MULTIPHYSICS SIMULATIONS USING NACS IN COMBINATION WITH GID

Martin Meiler*, Hermann Landes* and Manfred Kaltenbacher*

*SIMetris GmbH
Am Weichselgarten 7
91058 Erlangen, Germany
Email: info@simetris.de – Web page: http://www.simetris.de

Key words: Simulation, Multiphysics, Finite Element Analysis, NACS, GiD Interface

Abstract. *An interface between the finite element software NACS and GiD has been developed by SIMetris recently. NACS (Numerical Analysis of Coupled Systems), which is developed and marketed by SIMetris, has been designed as a finite element software for the efficient solution of multiple coupled field problems. Currently, it provides solution facilities for piezoelectric, acoustic, magnetic, and mechanic problems as well as combinations of those. In the presentation the required adaptions within GiD's graphical user interface (GUI) to support NACS will be described. Furthermore, we will present the implementation of a scripting facility which allows an easy-to-use generation of parametric models using dedicated GiD input scripts. Finally some demonstration examples will be presented.*

1 INTRODUCTION

In this paper, the use of GiD in combination with the finite element software NACS (Numerical Analysis of Coupled Systems), which has been developed by SIMetris, will be demonstrated. In order to support NACS, a special interface has been developed for GiD which does not follow the customization as proposed by GiD, but introduces a completely redesigned GUI adaptation.

NACS is a multiphysics finite element software whose single field applications cover magnetics, mechanics, electrostatics and acoustics. Since NACS has been developed with regards to coupled fields, nearly arbitrary combinations of these single fields may be solved including, but not limited to piezoelectric, magneto-mechanic or, acoustic-mechanic tasks. This allows the simulation of sensors, actuators or even complete systems with applications reaching from medical systems, power transformers to small sensor systems like piezoelectric transducers.

Since NACS does not include a pre- or postprocessor, interfaces to for commercial software packages which provide this kind of functionality are required. GiD is a good choice as pre- and postprocessor since it allows the user to generate models easily and in an intuitive way. The GiD interface will be presented in the following chapter.

2 GID INTERFACE FOR NACS

The GiD interface for NACS has to provide two basic functionalities. First, a geometric model has to be generated. Based on this geometric model the simulation setup of NACS is specified. This includes the selection of the computational domains, the definition of the analysis type, selection of included physics types, boundary conditions as well as the results that shall be obtained and stored during the simulation.

Two different approaches can be followed when trying to generate the simulation files. The first relies on using the GUI and working interactively with the program whereas the second approach requires the use of script files.

Regardless of the chosen method, the output files of the preprocessing consist of a mesh file, which is stored as a HDF5-file, and of a parameter file, which is stored as a xml-File. HDF5 is a standard file format that allows an efficient storage of large amounts of data.

The GiD interface itself is split into two separate parts. The first part is implemented in Tcl/Tk as an extension to GiD, whereas the second part consists of an external SOAP-Server, that allows a client-server communication with the localhost. The server process manages all settings according to the simulation setup. The choice of boundary conditions or results presented to the user depends on the previously selected analysis, geometry and physic types and is preselected by the server process.

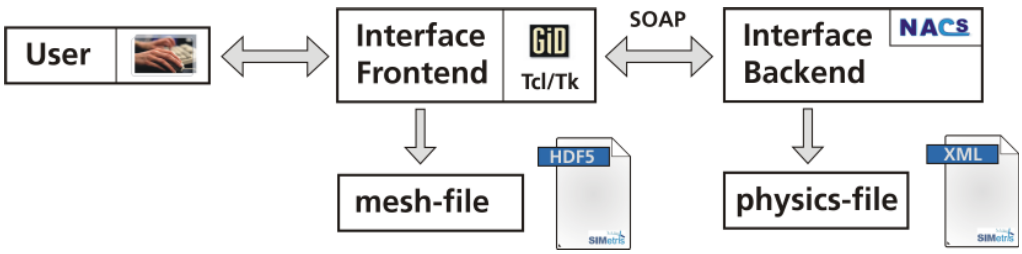

Figure 1: Work Principle of the NACS Interface for GiD

2.1 Graphical User Interface (GUI)

Using the GUI the user can interactively create the model and learn to use GiD as well as options and features NACS offers him. Therefore a Computation Wizard has been implemented guiding the user through the definition of the physical setup. This includes the selection of the geometry type, analysis type, physic types, couplings, boundary conditions, results, and solver. At the end of the model generation process the simulation input files will be created and the simulation can be started.

Figure 2 shows a sketch of the reworked GUI and includes the region definition window at the upper left corner of the display, the wizard, that guides the user through the parameterization process, in the lower left corner and the NACS command line at the upper right corner. The geometric model which consists of a steel plate with two piezo actuators on its surface can be seen in the upper right corner.

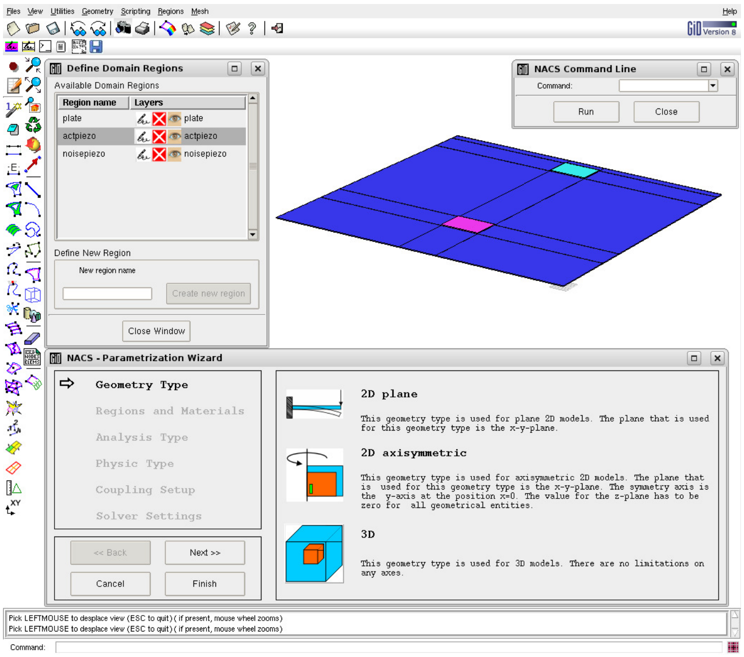

Figure 2: GUI of NACS Interface for GiD

```
...
## Region Definition
region plate plateLayer
## Surface Region Definition
surfregion fix Surfaces "1:10"
## Physical Setup
setgeometry 3d
matfile mat-nacs.xml
material plate st37
# Analysis Type
harm 1 linear 2 230 267.5
# Physic Type
physicreg 1 mech plate
# Boundary Conditions
bc 1 mech fix disp x 0
bc 1 mech fix disp y 0
# Results
result 1 mech disp "" all
# Create Mesh and write files
mesh
writemodel plate 1e-3
```

Figure 3: Scripting Example

2.2 Scripting Interface

The second approach, which relies on the use of script files including the process of model generation, meshing, and the definition of the physical setup of the simulation, will be the preferred method for most users. The main advantage of this method for creation of the simulation setup consists of the fact that it provides a reproducible way to generate models even from the command line, by using GiD in batch mode. Furthermore, parameter variations can easily be carried out by changing the corresponding values in the script file.

A part of a scripting file is show in figure 3. Within this part of the script the computational region plate is defined. Then the surface region fix is defined, consisting of all surfaces from nr. 1 to 10. After this step the geometry type is set to 3d, the material file is defined and the material of type st37 (steel) is set for the region plate. A harmonic analysis will be performed at two frequencies (230 Hz and 267,5 Hz). The physical simulation setup consists of a simple mechanic calculation in region plate with displacement boundary conditions specified for the x- and y-displacements in the surface region fix. Finally, the result type is specified (mechanic displacement), the meshing process is initiated, and the simulation files are written.

2.3 Post-Processing

The results obtained from a simulation run with NACS can easily be examined using GiDs post processing functionality. Only results that may not de displayed on the simulation grid like integral quantities, i.e. the electric charge or energy results, have to be examined with external tools.

3 EXAMPLE

A short example will illustrate the impact of piezoelectric transducers that are applied on a thin steel plate[i]. Whereas one of the transducers is used to excite the vibrations of the plate, the second transducer acts as a vibration cancellation actuator and tries to minimize the amplitude of the vibration. The model has been generated using the scripting interface for GiD. Parts thereof are displayed in figure 3 as well as the geometric model in figure 2.

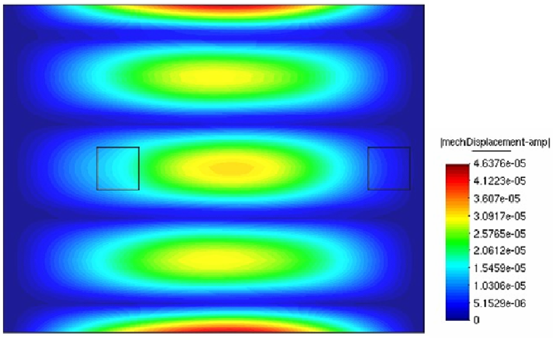

Figure 4: Vibrating Steel Plate excited by the Noise Actuator

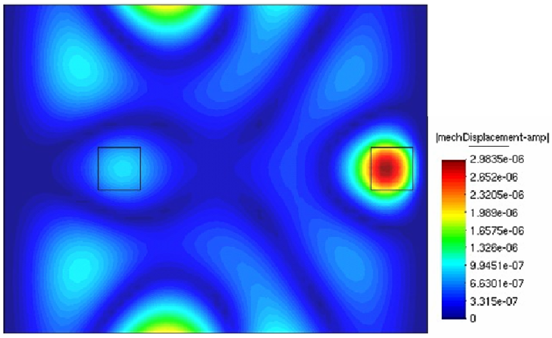

Figure 5: Vibration Result with applied Active Vibration Cancellation Actuator

Figure 4 shows the plate vibrations as excited by the first piezoelectric transducer. The result in figure 5 depicts the reduced vibration amplitude due to the presence of the active vibration cancellation actuator.

4 CONCLUSIONS

In this paper a GiD interface for NACS has been introduced. It was pointed out that GiD represents an intuitive and easy-to-use pre- and postprocessor for finite element simulations. Therefore the GUI has been adapted and a Tcl-based scripting interface has been developed in order to provide a dedicated interface for NACS.

The shown examples emphasize the capabilities of NACS in combination with GiD.

[i] M. Meiler, L. Messner, A. Dantele, M. Kaltenbacher, T. Hegewald, „Active Noise Cancelation with Smart Structures Analyzed by an Enhanced Finite Element Scheme for Non-linear Piezoelectricity“, Proc. ANSYS Conference & 25th CADFEM Users Meeting