ADVANCED VISUALIZATION AND TECHNIQUES IN ENSIGHT

IDAJ User Group Meeting

November 12, 2013

OUTLINE

- What is Ensight?
  - The Ensight Family
  - Some Ensight Strengths
- Examples of EnSight Usage
  - Automotive Examples of Post Processing with EnSight
  - In-Cylinder Example of Post Processing with EnSight
- Using Python + EnSight for enhanced capability

WHAT IS ENSIGHT?

THE ENSIGHT FAMILY

- From 2013 IDAJ Distributor

Desktop

Starter package

•Has all basic features

•Recommended for: ***low budget***

ACADEMIC

Free version

Standard (Pro)

General purpose

•Has full set of features, except for special cases

•Recommended for: ***most users***

ACADEMIC

Gold (HPC)

SMP & DMP

•More CPU threads (up to 128)

•The main feature is Distributed Memory Parallel. Useful for data with ~100 million cells or more.

DR (VR?)

VR & Distributed Rendering

•Virtual reality – very popular in China

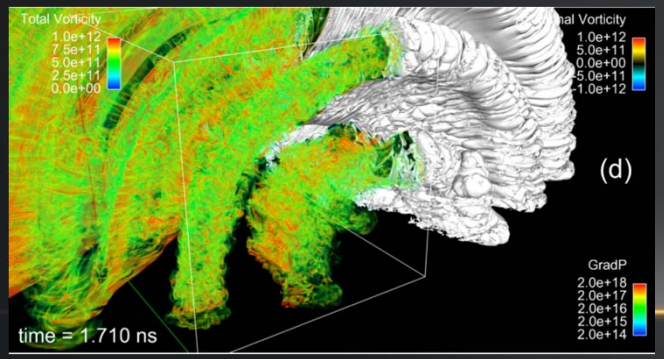
•DMP for graphics – quite rare and only for the largest data.

SOME ENSIGHT STHENGTHS

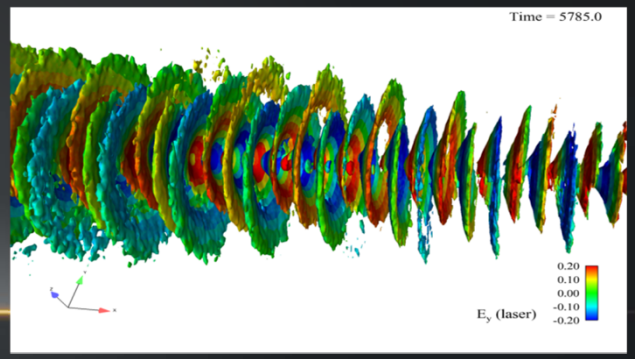
- Large Data
- Remote Client-Server Mode
- Multiphysics
- Beautiful Images

LARGE DATA

- EnSight comes from the supercomputing industry – designed to handle the largest data
- Over the past ~10 years contract development for Los Alamos National Laboratory has enhanced large data handling even more.
- Data sizes up to 2 billion cells – will be increased to 20 billion in the near future
- Only load what needs to be loaded



Nearly 1 billion cells

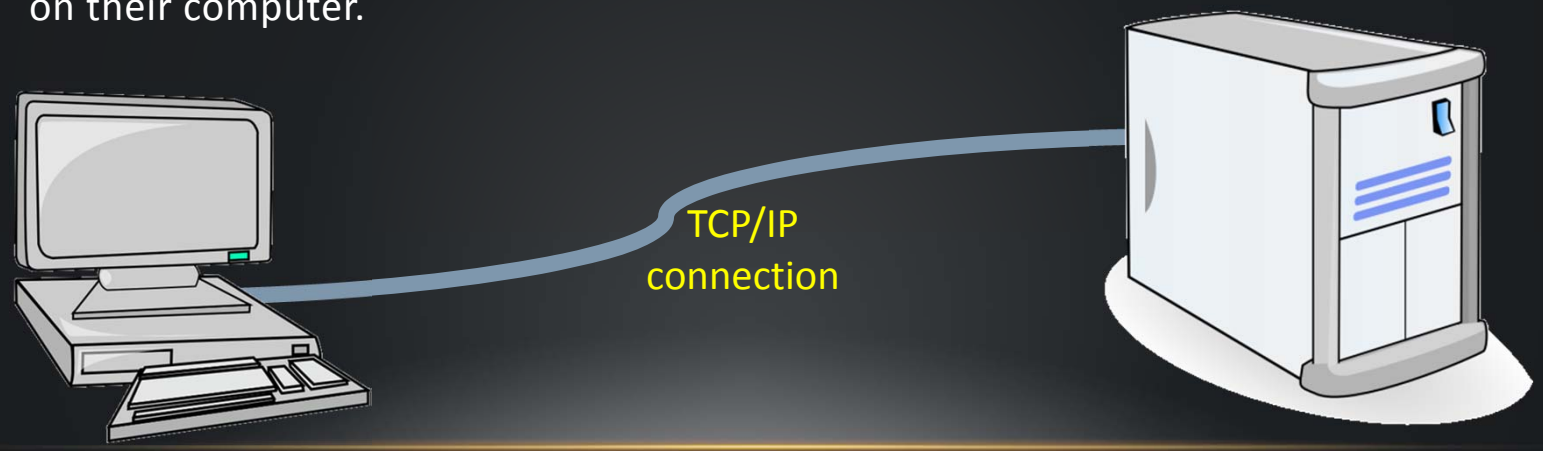


1 trillion particles

…Analyze, Visualize, Communicate…

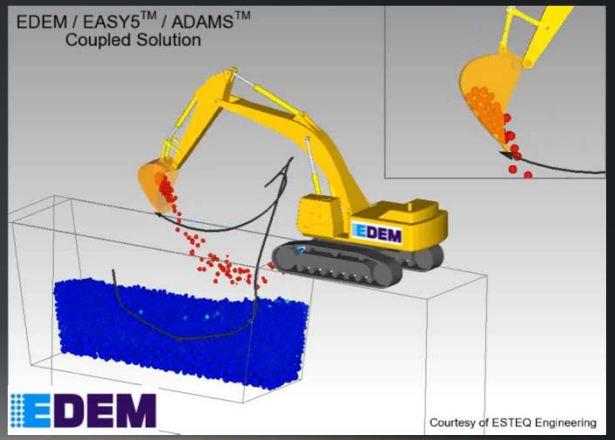
REMOTE CLIENT-SERVER MODE

- EnSight has always been a client-server application
- The server can be run on a remote computer and connect over TCP/IP
- This means the remote data can be loaded by the server, and the user runs EnSight on their computer.



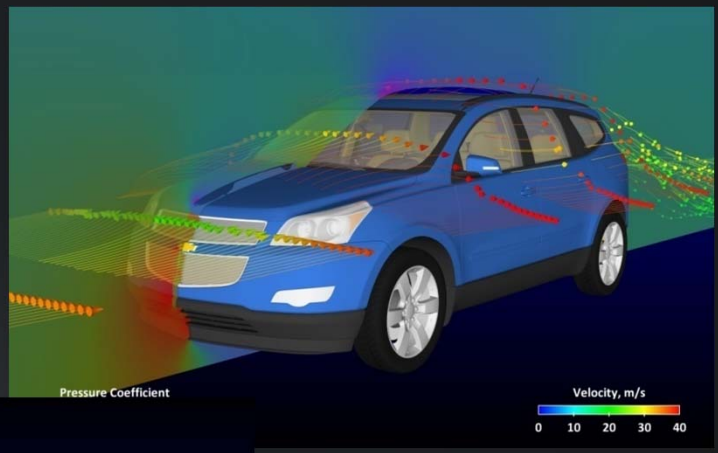
MULTIPHYSICS

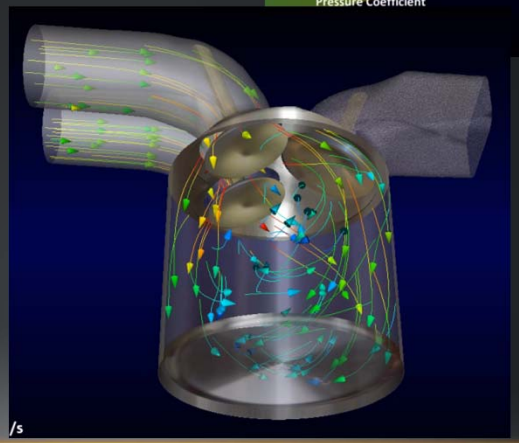
- Load up to 32 datasets (cases) at the same time
- Have complete control of the view for all cases
- Load any combination of data. CFD, FEA, DEM, EMAG, MBD, measured, CAD
- Great for MpCCI customers



BEAUTIFUL IMAGES

- Full control of the view
- Large resolution images for posters, etc.
- Many output format and quality options
- Image backgrounds and logos
- Texture map 3D objects
- Volume rendering
- Smooth shading, Antialiasing

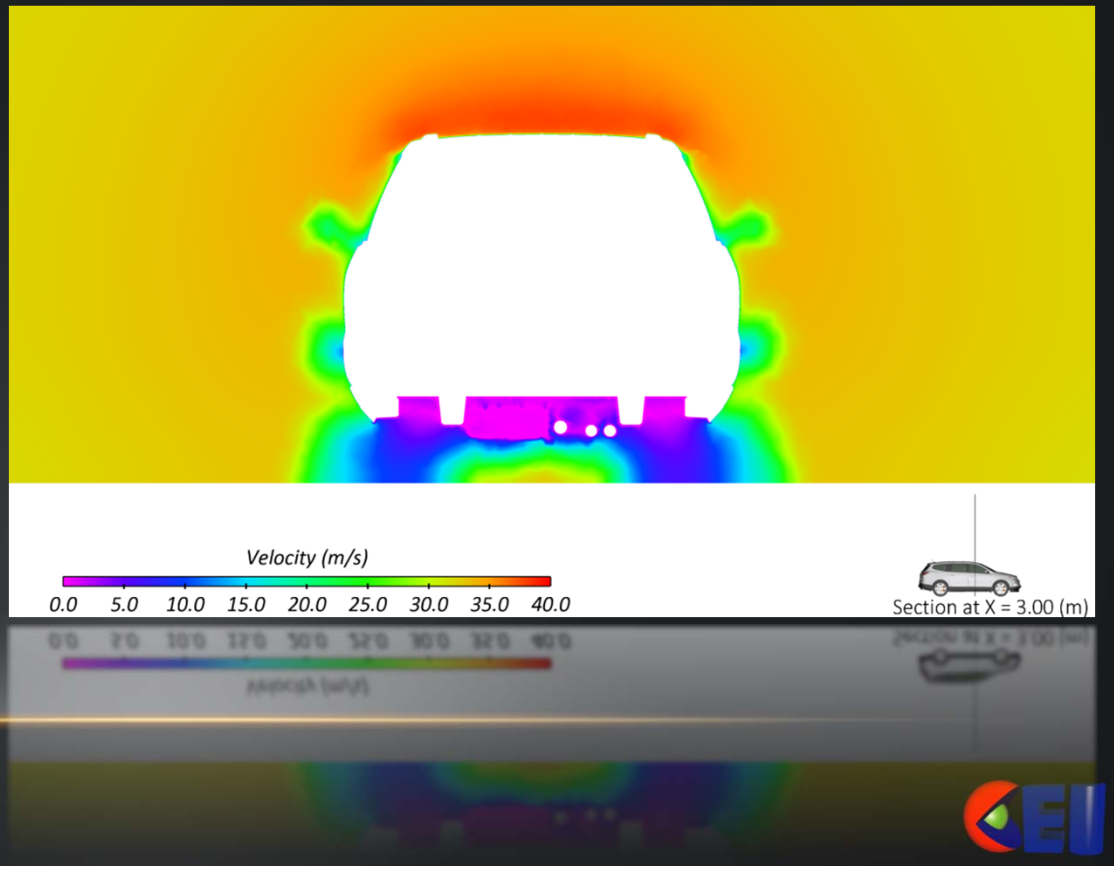




AUTOMOTIVE POST PROCESSING

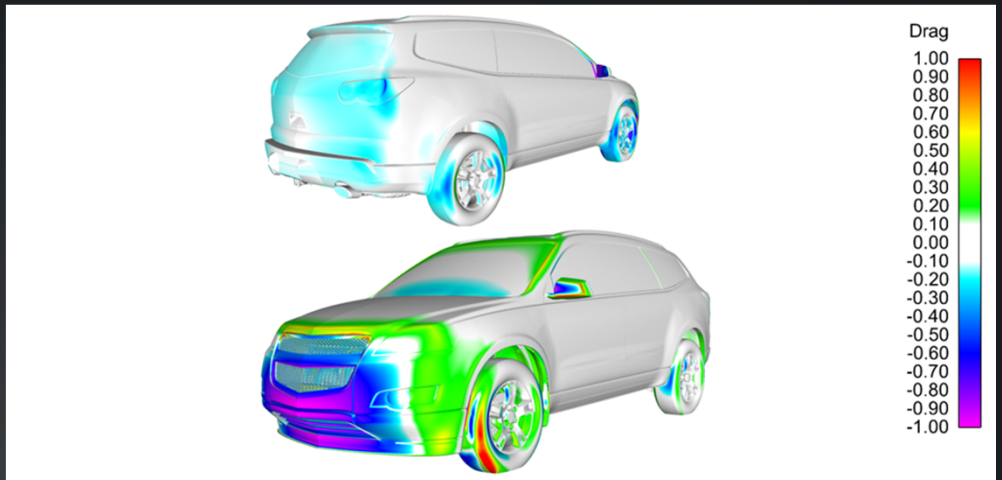
MULTI-VIEWPORT, ICON VIEW

- Additional Viewport with Icon view
- Automatic section label
- Line clip Illustrating location of clip



ISOLATION OF DRAG OR LIFT CONTOURS

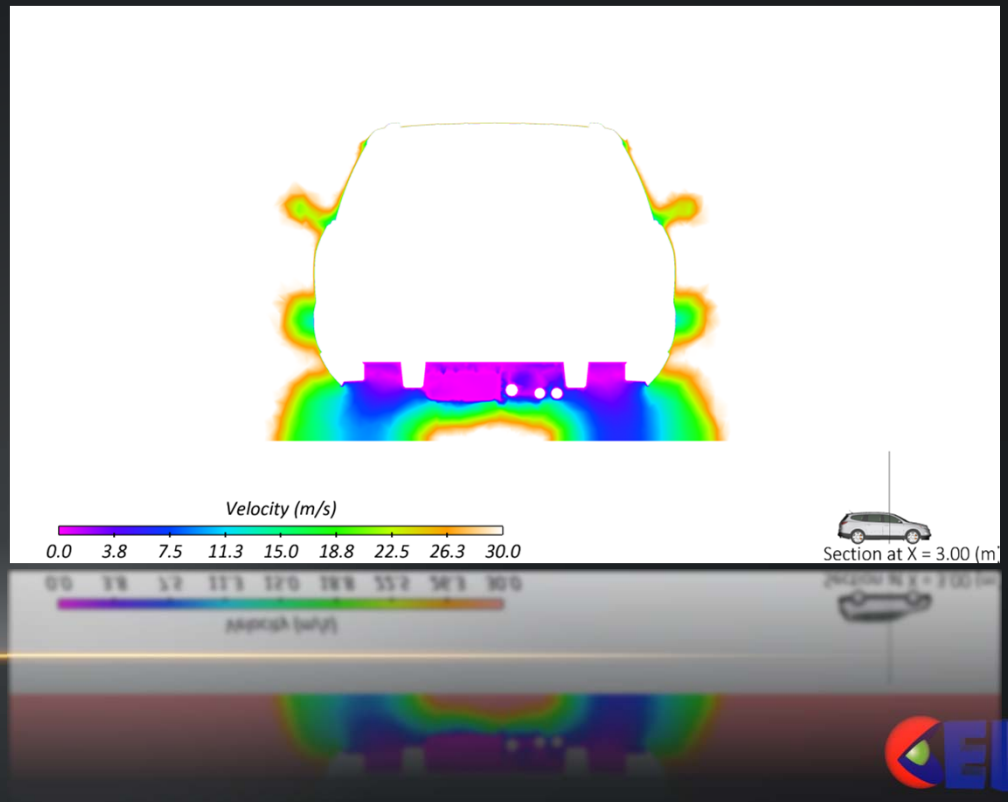
- Filled plots of drag or thrust generating surfaces
- Pressure and Surface Normal combined together and restricted along an axis direction
- Grey middle scale washes out un-interesting values.
- Cold colors == > Drag. Warm == > Thrust. (Taking into account of surface direction)



Drag Contour
Colder colors indicate drag producing areas
Warmer colors indicate thurst producing areas

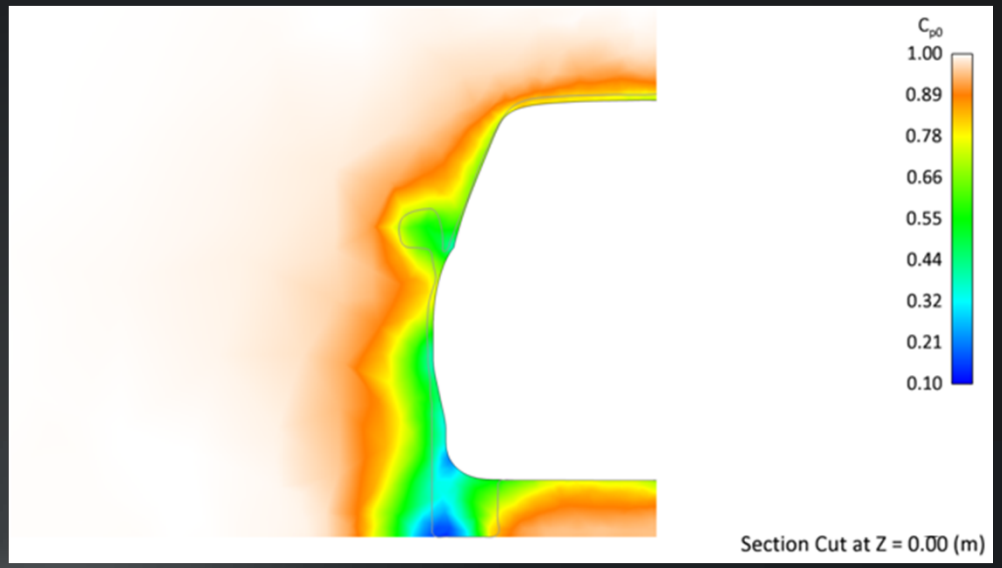
REMOVAL OF SUPERFLUOUS VALUES

- Common situation :
  - lots of one color
  - uninteresting values
- Utilize either color palette options or limit fringes to eliminate values from the plot.
- Example: adjust range, turn value to white



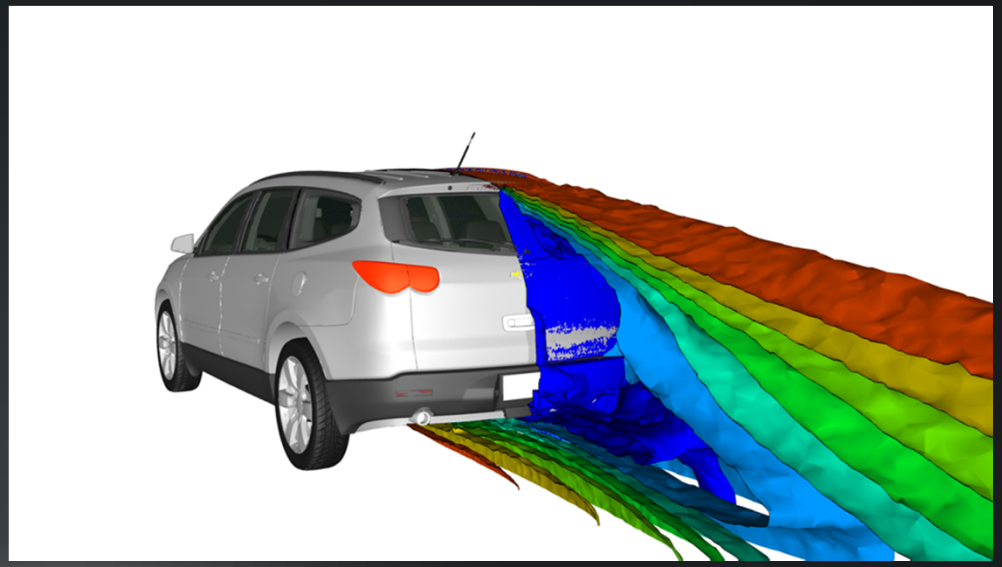
OUTLINE REFERENCE

- Utilization of **Splines** in EnSight to represent the maximum cross-section, or some geometric feature
- Set spline at location in foreground, with perspective off.



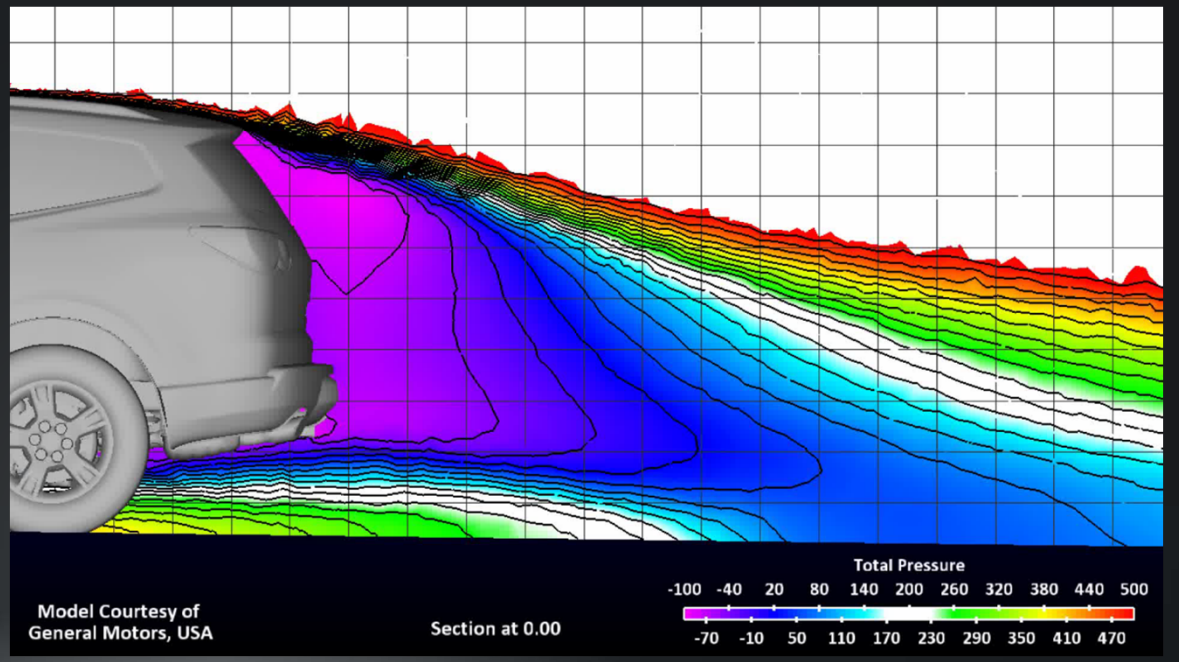
MULTIPLE ISOSURFACES

- Create multiple IsoSurfaces with a single command in EnSight.
- Use of Auxiliary clip to cut way the clip.
- Create black outlines to further mark the isosurface
- Can use either visual or geometric smoothing.



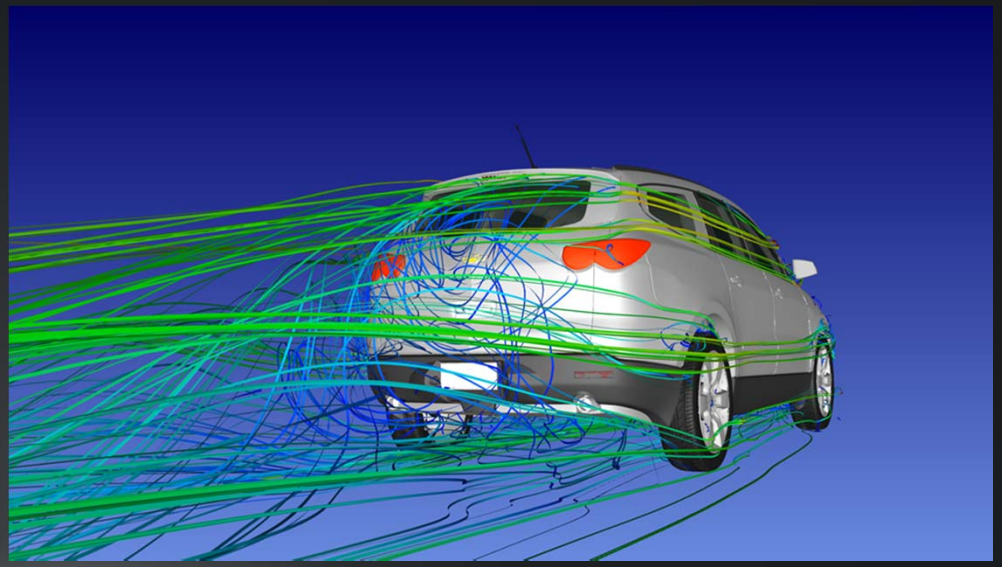
REFERENCE LINES

- Utilize Contours of Coordinates to generate a reference grid on the plot to easily add spatial reference.
- Utilization of contours of the variables to denote gradients better.



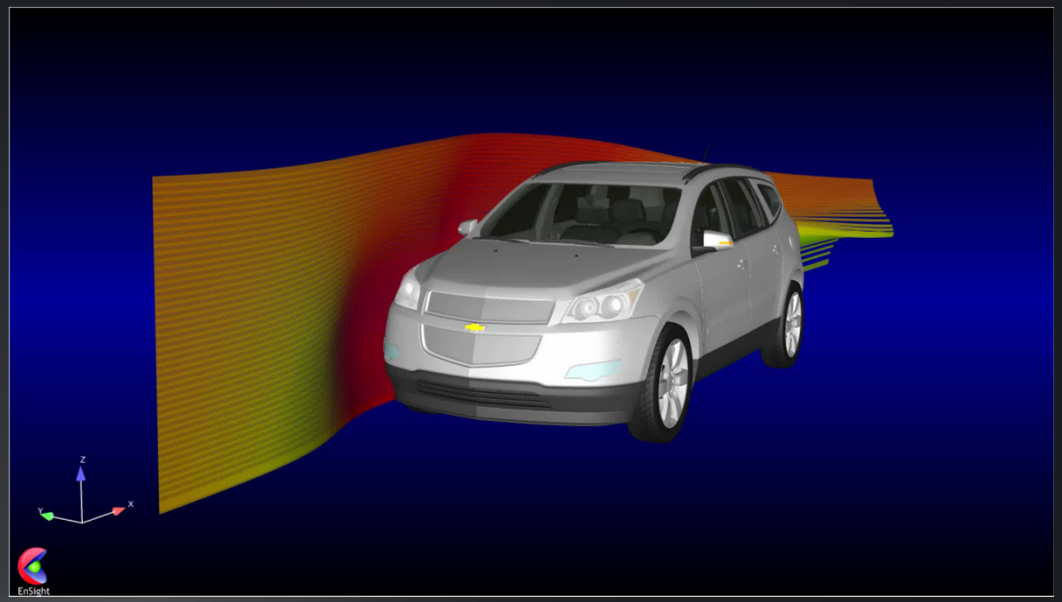
VORTEX CORES

- Utilize vortex core calculation in EnSight to indicate the possible location of Vortices.
- Use this part to seed streamlines from, to get a better indication of the flow in/around the vortices.



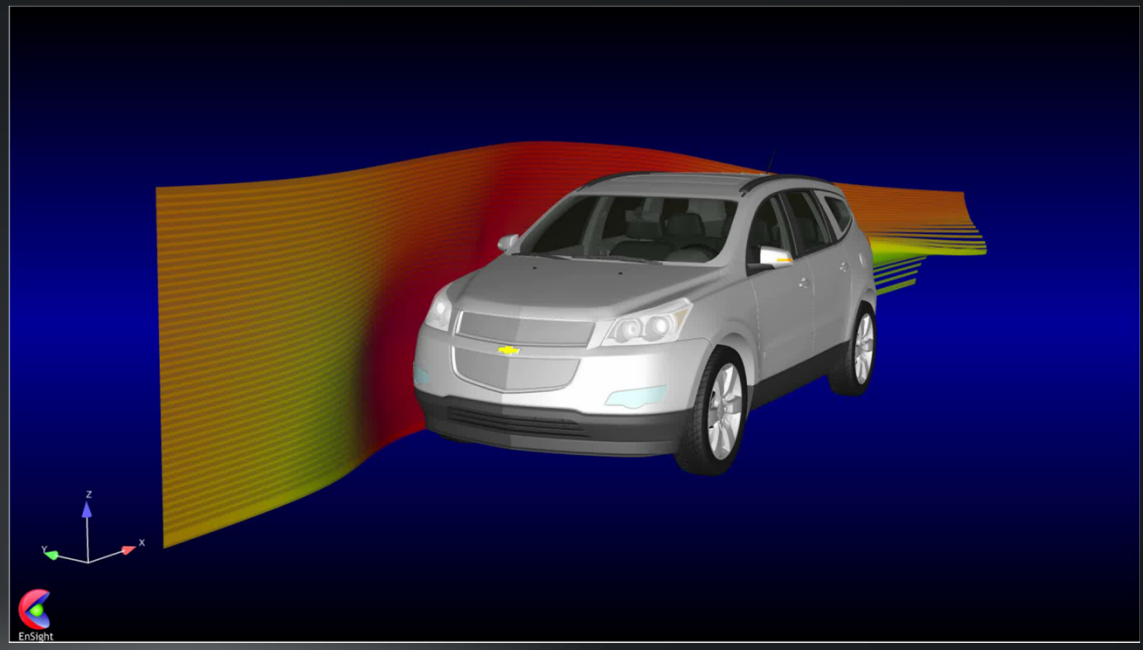
MOVING STREAMLINES

- Create a **Clip Line** from which to seed streamlines from.
- Utilize interactive capability of the Clip Line to move the seed location around the model.



KEYFRAME ANIMATION

- Utilize **Keyframe Animation** to take user around the model.
- Point of View Animations
- Can be combined with transient play, interactive isosurfaces or clips.



Two Examples of the power of EnSight for In-Cylinder Post Processing

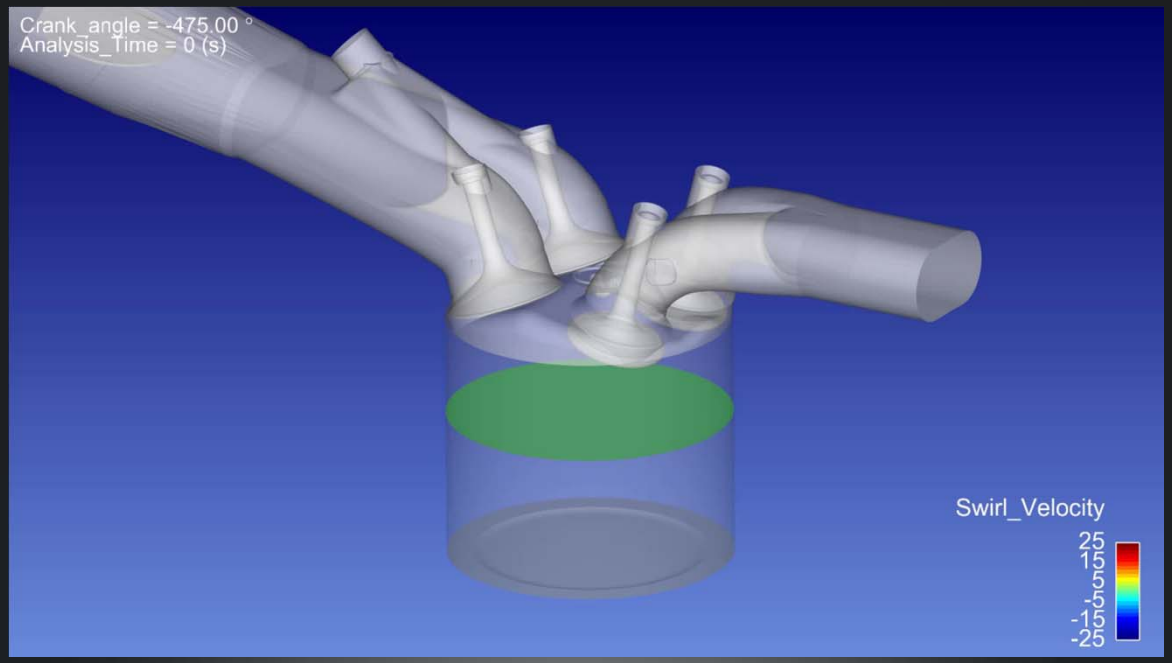
IN-CYLINDER

MOVING CLIP EXAMPLES

- Unique example particularly useful with Moving Geometry in CFD models (common to In-Cylinder models)
  - Tie a Clip to be a fixed location from a moving part.
  - Maintain distance as half way in the combustion volume at each timestep.
  - Track a particular part, making the clip a particular offset distance.

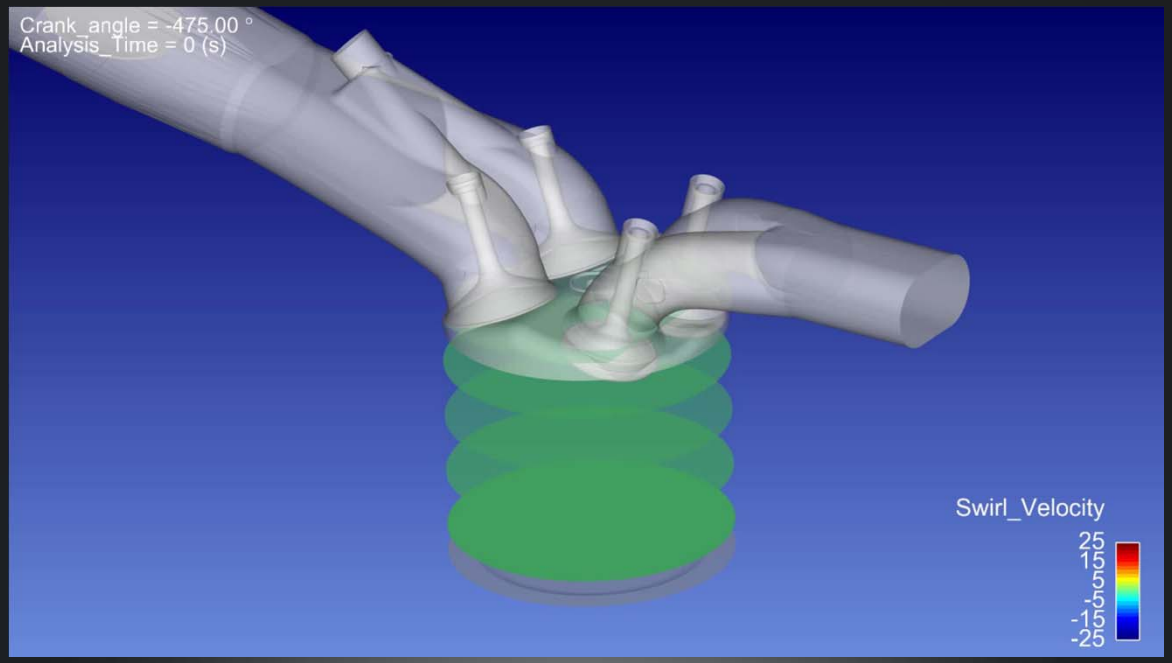
MOVING CLIP EXAMPLE

Clip remains half way from piston and Combustion Dome



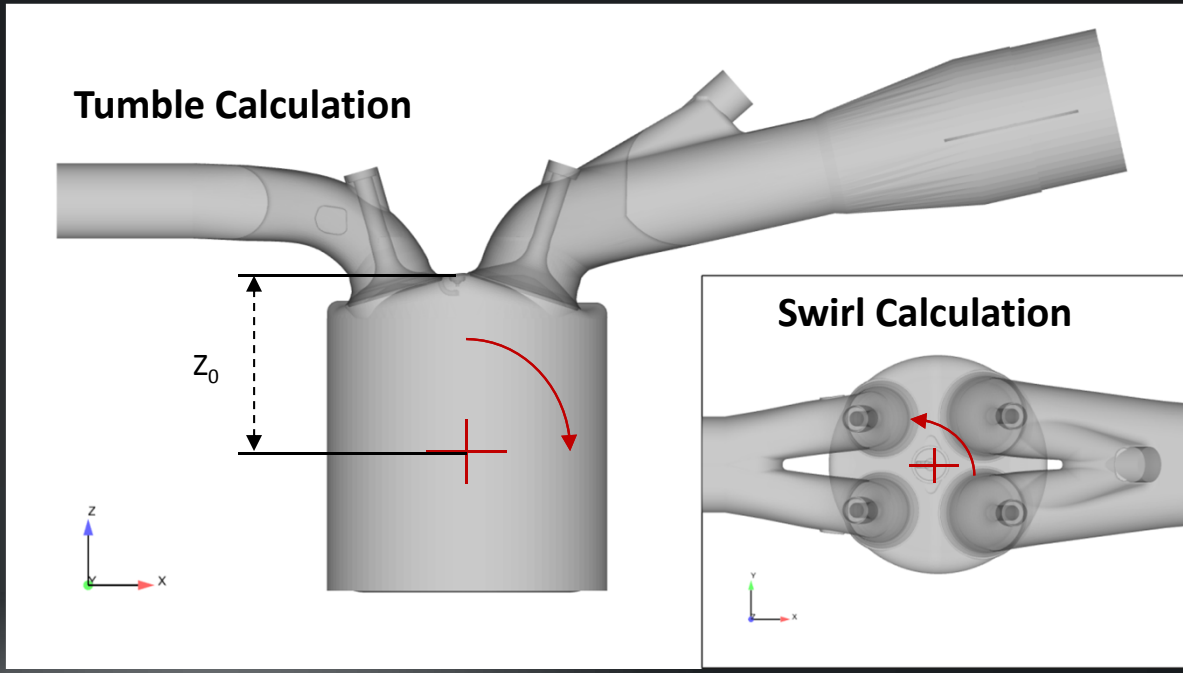
MOVING CLIP EXAMPLE

Multiple Clips, at fixed intervals, which move relative to piston



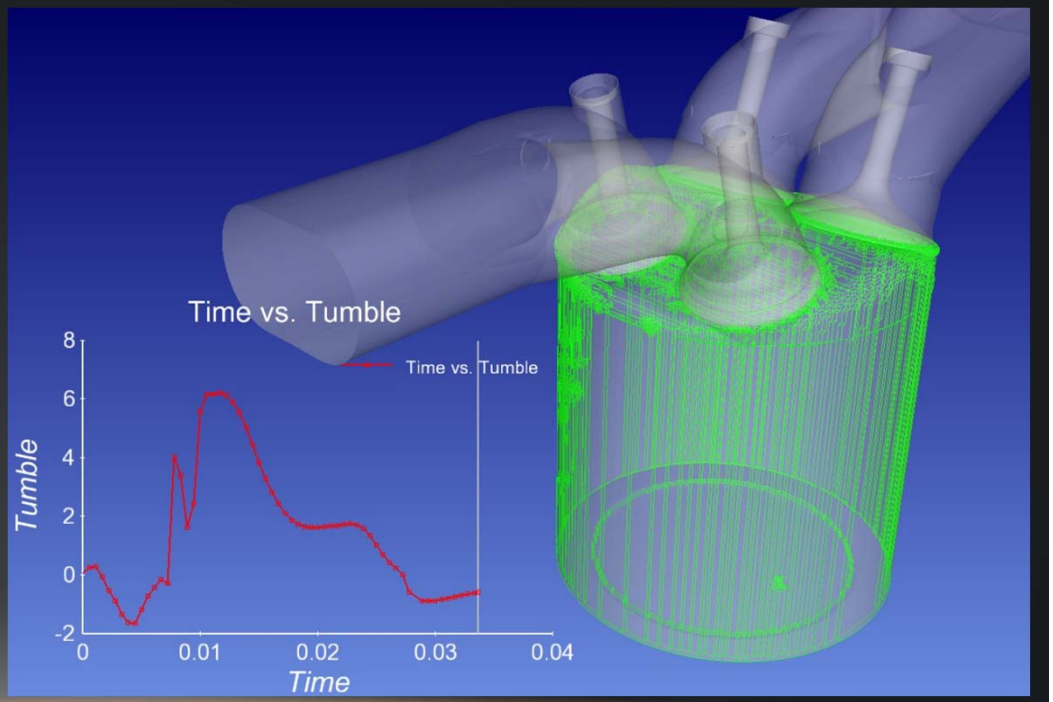
QUANTIFICATION OF TUMBLE AND SWIRL

- Use EnSight's Calculator to derive the Tumble and Swirl within a Cylinder.
- Tumble Center dynamically moves as the cylinder volume changes.
- Swirl more directly calculated about the vertical axis



TUMBLE AND SWIRL

- Here, the raw query of tumble vs. time is shown.
- Note here that the green wireframe surface corresponds to the cylinder region of the model, which is used as the parent for the calculation of both the Swirl and Tumble.



How Python-based tools/techniques can benefit users

PYTHON

WHY PYTHON?

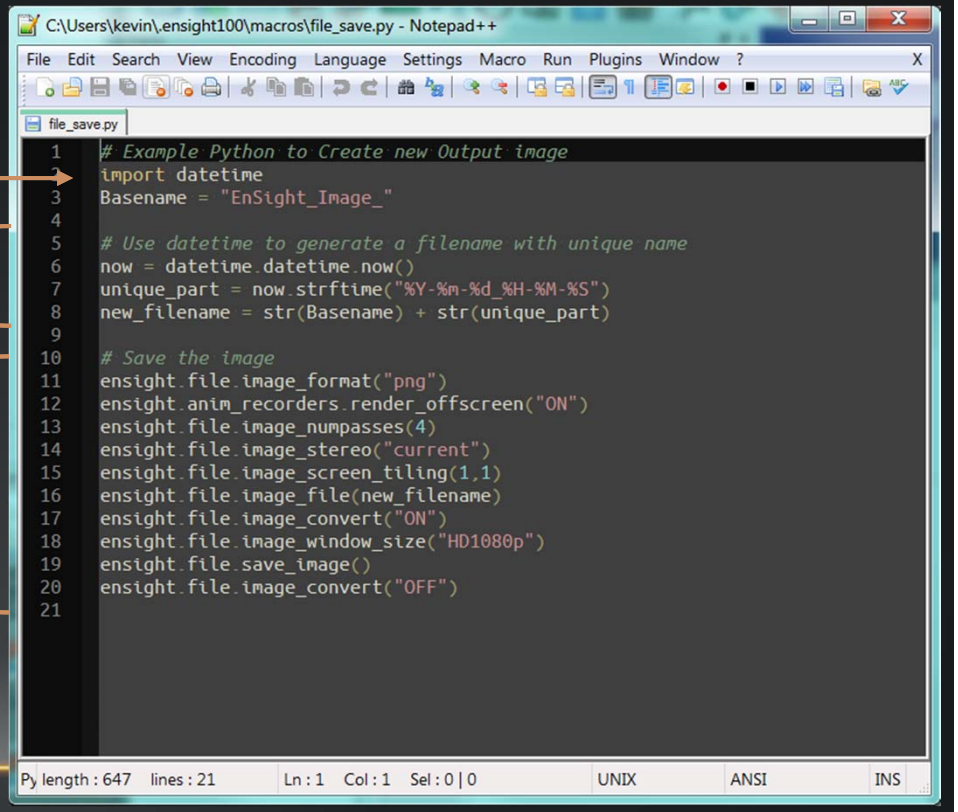
- Python based tools/scripts help user via:
  - Completing complex multi-step tasks as one large macro
  - Programming constructs make routines more capable/generic
  - Integration of capability not available in the normal GUI
  - Batch/Scripting to perform large operations automatically.

EXAMPLE 1 : AUTOMATICALLY SAVE IMAGE

- User Requirement:
  - Save Image, with certain attributes:
    - default print colors, 1920x1080, PNG format
    - automatically choose filename, single keystroke
  - Can all be done manually, but requires:
    - Up to 9 clicks to get to File -- > Export -- > Image, Set the format, size, default print colors, filename
    - User must type in filename each time.

EXAMPLE 1 : AUTOMATICALLY SAVE IMAGE

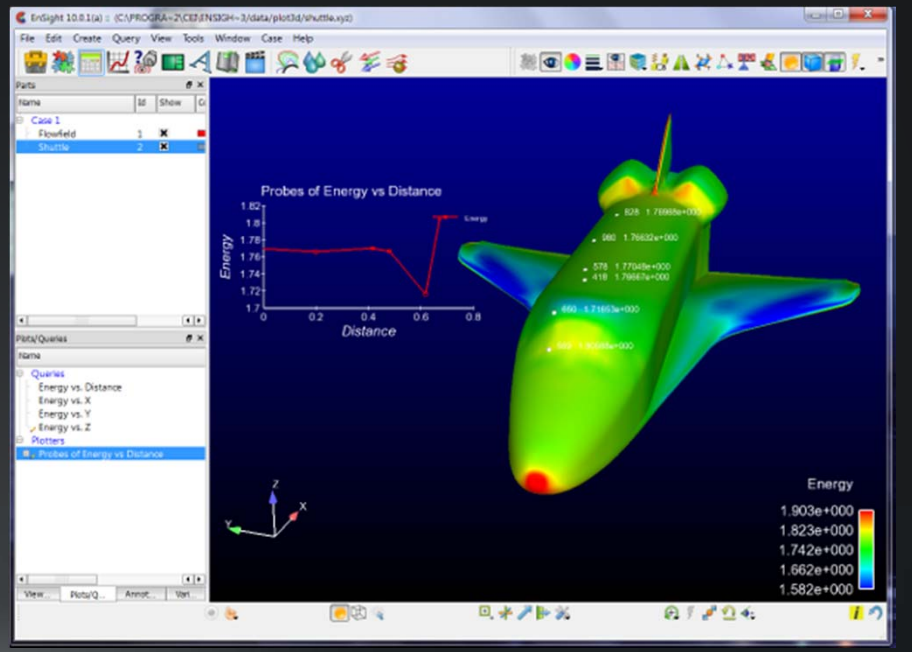
- Python module (datetime) to determine current date and time (to create a unique filename from)
- 3 line of “Python” to determine a unique filename
- Basic EnSight commands, in “python-journal” syntax.
  - Control settings, default print colors, size, format
- Last step: Assign to a macro as a single keystoke



EXAMPLE 2: PICK VALUES IN CUSTOM MANNER

- Use “Interactive Probe” values as entities in a graph
- User has access to attributes of most all of EnSight
- With Python, pull out this information from the Probe, and populate a Query

```
a =
ensight.query(ensight.QUERY_PROBE_DATA)
```



EXAMPLE 3: TABLES

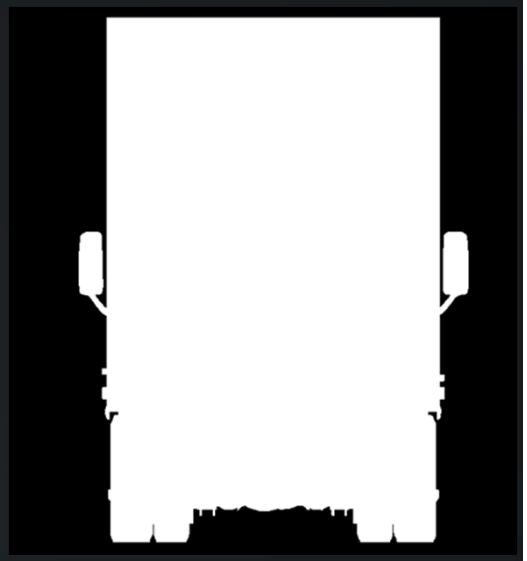
- The default Force Function reports the total forces for all of the parts selected.
- Use Python with similar Force Function, but loop over each part individually and summarize in a table form.
- Utilize external module ‘matplotlib’ to generate table.

Drag Force Table [lbf]

	Press Drag	Shear Drag	Total	Cd	% Total
Body	1101.0	913.8	2014.8	0.0262	18.64
Vert	4.6	96.7	101.2	0.0013	0.94
axle_brace	254.4	58.1	312.5	0.0041	2.89
canard	14.2	16.0	30.2	0.0004	0.28
exh_duct	204.2	73.4	277.6	0.0036	2.57
mid_support	3137.1	-1.8	3135.3	0.0408	29.00
mid_wheel	402.6	5.0	407.6	0.0053	3.77
parachute_can	78.0	4.3	82.3	0.0011	0.76
rear_axle	2489.7	39.4	2529.1	0.0329	23.40
rear_wheel	1885.9	33.7	1919.6	0.0249	17.76
Total	9571.4	1238.8	10810.2	0.1405	100.00

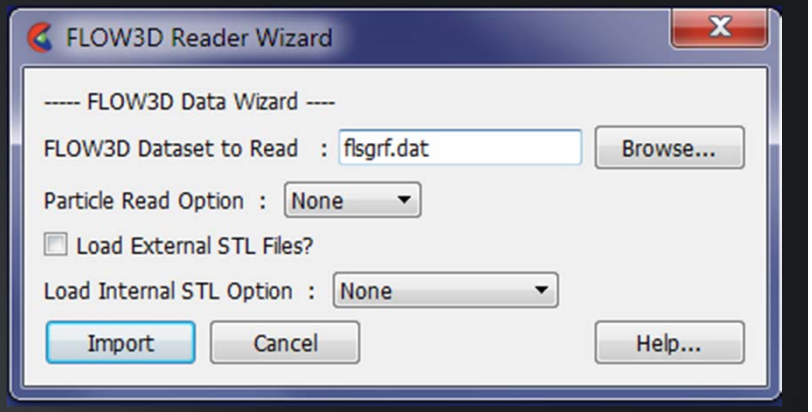
EXAMPLE 4: FRONTAL AREA

- Although obtaining the surface area of a set of parts is easy to obtain via Area(), obtaining the projected frontal area of set of surfaces is not available.
- Use Python's ability to call out to EnVe, to approximate the frontal or projected area.
- Utilize a reference geometry and image size (generated by the Python script).
- Extrapolates frontal area of geometry.



EXAMPLE 5: USER BASIC GUI

- EnSight users in Python can access “CeiQtGenericDialog” GUI generation to populate simple GUI’s.
- User Input/Output control
- Parts, Variables, Files, Text, Floats/Ints, etc.
- In this example, invoke reader with specific options, followed by specific functions done automatically.



CONCLUSION

- Quantification of the Results (Calculator, extraction of numerical results, Queries, Graphs) are an immensely powerful capability in EnSight.
- Combining Visual display of results, along with Quantification of results engages both sides of the brain to convey the information from the result with more inherent understanding.
- Utilization of various techniques together in EnSight allow for new methods to visualize, analyze and communicate information.
- Use of Python control allows for customization, automation, and leverages the power of EnSight for data analysis and communication.

DEMO

THANK YOU