



Computational Grid

Geometry definition

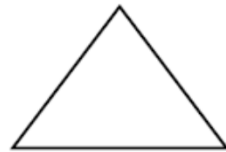
- Sources of geometry definitions
 - CAD definition of the structure (complex “engineering” geometries)
 - Mathematical definition of surfaces (simple geometries)
 - Surface grid (previous CFD or other computations)
- Need to be converted for input to grid generation tools
 - Preferable in “clean surface definitions” (e.g. splines)
 - Cleaning of CAD definitions no at all a trivial task



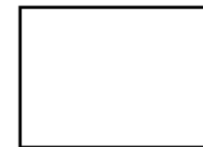
Element types



– 2D:

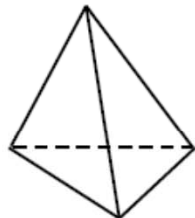


triangle
("tri")

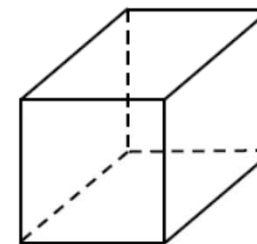


2D prism
(**quadrilateral**
or "**quad**")

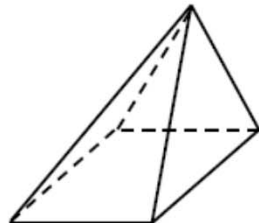
– 3D:



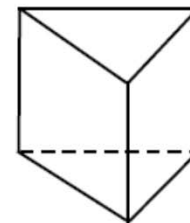
tetrahedron
("tet")



prism with
quadrilateral base
(**hexahedron** or "**hex**")



pyramid



prism with
triangular base
(**wedge**)

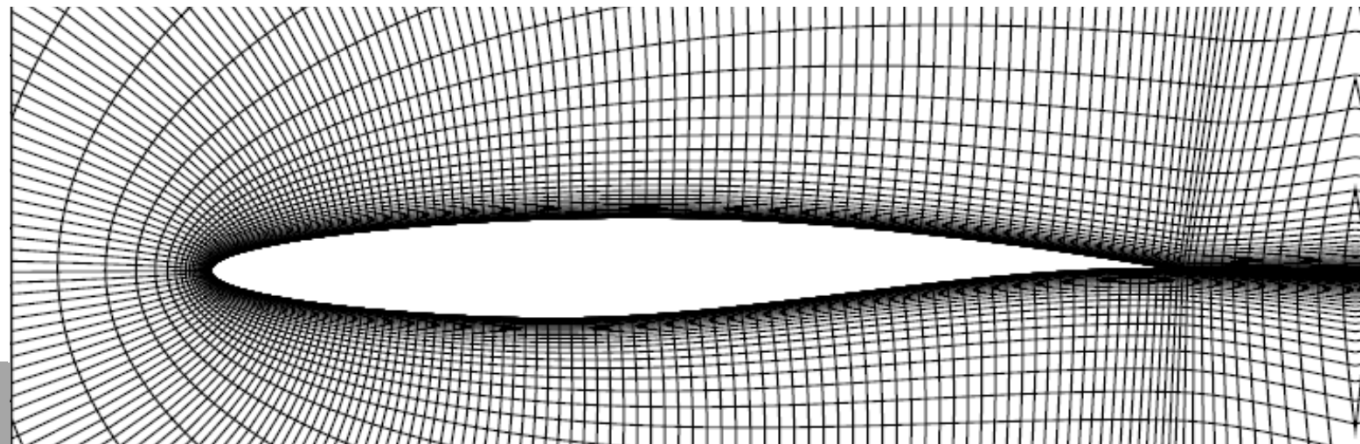
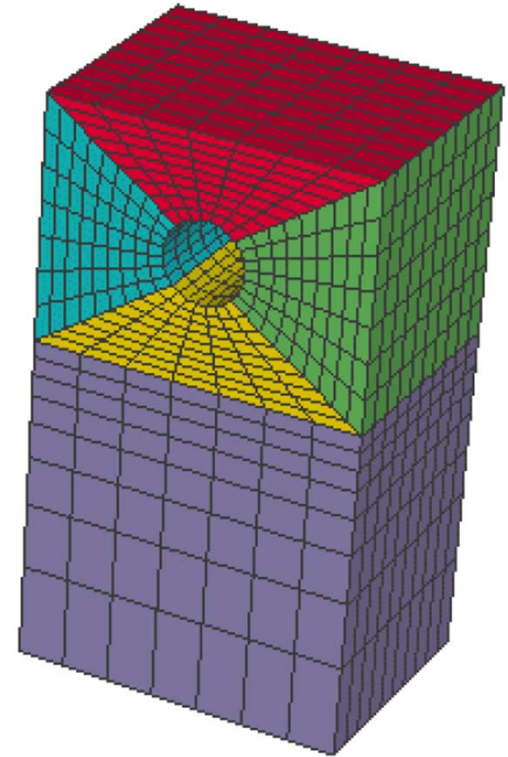
Body-fitted grids

- Grid lines follow the surfaces
- Geometry details can be captured
- Grid points easily clustered in viscous boundary layer
- Could be structured or unstructured or hybrid
- Most frequently used



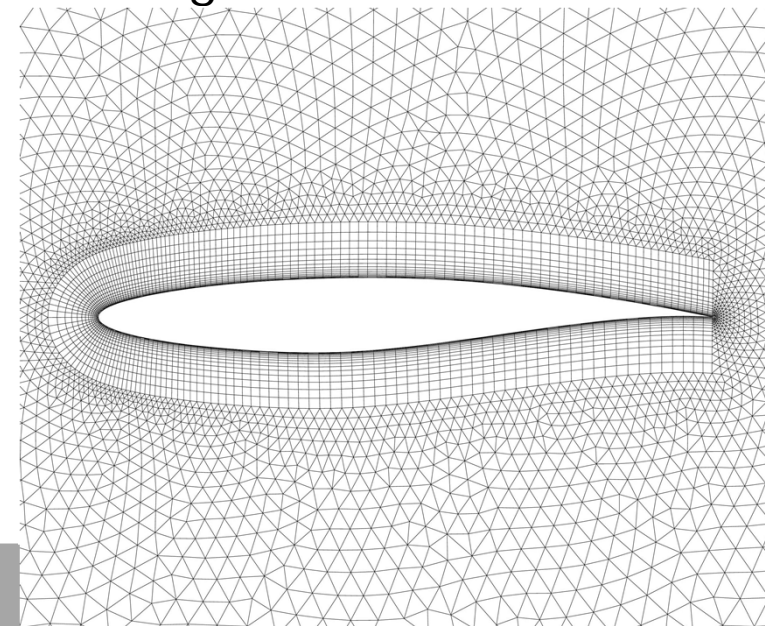
Structured body-fitted grids

- Efficient solver algorithms
- Solution of high accuracy on well designed grids
- Multi-block approach for complex geometries
- No general automatic grid generation algorithm
- Grid generation a tedious “art” (complex grids can take months!)
- Grid points not easily located where they are needed



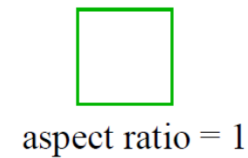
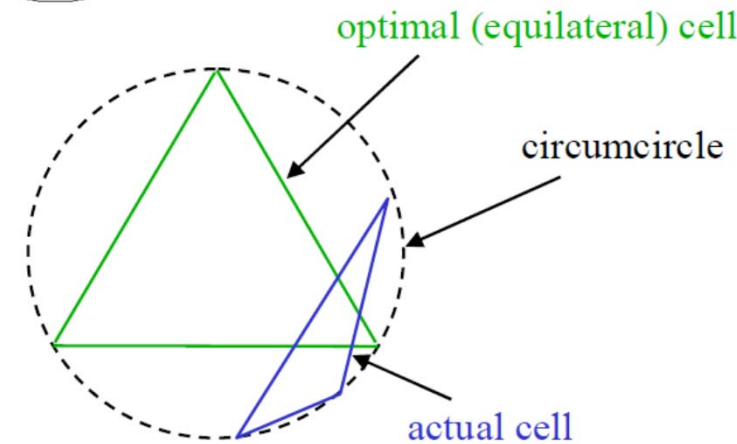
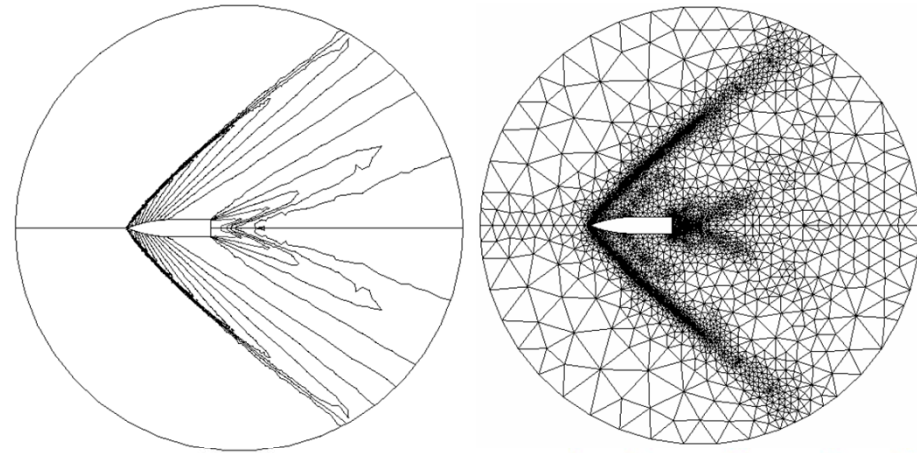
Unstructured body-fitted grids

- Most common in commercial CFD solvers today
- Grid cells of different types (tetrahedra, hexahedra, prisms and pyramids)
- Cell connectivity information -> less efficient solver algorithms
- Grid generation can be highly automatized
- Grid points easily clustered without influencing the whole computational domain



Grid quality

- Sufficiently fine grids
 - Gradients
 - Adaptation
- Shape of the cells
 - Skewness
 - Aspect ratio
- Orientation of cell faces
 - Normal to gradients
- Spatial distribution of cell sizes
 - Smooth change – max 20%



aspect ratio = 1



high-aspect-ratio quad



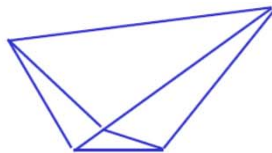
aspect ratio = 1



high-aspect-ratio triangle



smooth change
in cell size



sudden change
in cell size — **AVOID!**



Grid quality ...



- Grid quality is particularly important around large gradients
- Grid quality may influence both
 - accuracy and
 - numerical stability
- Grid topology
- “Prismatic layers” in boundary layers (unstructured grids)
 - “structured” near-wall grid
 - Improves grid quality
 - High Re boundary layers