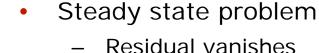


# Quality and sources of error

### Convergence



- Forces levels out
- Flow field does not change
- If oscillations
  - Problem <u>might be</u> unsteady
  - Do time accurate computation
- Time dependent computations
  - Estimate time scales (~L/U)
  - Implicit or explicit in time subiterations
  - Might become steady



#### Grid



Grid convergence studies

Compare solutions on different grid levels (3 grids needed)

- Manually generated e.g. with  $\Delta \sim 1.5$ , 1, 0.7
- Grid adaption
- $y^+$  in first grid points

Check requirements depending on

- turbulence model and
- boundary conditions

Verify by plotting  $y^+$ 

- Resolution of gradients
  - Look carefully at the solution
  - identify the different gradients

## Geometry



- Wing trailing edge
- Junctions
- Small holes, screws et.c.
- wind tunnel effects
  - Blockage
  - 3D effects
  - wall effects
  - "free stream" conditions



## Physical model



- Flow assumptions:
  - Viscous inviscid
  - Compressibility
  - Turbulence & transition
  - Other flow physics
- Turbulence model

Critical if flow contain

- boundary layer separation from smooth surfaces
- rotation and swirl
- Check sensitivity by computing with other models

#### **Numerical scheme**



- Check influence of scheme
  - at least 2nd order scheme
  - 1st order upwind used to be default in Fluent now (14.x)
    2<sup>nd</sup> order
- Sensitivity of scheme decreases on finer grids
  - A 1st order scheme might need more than 10 times the number of grid points compared to a 2nd order scheme.
- Check convergence rate:
  - Residuals reduced at least 5 decades (not universal)
  - Do more iterations and compare solution.
  - 3 decade reduction is default in Fluent must be changed !!!