Elmer

Alternative Pre-processing tools

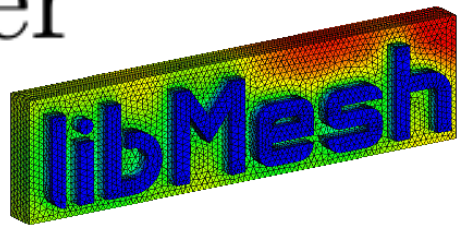
ElmerTeam
CSC – IT Center for Science

Mesh generation capabilities of Elmer suite

- ElmerGrid: native generation of simple structured meshes
- ElmerGUI: plugins for tetgen and netgen
- No geometry generation tools to speak about
- No capability for multibody Delaunay meshing
- Limited control over mesh quality and density

- Complex meshes must be created by other tools!

Open Source software for Computational Engineering



Open source software in computational engineering

- Academicly rooted stuff is top notch
  - Linear algebra, solver libraries
  - PetSc, Trilinos, OpenFOAM, LibMesh++, …
- CAD and mesh generation not that competitive
  - OpenCASCADE legacy software
  - Mesh generators netgen, tetgen, Gmsh are clearly academic
  - Also for OpenFOAM there is development of commercial preprocessing tools
- Users may need to build their own workflows from the most suitable tools
  - Also in combination with commerial software

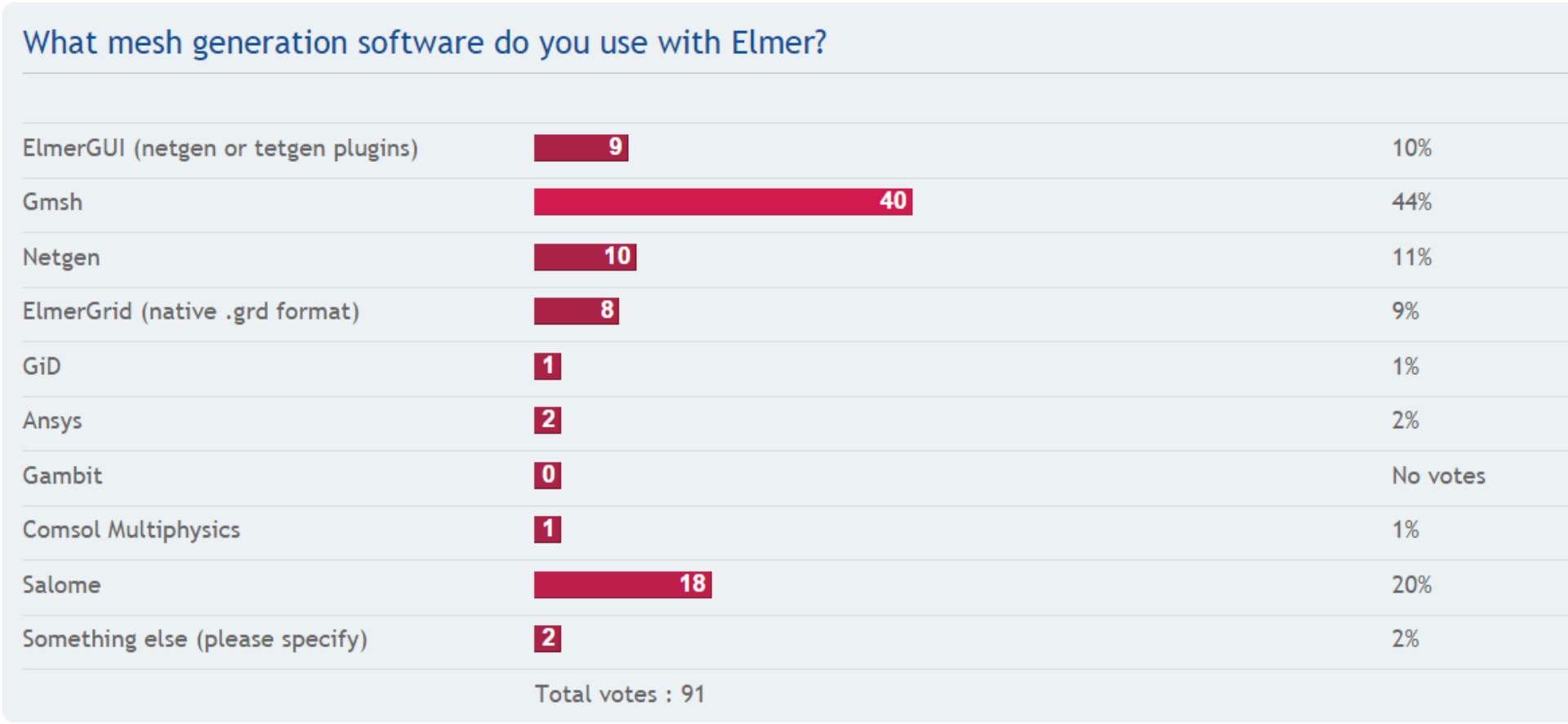
Open Source Mesh Generation Software for Elmer

- ElmerGrid: native to Elmer
  - Simple structured mesh generation
  - Usable via ElmerGUI
- ElmerMesh2D
  - Obsolite 2D Delaunay mesh generator usable via the old ElmerFront
- Netgen
  - Can write linear meshes in Elmer format
  - Usable also as ElmerGUI plug-in
- Tetgen
  - Usable as ElmerGUI plug-in
- Gmsh
  - Includes geometry definition tools
  - ElmerGUI/ElmerGrid can read the format msh format
- SALOME
  - ElmerGrid can read the unv format written by SALOME
- Triangle
  - 2D Delaunay
  - ElmerGUI/ElmerGrid can read the format

Commercial mesh generation software for Elmer

- GiD
  - Relatively inexpensive
  - With an add-on module can directly write Elmer format
- Comsol multiphysics
  - ElmerGUI/ElmerGrid can read .mphtxt format
- Gambit
  - Preprocessor of Fluent suite
  - ElmerGUI/ElmerGrid can read .FDNEUT format
- …
- Ask for your format:
  - Writing a parser from ascii-mesh file usually not big a deal

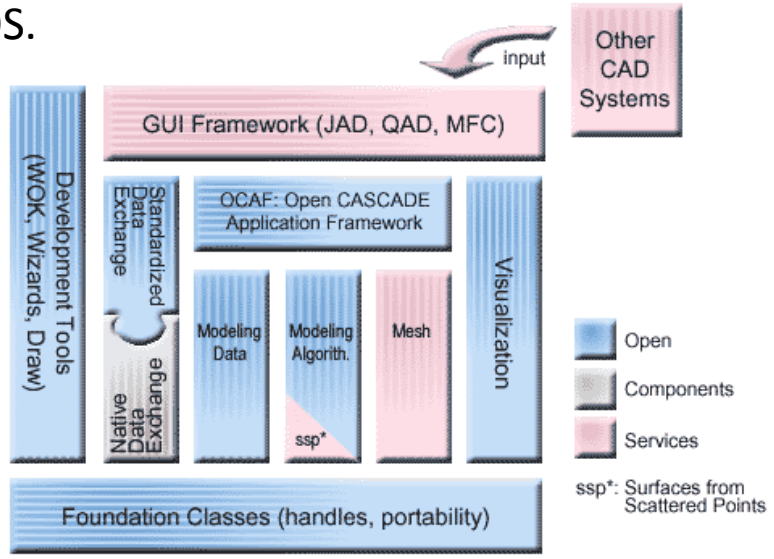
Mesh generation tools – Poll 10/2014



CAD – OpenCASCADE

http://www.opencascade.com/
http://www.opencascade.org/

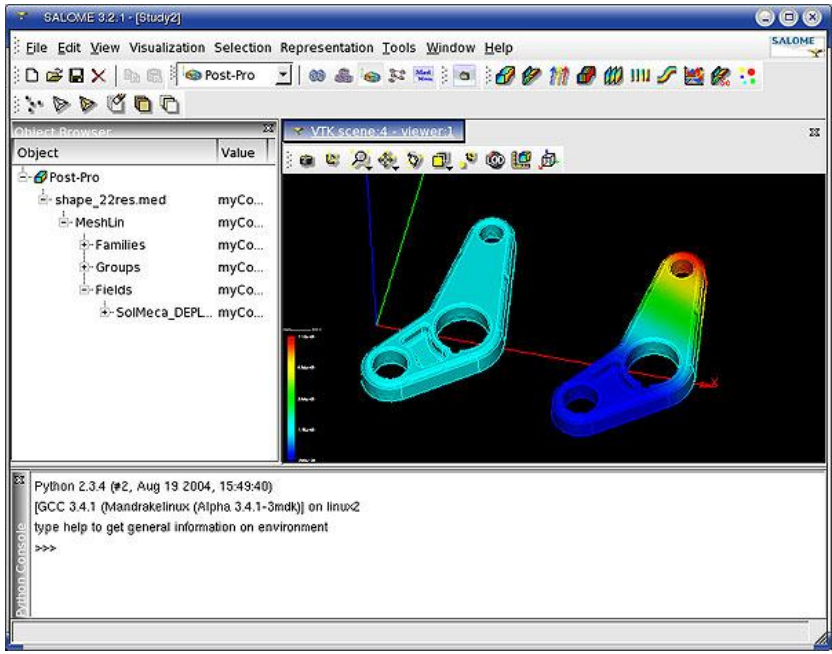
- What is it?
  - Open CASCADE is a powerful CAD/CAM/CAE kernel and development platform for 3D modeling applications.
  - It consists of reusable C++ object libraries and a set of development tools available under OS.
  - Modular structure (see diagram)
- Devolopment history
  - EUCLID-IS CAD/CAM system 1987
  - Published under Open Source in 1999 as OpenCASCADE
  - Curstomers CEA, BMW, SAMTECH, EADS, RINA, Alcatel,…
- The only proper CAD library under Open Source?



CAD – SALOME

http://www.salome-platform.org/

- What is it?
  - Free software that provides a generic platform for Pre and Post-Processing for numerical simulation.
- Based on a number of free software libraries
  - Qt, OpenCASCADE, Doxygen, Python, VTK
- Main functions
  - Create/modify, import/export (IGES, STEP), repair/clean CAD models
  - Mesh CAD elements, check mesh quality, import/export mesh (MED, UNV, ASCII)
  - Handle physical properties and quantities attached to geometrical items
  - Perform computation using one or more external solvers (coupling)
  - Display computation results
  - Manage studies (creation, save, reload)



Using Salome with Elmer

There are some instructions in Wiki

- http://www.elmerfem.org/wiki/index.php/Salome
- The .unv format provides a channel from Salome to Elmer
  - **ElmerGrid 8 2 test.unv –autoclean**
  - Or direct opening with ElmerGUI

Meshing - Gmsh

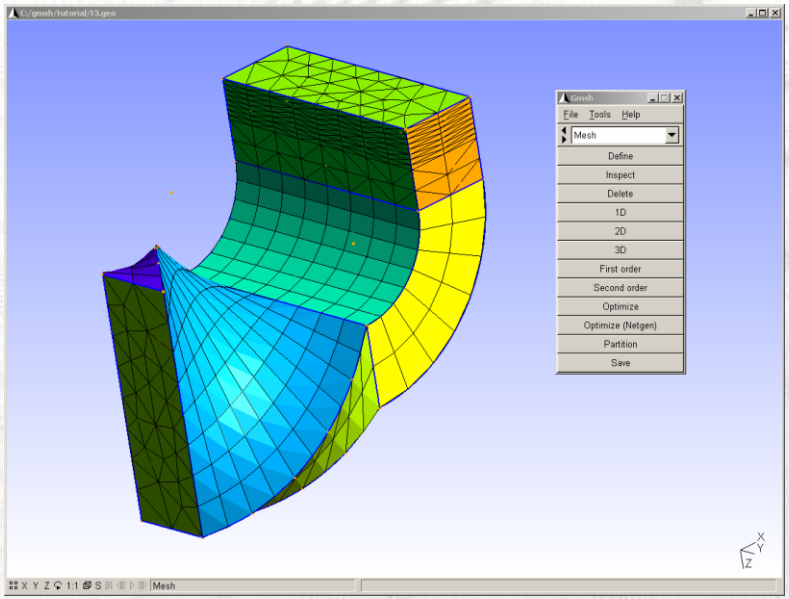
http://geuz.org/gmsh/

- Gmsh is a 3D finite element grid generator with a build-in CAD engine and post-processor
- Its design goal is to provide a fast, light and user-friendly meshing tool with parametric input
- Gmsh is built around four modules: geometry, mesh, solver and post-processing.
- The specification of any input to these modules is done either interactively using the graphical user interface or in ASCII text files using Gmsh's own scripting language.

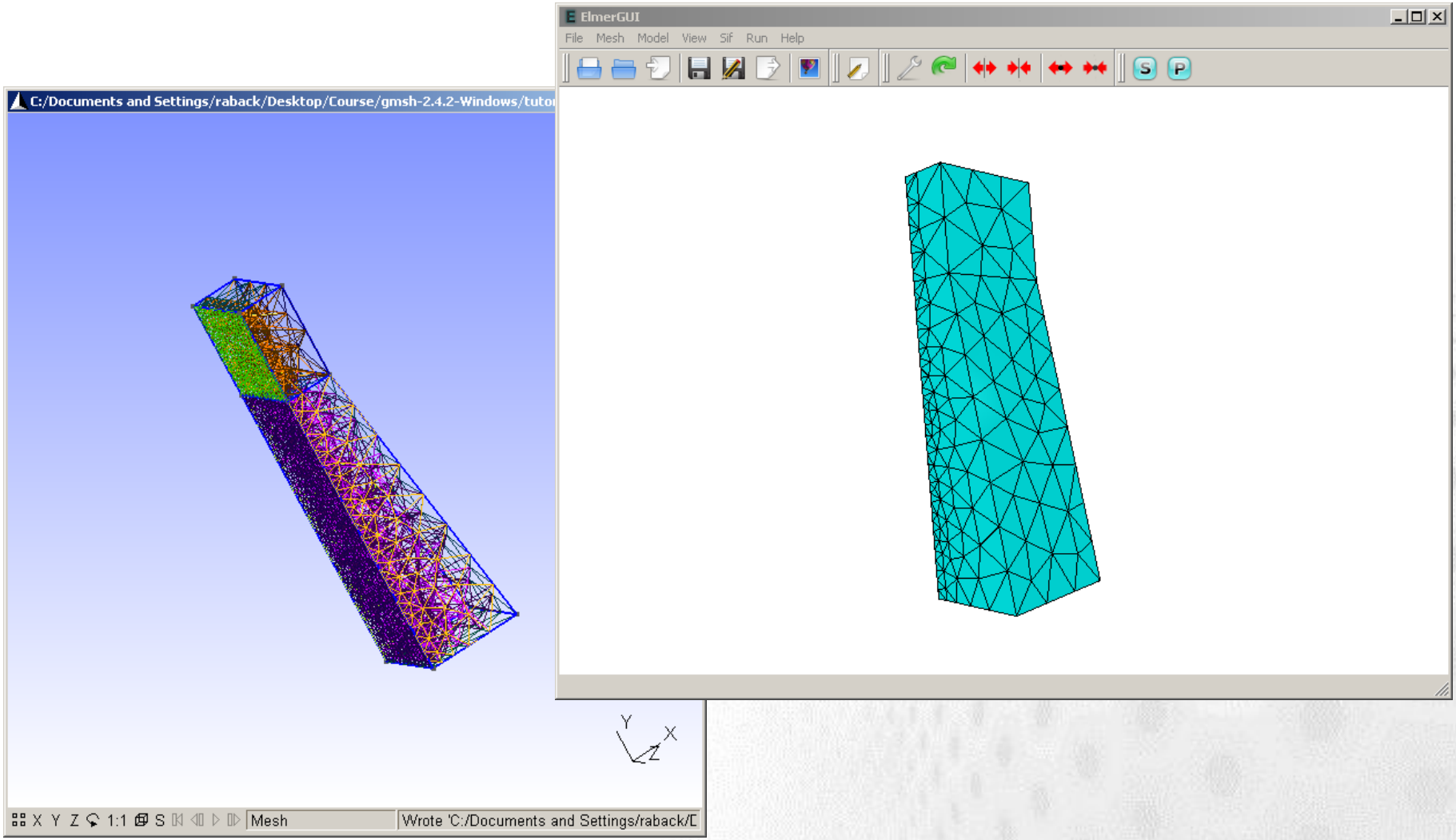
- Probably the most popular academic mesh generation package under open source

Using Gmsh with Elmer

- Saving of the mesh in native gmsh format
  - Suffix .msh
- Usually saving all geometric entities is most robust method
  - Elmer automatically drops lower dimensional entities
  - Elmer renumbers BCs and bodies with 1,2,3,….
- In practice:
- In Gmsh:
  File -> Save as
  Filename: test.msh
  MSH Options
  Version 2.0 ASCII
  Save all (ignore physical groups)
- In ElmerGUI
  File -> Open : test.msh
- Or ElmerGrid:
  ElmerGrid 14 2 test.msh -autoclean
  (creates a mesh file in directory test)

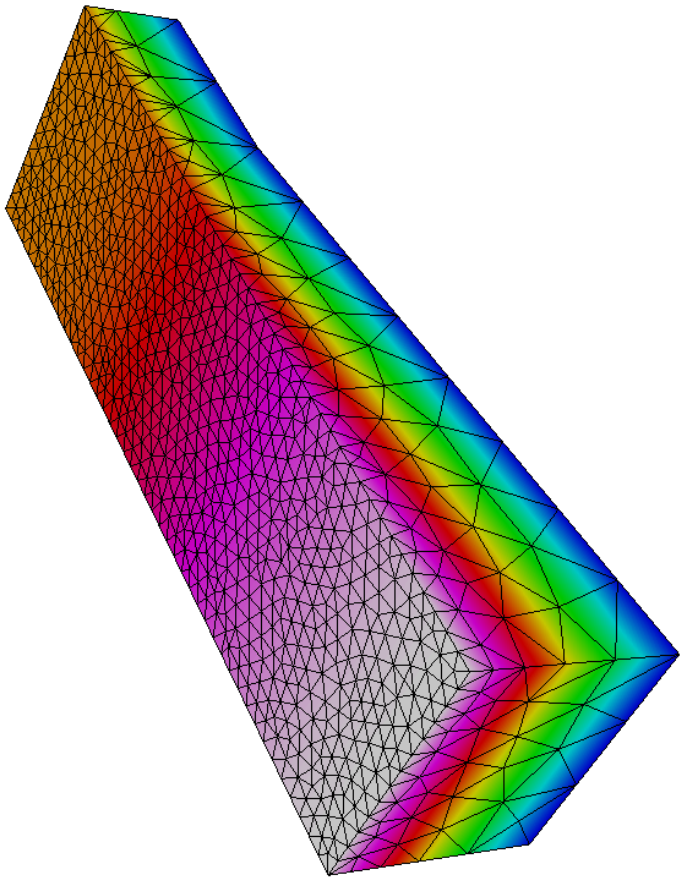


Example: exporting tutorial 2 of Gmsh



Exercise: Gmsh to Elmer export

- Start gmsh.exe
- Load a existing tutorial in Gmsh
  - t1-t6
- Create the default mesh for it
  - Mesh -> 1D, 2D, (3D)
  - A global size factor may be found at
    Options – Mesh – General – Max. Element size
- Open the mesh in ElmerGUI
- Perform a simple thermal analysis if you have time

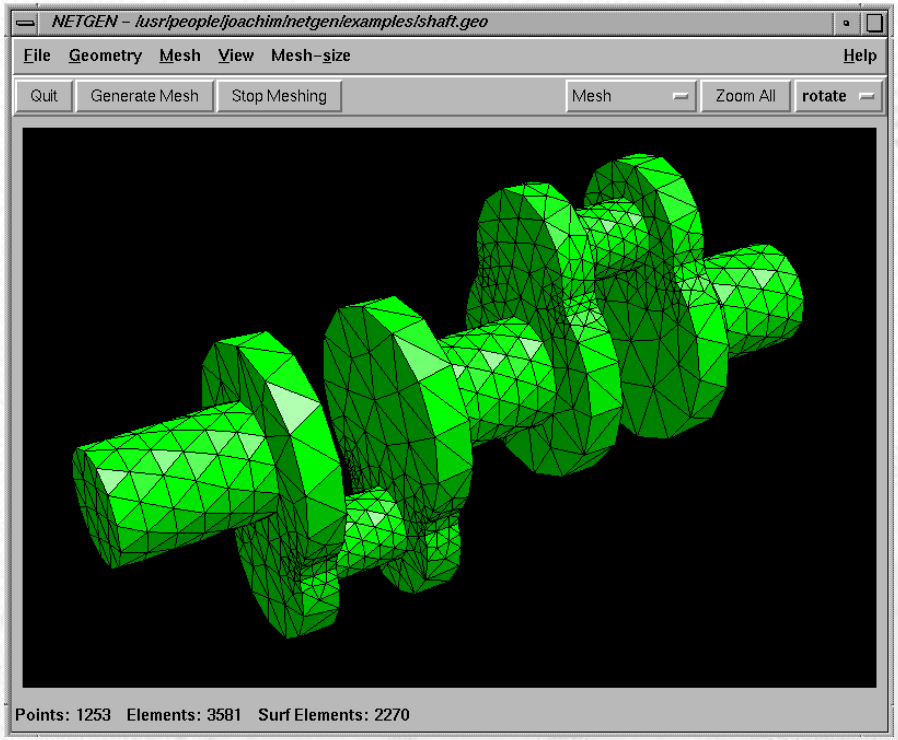


Tutorial 2 of Gmsh

Meshing - Netgen

http://www.hpfem.jku.at/netgen/

- What is it?
  - An automatic 2D/3D tetrahedral mesh generator
  - Developed mainly by Joachim Schöberl
- Key features
  - Accepts input from constructive solid geometry (CSG) or boundary representation (BRep) from STL file format
  - Connection to OpenCASCADE deals with IGES and STEP files
  - Modules for mesh optimization and mesh refinement
  - LGPL library

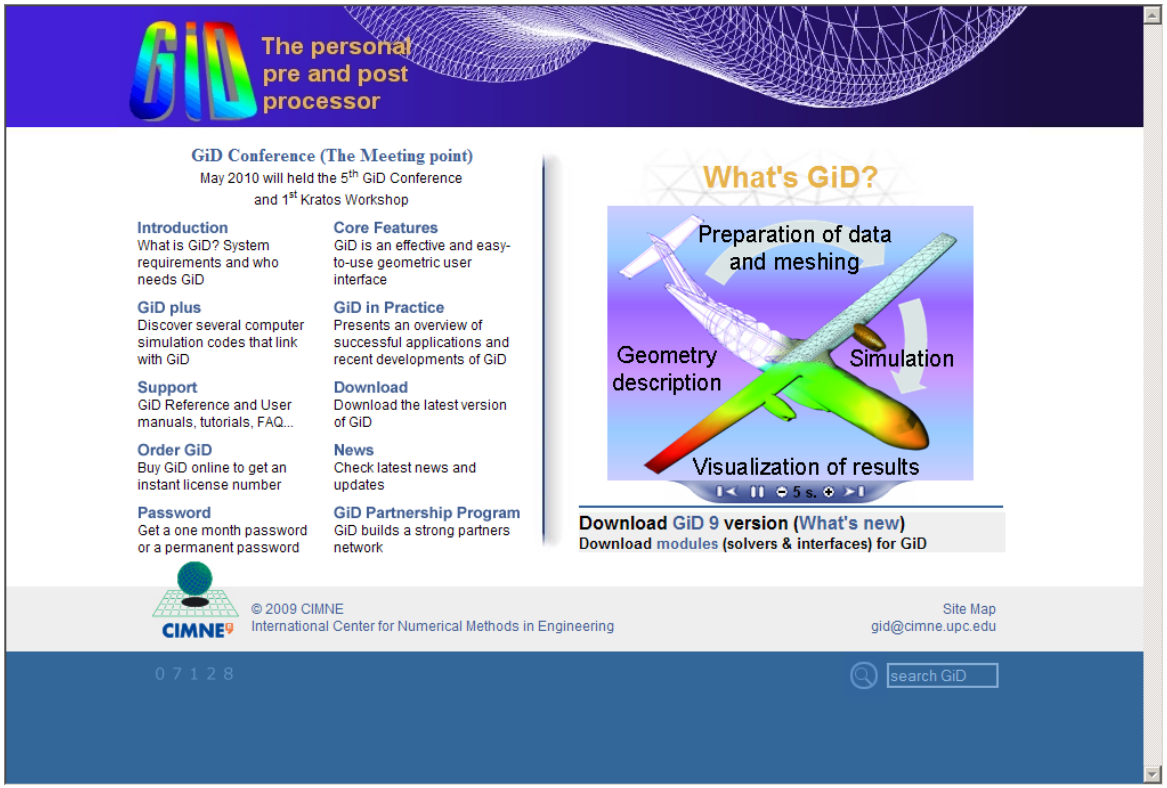


- Netgen library is utilized by a large number of GUI projects

GiD

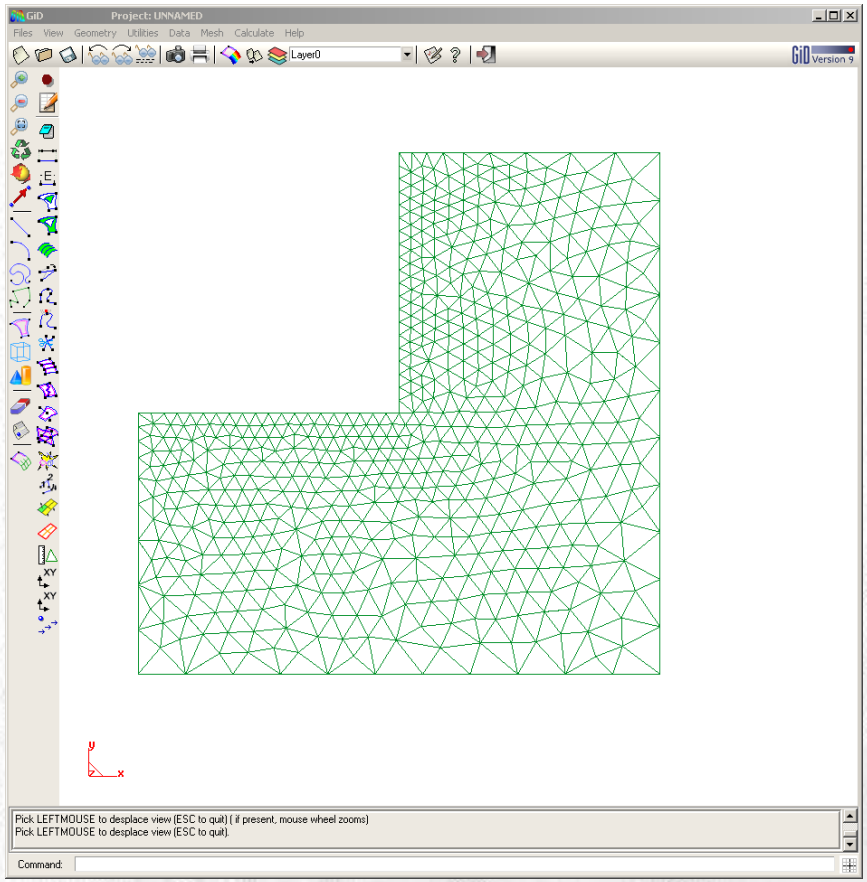
http://gid.cimne.upc.es/

- A good compromise between features and price
- Enables creation of hybrid meshes (not well supported in Gmsh)



Using GID with Elmer

- Requires special plugins that enable problemtype ”Elmer”
- Saves Elmer mesh files directly
- For more details see: http://www.csc.fi/english/pages/elmer/interfaces



Summary of Pre-Processing Workflows in Elmer

- Simple structured
  - ElmerGrid -> ElmerSolver
- Intermediate academic
  - Gmsh -> ElmerGrid/ElmerGUI -> ElmerSolver
- Complex free
  - SALOME -> ElmerGrid -> ElmerSolver
- Complex commercial
  - GiD -> ElmerSolver

- And many more….