Using Open Source CAE Software Efficiently

Hannes Kröger
hannes.kroeger@silentdynamics.de

OFW12
Contents

Motivation | InsightCAE | Analysis Examples | Summary |
---|---|---|---|
Motivation
InsightCAE
Analysis Examples
Summary
Common practice: *manual* analysis workflow:

- labour consuming
- potentially complicated, error prone

InsightCAE: *automated* workflow:
Automated workflow,

▶ to avoid errors

▶ to increase productivity, speed

▶ assist inexperienced users
Why Automation

and

- implement best practice by experts for users
- Bundle all software components
Applications

Applications in mind

- Design computations
  - manual investigation of many variants
- Optimization
  - automatic computation of many variants, e.g. by DAKOTA
- Quality control
  - implementation of testsuites and a standardized way for performing certain analyses
## Possibilities for Workflow Automation

<table>
<thead>
<tr>
<th>Motivation</th>
<th>InsightCAE</th>
<th>Analysis Examples</th>
<th>Summary</th>
</tr>
</thead>
</table>

1. **Shell scripts**
   - **Pro**: simple, next logical step after command line
   - **Con**: limited, even floating point arithmetics is a mess

2. **Python scripts**
   - **Pro**: scalable, much freedom
   - **Con**: if project grows large: very difficult to debug and maintain

3. **C++ project**
   - **Pro**: mature, all possibilities, best maintainability
   - **Con**: programming skills, more boilerplate in project setup

⇒ InsightCAE is written in C++
⇒ with python wrappers
InsightCAE is an **open source** project (GPL)

Source Code: [https://sourceforge.net/p/insightcae](https://sourceforge.net/p/insightcae)

- Install packages available. Install on current Ubuntu LTS:

  1. `sudo add-apt-repository http://downloads.silentdynamics.de/ubuntu`
  2. `sudo apt-key adv --recv-key --keyserver keys.gnupg.net 79F5CBA4`
  3. `sudo apt-get update`
  4. `sudo apt-get install insightcae-base`

- Build from sources:

  1. `git clone git://git.code.sf.net/p/insightcae/code insight-src`
  2. `mkdir insight && cd insight`
  3. `cmake ../insight-src`
  4. `make`

Add to your `~/.bashrc`: source `/path/to/insight/bin/insight_setenv.sh`

  - existing OpenFOAM installations will be detected.
  - kdevelop IDE can be used for coding
Not uploaded into public repository:

- execution-ready workflows (organized in add-ons)
  - ship resistance
  - propeller / turbomachinery analysis
  - hydrodynamics bearing analysis
Create the OpenFOAM by combining case elements with case builder

$ isofCaseBuilder
Case builder can also assign boundary conditions and create field files
GUI for editing parameters / run analyses / view results ("workbench")

Parameters

Documentation / Help

Alternative: Command line tool to perform analyses ("analyze")

$>$ analyze --double LaheadByL:2.3 inputfile.ist
Features

- CAD module
  - emphasis on model processing
    ⇒ import model from any source
  - based on OpenCASCADE, import of IGES, STEP, BREP
  - models are described by scripts
  - graphical interpreter for scripts ("iscad")
  - more features:
    - entity selection by filtering commands, e.g.
      \[\text{inlet} = \text{model}.\text{faces('isPlane } \&\& \text{ min(faceCoG.x)')}\]
    - meshing (through gmsh)
    - fully parametric parts, constraint-based sketches, assemblies, part library, drawing export (DXF)

Figure: screenshot of "iscad"
OpenFOAM Support

▶ in “toolkit”:
  ▶ Execution of OpenFOAM commands through batch systems
  ▶ When generating case setups, differences for multiple OpenFOAM version is accounted for (1.6-ext, 2.1, 2.2, 2.3)
  ▶ Reasonable default solver settings for a number of solvers
  ▶ Dictionary parser

▶ direct additions for OpenFOAM are included as well:
  ▶ FEMDisplacement-BC for (steady) FSI with Code_Aster
  ▶ additional discretization schemes
  ▶ localized limited schemes for interpolation, gradient and sn-gradient
  ▶ additional tools for post processing
  ▶ additional BCs: inflowGenerator for LES/DNS
simple generic analysis modules for validation ("modules")

- channel flow
- flat plate
- 2D airfoil
- ...

(c) Copyright silent dynamics GmbH

OFW12
Additional workflows can be

- created as python scripts
- see ⇒ slides to training yesterday
Addons are loadable containers for specific analysis modules.
They need to be created for the specific problem under consideration.
Available so far:
Ship resistance analysis

- CFD (OpenFOAM) of ship resistance
  - single phase (simpleFoam)
  - single phase with free surface (potentialFreeSurfaceFoam)
  - two phase (interFoam or LTSInterFoam)
  - two phase with trim and sinkage (LTSInterDyM Foam)
Addon “ship”

- inheritance: meshing is (almost) the same for all analyses
- minimum parameters:
  - geometry of domain can be computed from given STL geometry
  - single parameter for resolution $n_{ax}$
  - BL thickness is estimated, $y^+$ is set accordingly
Marine propeller and propulsion analysis

- CFD (OpenFOAM) of single operation points and open-water curves (meta analysis)
  - free propeller
  - ducted propeller
  - axial pump
  - optimal diameter, optimal rpm, propulsion prognosis
Hydrodynamic bearing analysis

- CFD (OpenFOAM) of hydrodynamic bearings, single excentricity or characteristic curve/field (meta analysis)
  - circular journal bearing
  - multi-segment journal bearing
  - multi-segment journal bearing with fluid-structure interaction (Code_Aster)

**Figure:** Journal bearing characteristic map
Future Developments

- WiP: Web-Frontend ("web-workbench") for usage e.g. in on-premise clouds
- Integration in graphical programming language (DICE?)
- Windows version of Workbench (Remote execution of external tools on linux machine or cluster)
InsightCAE shall

- be an automation framework for analysis tasks,
- connect multiple necessary tools,
- encapsulate complicated workflows,
- thus help reducing errors
- and increase quality of daily work
Thank you for your attention!

Dr.-Ing. Hannes Kröger
Email: hannes.kroeger@silentdynamics.de
Tel.: +49 381 36 77 98 53

http://silentdynamics.de
http://sourceforge.net/projects/insightcae