11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Fluid Structure Interaction with Inconsistent Software Platforms

David Grasselt*, Prof. Dr.-Ing. Klaus Höschler and Aris Konstantinidis

Institute of Traffic Engineering, Brandenburg University of Technology Cottbus-Senftenberg (BTU),
Siemens-Halske-Ring 14, 03046 Cottbus, Germany,
David.Grasselt@tu-cottbus.de, http://www.tu-cottbus.de/flugtriebwerksdesign

Key Words: *Fluid Structure Interaction (FSI), Multiphysics Problems, Applications, Computing Methods, inconsistent Software Platforms*

The FSI problem class describes the mutual dependence of the multiphysical interaction between aerodynamic forces and structural mechanic deformation. The FSI effects become more significant and influences partially safety analysis when the dependence between the influence and response becomes stronger, e.g. the fluttering of aero-engine blades or the pumping of blood by the ventricles of the human heart. [1]

The modelling of fluid dynamic problems requires solutions different from those, which are relevant for structure mechanical issues. The coupling of modern numerical methods and tools enables the analysis of mutual dependencies. Although software companies develop more and more integrated solutions, inconsistent application of software solutions (SW) play an important role. Furthermore, automation of interface processing, finite-element analysis (FEA) and computational fluid dynamic (CFD) solution processes can lead to significant exploitation potential for example for design-optimisation applications, design evaluation with target solver-, Monte Carlo-, six sigma-, Taguchi- and stochastic design improval methods or is capable to just accelerate the design process. This requires the strict separation of method code and application dependent information.

The paper describes a coupling approach, in the case of obligatory use of inconsistent SW for the separate, mutual depending challenges of a FSI problem description, especially for strong displacement applications.

The first step of a FSI process chain is the solution of a fluid dynamic problem followed by a coupled FE Analysis. The start of the FE solution process can be divided into three steps:

- the pre-processing and generation of a finite-element-model input file,
- the manipulation with an external code, including the required time and data management,
- the execution of the FEM solver with the manipulated input file.

Typical finite-element-codes generate an input file and process this file with a SW specific interface. A self-coded Java programme uses this interface strategy to manipulate the structural solvers' input before executing the solver.

The outcome of the FE solution can be divided into two types of information. The most obvious is numerical output in form of stress or displacement. Additionally FSI process relevant information is required to allow the coupling of FEA to the CFD analysis: boundary conditions, like surface pressure or heat transfer coefficients distributions provoked deformation of the component. A key method to allow importing deformed surfaces to form the 2^{nd} coupling way is the description of surfaces using non-uniform rational B-splines [2].

The coupling of the 2^{nd} CFD-FEA iteration becomes more complex, due to the fact that the load information for the 2^{nd} iterations' non-deformed FE-model has to be recovered from the deformed CFD-CAD-model of the 1^{st} iterations' FEA deflection, see Figure 1.

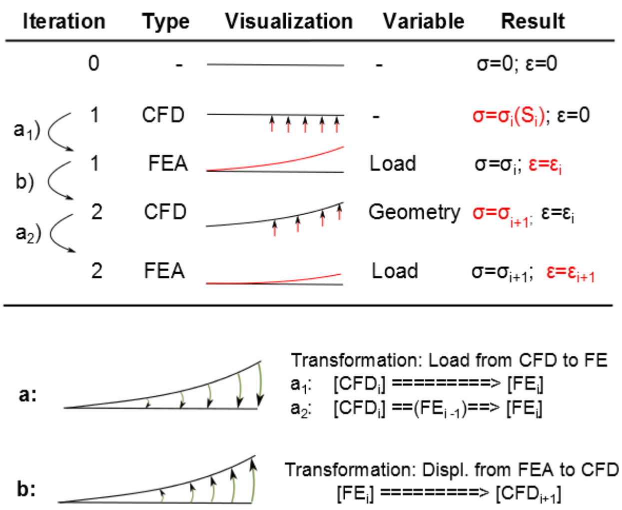

Figure 1 FSI Parameter-Exchange

Effort in automation of all subtasks, implemented between and into inconsistent software platforms, including the manipulation of CAD-models, CFD discretization & solution through macros, journaling or other tool depending utilities, lead to strategies for individual SW combinations. This grants a wide advantageous access to several SW, which might be required or preferred to be used <u>and</u> the benefits of rapid analysing of thousands of designs by high performance computing (HPC) exploitation.

REFERENCES

[1] H.-J. Bungartz, A.H. van Zuijlen and H.Bijl; Multi-Level Accelerated Sub-Iterations for Fluid-Structure Interaction, *Fluid Structure Interaction II*; p. 2, Springer 2007.

[2] Y. Bazilevs, K. Takizawa and T.E. Tezduyar; *Wiley Series in Computational Mechanics*; John Wiley & Sons Ltd 2013.

[3] J.H. Ferziger and M. Peric; *Computational Methods for Fluid Dynamics*; 3rd rev. ed. Springer 2002

[4] O.C. Zienkiewicz and R.C. Taylor, *The finite element method*, 6th Edition, Elsevier, 2005.