3D Transonic Flow Over a Wing - Numerical Results

Author: Ariane Walker-Horn, Cornell University

Problem Specification
1. Pre-Analysis & Start-Up
2. Geometry
3. Mesh
4. Model Setup
5. Numerical Solution
6. Numerical Results
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Exercises
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Numerical Results

In the first video we will:

1. Look at the lift and drag forces on the wing
2. Look at the lift and drag coefficients on the wing

In the second video we will:

1. Change units
2. Create pressure and Mach contours
3. Compare

In the third video we will:

1. Create contours of Mach number on symmetry plane
2. Look at the Boundary Layer before and after the shock

In the fourth video we will:

1. Create velocity vectors at the trailing edge plane
2. View trailing vortices

In the fifth video we will:

1. Create a chord line at spanwise fraction of .2
2. Plot Pressure Coefficient at spanwise fraction .2
3. Compare FLUENT Pressure Coefficient to experimental data

Numerical Results Part 1: Examining lift and drag

Summary of the above video:

1. Reports>Forces
   a. Look at drag and lift forces
   b. Look at drag and lift coefficients

Numerical Results Part 2: Looking at the Pressure and Mach Number Distribution

Summary of the above video:

1. Change Units in CFD Post
   a. Edit>Options>Units>English Engineering
2. Create Pressure Coefficient Contours on wing surface
   a. Reflect across symmetry plane
3. Create Pressure Coefficient Contours on symmetry plane
   a. disable contour bands
4. Create Mach Number Contours on wing surface
Numerical Results Part 3: Investigating the Boundary Layer

Summary of the above video:
1. Create Contours of Mach Number on Symmetry Plane
2. Turn on Pressure Coefficient Contours on Symmetry Plane
3. View Divisions of contours
   a. Mach Contours > Render > Constant Coloring

Numerical Results Part 4: Looking at Trailing Edge Vortices

Summary of the above video:
1. Create Plane at Trailing Edge
   a. Method > Point and Normal
   b. Bounds>Rectangular
   c. Plane Type>Sample
2. Create Velocity Vectors on Trailing Edge Plane
   a. Sampling>Equally Spaced
   b. Symbol>Symbol Size>.5
3. Change Background Color
   a. Right Click>Viewer Options>Background>Color Type > Solid White

Trailing edge vortices or lift induced vortices are a really important phenomenon when it comes to finite wings. If you are interested in a real life visualization, you can see in this video how a plane flies through smoke and a vortex forms behind it. These vortices are formed because of the finite length of the wing. The high and low pressure regions interact with one another at the wingtips and this interaction creates the vortices trailing downstream of the wing.

Numerical Results Part 5: Plotting and Comparing the Pressure Coefficient

Download Comparison Data: Download

Summary of the above video:
1. Create Line at Z = -.2
   a. X1 = .1155, X2 = .73038
2. Create Plane at Z = -.2
3. Create Polyline at Z = -.2
   a. Boundary Intersection
      i. Wing Surface and Plane at Z = -.2
4. Create Expression for x/L for y/b = .2
   a. Right Click>New Expression
5. Create Variable for x/L
   a. Right Click>New Variable
   b. From Expression>Select Expression
6. Create Chart
   a. Data Series>Source>Polyline 2
   b. X axis>Variable>x/L Variable
   c. Y axis>Variable>Pressure Coefficient
   d. Invert Axis
7. Import Experimental Data
   a. New Series>From File
   b. Change Line Type to Symbol

Pressure Contours Animation

Below is a video of the pressure contours on the symmetry plane. We move these pressure contours along the span of the wing to see how they change. If you would like to learn more about creating animations similar to this one, click here.
Visualizing Vorticity

Below are some images of the vorticity that is generated by the wing. The first image shows the vorticity at the wingtip and the level is made clear in the wake region behind the wing. This image was generated on a very fine mesh of over one million cells. The second image was generated on a less fine mesh (clear because of the coarseness seen in the color of the vorticity) but this one also shows the Q Criterion at a level of .001 so we can see the vorticity present on the wing. You can compare the large region of vorticity at the wing tip to the relatively small regions on the wing surface. Again you can also see the vorticity existing in the wake region behind the wing at the trailing edge near the tip.
Go to Step 7: Verification & Validation

Go to all FLUENT Learning Modules