TECHNISCHE UNIVERSITÄT WIEN
Vienna | Austria

Institute of Analysis and
Scientific Computing
Wiedner Hauptstr. 8
1060 Vienna, Austria
www.asc.tuwien.ac.at/cme

Multi-physics simulation software NGSolve

For the engineering of machines and components with complex physical properties

Computer simulations are becoming increasingly important in product development and product design – think of crash tests or the engineering of machines and components with regard to their mechanical, electromagnetic, fluidic, acoustic or nano-optical properties and their optimization. Simulations allow for studying the product's properties on the model before prototypes have to be produced. This saves costs and a lot of time. With complicated geometries or couplings of different physical phenomena, however, conventional simulation software often reaches its limits. A reliable simulation then requires unreasonable computing time or is not possible at all.

Current mathematical research often provides approaches to solve such problems efficiently, for example by new discretizations and algorithms, variable polynomial degrees, use of automated code generation or parallelization of algorithms to better leverage modern computational architectures.

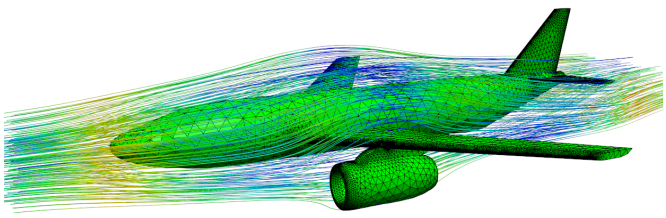
Objective

The aim of the working group headed by Prof. Joachim Schöberl at the Institute of Analysis and Scientific Computing of TU Wien is to make the state of science available to the industry and to provide particularly flexible, highly efficient and cost-effective software tools for a wide variety of applications in various sectors of the economy.

Solution

For 25 years, Prof. Schöberl has been developing the software packages Netgen and NGSolve with his colleagues, often in cooperation with the industry. The software packages are modular and comply with the current state of the art.

The programs are provided free of charge via a permissive license (LGPLv2). Every user may use, adapt, and integrate them into their workflow. For particularly challenging tasks, the working group Computational Mathematics in Engineering headed by Prof. Schöberl will be glad to help.



Airplane model in aerodynamic flow

Special features of the software

Netgen is by now a very common mesh generator used in particular for special geometries, such as thin layers or elongated structures. Here Netgen stands out with its special meshing techniques, which enable a small number of elements and thus little computational effort. Because of its efficiency and robustness, Netgen is also used in a number of commercial simulation programs.

NGSolve is a finite element package used to solve differential equations on Netgen meshed geometries. Both packages are programmed in modern C++, both shared-memory (C++11 threads) and distributed-memory (MPI) parallel and optimized for modern hardware structures.

Results

The users may quickly simulate their components and systems. Through their graphical user interface, Netgen and NGSolve may be used intuitively and customized easily for each specific application. Their Python interface makes them easy to integrate into existing user workflows, as other software often also features a Python interface or can be controlled by Python. Both program packages can also be used separately by the user and linked to their existing programs.

Applications

Netgen has been integrated by various software companies into their modeling and simulation tools as a mesh generator – for example, in Salome, FreeCAD or Z88.

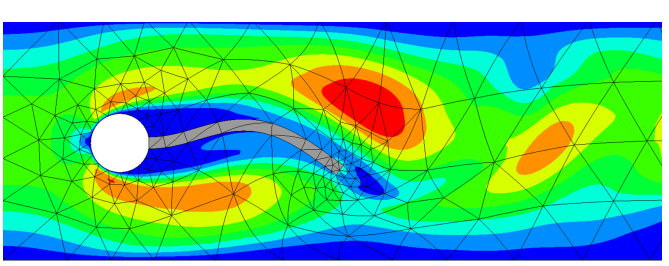
www.ngsolve.org

NGSolve is used successfully by industrial companies; often the coupling of different physical phenomena is required.

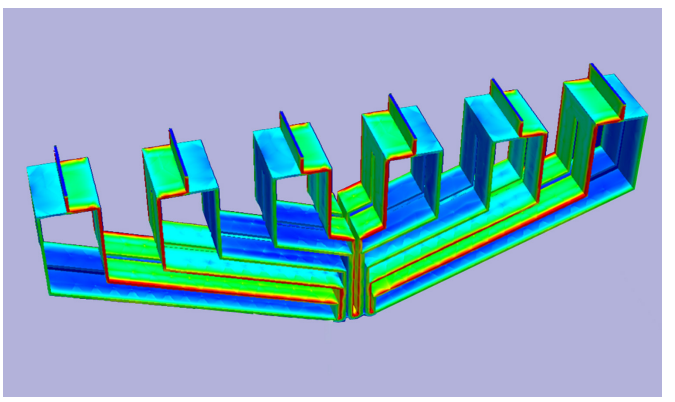
Users are for example:

- Toyota (shape optimization)
- Siemens Transformers (Transformatoren)
- Schlumberger (sensors for drilling)
- Endress+Hauser (electromagnetic flow measurement)

In these applications, the features of the programs unfold their potential: NGSolve for example, delivers a high resolution of the penetration depth of the fields into the thin shields of the transformer or Netgen is able to mesh the elongated hole with a few elements. Then, algorithms specifically developed in NGSolve for electrodynamics, acoustics or fluid mechanics are applied to these meshes. This interaction of the mesh generator with the finite element package can solve even highly complex problems on conventional desktop PCs in just a few minutes. This enables even automatic optimizations and parameter studies.



For coupled phenomena NGSolve is
highly efficient - here: elastic fin in a fluid flow



Loss density in a busbar -
due to induced eddy currents in the outermost layers

Your benefits

- free open source software; both packages may be used, distributed and modified free of charge (LGPLv2 license)
- platform-independent (Windows, MacOSX, Linux)
- downloads at **www.ngsolve.org**
- flexible and quick adaptation to changing requirements
- support by the TU Wien team for adaptation to own requirements and integration into own workflow
- access to updates free of charge making available the latest state of the art in mathematical science

Notes

Contact

Prof. Dr. Joachim Schöberl
TU Wien – Institute of Analysis and
Scientific Computing
www.asc.tuwien.ac.at/cme
+43 1 58801 10128
joachim.schoeberl@tuwien.ac.at