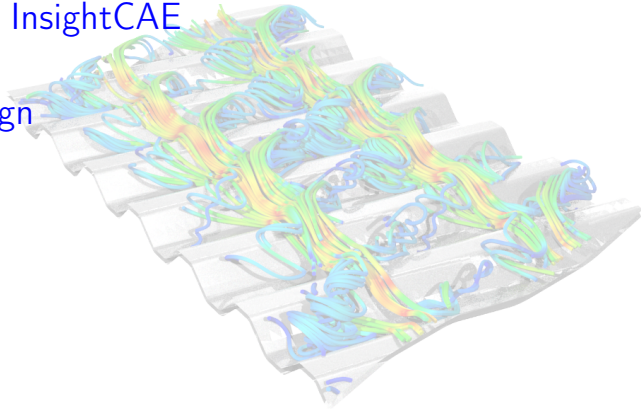


# silentdynamics

Workbench InsightCAE

-

Airfoil Design



2020

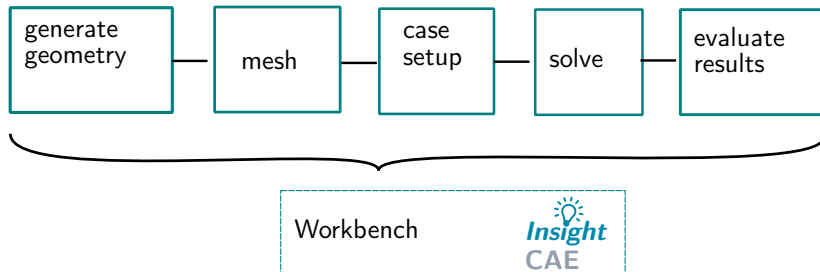
## Our Goal

Using FEA software *efficiently*

- ▶ Simple and quick setup of CFD and FEM analysis
- ▶ As much automated as possible
- ▶ Quick repetition of analysis after geometry or BC change  
⇒ prerequisite for optimization
- ▶ Quick and reliable documentation of results



A software framework to bundle



InsightCAE provides:

- ▶ modular handling of input parameters and result sets
- ▶ GUI for parameter editing
- ▶ Automatic report generation

InsightCAE is an **open source** project (GPL)

Source Code: <https://sourceforge.net/p/insightcae>

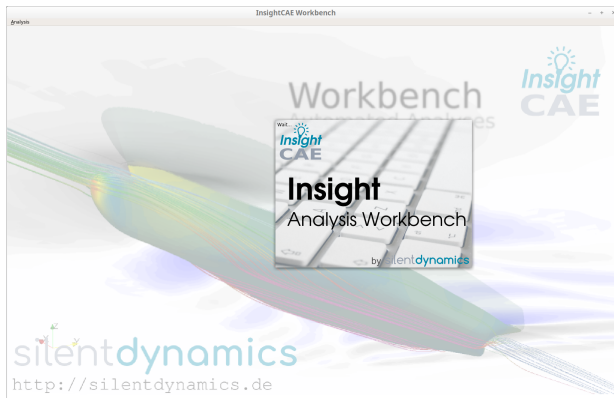
Install packages available. Install on current Ubuntu LTS:

```
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-ce
```

Build from sources:

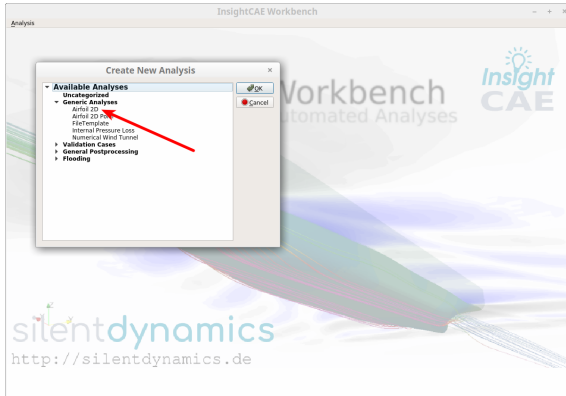
```
1 $ git clone git://git.code.sf.net/p/insightcae/code insight-src
2 $ mkdir insight && cd insight
3 $ cmake ../insight-src
4 $ make
```

## 1 \$ workbench



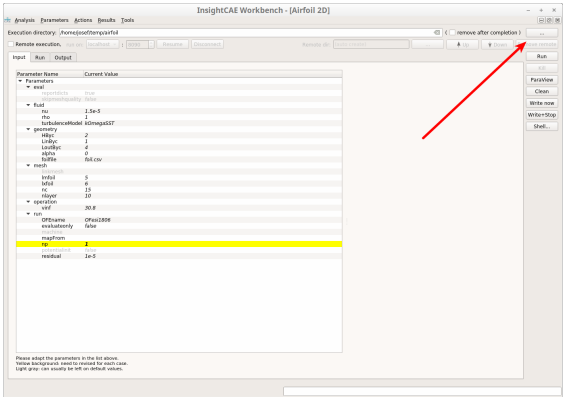
## Airfoil 2D

- Select Generic Analysis → Airfoil 2D



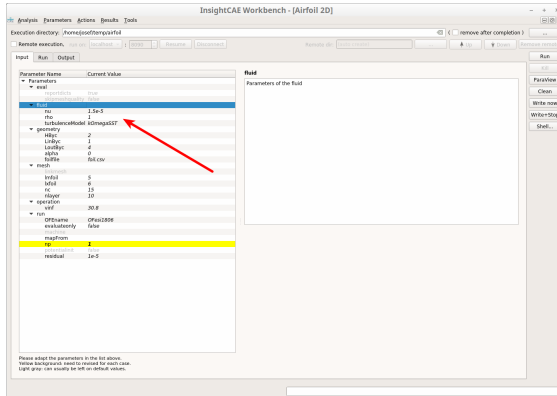
## Parameter Set

- ▶ Select execution directory



## Parameter Set: Fluid parameters

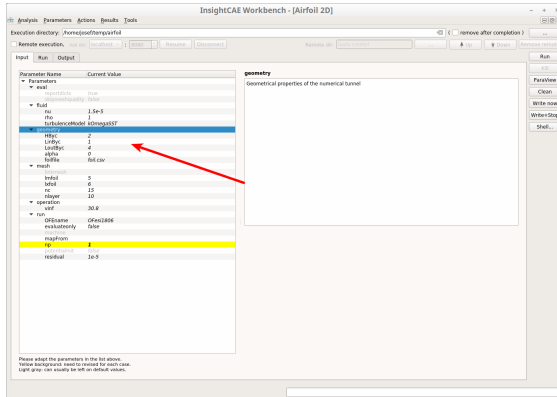
- Select fluid properties and turbulence model





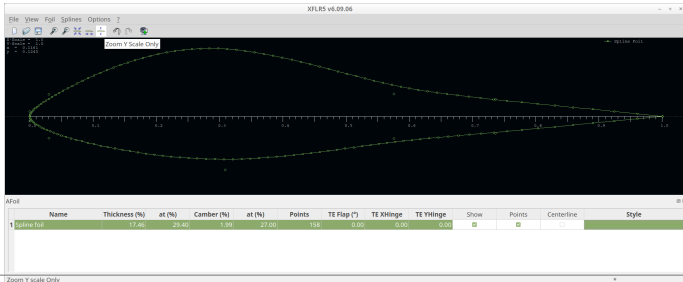
## Parameter Set: Geometry

- ▶ Select geometry properties
  - ▶ Bounding boxes
  - ▶ angle of attack  $\alpha$



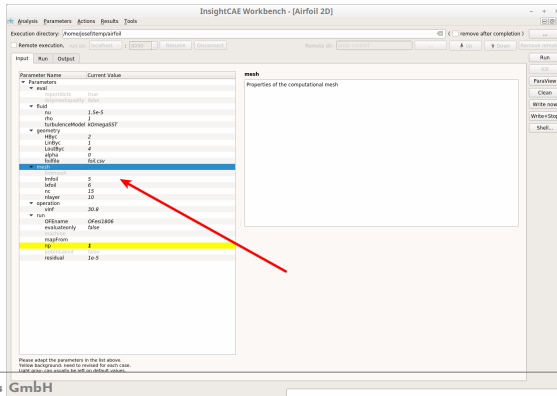
## Parameter Set: Foil Geometry

- ▶ Define Airfoil Geometry providing 2D points on the foil contour.
- ▶ X-coordinate is in the first column
- ▶ Y-coordinate in the second column
- ▶ Use simple airfoil program: **XFLR5**
  - ▶ E.g. direct foil design
  - ▶ Splines → Export Splines to file
  - ▶ Import to InsightCAE Workbench



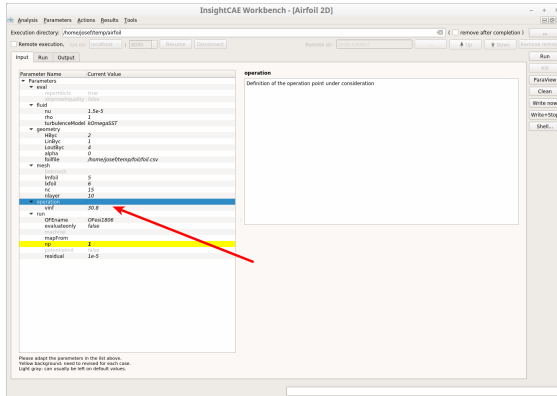
## Parameter Set: Mesh

- ▶ Meshing parameters
  - ▶ Cells along the span  $nc$
  - ▶ Set the minimum and maximum refinement level  $lm_{foil}$ ,  $lx_{foil}$
  - ▶ Number of prism layers  $n_{layer}$



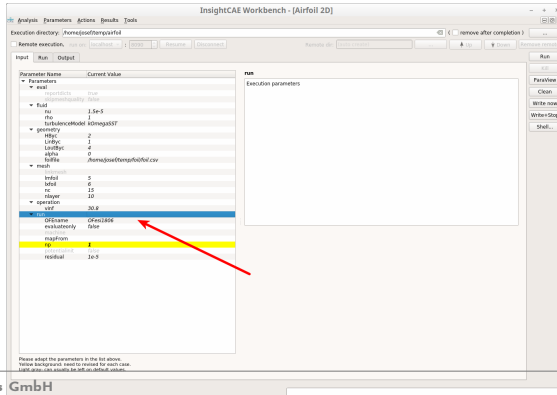
## Parameter Set: Operation Point

- Select infinite velocity



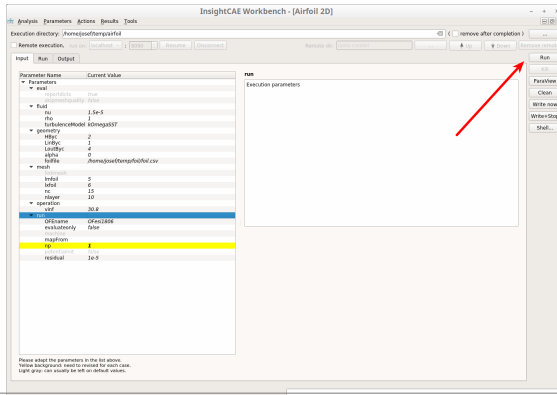
## Parameter Set: Simulation

- ▶ Select OpenFOAM Version
  - ▶ Number of processors *np*
  - ▶ Residual limit *residual*
  - ▶ Optional: potential init to enhance convergence



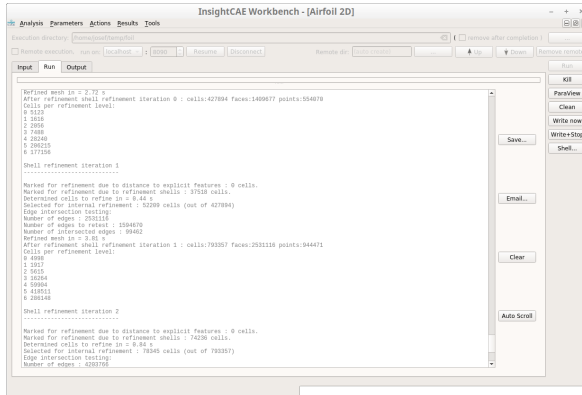
## Running the simulation

- ▶ Hit the RUN Button
- ▶ Meshing (snappyHexMesh/extrudeMesh), Solving (simpleFoam) processes using OpenFOAM will run in background



## Running the simulation

- ▶ Tab *Run* displays actual commands/processes
- ▶ OpenFOAM data is written to disk



The screenshot shows the InsightCAE Workbench interface for an Airfoil 2D simulation. The 'Run' tab is active, displaying the execution log. The log shows the refinement process, including the number of cells, faces, and points at each iteration. The output is as follows:

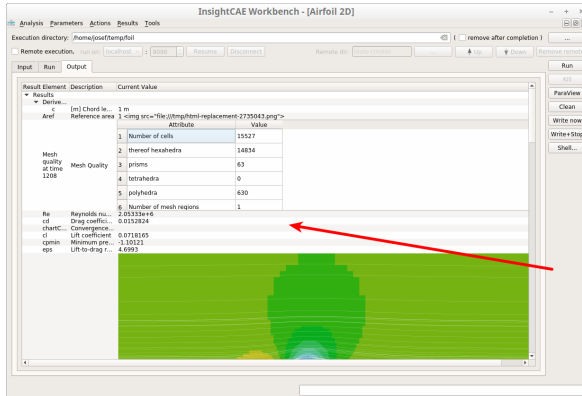
```
Refined mesh in = 2.72 s
After refinement shell refinement iteration 0 : cells:427894 faces:1409577 points:554070
Cells per refinement level:
0 5123
1 1616
2 2896
3 7488
4 28240
5 298215
6 377156

Shell refinement iteration 1
-----
Marked for refinement due to distance to explicit features : 0 cells.
Marked for refinement due to refinement shells : 37518 cells.
Determined cells to refine in = 0.44 s.
Selected for internal refinement : 52209 cells (out of 427894)
Edge intersection testing:
Number of edges : 2531116
Number of edges to refine : 1594670
Number of intersected edges : 99462
Refined mesh in = 3.81 s
After refinement shell refinement iteration 1 : cells:793957 faces:2531116 points:944471
Cells per refinement level:
0 4988
1 1357
2 5615
3 16264
4 59904
5 418511
6 285148

Shell refinement iteration 2
-----
Marked for refinement due to distance to explicit features : 0 cells.
Marked for refinement due to refinement shells : 74236 cells.
Determined cells to refine in = 0.44 s.
Selected for internal refinement : 78345 cells (out of 793957)
Edge intersection testing:
Number of edges : 4203766
```

## Postprocessing

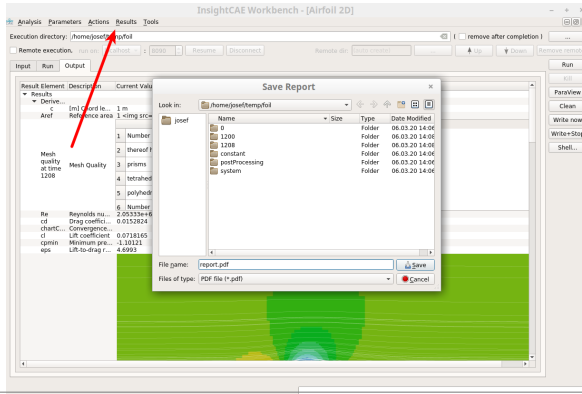
- Tab *Output* displays the results for the selected airfoil





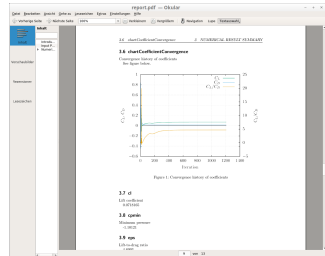
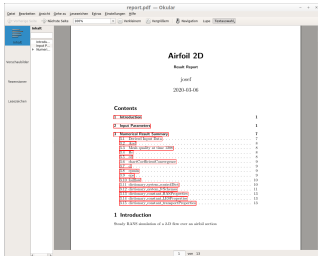
## Postprocessing

- ▶ Click on "Paraview" to view results directly
- ▶ Click on "Shell" to view data directory using bash
- ▶ Go to "Results" to create PDF report



## Postprocessing

- Report includes all simulation data



## Download report

## Remote execution

- ▶ Save case as *airfoil.ist*
- ▶ Pack all files (including geometry) into *airfoil.ist* for easy exchange
- ▶ Run on remote shell by

```
1 analyze airfoil.ist
```

- ▶ Simple run a parameter variation by (Velocity  $v_{inf}=50\text{m/s}$ )

```
1 analyze airfoil.ist --double operation/vinf:50
```

- ▶ Or mesh study by changing refinement levels




```
1 analyze airfoil.ist --int mesh/lxfoil:7 --int mesh/  
lmfoil:6
```

- ▶ See help

```
1 analyze --help
```

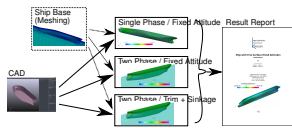
## Download file

## simple generic analyses for validation

- ▶ channel flow  

- ▶ flat plate  

- ▶ 2D airfoil  

- ▶ ...

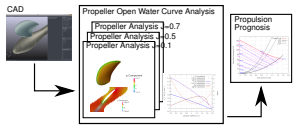
## CFD of ship resistance

- ▶ single phase
- ▶ two phase fixed
- ▶ two phase with trim and sinkage



## propeller and turbomachinery analyses

- ▶ free propeller
- ▶ ducted propeller
- ▶ axial pump
- ▶ optimal diameter, optimal rpm, propulsion prognosis



Thank you

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