflow definition and 1 metric (from Part Browser) into test bench. The metric must be named “RAMD” as shown in Figure 6 (this is what is searched for in the testbench_manifest.json file and used for scoring).

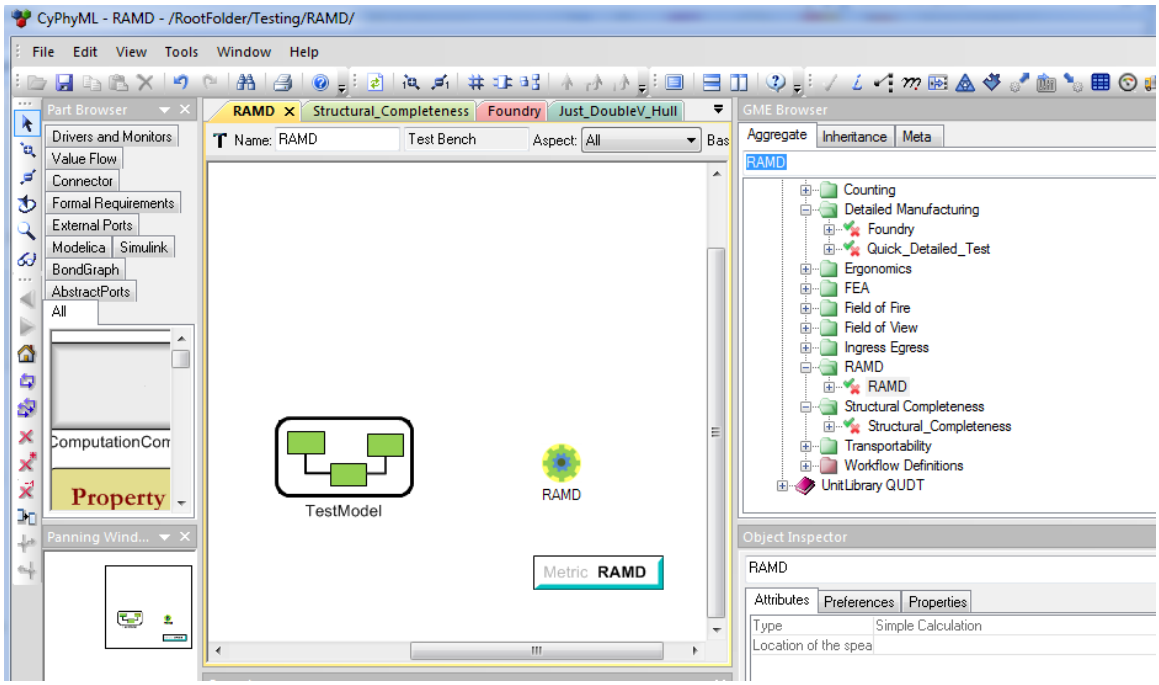

Figure 6: “RAMD” Test Bench.

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_Separate_Part_Files" as shown in Figure 7. For user-created components that are not imported into GME, point to the Creo file location (the CAD folder in your project directory) for the "CAD Auxiliary Directory" field, otherwise the project.manifest.json file should contain the information to point to the correct CAD files.

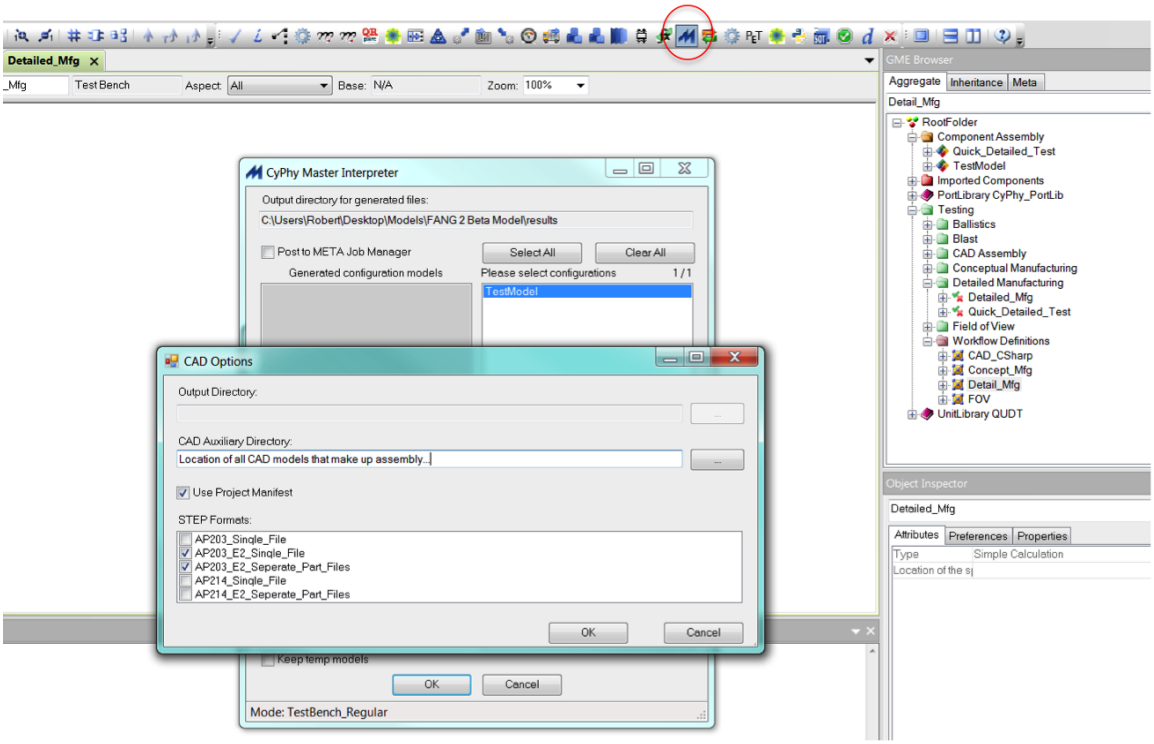

Figure 7: Running the Test Bench.

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 the testbench_manifest.json output file. The testbench_manifest.json file contains information from the RAMD test bench that can be used to evaluate the design. Typical analysis times are between 0.5 and 1 hour.

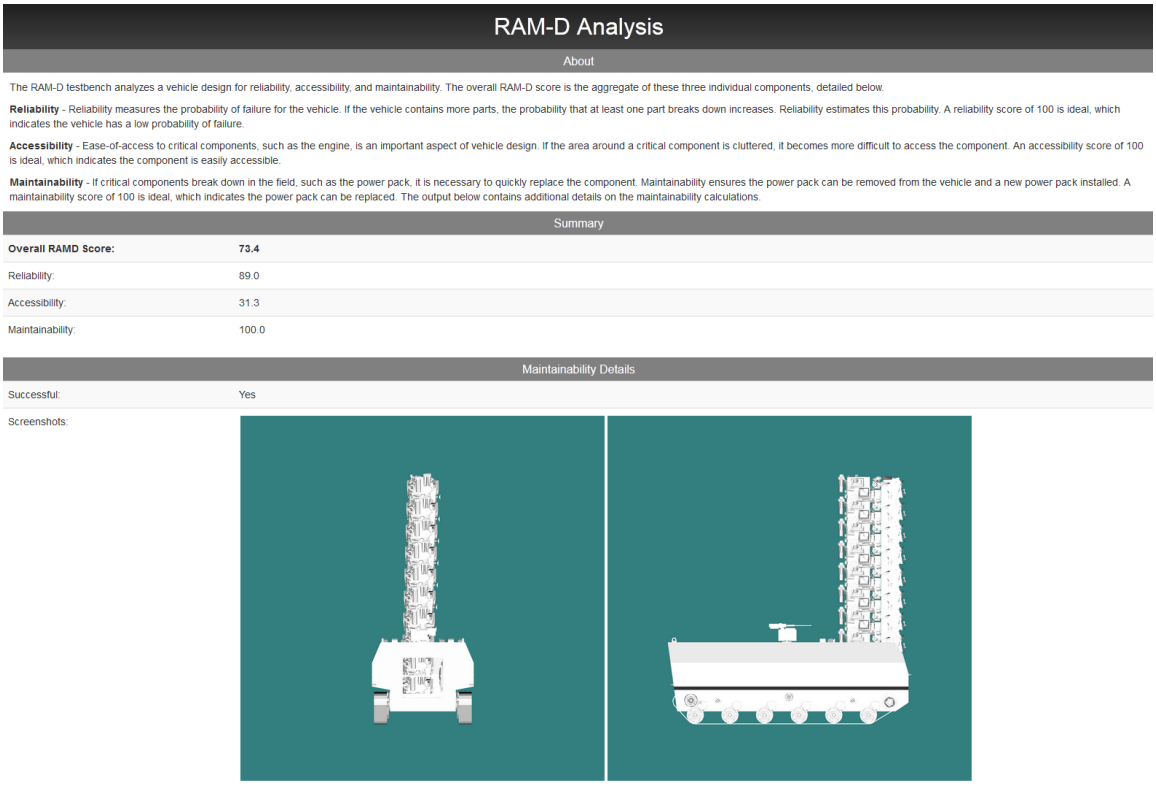

Figure 8: RAMD Results Viewing Engine Assembly Removal

Step 9

To view more details on the RAMD analysis, navigate to the results folder of the detailed level manufacturability test bench output and double click on the RAMD_Results.html file. The html viewer works with Firefox and Internet Explorer browsers. Other browsers (Chrome) can be used by setting the "target" for the shortcut startup to: "C:\Program Files (x86)\Google\Chrome\Application\chrome.exe" –allow-file-access-from-files. You will need to change the file path of the installation location for Chrome if it is different on your machine.

7.0 Description

The RAMD analysis calculates the efficacy of the given design for reliability, accessibility and maintainability. 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 through detailed design, however the anticipated benefit will come later in the design stages.

The items that should be included in the design are the engine, transmission, starter motor, and final drives. These components are the basic components that will need to be removed quickly and thus comprise the maintainability portion of the RAMD test bench.

Results are returned in the "testbench_manifest.json" file and can be viewed using the dashboard. Additionally, the RAMD_Results.html web page saved in the results folder displays details on the RAMD analysis in Firefox and IE.

The HTML page shows details on the maintainability calculation, including screenshots showing the path found to remove the components (engine, transmission, etc.). The maintainability calculation can fail for one of the following reasons:

- The part collides with one or more components at its installation location. If this message appears, there is likely another component that is colliding with the engine, transmission, etc. Check the 3D CAD representation to correct the collision.
- Unable to move the part outside the hull. The goal point (the final position the components are moving to) is invalid due to the components colliding with the hull. By default, the path planner attempts to lift the engine upwards by 7 meters. If needed, you can edit the C:\PSU-RAMD-Tools\main\RAMD\config.json file and increase the detla_x, delta_y, and delta_z position.
- Unable to find a valid path. The path planner was unable to find a path to remove the engine from the hull. This is likely caused by (1) another component blocking the path; or (2) the openings in the hull are not large enough to fit the components through.

8.0 Metrics

RAMD (percentage between 0 and 100): Reliability, Accessibility, and Maintainability of a given design.

Test Bench #	Metric	Description
153	RAMD	Evaluation of the reliability, accessibility, and maintainability of the design.

9.0 Required Connections to System under Test

NONE

10.0 Outputs

The output of this test bench is the “testbench_manifest.json” file.


```
{
    "Status": "OK",
    "Parameters": [],
    "TierLevel": 0,
    "Artifacts": [],
    "AnalysisStatus": "OK",
    "Created": "2013-11-26T19:31:11.8531987Z",
    "DesignName": "TestModel",
    "Metrics": [
        {
            "Description": "",
            "DisplayedName": null,
            "GMEID": "id-0067-000010e1",
            "Value": "0.935163851921",
            "ID": "349be36b-280a-4df3-9517-1741049d7371",
            "Unit": "",
            "Name": "RAMD"
        }
    ],
    "DesignID": "{def04a1e-dc80-4852-a2df-52bb7a66cdfd}",
    "Steps": [
        {
            "ExecutionCompletionTimestamp": null,
            "Description": null,
            "Parameters": [],
            "ExecutionStartTimestamp": null,
            "Invocation": "run_RAMD.cmd",
            "PostProcess": null,
            "PreProcess": null,
            "Type": null
        }
    ],
    "TestBench": "RAMD"
}
```


Figure 9: Portion of Summary Results.

The summary results can be seen and compared with other system metrics in the Dashboard. For further information on using the dashboard, please go to https://beta.vehicleforge.org/fang_beta2/resourcesf2/Local%20Dashboard.