

Combined Visualization

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THEME

Visualization.

KEYWORDS

Post-processing, Visualization, Communication.

SUMMARY

In recent years there has been an increased focus on combining simulation results from different engineering disciplines. In addition, results from experiments are frequently used to improve and calibrate simulation result. As a result, the need for advanced 3D visualization tools has emerged. Powerful tools for combining, visualizing and inspecting simulated and experimental data increases the understanding of complex physical phenomena. Combining data sets is often a time consuming process including handling of very large amounts of data in different formats and resolutions. The functionality of the 3D Visualization tool, GLview Inova, has been extended to deal with combined visualization, and include advanced features for data interpretation which gives the engineer the opportunity to focus on understanding the content of the data.

The focus of this presentation is to discuss and demonstrate tools and methods to visualize data from different applications areas in combined ways that allows the user to compare data from different sources directly and interpret and understand them. The topics that are covered are:

- Visualization of data from coupled analysis
- Visualization of simulated data and measured results in combination
- Future development of multi-discipline visualization

During the presentation, lightweight and free tools to facilitate better understanding and communication of multi-discipline problems will also be demonstrated.

Preface

In recent years there has been an increased focus on combining simulation results from different engineering disciplines. In addition, results from experiments are frequently used to improve and calibrate simulation result. As a result, the need for advanced 3D visualization tools has increased. Powerful tools for combining, visualizing and inspecting simulated and experimental data increases the understanding of complex physical phenomena.

Visualization of data from coupled analysis

This presentation takes a closer look at four main areas where visualization of data from coupled analysis is especially useful:

1. Control of coupling parameters at setup
2. Monitoring of coupling progress
3. Post-processing of results
4. Presentation and communication of engineering results

Ceetron has had the opportunity to work with Fraunhofer SCAI to develop the new MpCCI Visualizer (see figure 1), which recently was released in version 3.1. This is one example of a tool that is very

useful for visual inspection of the coupling parameters (alignment, mesh fit etc.) that can be performed before the actual analysis is started. The MpCCI Visualizer will enable the user to verify the consistency of the coupled models before a time-consuming job is started and hence save time and money by avoiding setups with a bad fit.

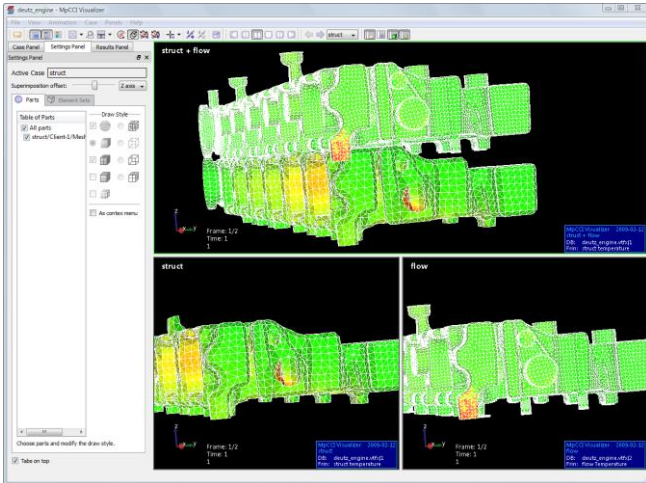


Figure 1: Inspection of coupling parameters using MpCCI Visualizer

In its next release, the MpCCI Visualizer will include on-line monitoring capability to monitor the analysis as it is progressing. This will enable the user to control that the analysis is progressing as planned. Again, this enables the engineer to save time and money by

interrupting an analysis that is not progressing as expected, for whatever reason, at an early stage.

This presentation will proceed to look at how the outcome from a coupled analysis can be post-processed and then presented to relevant stakeholders.

Most simulation codes today come with their own post-processing software, which is well tailored to

post-process the output from that simulator. However, what most of these tools are lacking is the ability to read and post-process data from other sources – especially if the other source is from another domain (i.e. FEM and CFD for a FSI problem).

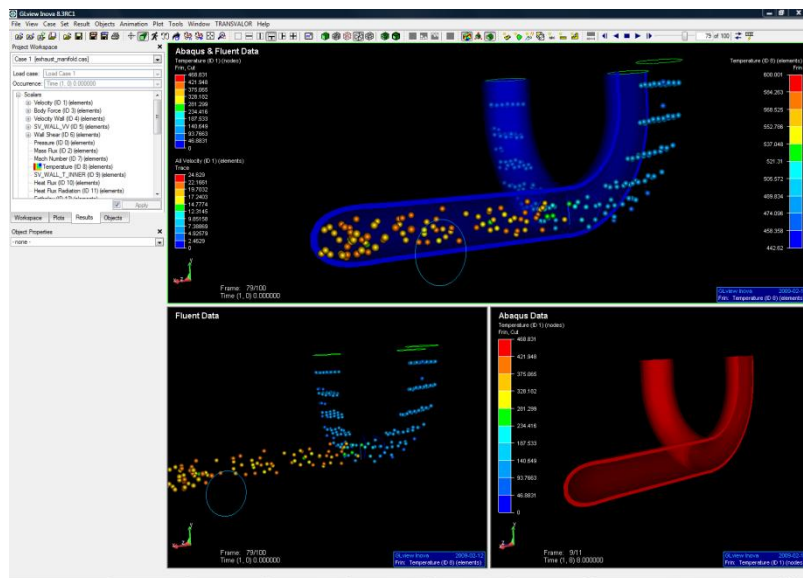


Figure 2: Post-processing data from multiple sources in GLview Inova

There are some general purpose post-processors available in the market, which will allow you to overcome this problem – one of them is GLview Inova (see figure 2), built on the same technology as the MpCCI Visualizer. A short demonstration of the advantages of being able to combine two datasets in one post-processor will be given in the presentation.

Further development

Features to make it easier to work on superimposed cases will improve usability. For instance,

- Ability to add cut-planes that intersects all geometries in a view
- Ability to change or modify units to align and compare results from different sources having different scaling and units
- Functionality to work with mirroring (symmetry) and feature extraction
- Extended features for synchronization of time series and animations

Presentation and data sharing

For the engineer, there always comes a time when the outcome of the job done needs to be

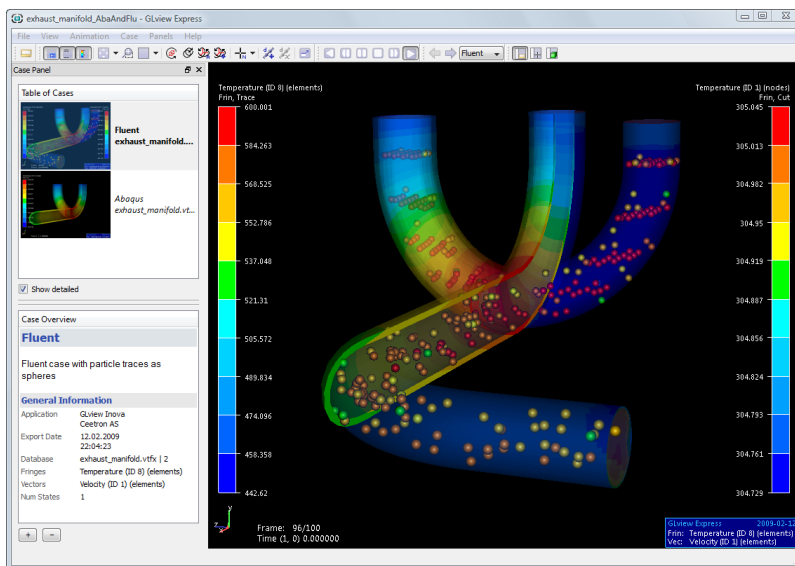


Figure 3: Multi-case visualization in GLview Express

presented to stakeholders in the project or discussed with colleagues. Known challenges at this stage is transporting or accessing the large datasets needed to visualize the data, getting a token to the application needed to do the visualization, or making enough images and animations available to be able to discuss the problem.

For this purpose, the models, the selected results and any feature extractions applied, can be exported to a very compact and efficient file format that can be viewed in free viewers. The free viewers enable

interactivity like zoom, pan and rotate, result picking, as well as the ability to run

animations. A short demonstration of the use of GLview Express and the GLview 3D Plugin will be given during the presentation.

Visualization of simulated data and measured results in combination

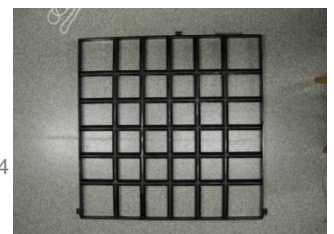
Another area where combined visualization has clear benefits is when one needs to compare simulated data with measured results from experiments.

In the example that will be used in this presentation, SINTEF Fisheries are doing a study of the flow around fish-nets to determine which forces are working on them as they are dragged through sea water. It is suspected that the knots in the nets are a large source of the drag force generated. The overall goal is to design new and better fish-nets.



A PIV (Particle Image Velocimetry) experiment was conducted at SINTEF Marintek in Trondheim, Norway – with simulated results for comparison from The Norwegian University of Science and Technology (NTNU), Department of Marine Technology.

The PIV experiment uses lasers to illuminate particles that are released into a 10 m/s water flow past a grid (see figure to the right) representing the fish-net. Two video cameras are used to capture the movement of the particles at a frequency at 10Hz –



the offset between the cameras enable the measurements to be done in 3D – the resulting data is well suited for visualization.

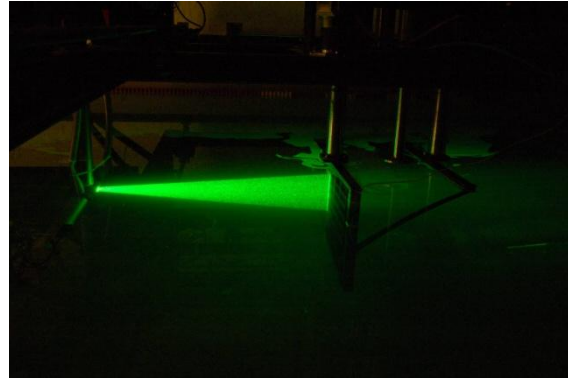


Figure 4: Picture from the experiment

The simulated results in this example were obtained using Gerris Flow Solver

(http://gfs.sourceforge.net/wiki/index.php/Main_Page).

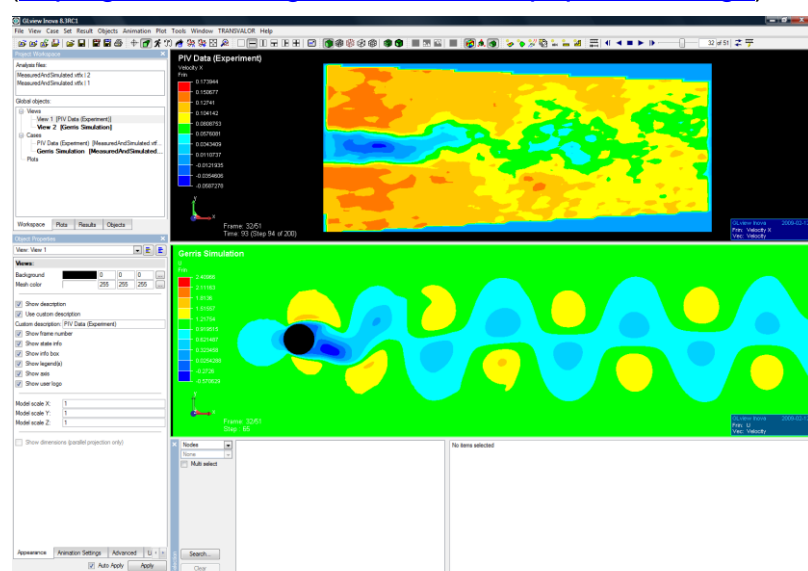


Figure 5: Post-processing simulated and measured results in GLview Inova

The datasets that are available for this presentation are the very first ones that have been produced. The correlations that were expected in these initial studies are not that evident. The preliminary conclusion is that further investigation of the underlying problem is needed. However, the example will serve to illustrate the need for such a tool.

A short demonstration of how GLview Inova can be used to post-process a combination of simulated and measured results will be given during the presentation.

Further development

The following features are identified as potential enhancements, to make the tool more powerful for post-processing measured results.

- Extending the PIV dataset to full 3D
- Visualization of other measured results (may not be as straight forward as the example shown)
- Change of units in dataset to facilitate direct comparison of data from different sources
- Synchronization of time-steps and animation
- Support for combining Video and Simulated Results
- Features for alignment of geometries

Acknowledgements

The authors would like to thank:

- Chittiappa Muthanna, from SINTEF Marintek, for the use of the PIV data and the explanations given to the experiment and the data.
- Håvard Holm, The Norwegian University of Science and Technology (NTNU), Department of Marine Technology for the use of the Gerris dataset and the explanations given to that data.
- Klaus Wolf, Fraunhofer SCAI for providing the Exhaust Manifold Dataset.