Overview

1. Genesis CFD

2. Sample Curriculum

3. Examples
   - Supersonic Airfoil
   - Transonic Wing
Genesis-CFD Components/Capabilities

- Single Mesh Unstructured Solver
  - Euler/Laminar/RANS/DES
  - Ideal Gas
  - Limited cores per job (128-256)
- Motion
  - Prescribed (including arbitrary)
  - 6-DOF without constraints
- Structures
  - Modal solver
- Plugins useable, but without SDK to develop

- Propulsion
  - 0-D Linear engine model for BC’s
  - Rotating reference frame
  - Sliding interfaces

- Visualization features
  - Full Volume write to Tecplot, FieldView, Ensight
  - Extracts for FieldViewXDB, Silo, Tecplot, VTK
  - In-Situ using VisIt

Distribution Statement A.
Sample Curriculum

- **Core courses**
  - Fluids I (Incompressible)
  - Fluids II (Compressible)
  - Experimental Methods / Labs

- **Electives**
  - Applied CFD
  - Propulsion
Lectures – Use canned CFD solutions for illustration (cylinder, sphere, airfoil),examples

- Langrangian derivative terms on a cylinder, e.g. \( \nu \frac{\partial u}{\partial y} \)
- Fluid “particle” deformation types (e.g. angular/linear deformation, rotation, strain, volume dilatation).
- Gradients (e.g. pressure)
- Steady vs. Unsteady
- Streamlines, Streaklines, Pathlines
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- Basics of CFD (1-2 lectures)
  - Show simple model problem (1-D linear convection, burgers eqn)
  - Finite difference derivation from Taylor series. Order of accuracy
  - Explicit vs. implicit
  - When to use CFD vs. potential based methods

- CFD project (sphere at various Re)
  - Simple geometry or provide meshes
  - Grid and/or timestep refinement
  - Comparison to experimental data
Experiment/Lab course
- Subset of students provide CFD support
- Possible uses of CFD:
  - Analyze wind tunnel wall effects
  - Visualize the flow being measured
  - Test validity of CFD

Propulsion
- Single Stage Analysis using rotating reference frame and sliding interfaces
- Inlet losses using Engine boundary condition

Design
- CFD of final designs using DaVinci
- Verify performance
- More advanced - look at dynamic stability derivatives
Examples - Diamond Airfoil

- **Description:**
  - Fluids II
  - Student project or as a lecture aid
  - Slow oscillating pitch motion to show effect of $\alpha$

- **Time:**
  - Meshing: 15 minutes
  - Job Setup: 10 minutes
  - Post-processing: 30 minutes

Mach over Diamond Airfoil at Mach=2.0, $\alpha = \pm 10\, \text{deg}$
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Pressure over Diamond Airfoil at Mach=2.0, $\alpha = \pm 10$ deg
Examples - Onera M6

- Description:
  - Fluids II
  - Student project or as a lecture aid
  - Shows transonic effects
- Time:
  - Meshing: Provided
  - Job Setup: 10 minutes
  - Post-processing: 30-60 minutes

Mach cutting plane with surface pressure on OneraM6 wing.