Field of Fire

User Tutorial for the Field of Fire Test Bench

May 2, 2014

1.0 Purpose

The purpose of the Field of Fire Test Bench is to provide the designer with information about the effective range of the design's main weapon.

2.0 Procedures

2.1 Installation

Initial installations will be provided with the installation of the CyPhy tool suite and Ricardo seed design. Future version may be packaged as a standalone or combined package for test benches.

2.2 Tool

The Field of Fire Test Bench in GME allows the user to interface with the Field of Fire Tool which is a software application that accepts a design, analyzes it and returns a list of parameters regarding the effective range of the main weapon.

3.0 Requirements tested

- **Minimum fire distance:** the minimum distance that the main weapon can be fired safely. This requirement is given for both fore and aft arc.
- **No fire area:** The area around the vehicle in which it cannot use the main weapon effectively

4.0 Required Components

- Field of Fire

4.1 Explicit requirements

The following components are the minimum set required for the test bench to operate. The Datum(s) next to each required component provide more detail on the specific area or interface of the component that the test bench reasons about.

```
parts_of_interest = {
"Weapon_Station_Remote": {
                      "Datum": [
                          "EXT_WEAPON_MUZZLE",
                          "EXT_TURRET_ELEVATION",
                          "EXT_TURRET_TRAVERSE"
                               ],
                      "Property":[
                          "angle_max_elevation",
                          "angle_max_depression",
                          "angle_traverse_if_not_continuous_neg_z",
                          "angle_traverse_if_not_continuous_pos_z",
                          "traverse_continuous"
                                 ],
                      "Required" : "{1}"}
                  }
```

4.2 Implicit requirements

The field of fire test bench looks for geometry that could potentially obstruct the weapon fire. This requires a reasonably complete vehicle mode, for example, the designer should include a hull to get a meaningful result. Some artifacts may occur if components are physically detached (e.g. if the weapon station hovers over the vehicle).

All geometry is considered (with the exception of components- such as crew seats or engine- that would never be outside the vehicle, and thus would not interfere with line of fire.

5.0 Theory of Operation

The system (design) is assembled into a 3D CAD representation with the customization / generation of parameterized components. The data is analyzed to determine the effective minimum range of the main weapon.

6.0 Running the Test Bench

The test bench contains a system under test that is assembled and analyzed for transportability parameters.

In the GME Browser, insert a new Test Bench subfolder ("Field of Fire") within the "Testing" Test Bench folder.

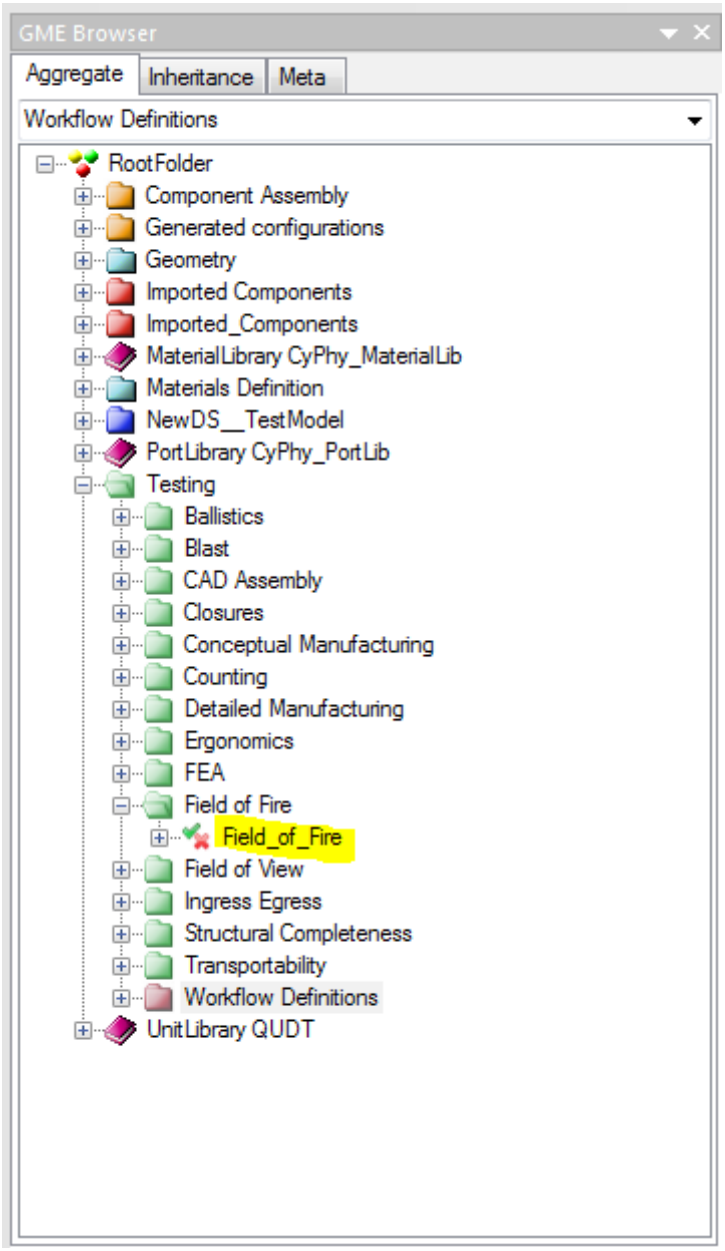


Figure 1: Insert Field of Fire subfolder into testing

Next, create a test bench called “Field_of_Fire” by inserting a new test bench model under the FoF test bench folder.

An assembly now needs to be added to the test bench. In the “Field of Fire” test bench Copy/Paste…As Reference the assembly to be tested.

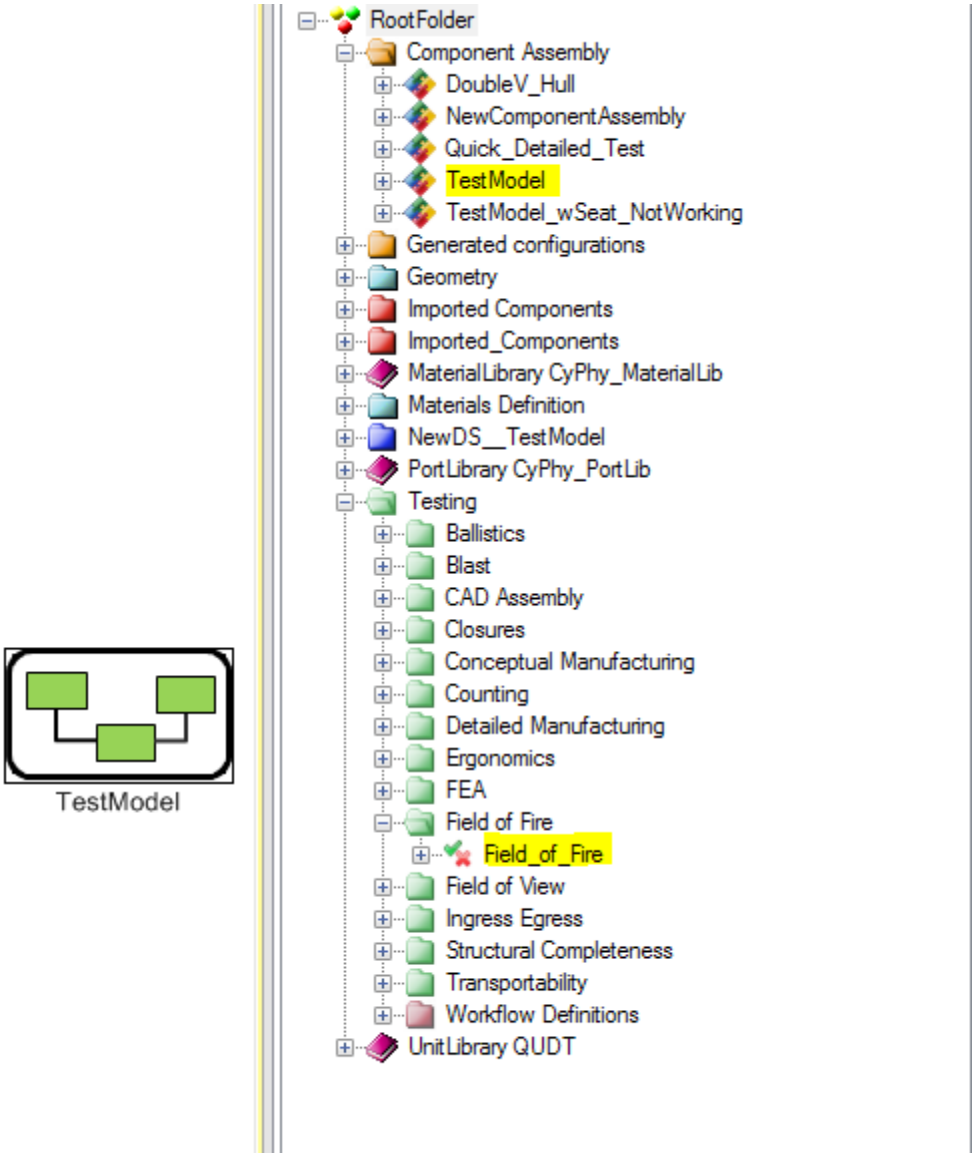


Figure 2: Copy/Paste...As Reference

In GME, within the Workflow Definition subfolder create a new workflow model named “FOF”.

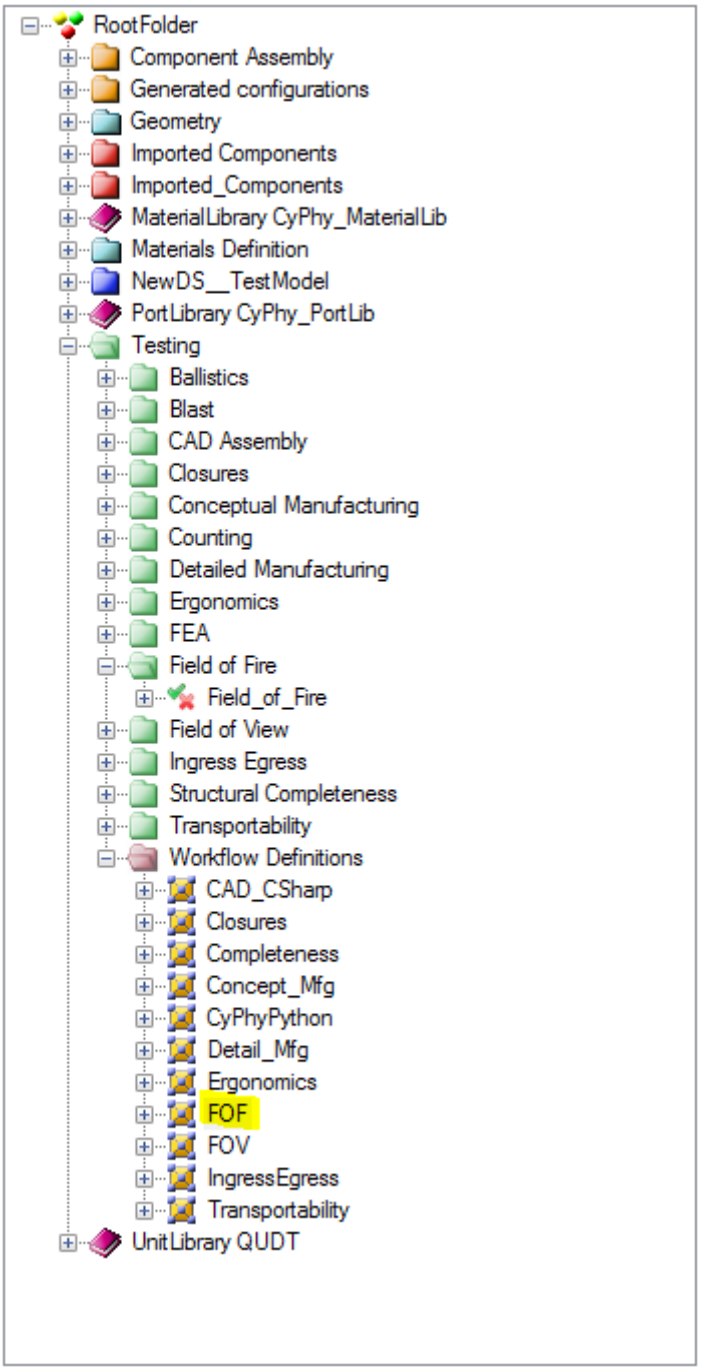


Figure 3: Workflow definition

Open the "FOF" Workflow Model and drag a "Task" element into the workspace. Select "CyPhyCADAnalysis" as the interpreter from the window that pops up.

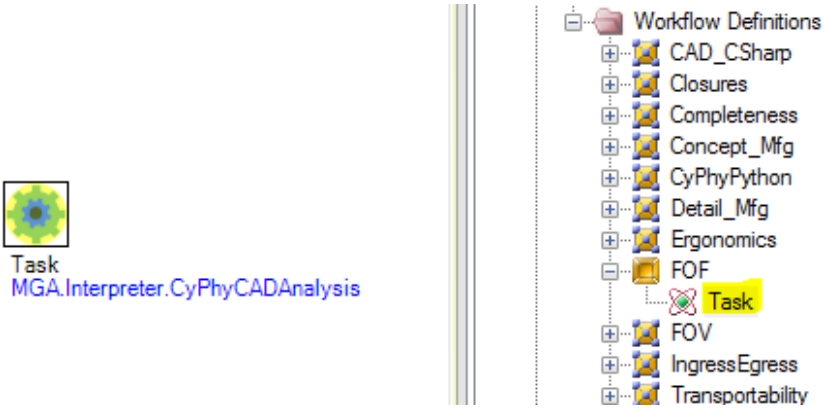


Figure 4: Add a task to the FOF Workflow

Double click the newly created task and select "field_of_fire" as the analysis tool. Set the Workflow Parameters as shown in Figure 5.

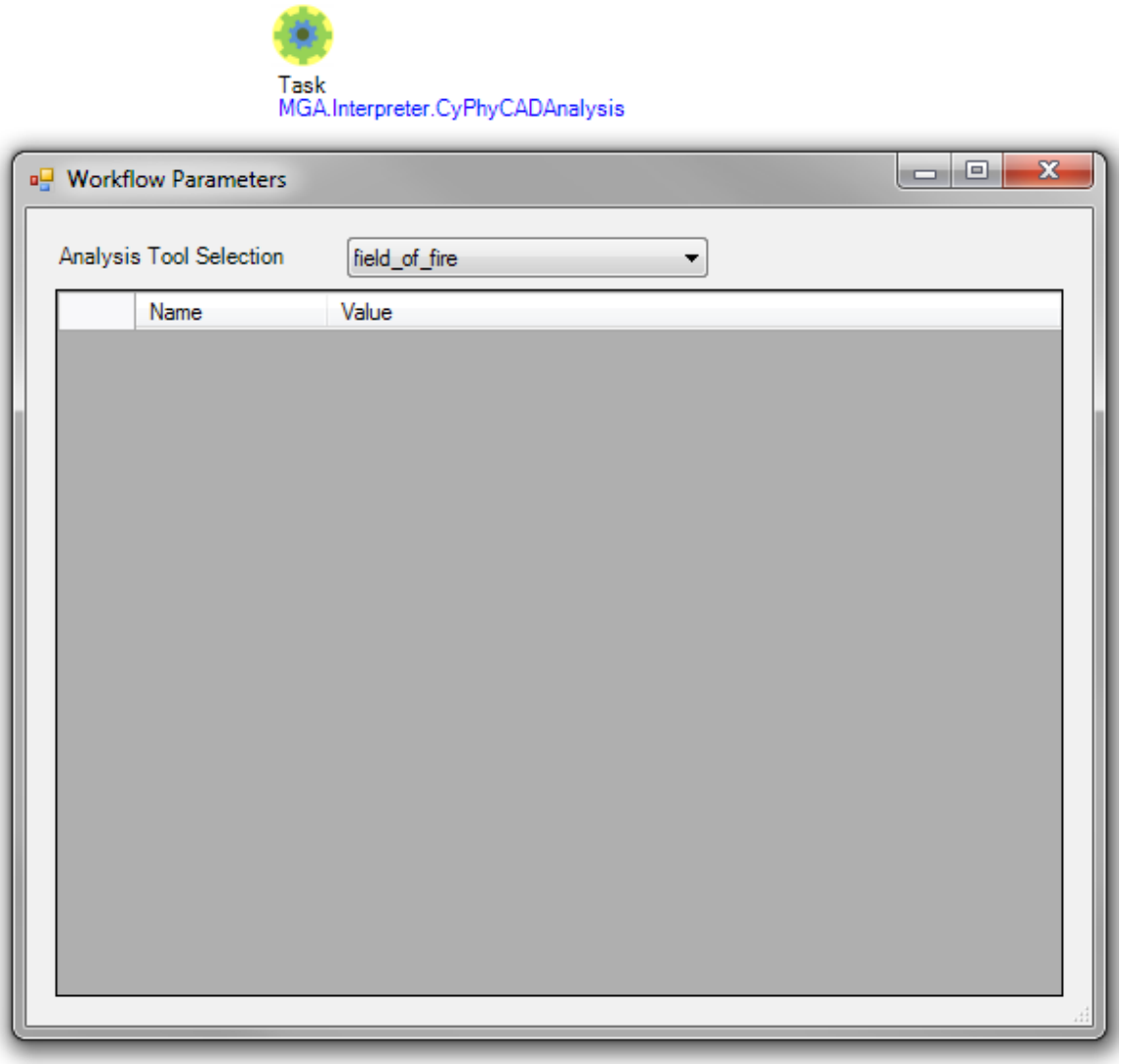


Figure 5: Setting Workflow parameters for the new Task

Open the "Field of Fire" test bench drag and drop the "FOF" workflow definition and 3 metrics. From the Part Browser, drag in 3 metric blocks and name them in accordance to Figure 6.

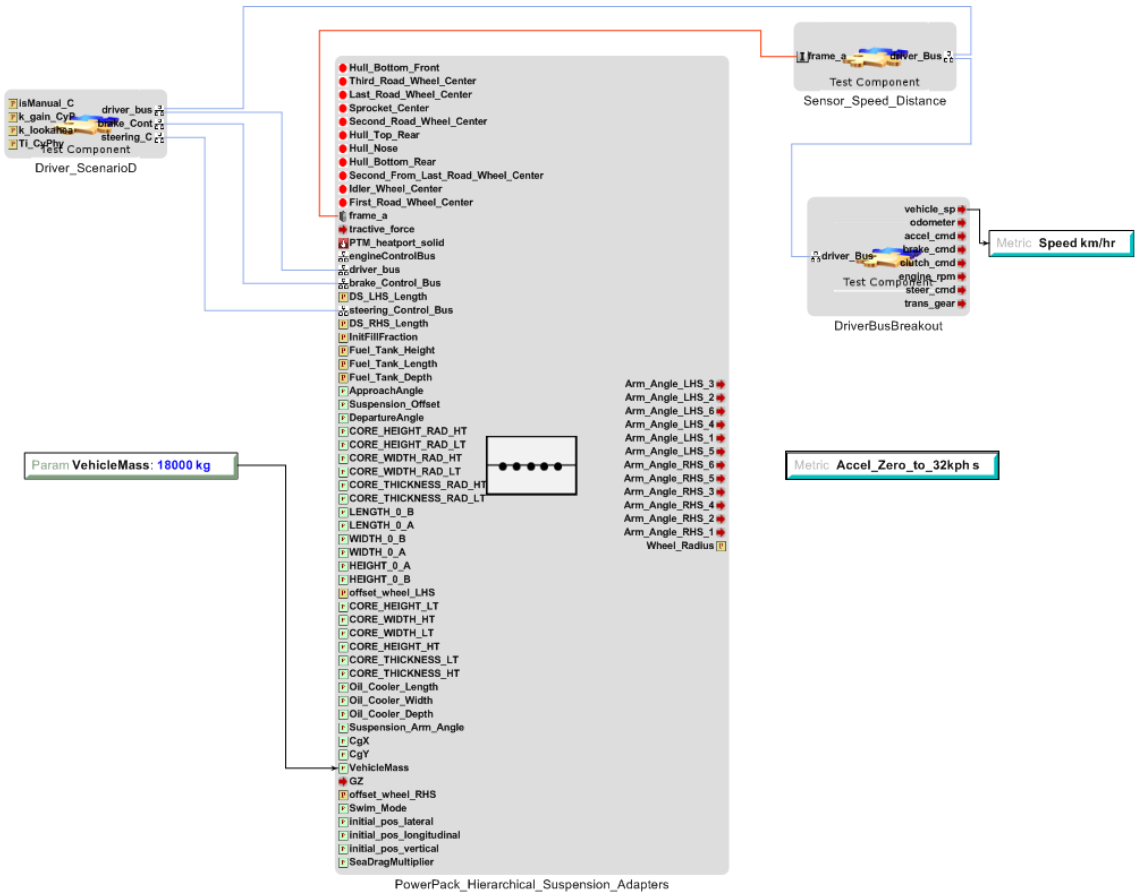


Figure 6: Field of Fire Test Bench

To exercise the test bench, run the Master Interpreter. For the Field of Fire test bench, there is no need to check the box for any of the STEP file formats. However, the "Use Project Manifest" box must be checked.

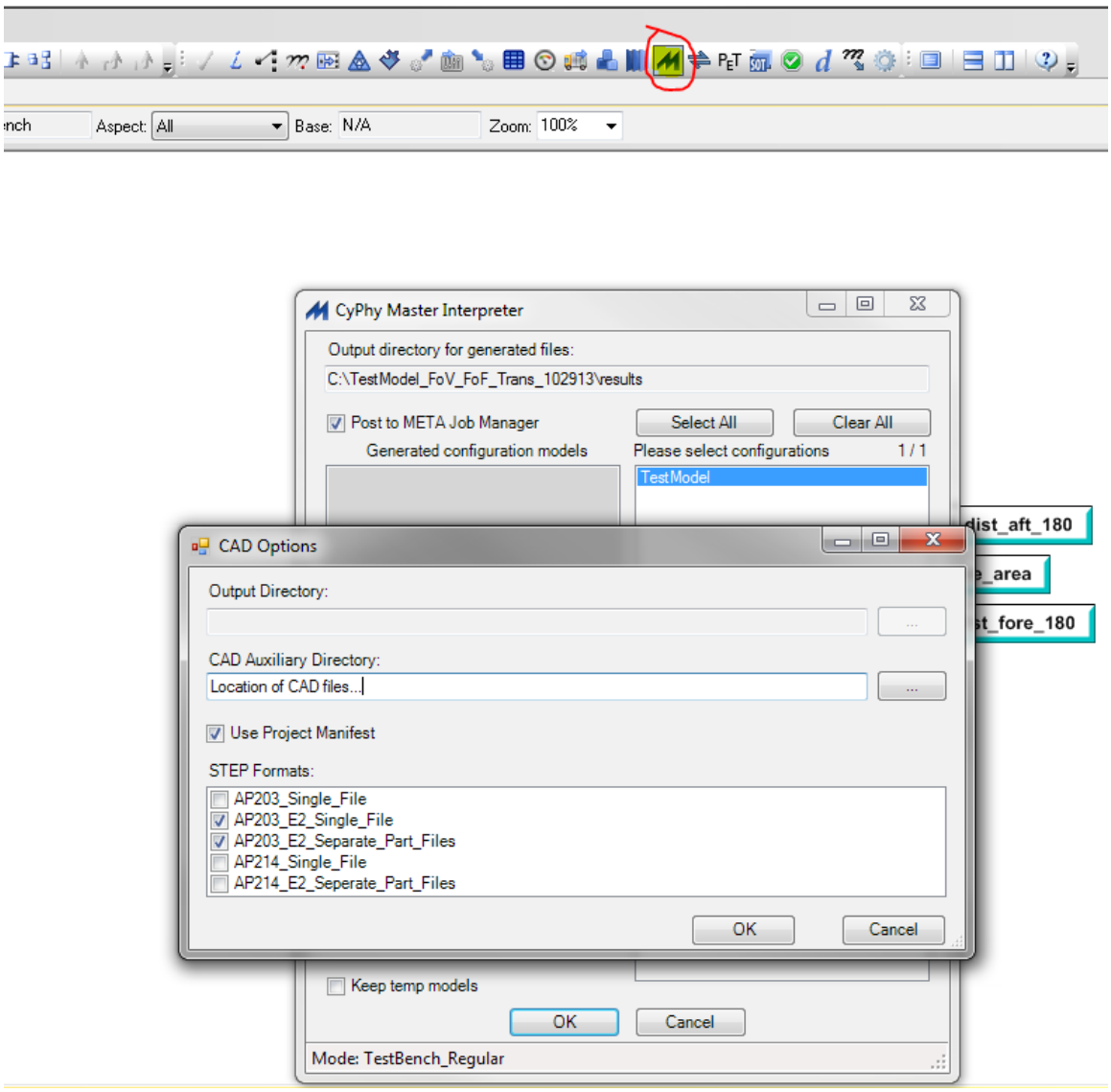


Figure 07: Running the Field of Fire test bench

The test bench will create a results folder and then run. To access the results folder right click the job in Job Manager and choose "Show in explorer".

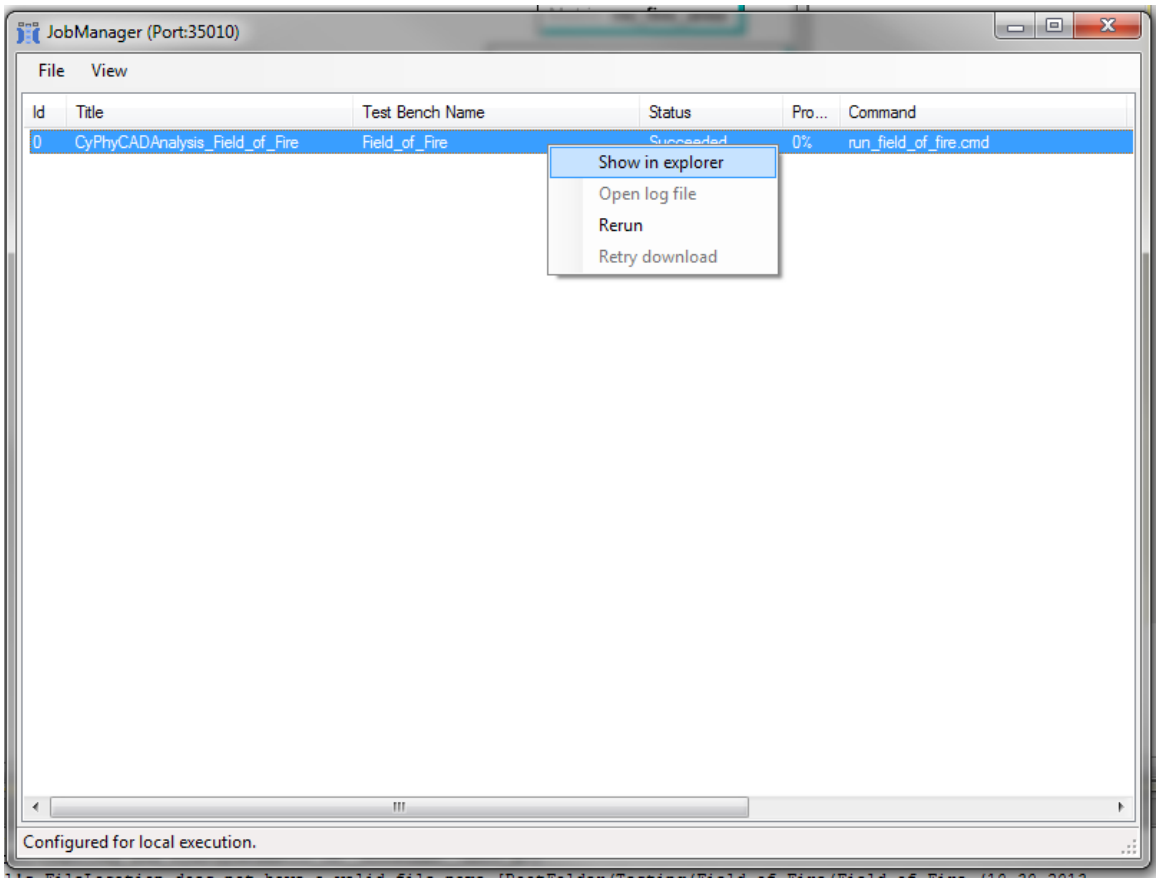


Figure 8: Accessing the test bench result folder

7.0 Description

Field of Fire analyzes the design and finds the minimum distance for safe operation of the main weapon in both the front and aft arcs. The Field of Fire also calculates the area around the vehicle within which the main weapon cannot be used.

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 FOF Tool as a post-processing step.

Results are returned in two text files. “testbench_manifest.json” is a summary of the test bench status and results. “output.json” is just the results that the test bench calculated. An image file, “field_of_fire_pic.png”, is also generated.

7.1 Metrics

Type	TB #	Metrics	Description
Minimum Fire Distance	42	Field_of_Fire_Depression_Forward	In the fore 180 degrees, the shortest distance from the vehicle that the weapon can fire in meters
	43	Field_of_Fire_Depression_Aft	In the aft 180 degrees, the shortest distance from the vehicle that the weapon can fire in meters
No fire area	44	Field_of_Fire_Traverse	The area around the vehicle with in which the main weapon cannot fire in meters squared

Table 1: FoF Metrics by vehicle role

7.2 Required Connection to System Under Test

NONE

7.3 Outputs

7.3.1 Text & 2D

The output of the test bench is in two files: "testbench_manifest.json" and "output.json". The metric names in testbench_manifest.json correspond to the official names used for scoring. In both files the minimum fire distance metrics are measured in meters (m), and the "no_fire_area" is measured in meters squared (m2). The image file "field_of_fire_pic.png" is also generated.

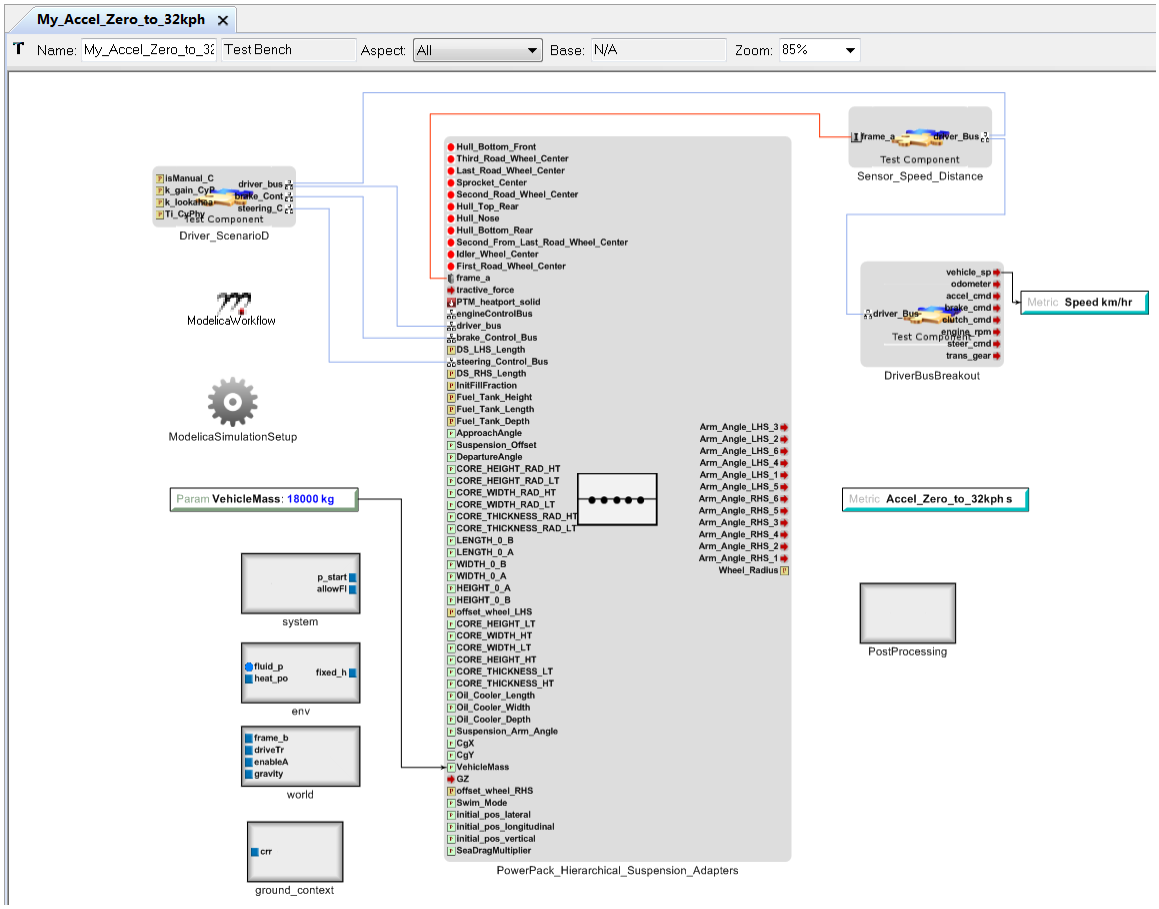


Figure 9: Summary Results sample


```
{
    "min_fire_dist_fore_180": 63.049630899393144,
    "no_fire_area": 1765.5812915920467,
    "min_fire_dist_aft_180": 29.171991584419292
}
```


Figure 10: Field of Fire output.json

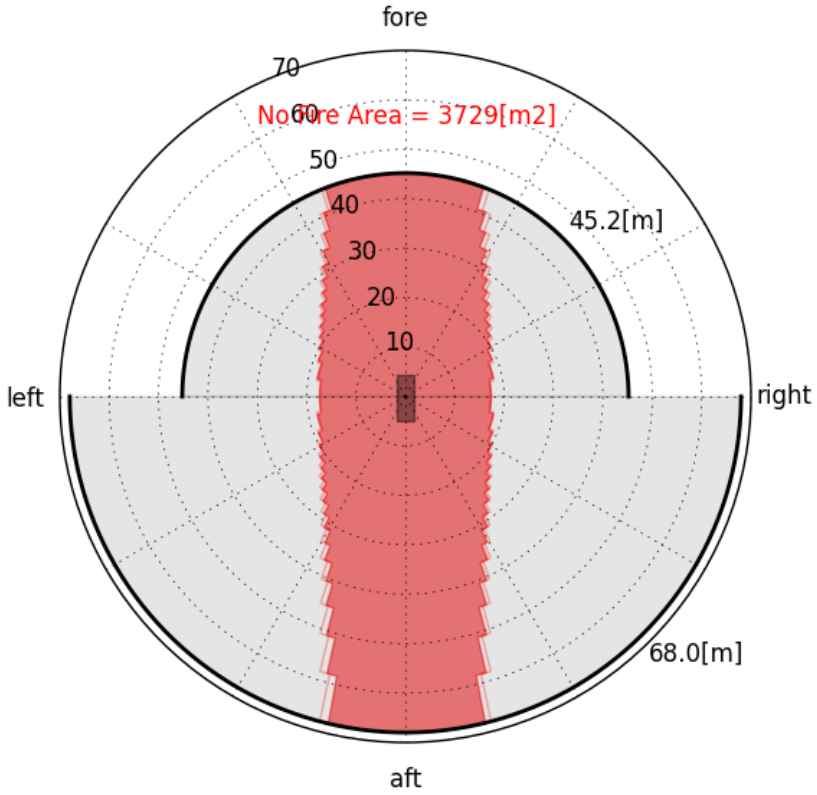


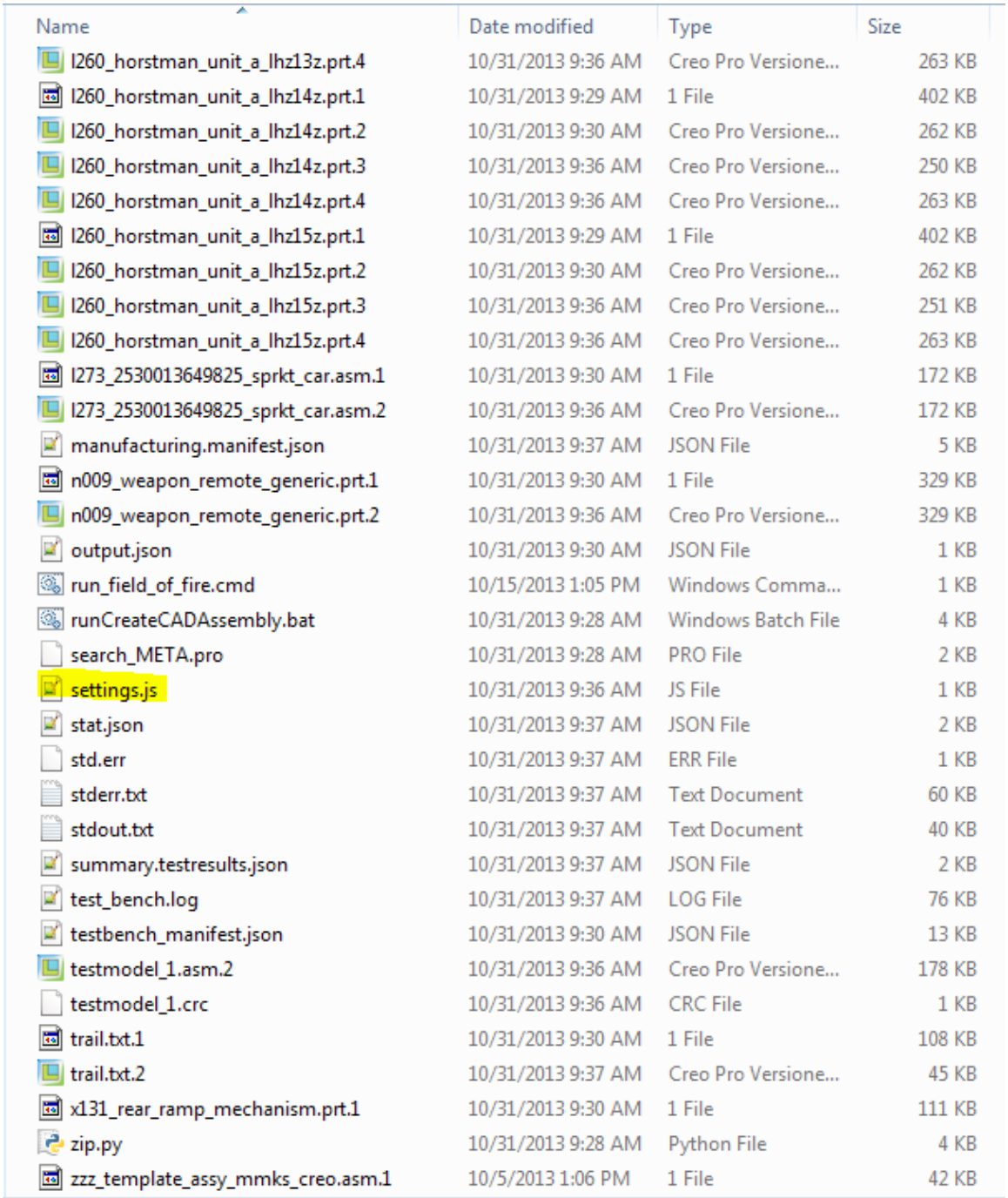
Figure 11: field_of_fire_pic.png sample

In the image above, the vehicle is shown as a small grey rectangle near the center, and the red region represents the no fire area. Forward and aft arcs representing the max no-fire distance (also known as the minimum uninterrupted firing distance) are represented as light grey regions bounded by solid black lines.

7.3.2 Visualization

A 3D visual representation of the Field of Fire is also available. First, Mayavi needs to be installed to run with your python distribution. Mayavi can be found at http://docs.enthought.com/mayavi/mayavi/installation.html

Second, “show_3d” in the “settings.js” file needs to be changed to “true”. The “settings.js” file can be found in the results folder created when the test bench was run (see Figure 8).



Name	Date modified	Type	Size
l260_horstman_unit_a_lhz13z.prt.4	10/31/2013 9:36 AM	Creo Pro Versione...	263 KB
l260_horstman_unit_a_lhz14z.prt.1	10/31/2013 9:29 AM	1 File	402 KB
l260_horstman_unit_a_lhz14z.prt.2	10/31/2013 9:30 AM	Creo Pro Versione...	262 KB
l260_horstman_unit_a_lhz14z.prt.3	10/31/2013 9:36 AM	Creo Pro Versione...	250 KB
l260_horstman_unit_a_lhz14z.prt.4	10/31/2013 9:36 AM	Creo Pro Versione...	263 KB
l260_horstman_unit_a_lhz15z.prt.1	10/31/2013 9:29 AM	1 File	402 KB
l260_horstman_unit_a_lhz15z.prt.2	10/31/2013 9:30 AM	Creo Pro Versione...	262 KB
l260_horstman_unit_a_lhz15z.prt.3	10/31/2013 9:36 AM	Creo Pro Versione...	251 KB
l260_horstman_unit_a_lhz15z.prt.4	10/31/2013 9:36 AM	Creo Pro Versione...	263 KB
l273_2530013649825_sprkt_car.asm.1	10/31/2013 9:30 AM	1 File	172 KB
l273_2530013649825_sprkt_car.asm.2	10/31/2013 9:36 AM	Creo Pro Versione...	172 KB
manufacturing.manifest.json	10/31/2013 9:37 AM	JSON File	5 KB
n009_weapon_remote_generic.prt.1	10/31/2013 9:30 AM	1 File	329 KB
n009_weapon_remote_generic.prt.2	10/31/2013 9:36 AM	Creo Pro Versione...	329 KB
output.json	10/31/2013 9:30 AM	JSON File	1 KB
run_field_of_fire.cmd	10/15/2013 1:05 PM	Windows Comma...	1 KB
runCreateCADAssembly.bat	10/31/2013 9:28 AM	Windows Batch File	4 KB
search_META.pro	10/31/2013 9:28 AM	PRO File	2 KB
settings.js	10/31/2013 9:36 AM	JS File	1 KB
stat.json	10/31/2013 9:37 AM	JSON File	2 KB
std.err	10/31/2013 9:37 AM	ERR File	1 KB
stderr.txt	10/31/2013 9:37 AM	Text Document	60 KB
stdout.txt	10/31/2013 9:37 AM	Text Document	40 KB
summary.testresults.json	10/31/2013 9:37 AM	JSON File	2 KB
test_bench.log	10/31/2013 9:37 AM	LOG File	76 KB
testbench_manifest.json	10/31/2013 9:30 AM	JSON File	13 KB
testmodel_1.asm.2	10/31/2013 9:36 AM	Creo Pro Versione...	178 KB
testmodel_1.crc	10/31/2013 9:36 AM	CRC File	1 KB
trail.txt.1	10/31/2013 9:30 AM	1 File	108 KB
trail.txt.2	10/31/2013 9:37 AM	Creo Pro Versione...	45 KB
x131_rear_ramp_mechanism.prt.1	10/31/2013 9:30 AM	1 File	111 KB
zip.py	10/31/2013 9:28 AM	Python File	4 KB
zzz_template_assy_mmks_creo.asm.1	10/5/2013 1:06 PM	1 File	42 KB

Figure 12: Location of "settings.js" in the results folder

```
{
    "metrics_file" : "CADAssembly_metrics.xml",
    "path_to_instance_xmls" : "ComponentACMs",
    "path_to_instance_stls" : "STL_BINARY",
    "instance_file": "component_index.json",
    "output_json_file" : "output.json",
    "show_3d" : true
}
```

Figure 13: Change "show_3d" to "true"

After editing the "settings.js" file, re-run the FOF Test Bench from the Job Manager.

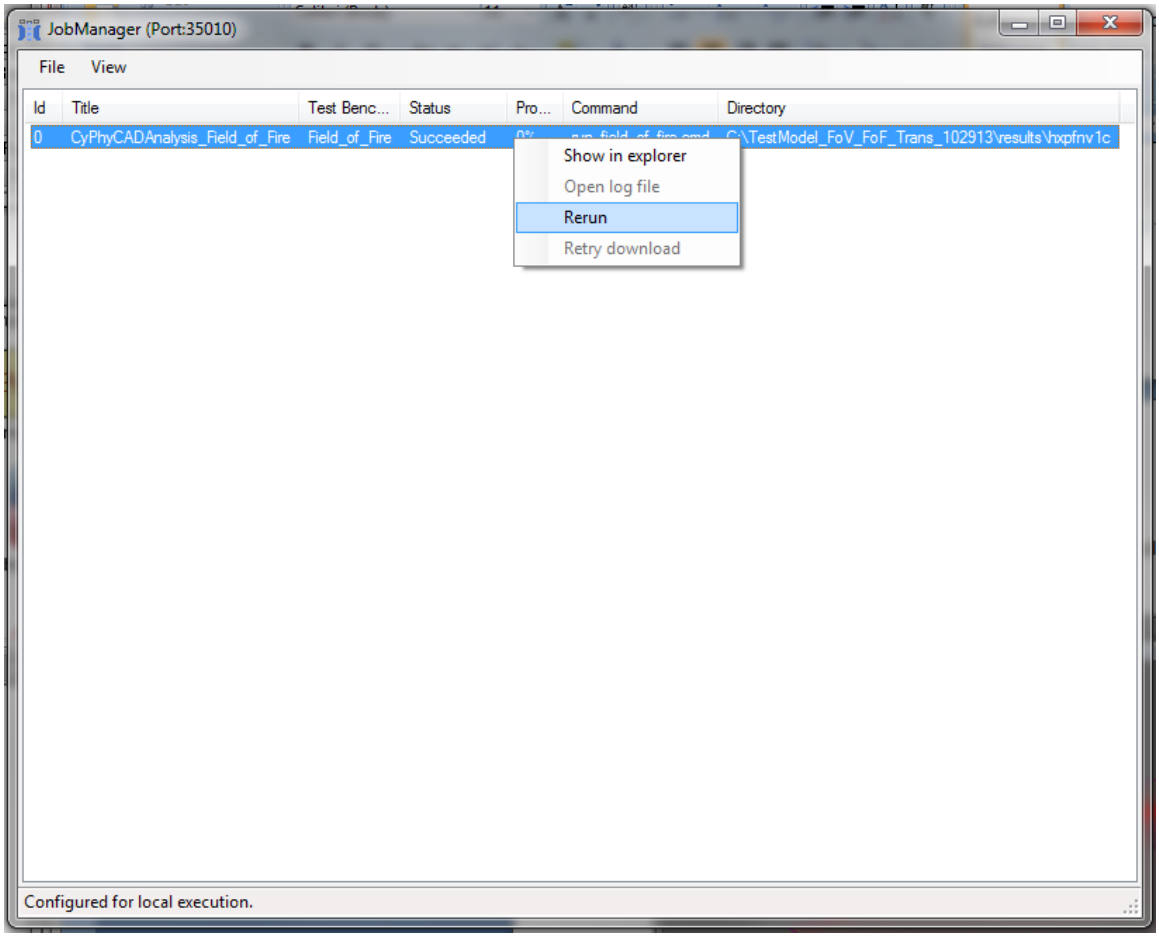


Figure 14: Re-running the FOF Test Bench

When the FOF Test Bench has completed successfully, a new window will be show with a 3D visualization of the design and the Field of Fire.

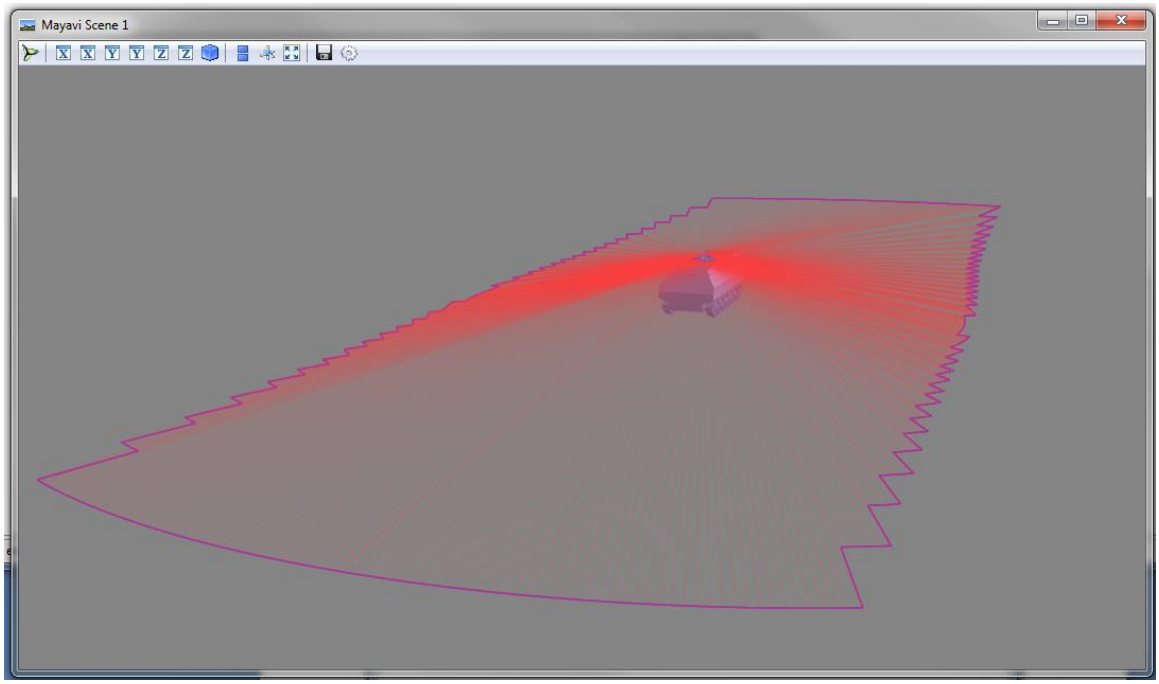


Figure 15: FOF Test Bench Visualization sample