



# 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  FOAM



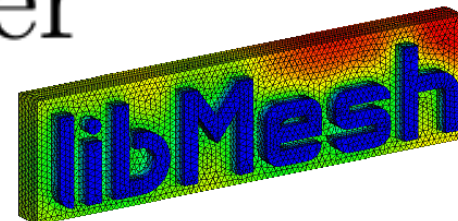
*Freefem++*



**Code\_Aster**



**Gmsh**



**PETSc**



# Open source software in computational engineering

- Academically 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 commercial software

# Open Source Mesh Generation Software for Elmer

CSC

- ElmerGrid: native to Elmer
  - Simple structured mesh generation
  - Usable via ElmerGUI
- ElmerMesh2D
  - Obsolete 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

What mesh generation software do you use with Elmer?

ElmerGUI (netgen or tetgen plugins)	9	10%
Gmsh	40	44%
Netgen	10	11%
ElmerGrid (native .grd format)	8	9%
GiD	1	1%
Ansys	2	2%
Gambit	0	No votes
Comsol Multiphysics	1	1%
Salome	18	20%
Something else (please specify)	2	2%

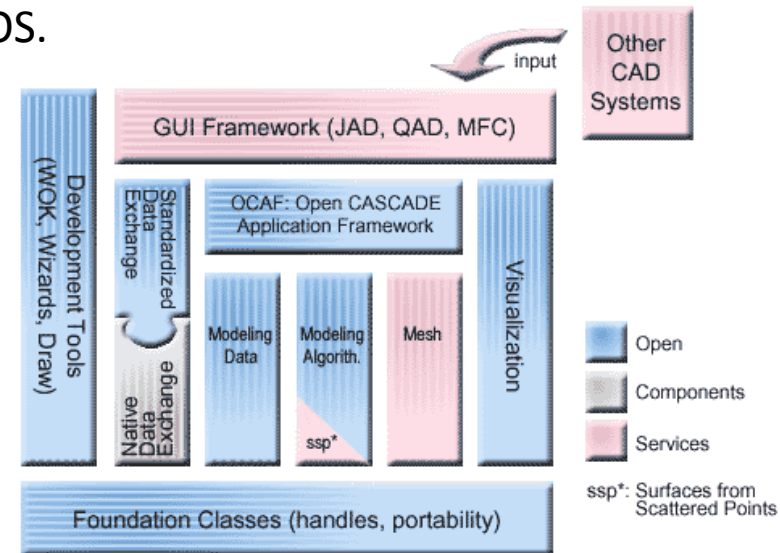
Total votes : 91

# 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)
- Development history
  - EUCLID-IS CAD/CAM system 1987
  - Published under Open Source in 1999 as OpenCASCADE
  - Customers CEA, BMW, SAMTECH, EADS, RINA, Alcatel,...
- The only proper CAD library under Open Source?

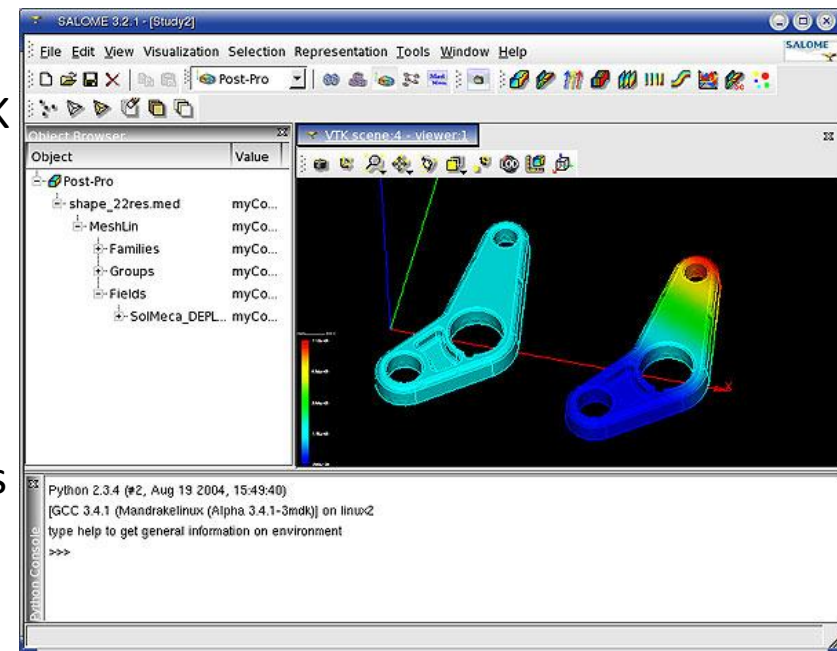




# CAD – SALOME

<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)

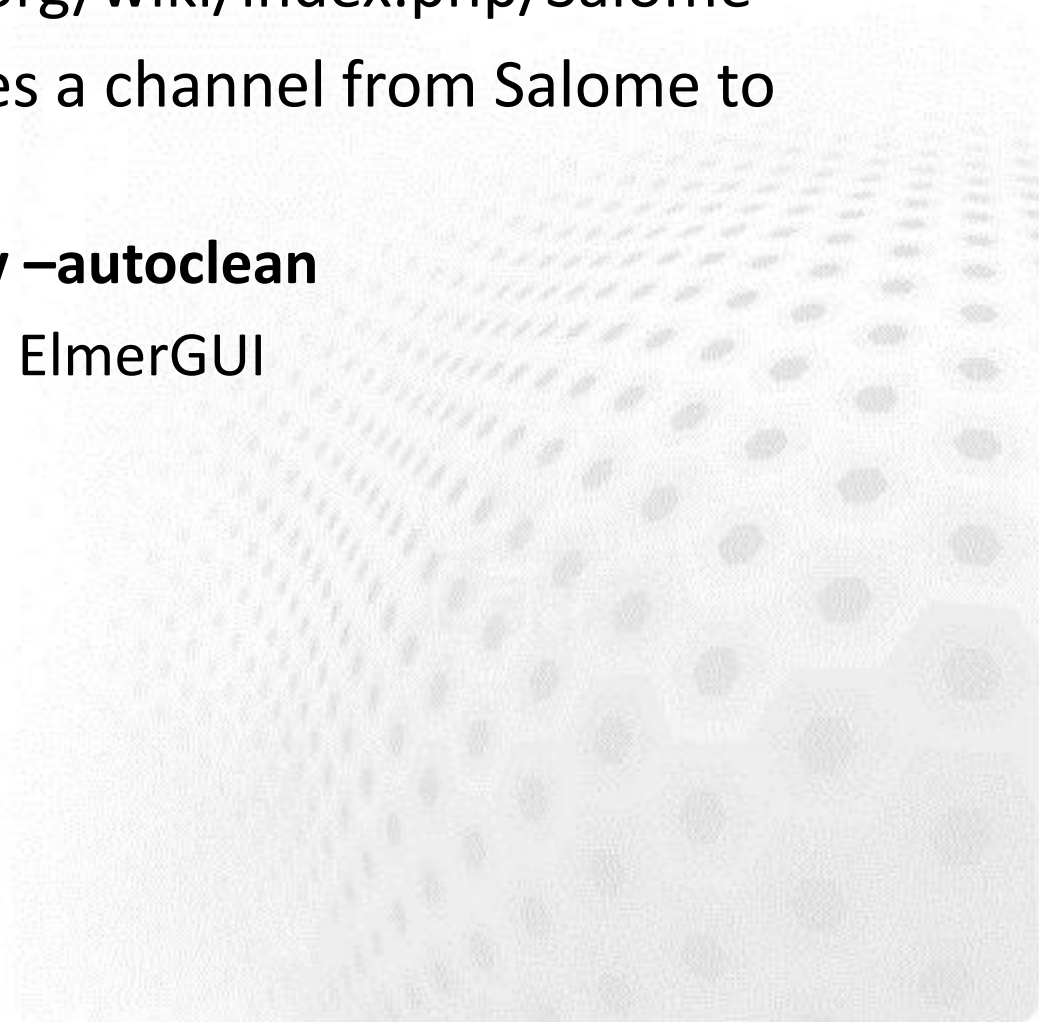


# Using Salome with Elmer



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



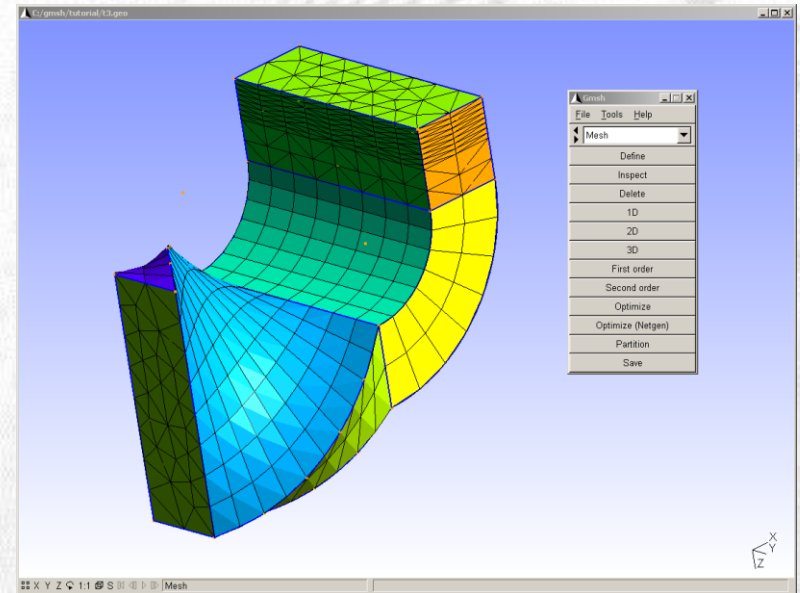
<http://geuz.org/gmsh/>

- 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

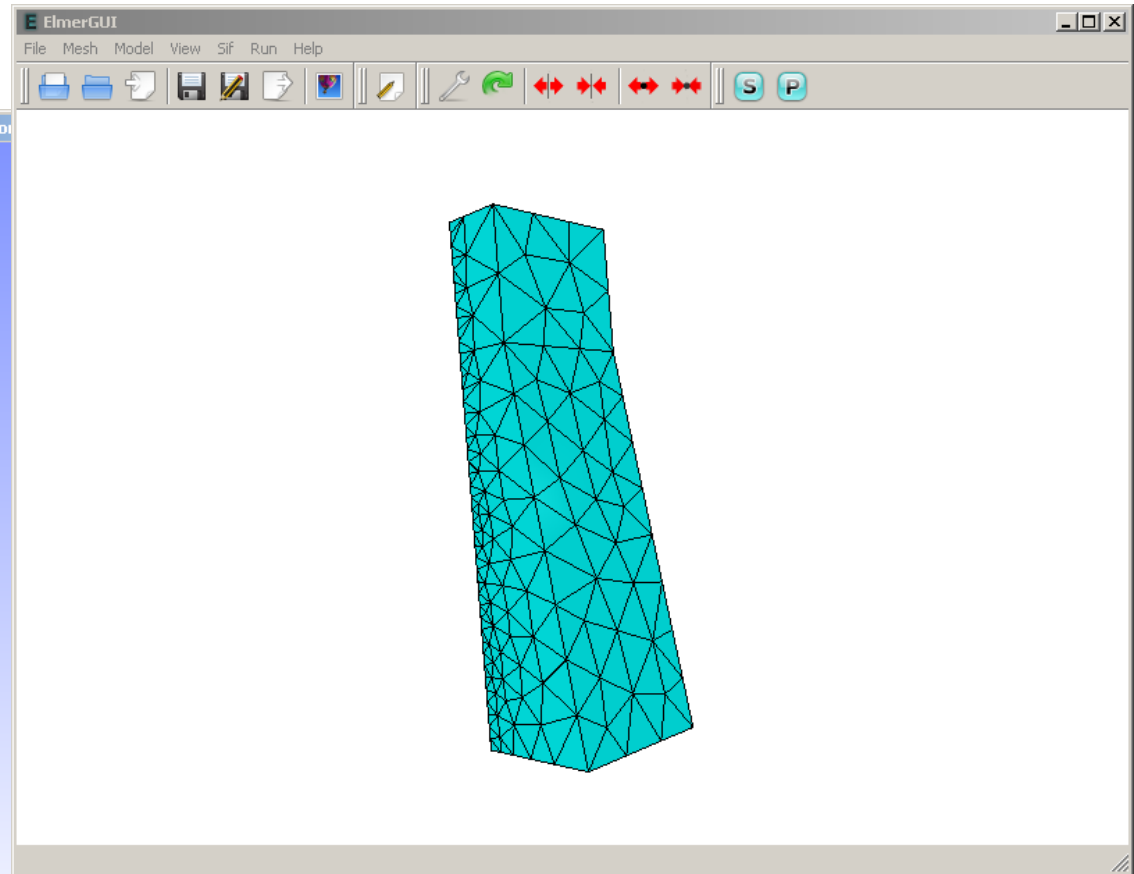
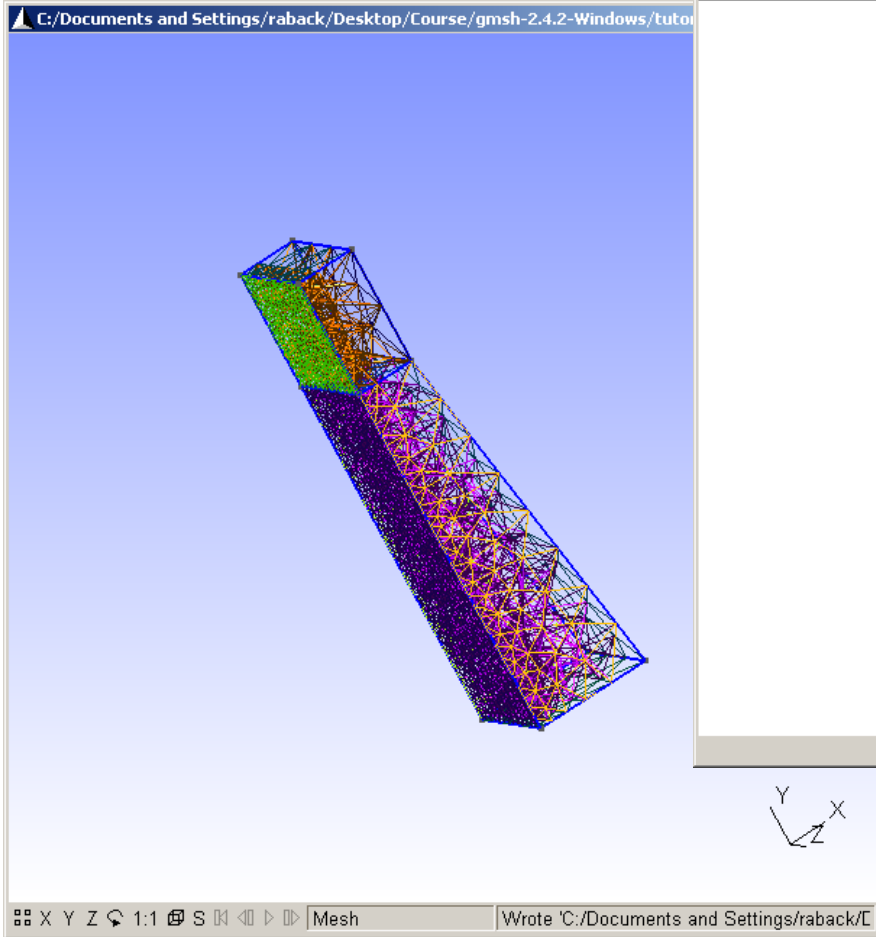
# Using Gmsh with Elmer



- 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 rennumbers 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)

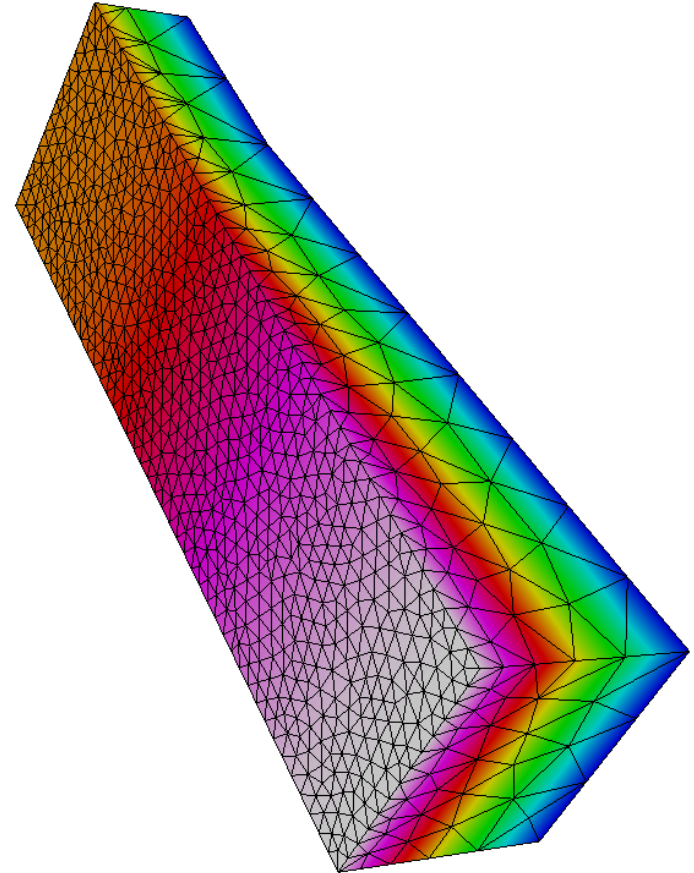


# Example: exporting tutorial 2 of Gmsh



## 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/>

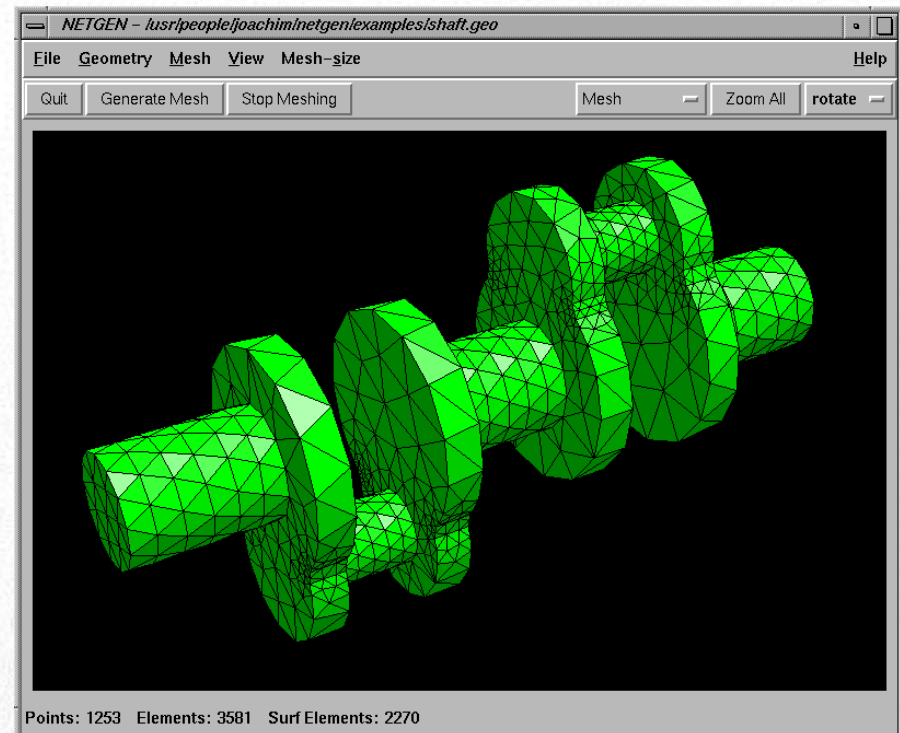
## ➤ What is it?

- An automatic 2D/3D tetrahedral mesh generator
- Developed mainly by Joachim Schöberl

## ➤ Key features

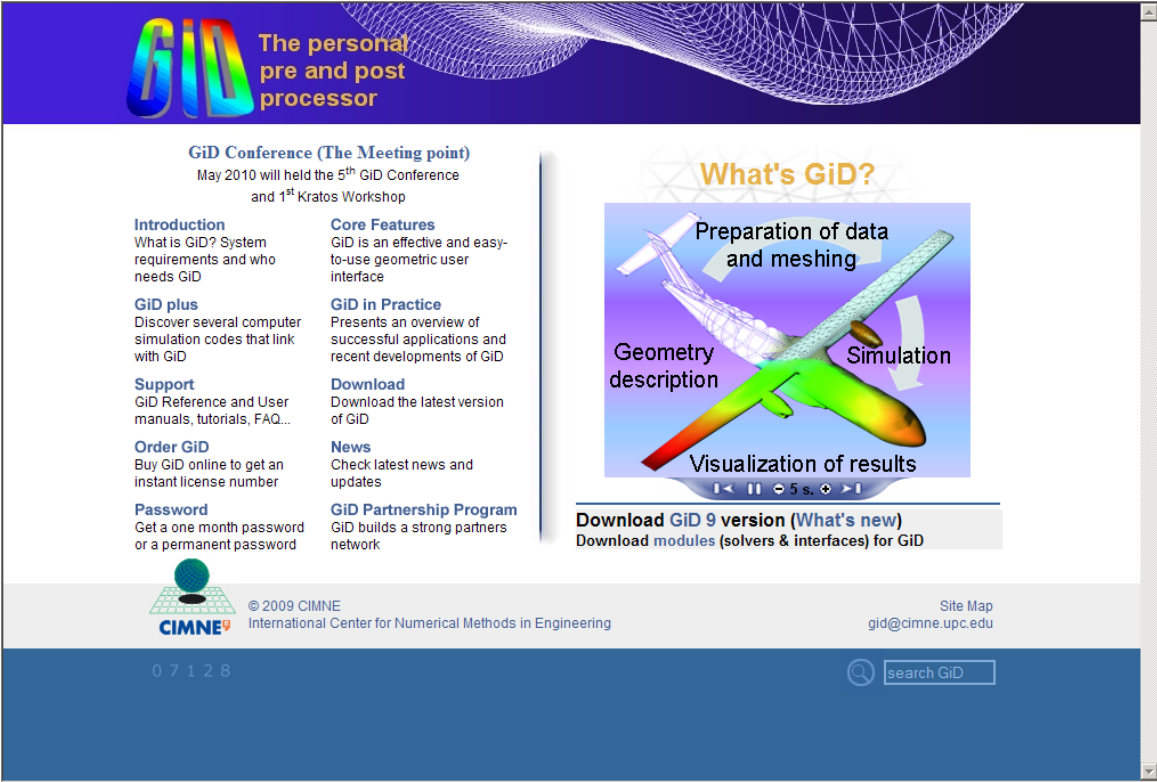
- Accepts input from constructive solid geometry (CSG) or boundary representation (BRep) from STL file format
- Connection to OpenCASCADE deals with IGES and STEP files
- Modules for mesh optimization and mesh refinement
- LGPL library

## ➤ Netgen library is utilized by a large number of GUI projects



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

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



The screenshot shows the homepage of the GiD website. At the top, there is a blue header with the GiD logo (a stylized 'G' and 'D' in blue and red) and the tagline "The personal pre and post processor". Below the header, the main content area is divided into several sections. On the left, there is a navigation menu with links for "Introduction", "GiD plus", "Support", "Order GiD", "Password", "Core Features", "GiD in Practice", "Download", "News", and "GiD Partnership Program". In the center, there is a section titled "GiD Conference (The Meeting point)" with the text "May 2010 will hold the 5<sup>th</sup> GiD Conference and 1<sup>st</sup> Kratos Workshop". On the right, there is a large graphic titled "What's GiD?" showing a 3D model of an airplane wing with a mesh overlay. The graphic is divided into four quadrants: "Preparation of data and meshing" (top), "Geometry description" (left), "Simulation" (right), and "Visualization of results" (bottom). Below the graphic, there are two buttons: "Download GiD 9 version (What's new)" and "Download modules (solvers & interfaces) for GiD". At the bottom of the page, there is a footer with the CIMNE logo, the text "© 2009 CIMNE International Center for Numerical Methods in Engineering", a "Site Map" link, and a search bar with the text "search GiD".

**GiD** The personal pre and post processor

**GiD Conference (The Meeting point)**  
May 2010 will hold the 5<sup>th</sup> GiD Conference and 1<sup>st</sup> Kratos Workshop

**Introduction**  
What is GiD? System requirements and who needs GiD

**GiD plus**  
Discover several computer simulation codes that link with GiD

**Support**  
GiD Reference and User manuals, tutorials, FAQ...

**Order GiD**  
Buy GiD online to get an instant license number

**Password**  
Get a one month password or a permanent password

**Core Features**  
GiD is an effective and easy-to-use geometric user interface

**GiD in Practice**  
Presents an overview of successful applications and recent developments of GiD

**Download**  
Download the latest version of GiD

**News**  
Check latest news and updates

**GiD Partnership Program**  
GiD builds a strong partners network

**What's GiD?**

Preparation of data and meshing

Geometry description

Simulation

Visualization of results

Download GiD 9 version (What's new)  
Download modules (solvers & interfaces) for GiD

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Site Map  
gid@cimne.upc.edu

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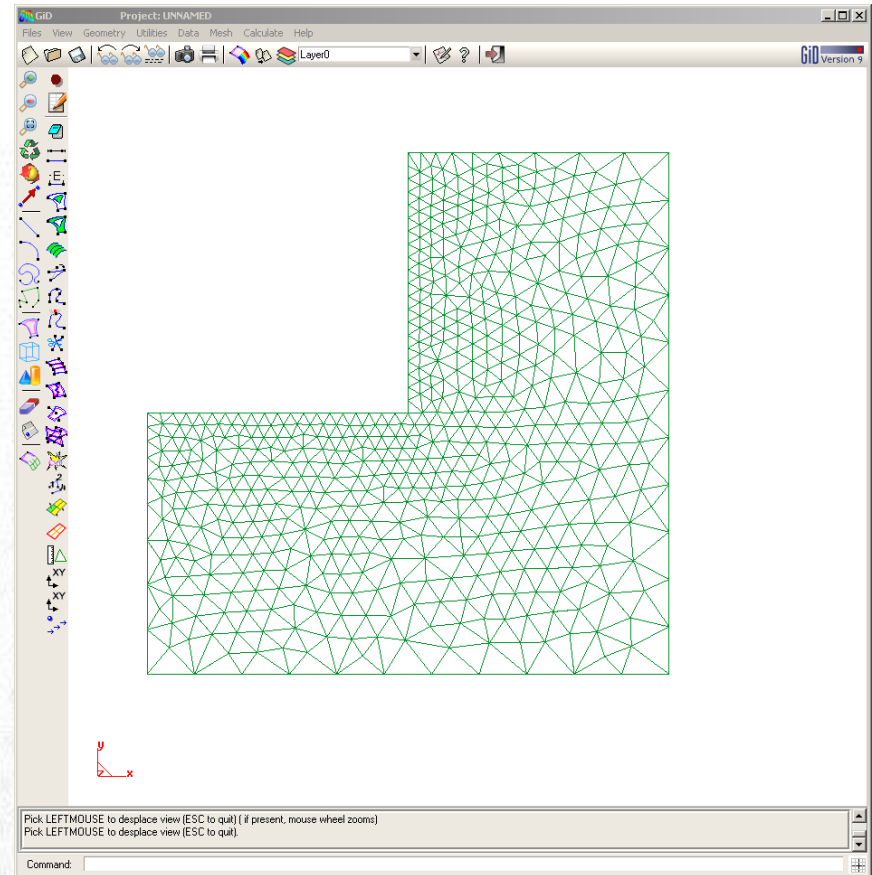
search GiD



# 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....