4th Symposium on Collaboration in Aircraft Design

Application of CPACS to existing software (PANUKL, SDSA, OPTOM)

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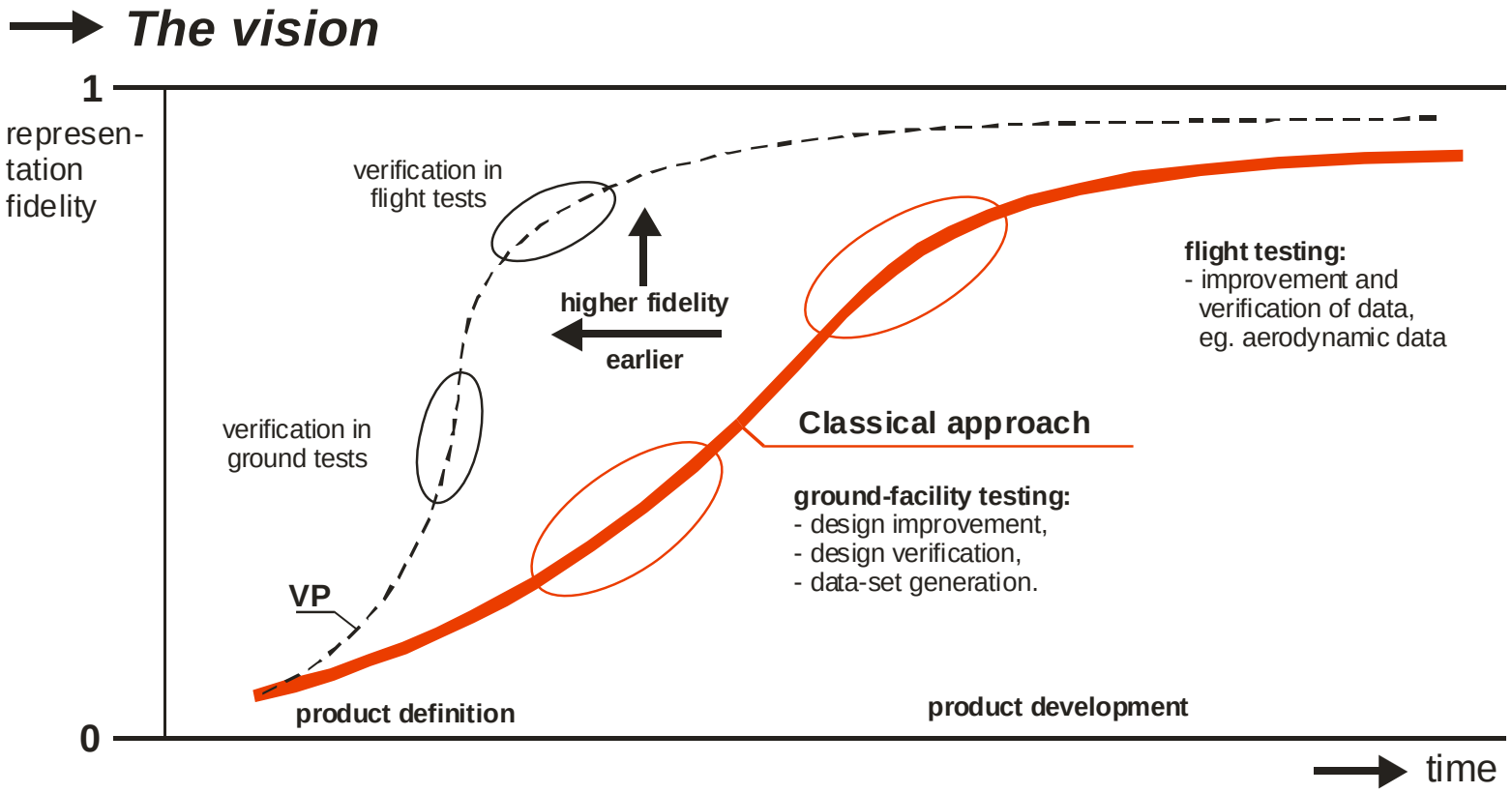
Outline

- Genesis
  - SimSAC – CEASIOM
  - OPTOM (optimization needs application in batch mode)
- Searching for common format of data
- Tools included in MADO
  - our code:
    - PANUKL
    - SDSA
    - OPTOM
  - external code
    - XFOIL
    - CALCULIX
- Conclusions

Genesis

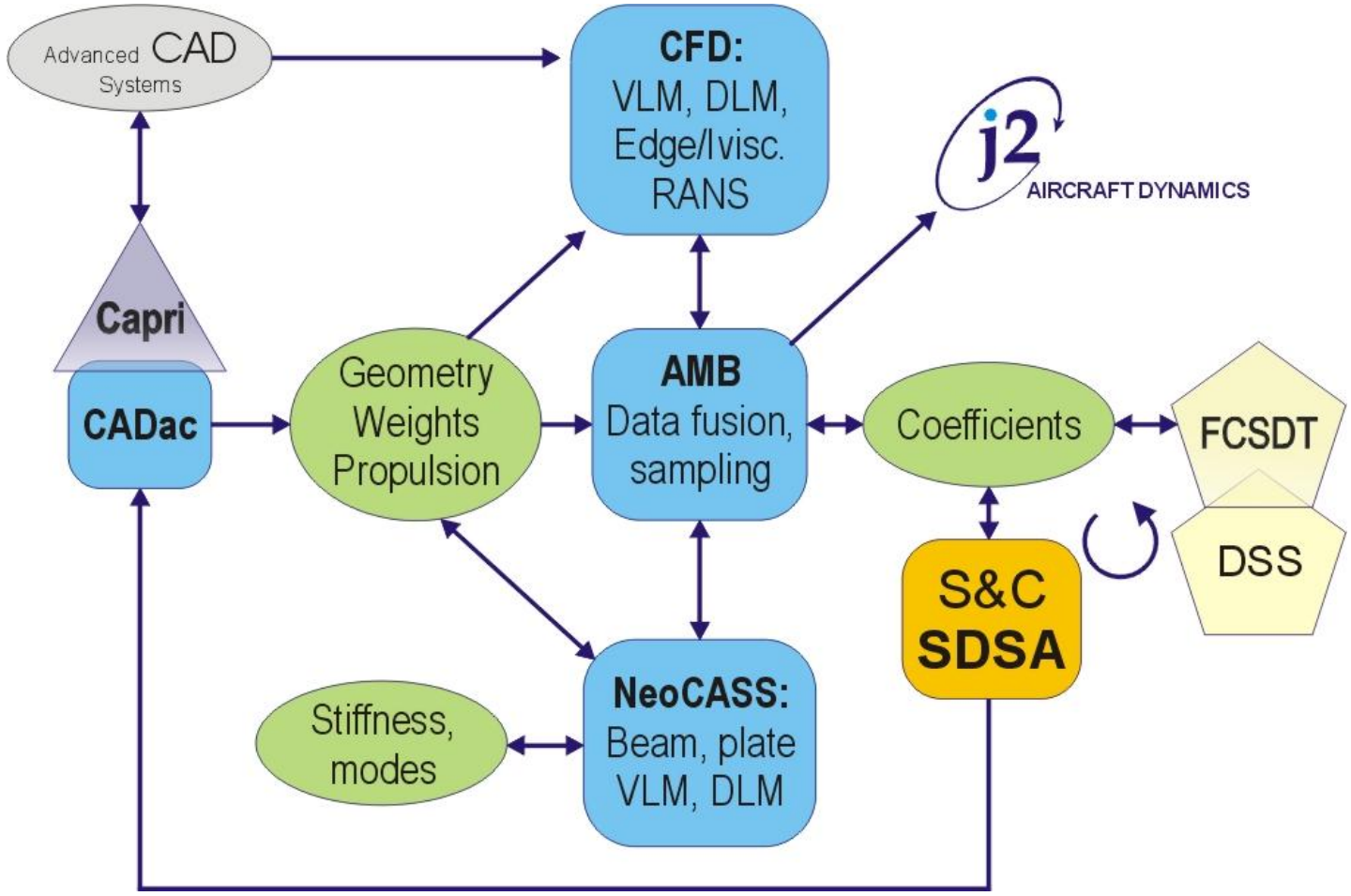
- in the beginning there was chaos
- after that was SimSAC

Genesis

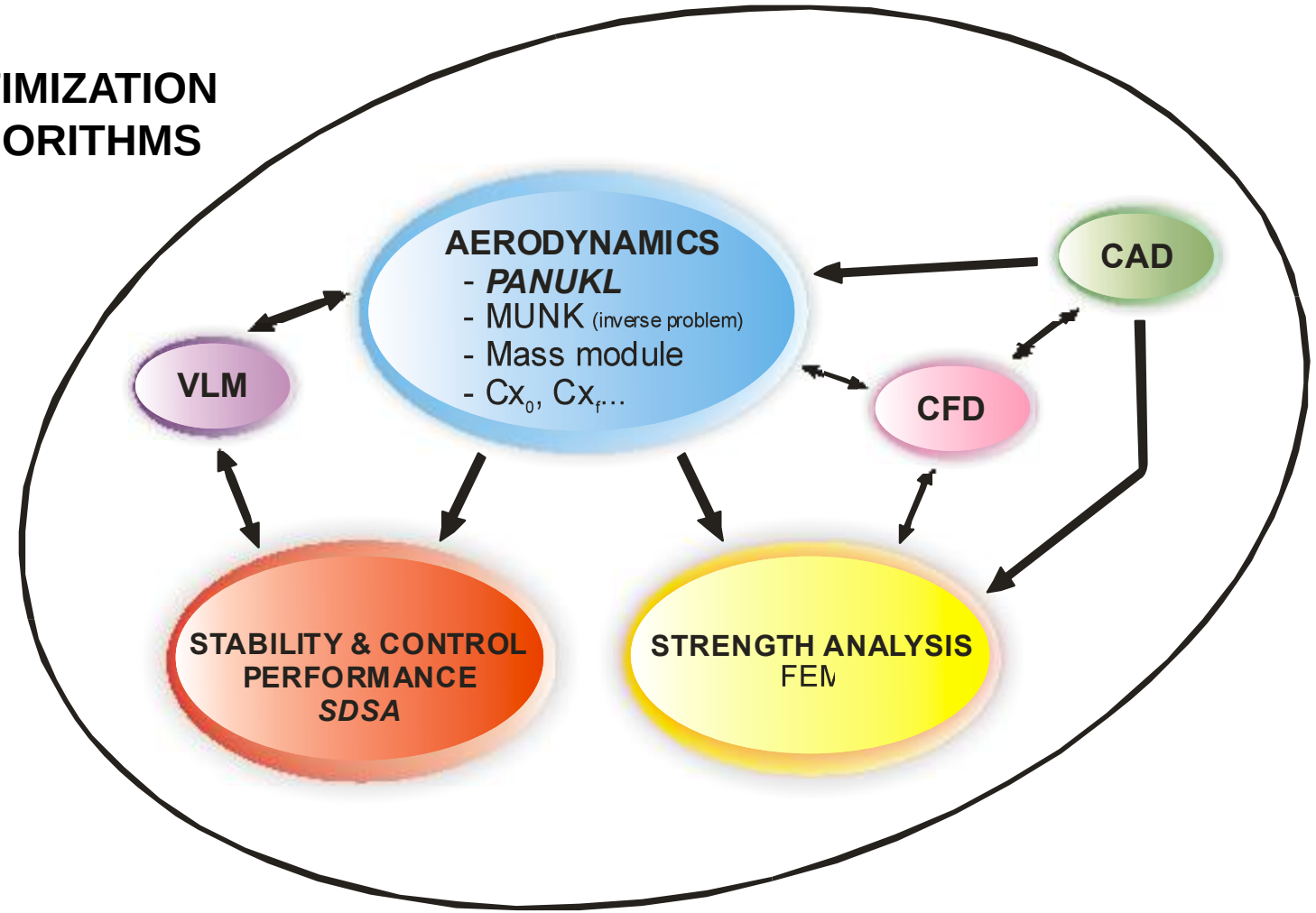


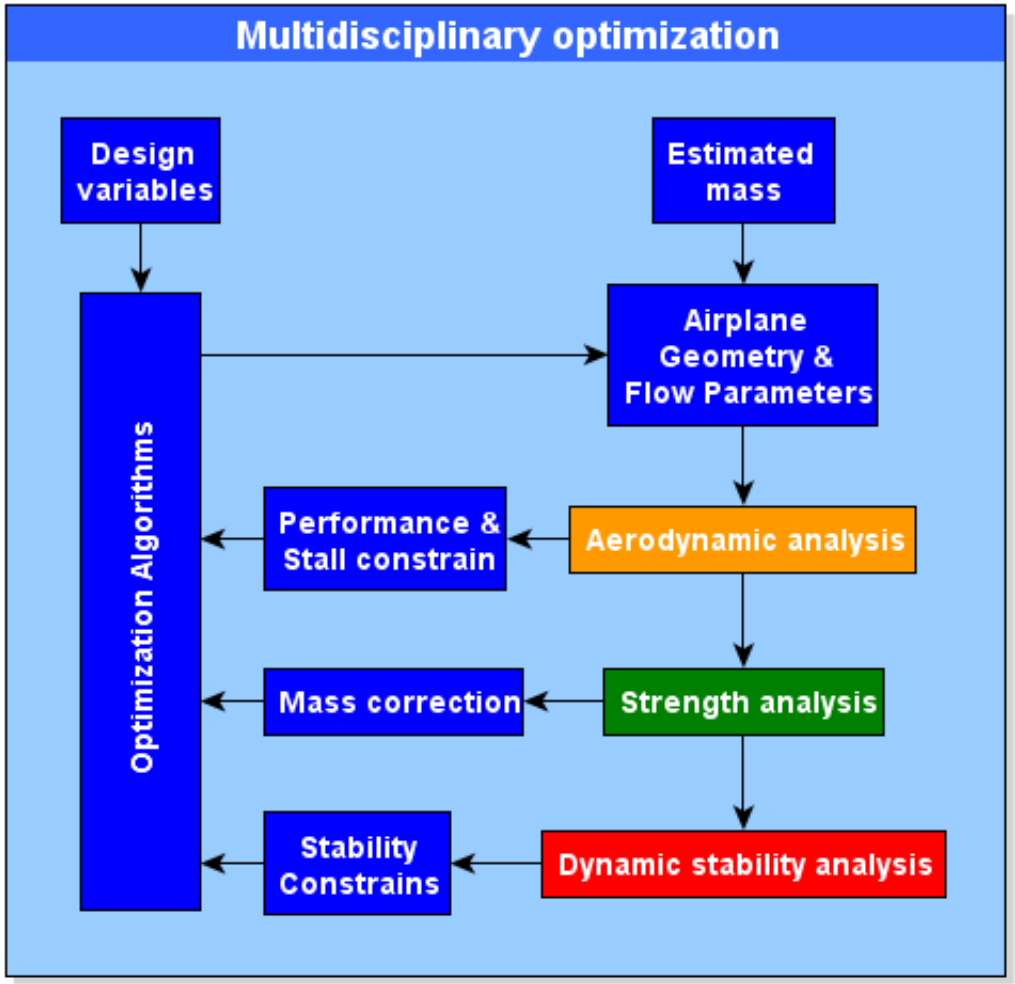
Idea of SimSAC

CEASIOM - architecture



Idea of MADO


OPTIMIZATION ALGORITHMS
AERODYNAMICS
- PANUKL
- MUNK (inverse problem)
- Mass module
- Cx_0, Cx_f...
CAD
VLM
CFD
STABILITY & CONTROL
PERFORMANCE
SDSA
STRENGTH ANALYSIS
FEM

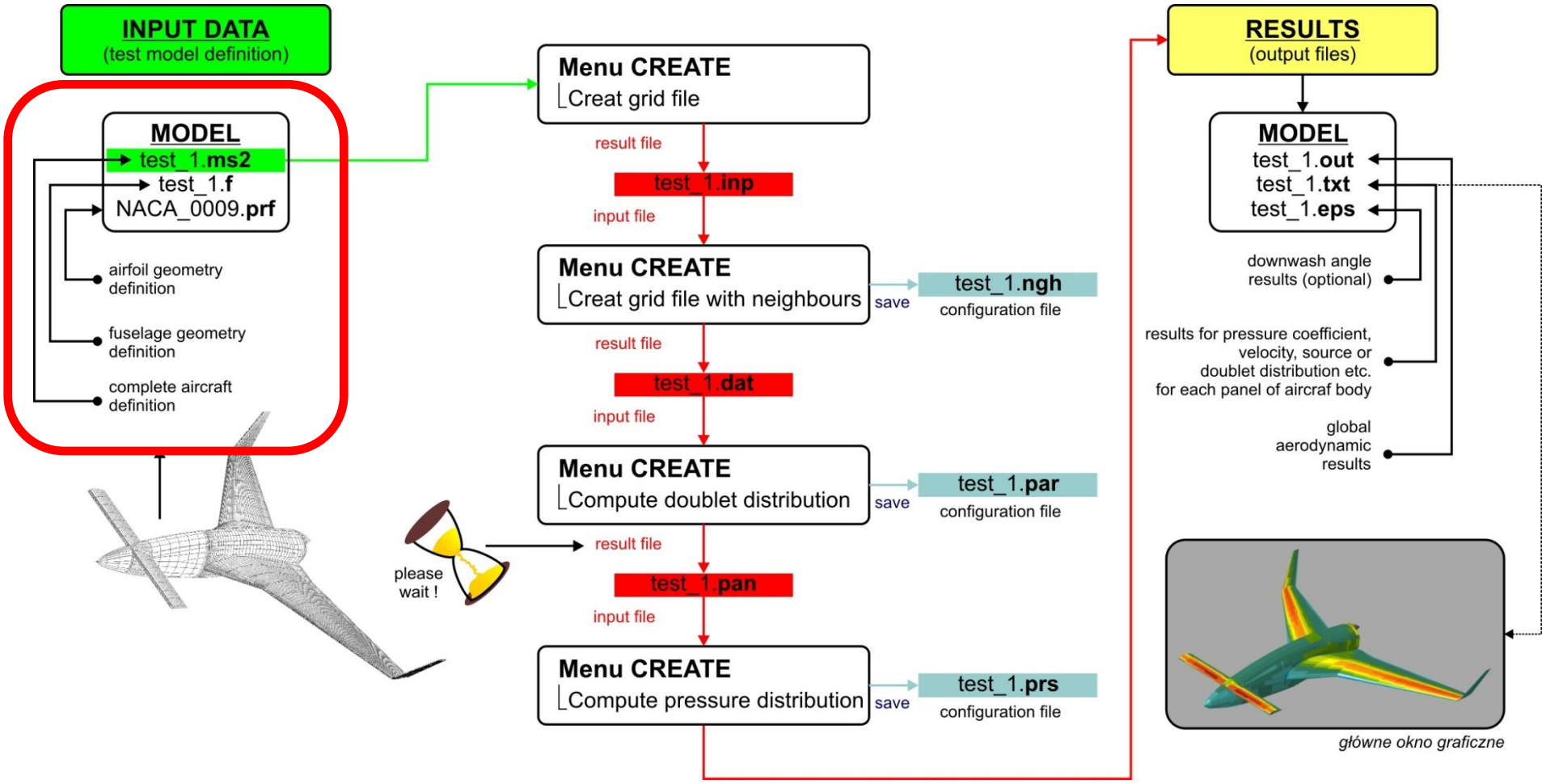


Data flow in MADO (Multidisciplinary Aircraft Design and Optimization)

Main problems

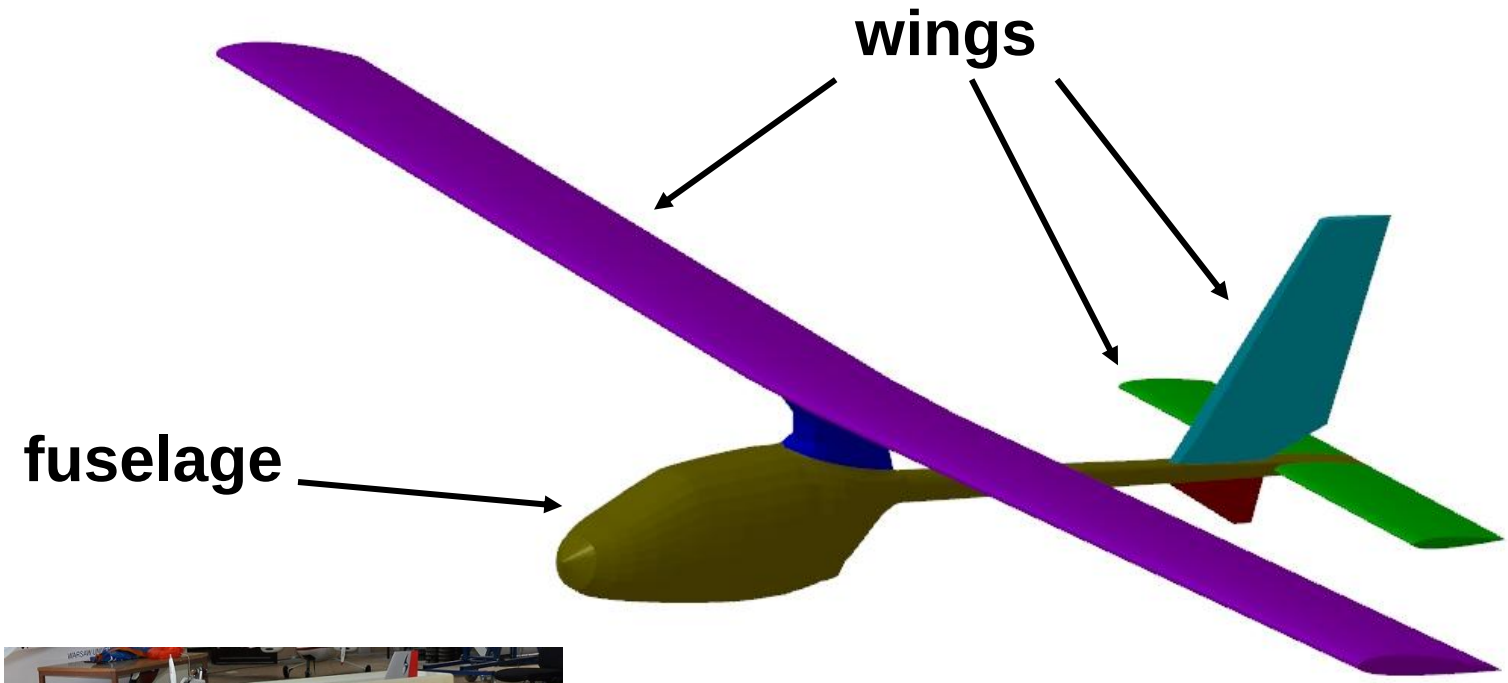
- common language for data flow
- most of application require interaction:
  - geometry (CAD systems, AMB, etc.)
  - grid preparing (preprocessors of CFD packages: VSARO, MGAERO, PANUKL)
  - FEM analysis (CalculiX)
  - Stability analysis (SDSA)

PANUKL - stages of analysis



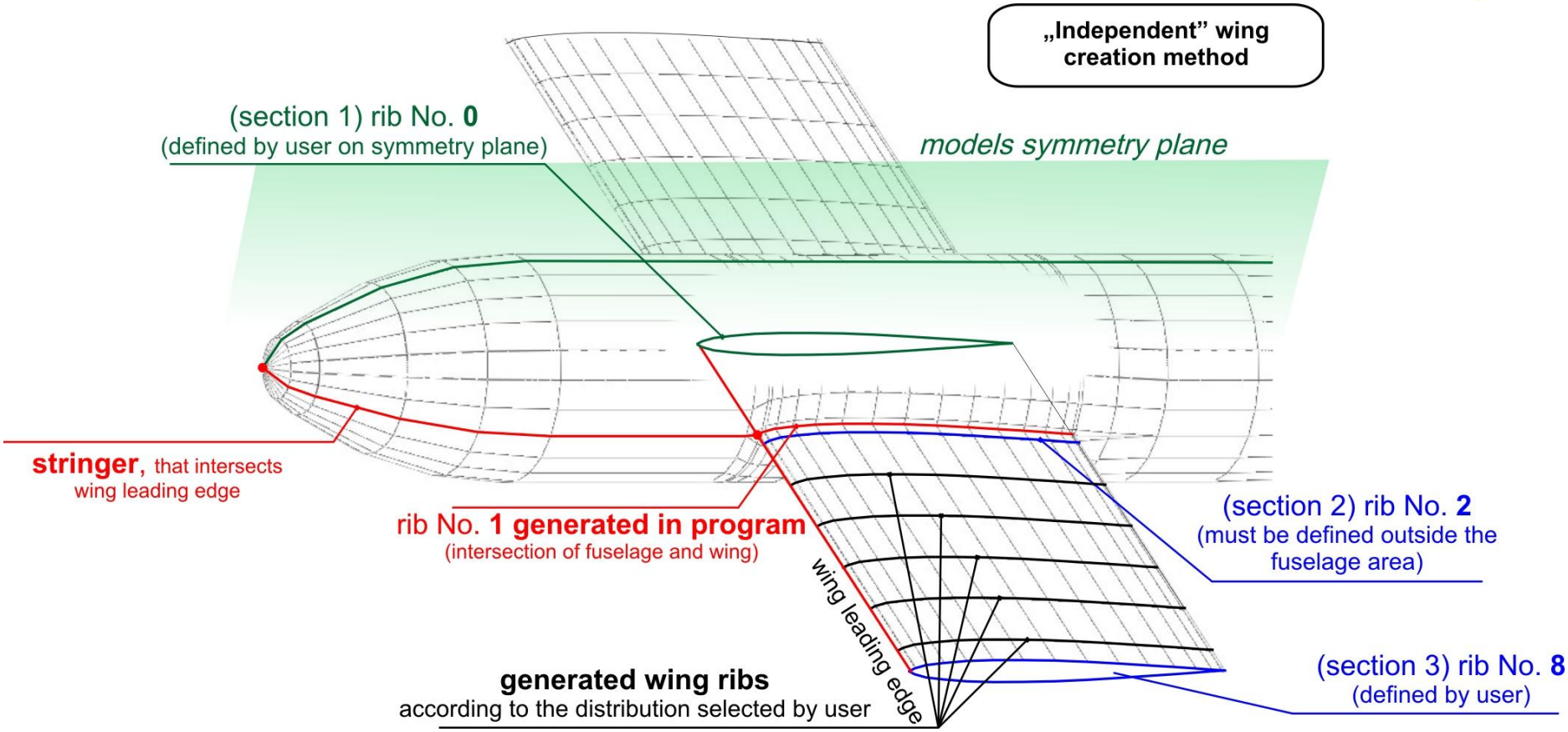
http://www.meil.pw.edu.pl/add/ADD/Teaching/Software/PANUKL

Main types of objects



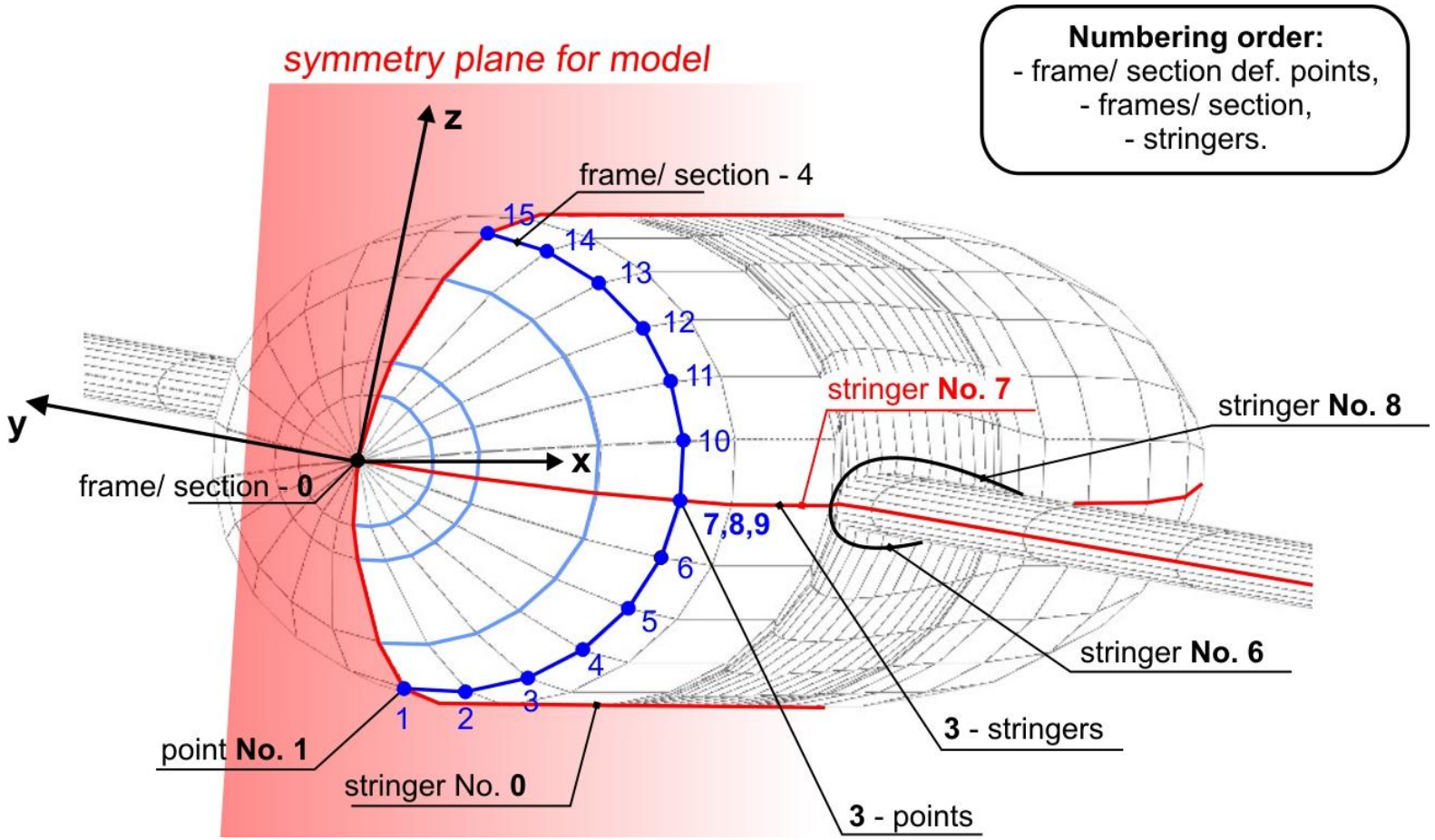
PW Zoom – currently in Antarctic (MONICA project)

Wings from sections – similar to CPACS



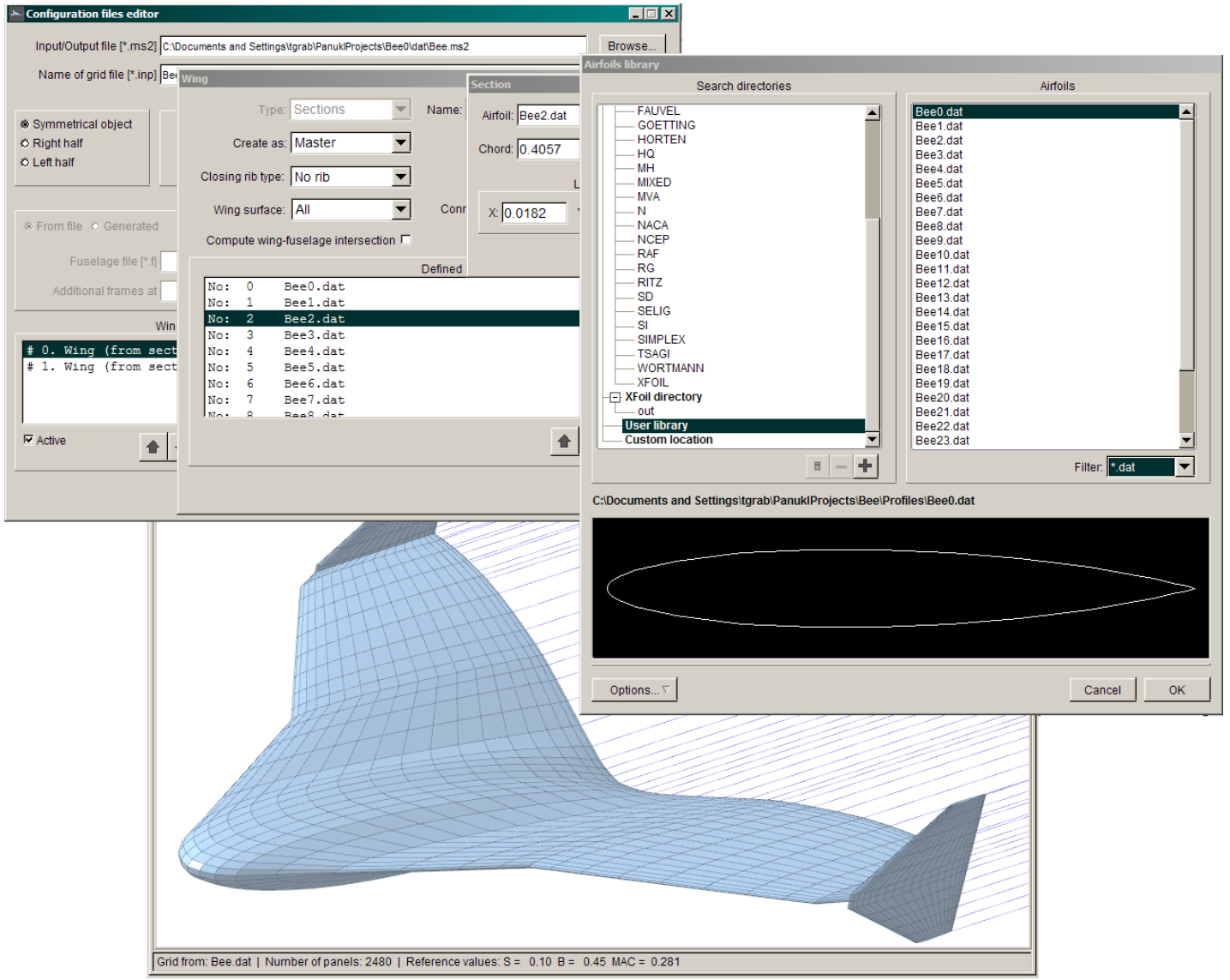
Airfoils are defined in separate files – four different formats are accepted (xfoil, koo, prf2, prf4)

Fuselage creation – similar to CPACS



Fuselage geometry description

Ms2editor



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Collaboration in Aircraft Design

MS2 and CPACS comparison

MS2	CPACS
	<rotation>
xrot	<x>
yrot	<y>
zrot	<z>

wing-fuselage paneling:

master/slave/independent → **?**

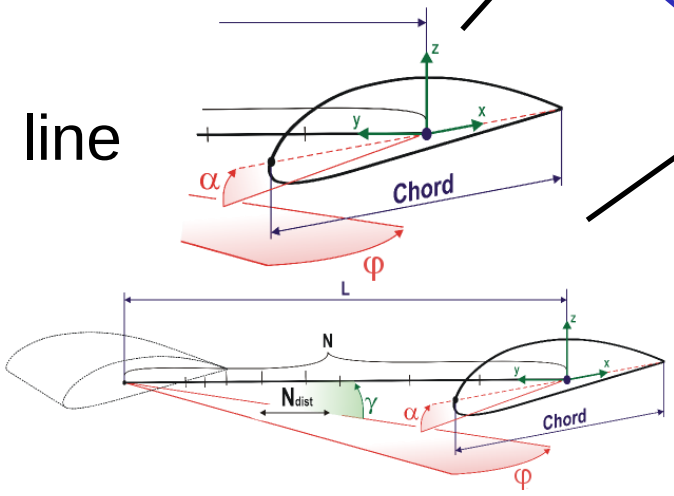
MS2 and CPACS comparison

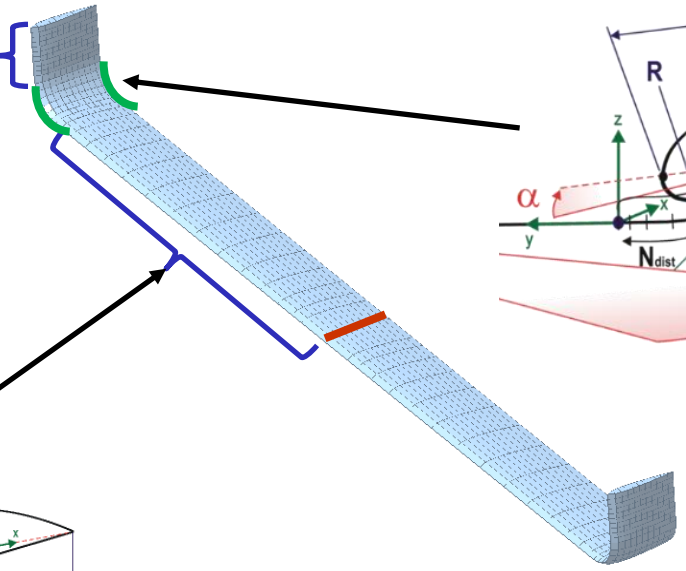
WINGS

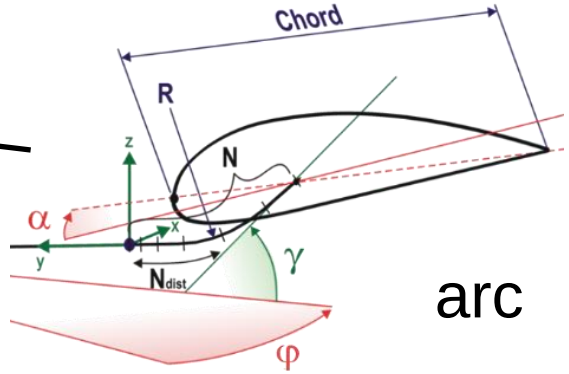
MS2	CPACS
MeshVersion	<version>
Header	<header>
reference area	<area>
MAC	<length>
wing span	<length>
X-0.25MAC	<x>
Z-0.25MAC	<z>
scale	<scaling>
output file (*.inp)	<name>
wings with chord paneling	
wings without chord paneling	
symmetry flag (int)	<symmetry>
wing - sections	<wings>
name	<name>
type	constant (sections)
master/slave/independent	
surface - all/bottom/top	
twist point	
chord type paneling flag (int)	
nr of chord panels	<chordwise>
tip rib flag (int)	<shape>
fus logeron-wing intersection	
cut/glue wing to fus flag (bool)	
wing span paneling type (int)	
section	
airfoil coordinates file name	<name>
chord	*<scaling>*
rib nr	*<sections uID>*
x	<x> (translation)
y	<y> (translation)
z	<z> (translation)
xrot (deg)	<x> (rotation)
yrot (deg)	<y> (rotation)
zrot (deg)	<z> (rotation)

Module wings

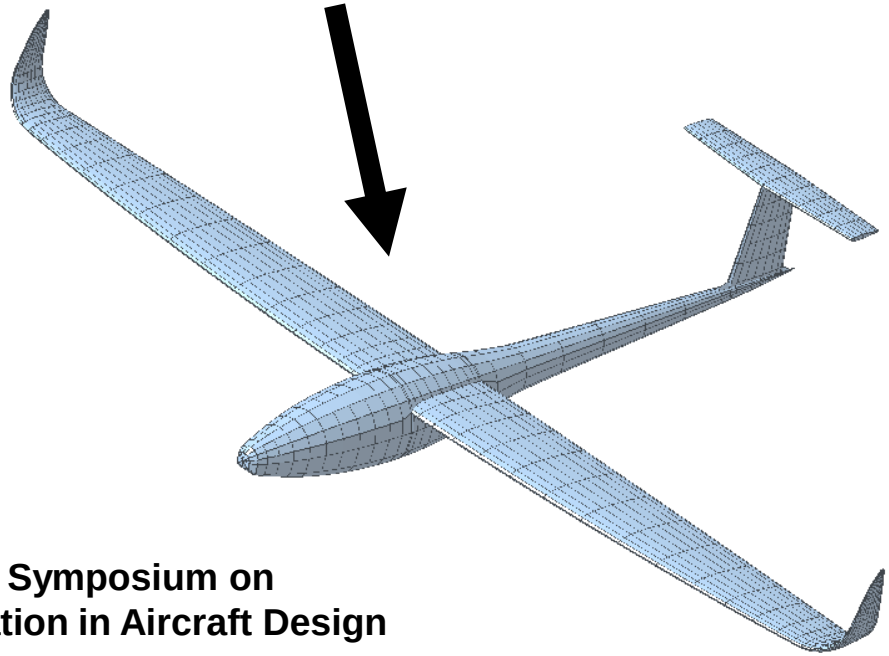
line







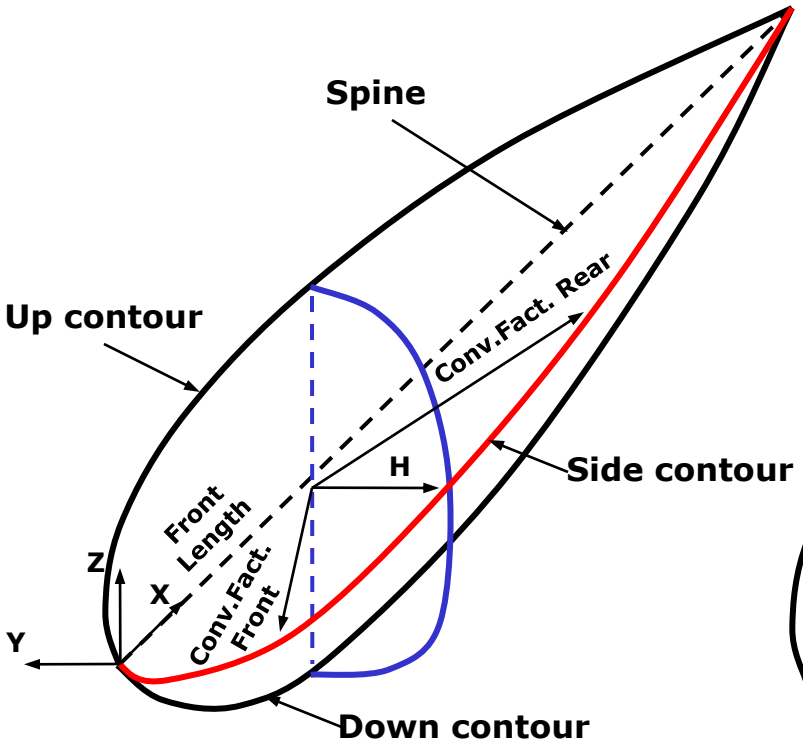
arc

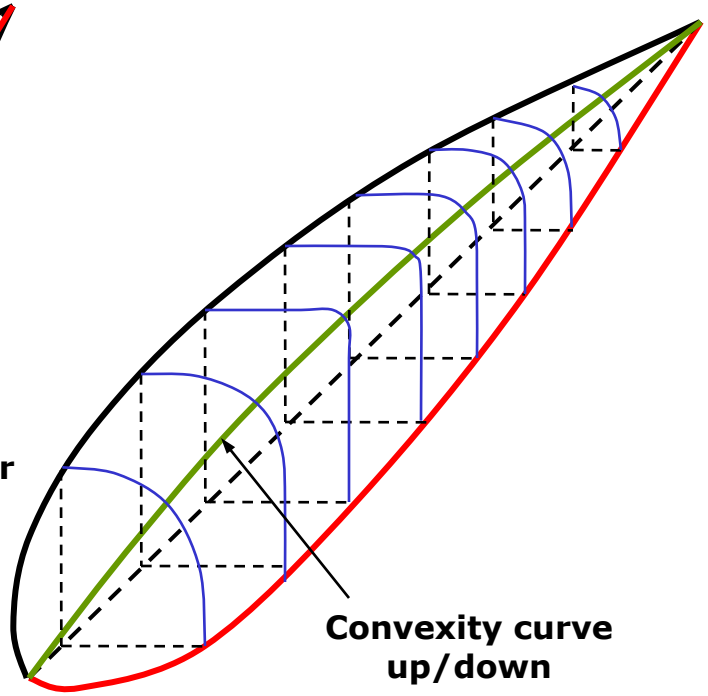


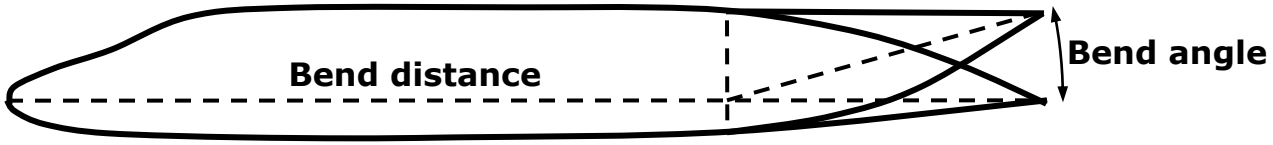
modules:

- root
- line
- equi.line
- arc

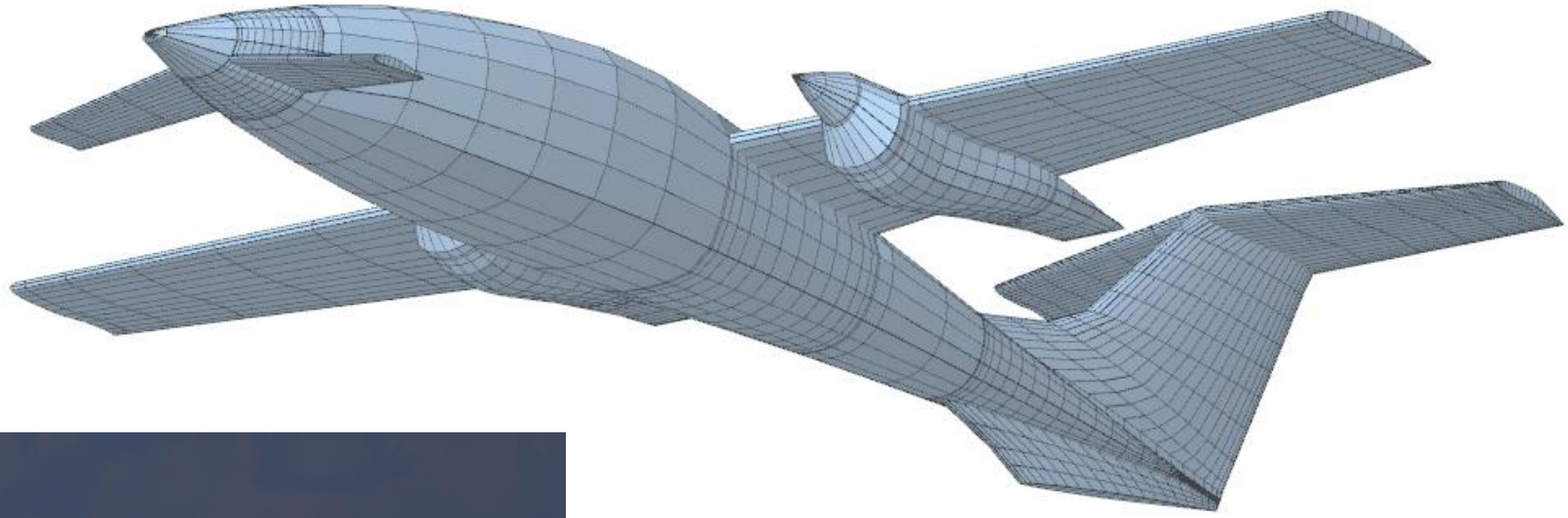
New fuselage definition



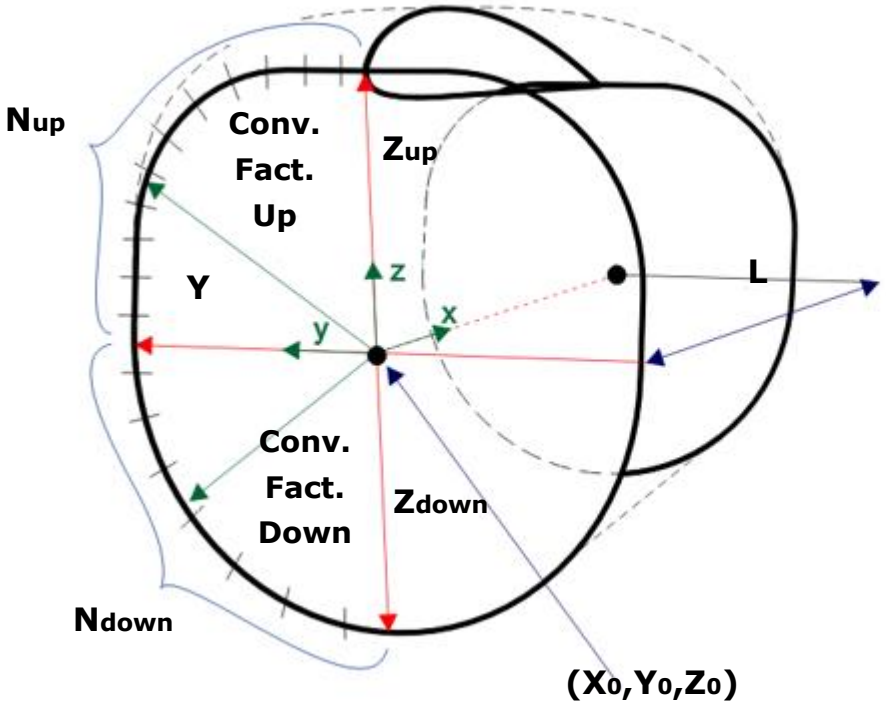


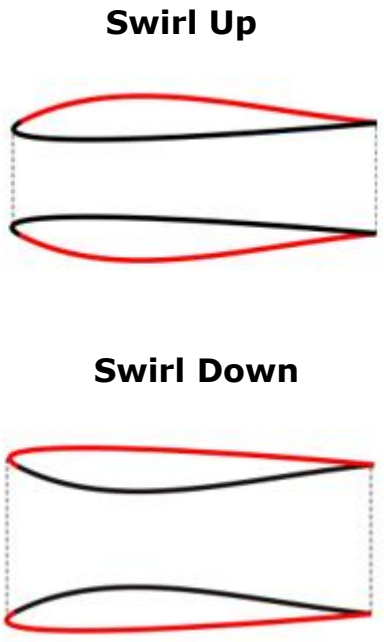


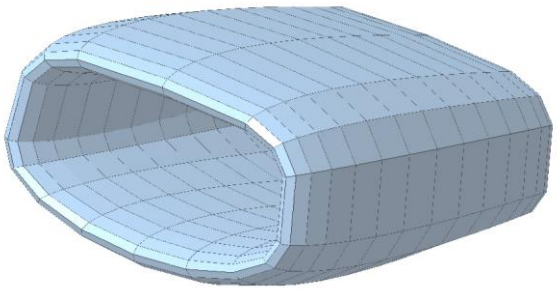
Nacelles (as fuselages)

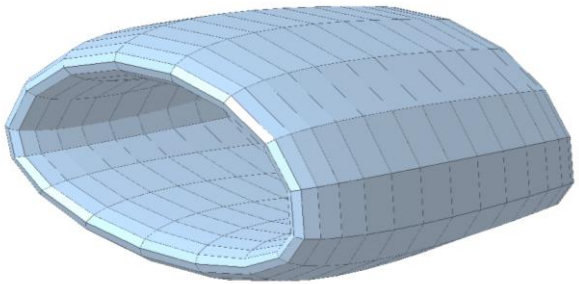


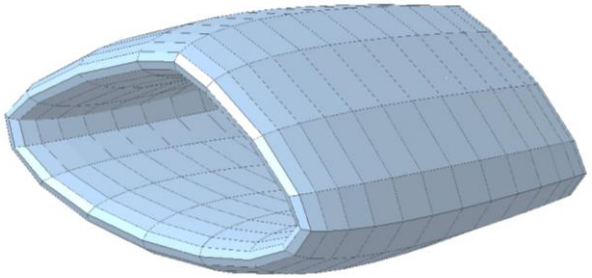
Nacelles (as wings)



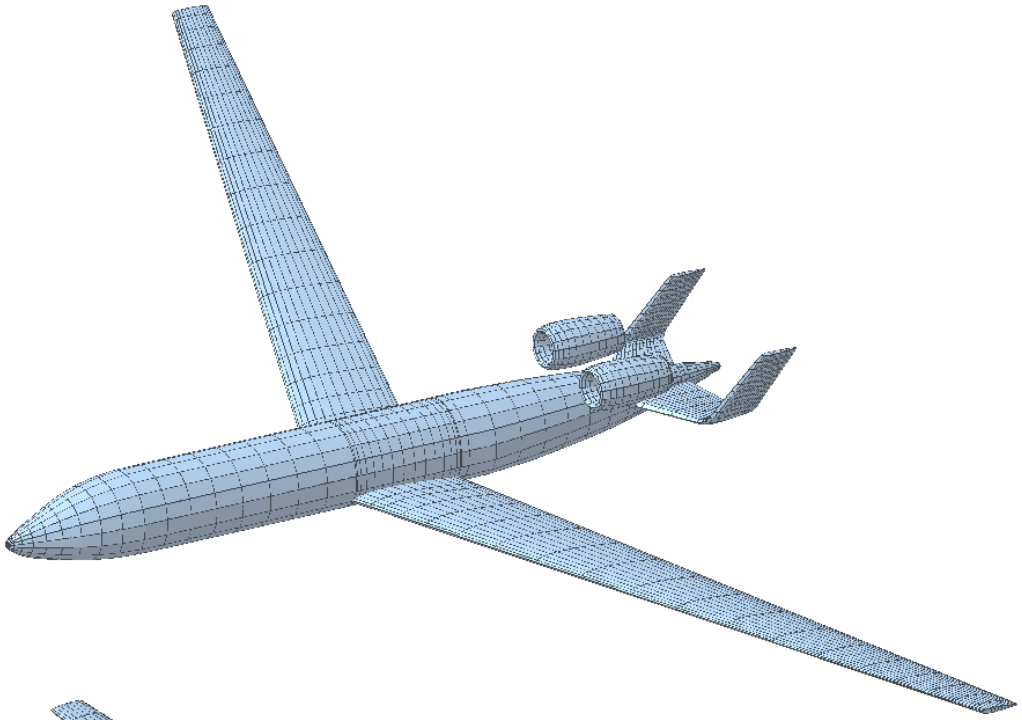


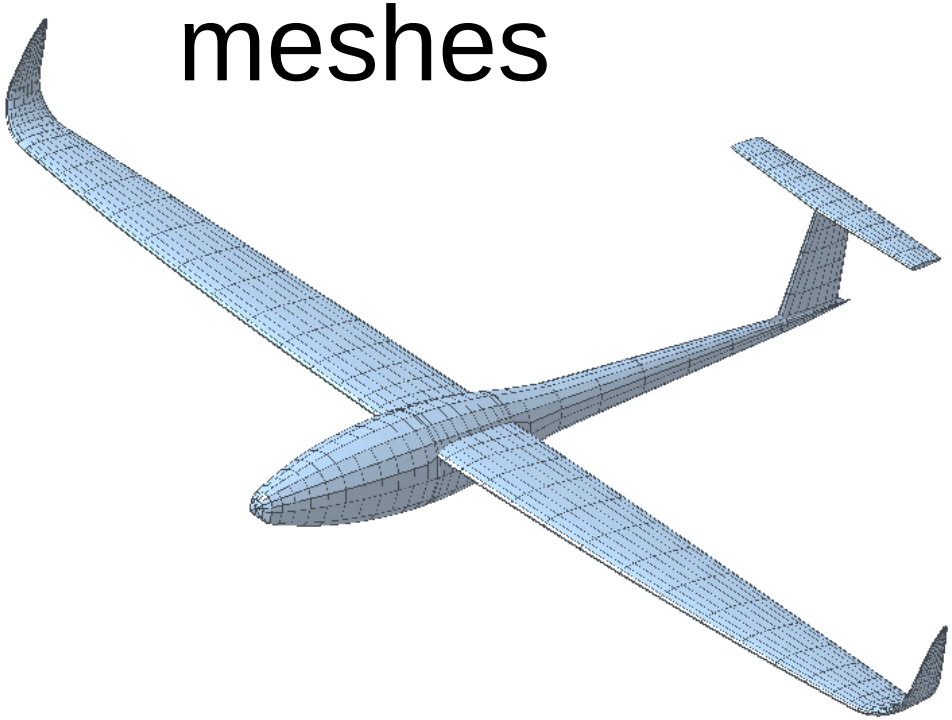


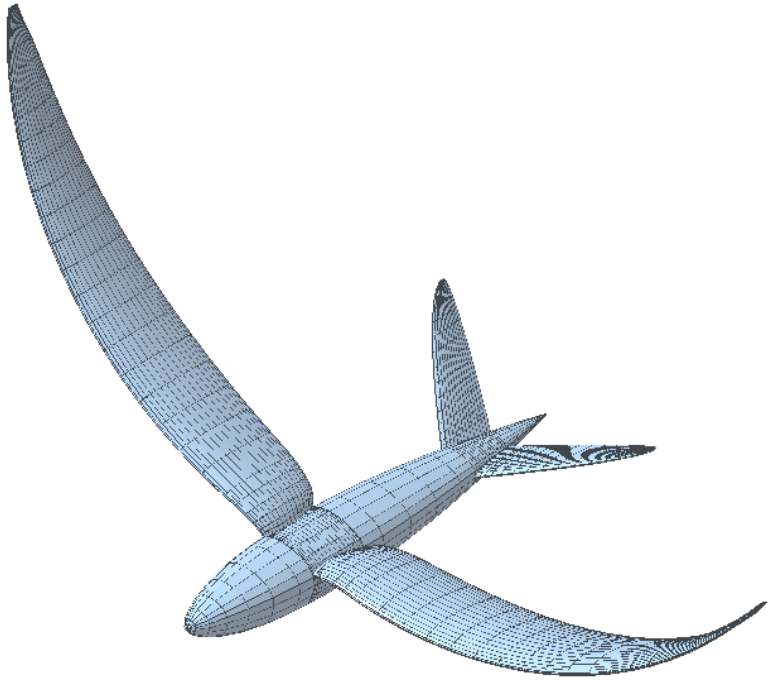




Examples of advanced meshes







Innovative airplanes mesh in CPACS

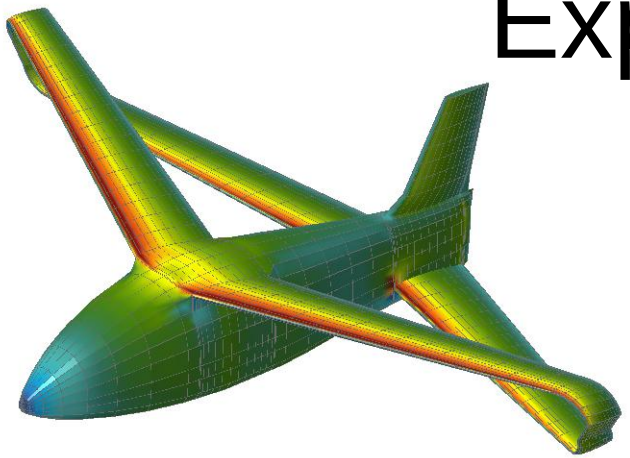
MS2 **CPACS**

Module structures → Based on sections ⇄ XML

One direction export.

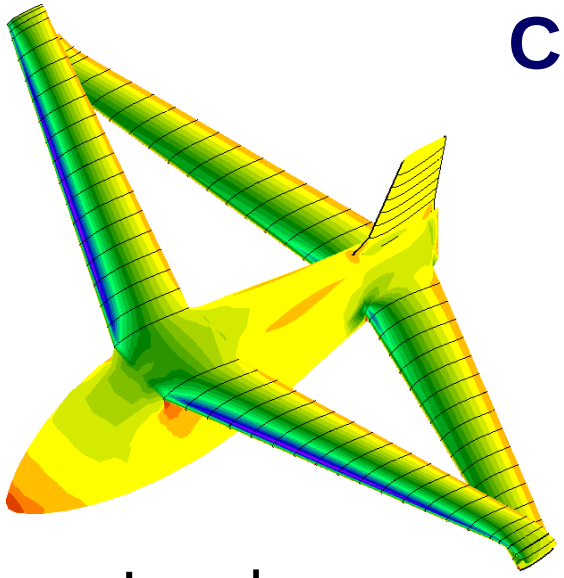
Is it satisfactory solution?

Export to CalculiX



PANUKL

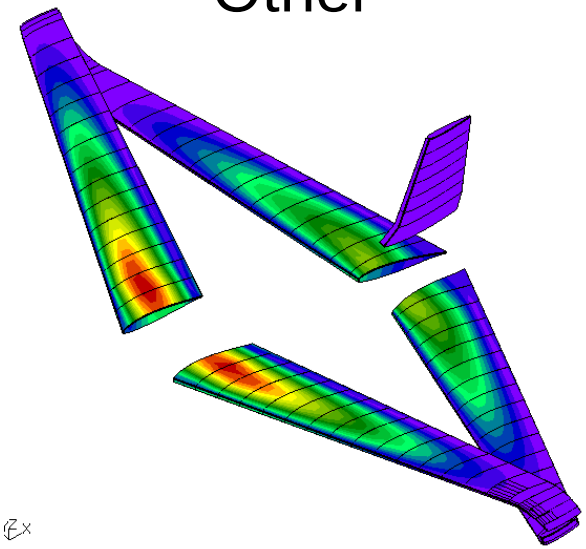
- Geometry
- Pressure distribution



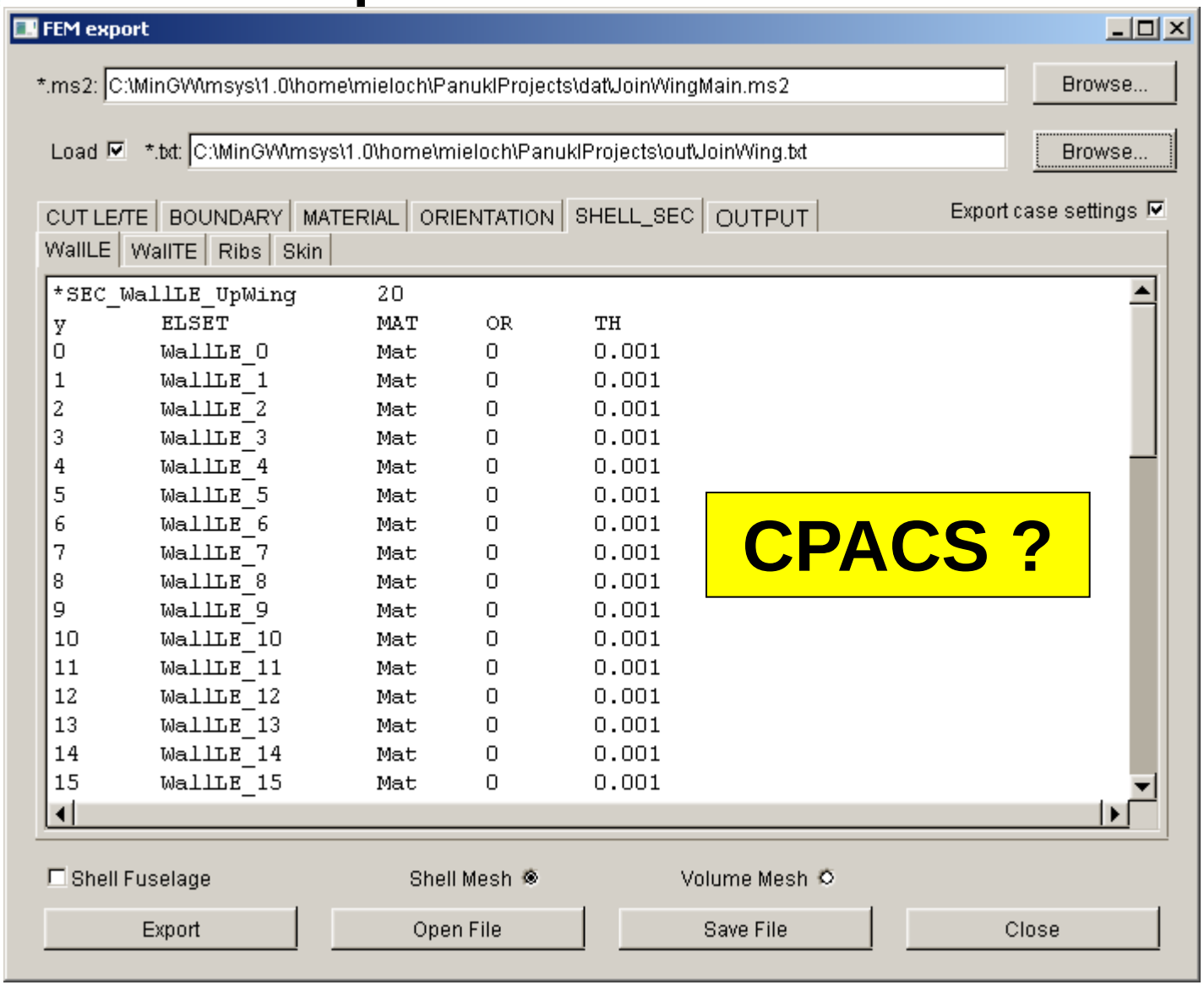
- Loads
- Constrains
- Material
- Other

CalculiX

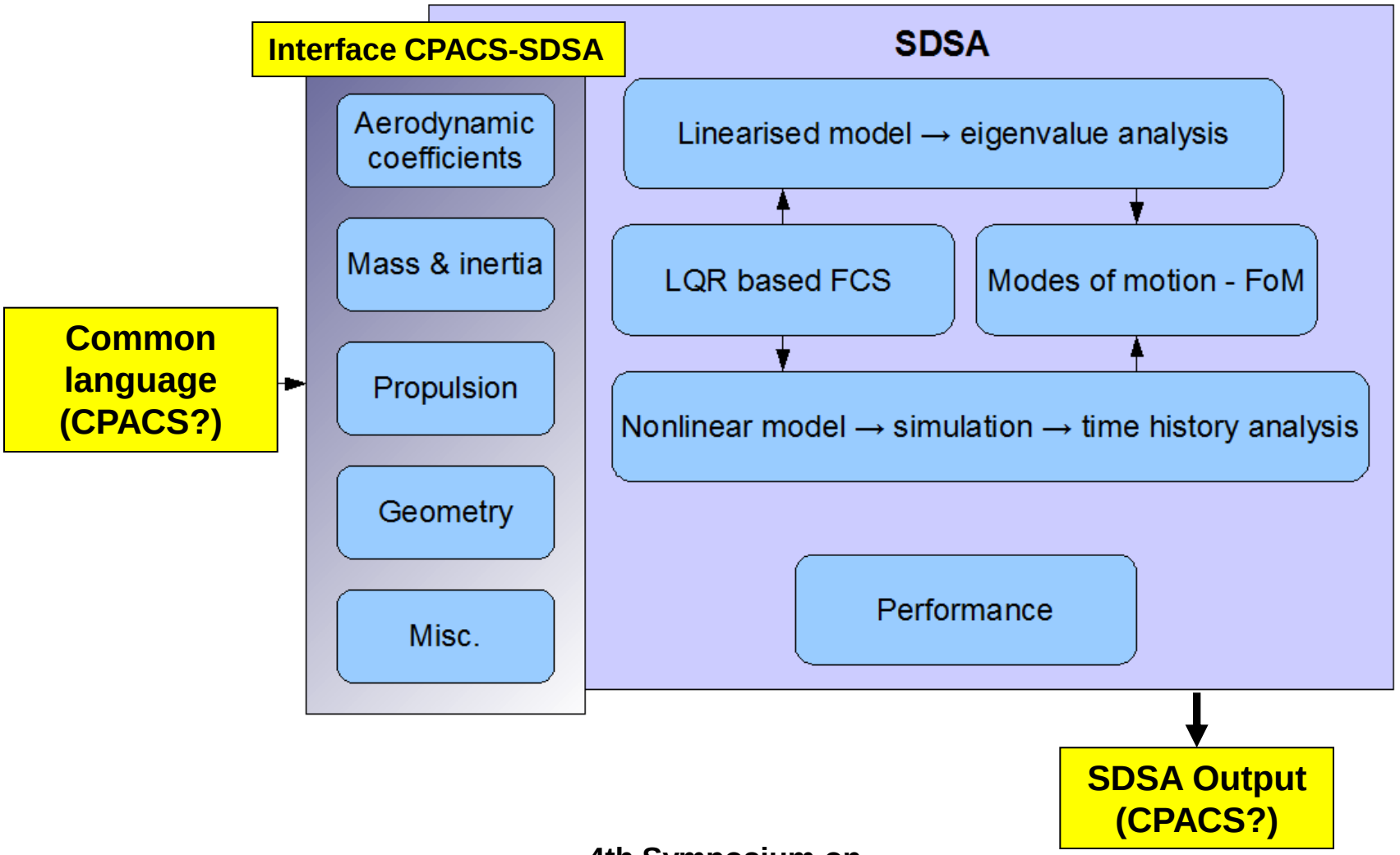
- Stress
- Deflection
- Other

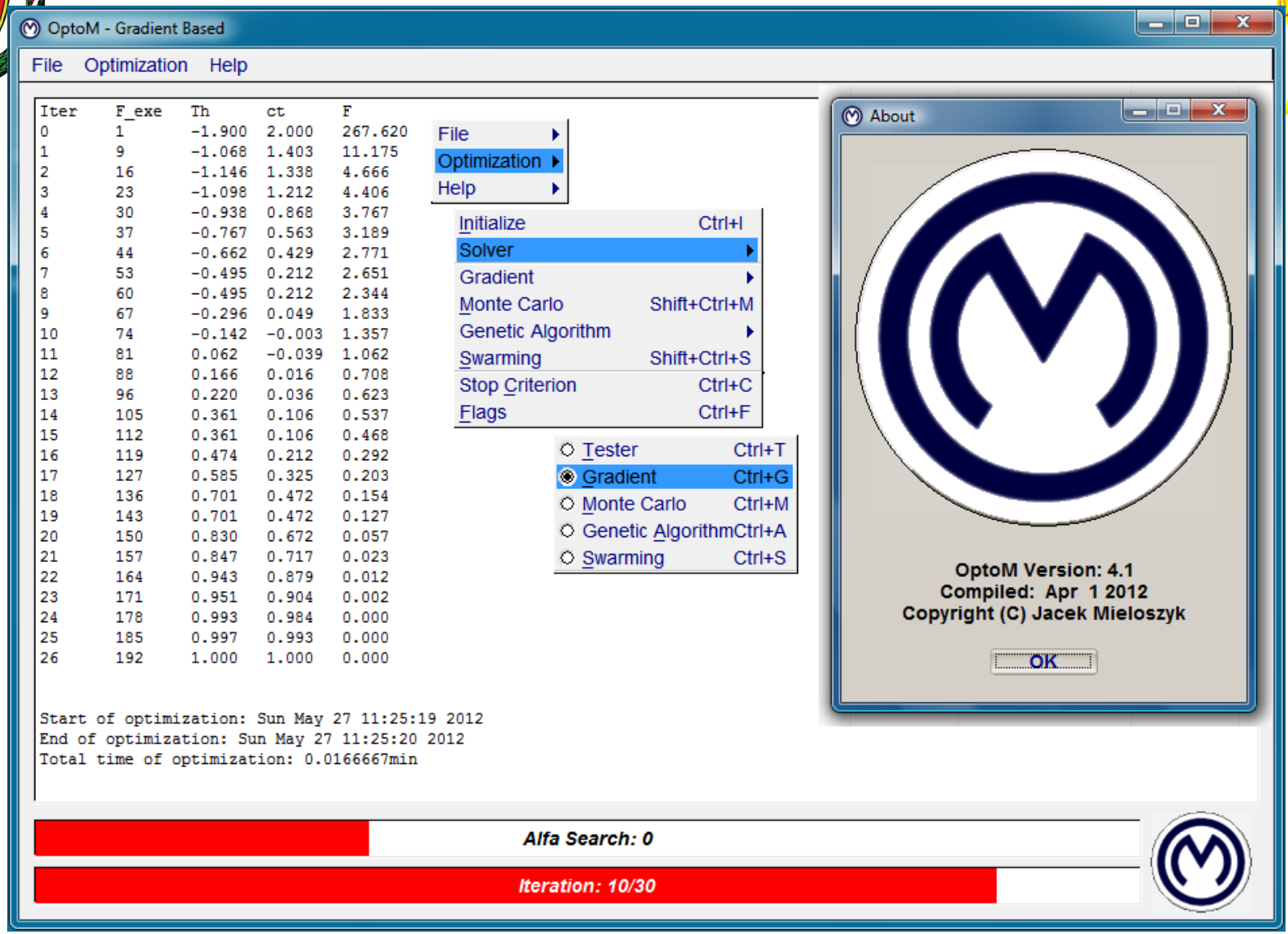


Export to CalculiX



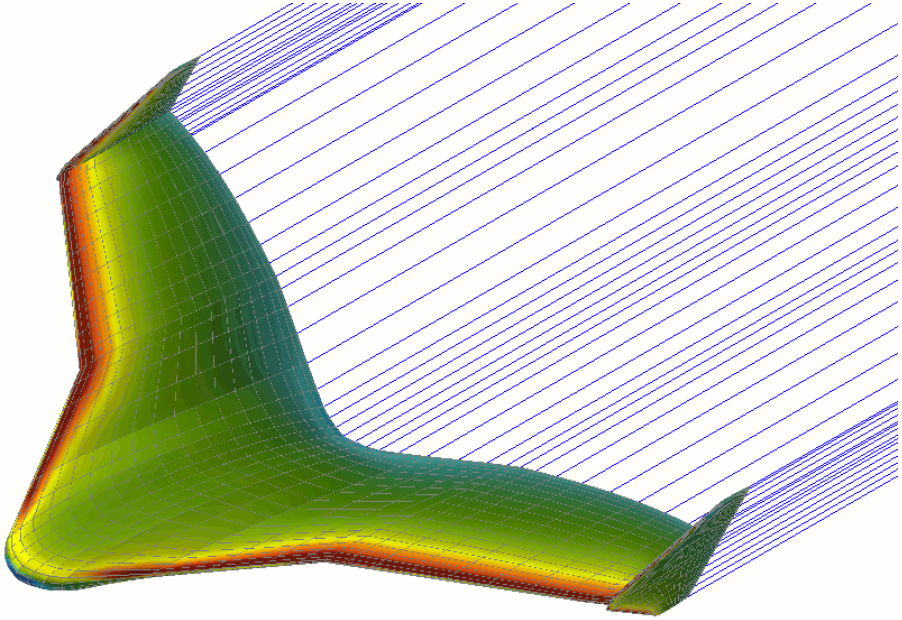
SDSA architecture

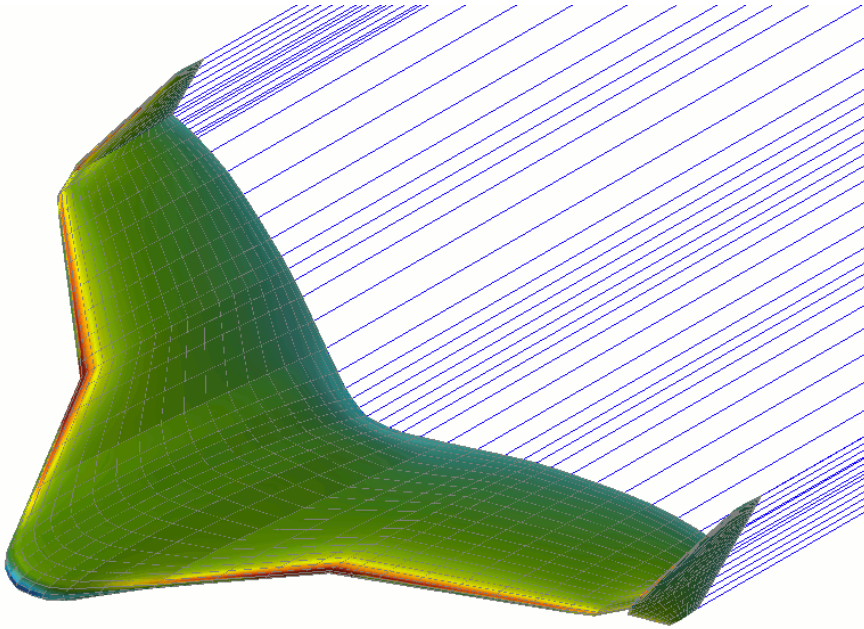



OptoM - Gradient Based
File
Optimization
Help
Iter F_exe Th ct F
0 1 -1.900 2.000 267.620
1 9 -1.068 1.403 11.175
2 16 -1.146 1.338 4.666
3 23 -1.098 1.212 4.406
4 30 -0.938 0.868 3.767
5 37 -0.767 0.563 3.189
6 44 -0.662 0.429 2.771
7 53 -0.495 0.212 2.651
8 60 -0.495 0.212 2.344
9 67 -0.296 0.049 1.833
10 74 -0.142 -0.003 1.357
11 81 0.062 -0.039 1.062
12 88 0.166 0.016 0.708
13 96 0.220 0.036 0.623
14 105 0.361 0.106 0.537
15 112 0.361 0.106 0.468
16 119 0.474 0.212 0.292
17 127 0.585 0.325 0.203
18 136 0.701 0.472 0.154
19 143 0.701 0.472 0.127
20 150 0.830 0.672 0.057
21 157 0.847 0.717 0.023
22 164 0.943 0.879 0.012
23 171 0.951 0.904 0.002
24 178 0.993 0.984 0.000
25 185 0.997 0.993 0.000
26 192 1.000 1.000 0.000
Start of optimization: Sun May 27 11:25:19 2012
End of optimization: Sun May 27 11:25:20 2012
Total time of optimization: 0.0166667min
File
Optimization
Help
Initialize Ctrl+I
Solver
Gradient
Monte Carlo Shift+Ctrl+M
Genetic Algorithm
Swarming Shift+Ctrl+S
Stop Criterion Ctrl+C
Flags Ctrl+F
Tester Ctrl+T
Gradient Ctrl+G
Monte Carlo Ctrl+M
Genetic Algorithm Ctrl+A
Swarming Ctrl+S
About
OptoM Version: 4.1
Compiled: Apr 1 2012
Copyright (C) Jacek Mieloszyk
OK
Alfa Search: 0
Iteration: 10/30

MADO – MAV optimization

Iteration 0

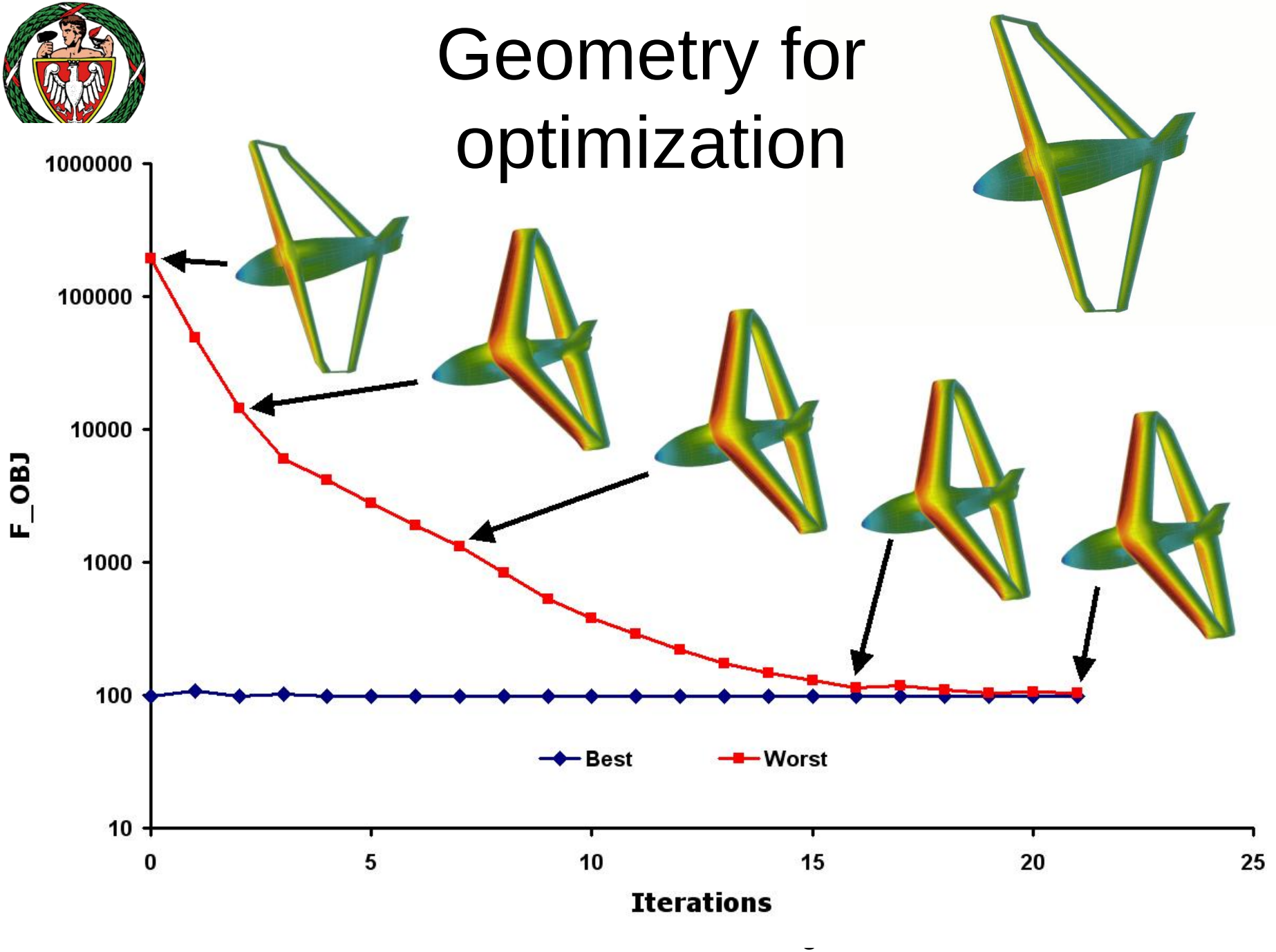




The worst in population

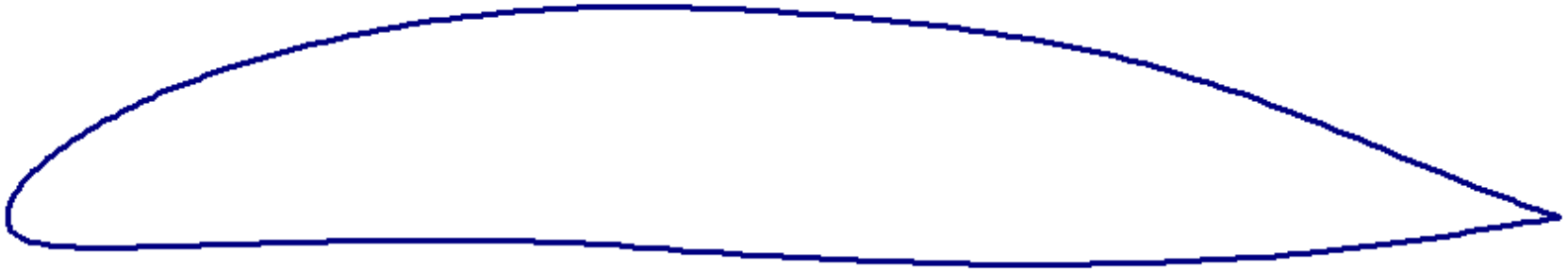
The best in population

Geometry for optimization



MADO – Airfoil optimization external application - Xfoil

Optimization of airfoil NACA 23012 for mini UAV (Re=200000)
$F_{OBJ} = 1/C_L$, variables: max. thickness, max camber, X_G, X_F
Applied algorithm – Monte Carlo



Iteration 0

Open problems

- AMB→CPACS→SDSA interface (AMB→SDSA already exist!)
- PANUKL→CPACS→SDSA interface? (PANUKL→SDSA already exist!)
- output from stability analysis (SDSA) included in CPACS?
- outputs from other applications?
- **CPACS code to input/output (read/write) the XML structure !!!**

Thank you for attention