



Applied Aerodynamics  
Technical Committee

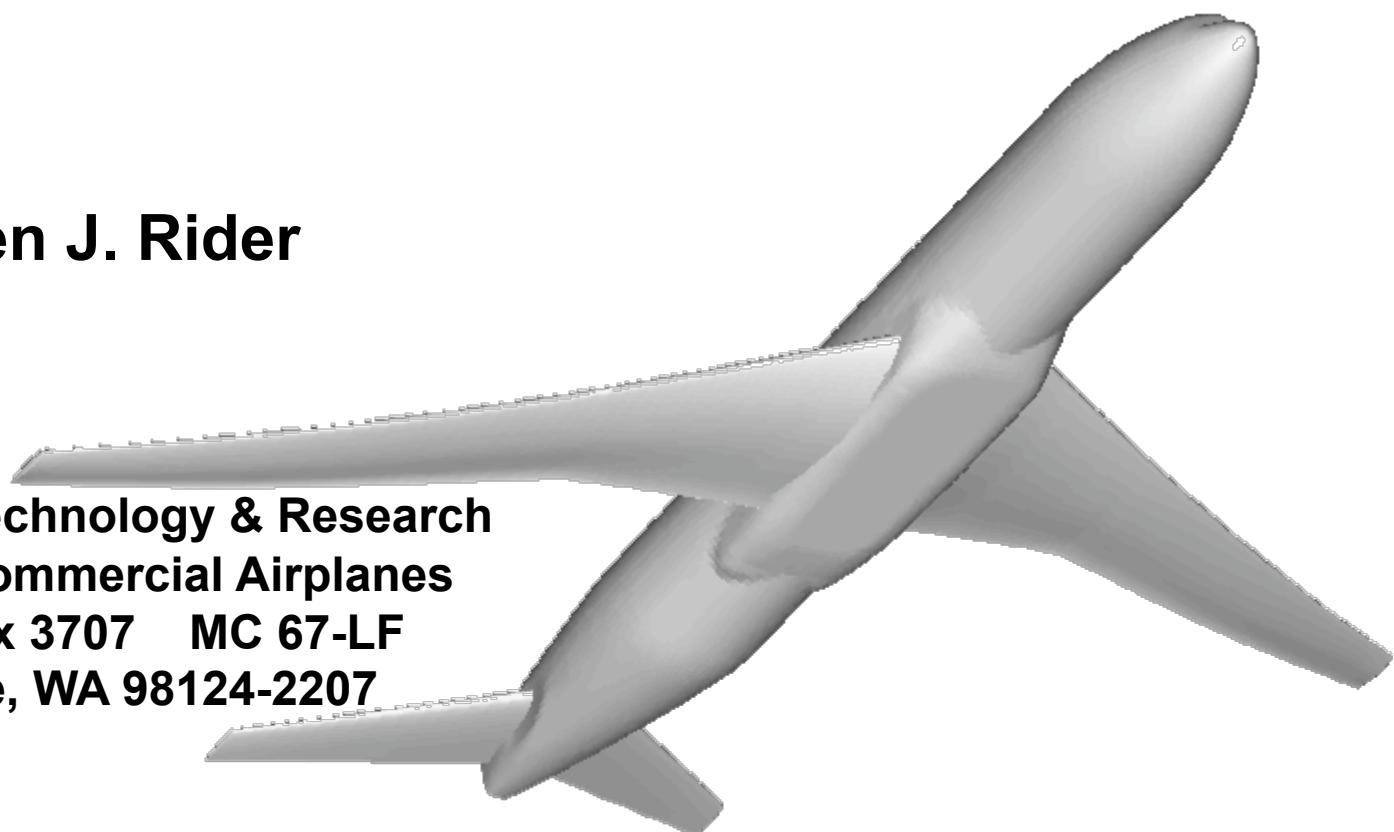
## 4th CFD Drag Prediction Workshop

San Antonio, Texas – June 2009

# Structured Grid Summary for the 4<sup>th</sup> Drag Prediction Workshop

Ben J. Rider

Enabling Technology & Research  
Boeing Commercial Airplanes  
P.O. Box 3707 MC 67-LF  
Seattle, WA 98124-2207





# 4th CFD Drag Prediction Workshop

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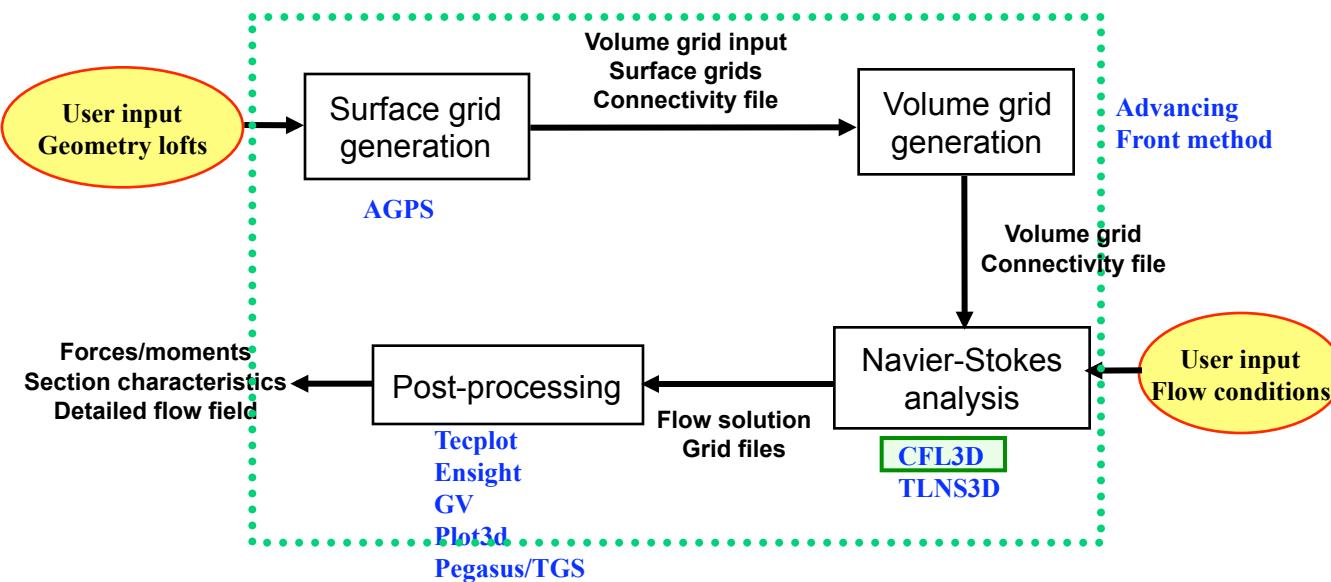
| Structured Grids |                 |                     |                       |                |            |
|------------------|-----------------|---------------------|-----------------------|----------------|------------|
| Symbol Key       | Company         | Code                | Grid Type             | Grid Generator | Turb Model |
| L                | Boeing Seattle* | CFL3D               | Multiblock/Structured | Zeus           | S-A        |
| M                | Boeing Seattle* | CFL3D               | Multiblock/Structured | Zeus           | SST k-w    |
| N                | Boeing Seattle* | CFL3D               | Multiblock/Structured | Zeus           | S-A        |
| O                | Boeing Seattle* | CFL3D               | Multiblock/Structured | Zeus           | SST k-w    |
| Y                | ONERA           | struc/finite volume | Multiblock/Structured | Zeus           | S-A        |
| A                | CFS             | NSMB                | Multiblock/Structured | ICEM Hexa      | SST k-w    |
| R                | ANSYS           | Fluent              | Multiblock/Structured | ICEM Hexa      | SST k-w    |
| V                | Airbus          | elsA                | Multiblock/Structured | ICEM Hexa      | SST k-w    |
| H                | JAXA            | UPACS               | Multiblock/Structured | Gridgen        | S-A mod    |
| U                | ZeusNumerix     | HLLC                | Multiblock/Structured | GridZ          | S-A        |
| P                | Boeing HB       | OVERFLOW            | Overset               | MADCAP/HYPGEN  | S-A        |

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### Boeing ZEUS/CFL3D Example

**Driver for Surface Grid Generation, Volume Grid Generation,  
Navier-Stokes Analysis, and Post-processing**



#### Acknowledgement

None of this work would have been possible without the considerable contributions of:

N. Jong Yu

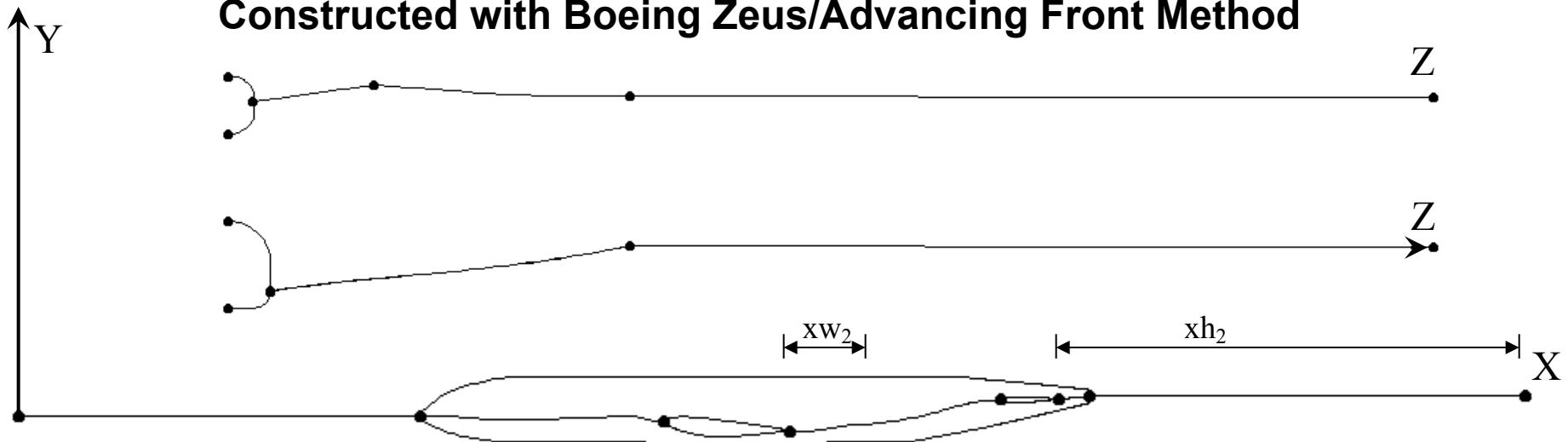
Tsong-Jhy Kao

Margaret M. Curtin

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### Structured Multi-Block Wing-Body Grids Constructed with Boeing Zeus/Advancing Front Method



|                    | X total | Y total | Z total |
|--------------------|---------|---------|---------|
| Coarse: 5M RE      | 377     | 65      | 97      |
| Medium: 5M RE      | 469     | 81      | 145     |
| Medium-Fine: 5M RE | 657     | 97      | 201     |
| Fine: 5M RE        | 873     | 105     | 257     |
| Medium: 20M RE     | 469     | 81      | 145     |

| Boundary Layer     | $\Delta y_1$ | Ave $y^+$ |
|--------------------|--------------|-----------|
| Coarse: 5M RE      | 0.000835530  | 0.5652    |
| Medium: 5M RE      | 0.000835530  | 0.5652    |
| Medium-Fine: 5M RE | 0.000557020  | 0.3768    |
| Fine: 5M RE        | 0.000417765  | 0.2826    |
| Medium: 20M RE     | 0.000139255  | 0.33975   |

| Blunt TE               | xw2 | xh2 | Y  |
|------------------------|-----|-----|----|
| Coarse: 5M RE          | 25  | 41  | 57 |
| Medium: 5M RE & 20M RE | 25  | 57  | 65 |
| Medium-Fine: 5M RE     | 25  | 81  | 73 |
| Fine: 5M RE            | 25  | 101 | 81 |

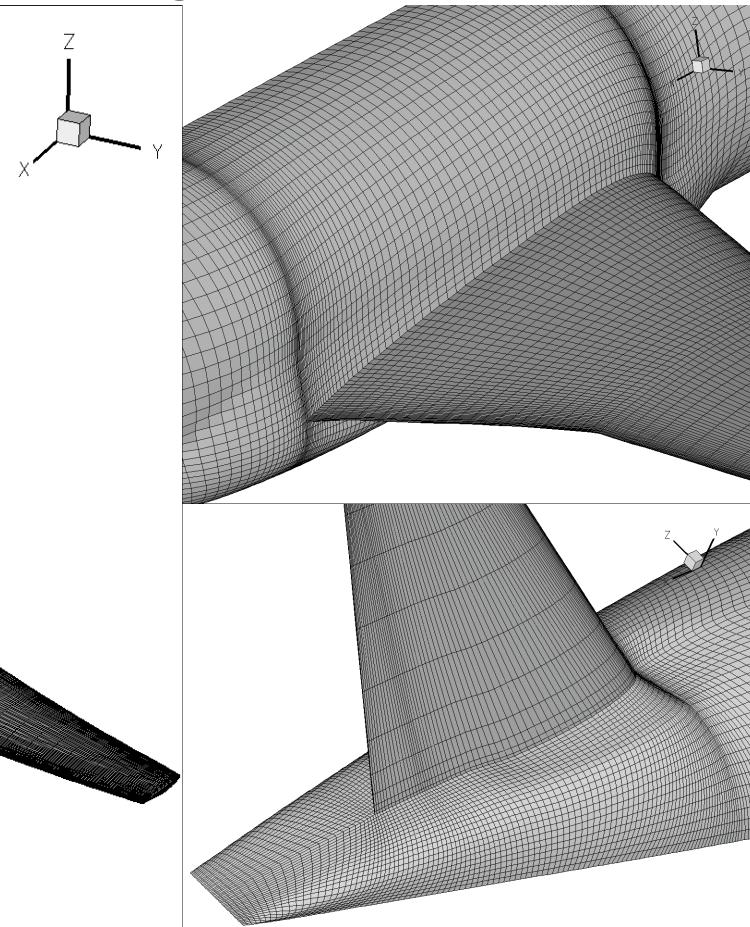
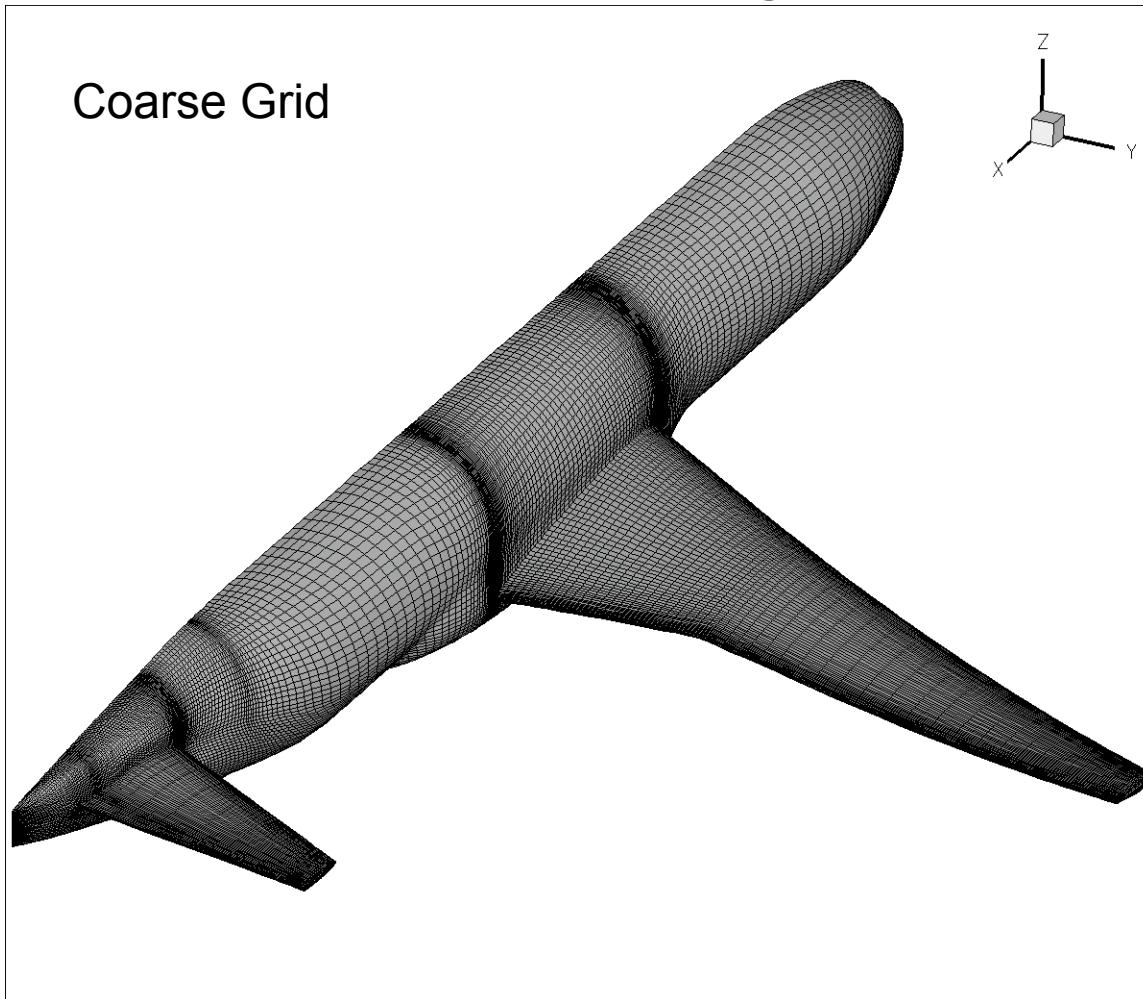
| Total Grid Size        | Grid Cells |
|------------------------|------------|
| Coarse: 5M RE          | 4.8M       |
| Medium: 5M RE & 20M RE | 11.0M      |
| Medium-Fine: 5M RE     | 25.7M      |
| Fine: 5M RE            | 47.2M      |

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## Structured Multi-Block Wing-Body Grids Constructed with Boeing Zeus/Advancing Front Method

Coarse Grid

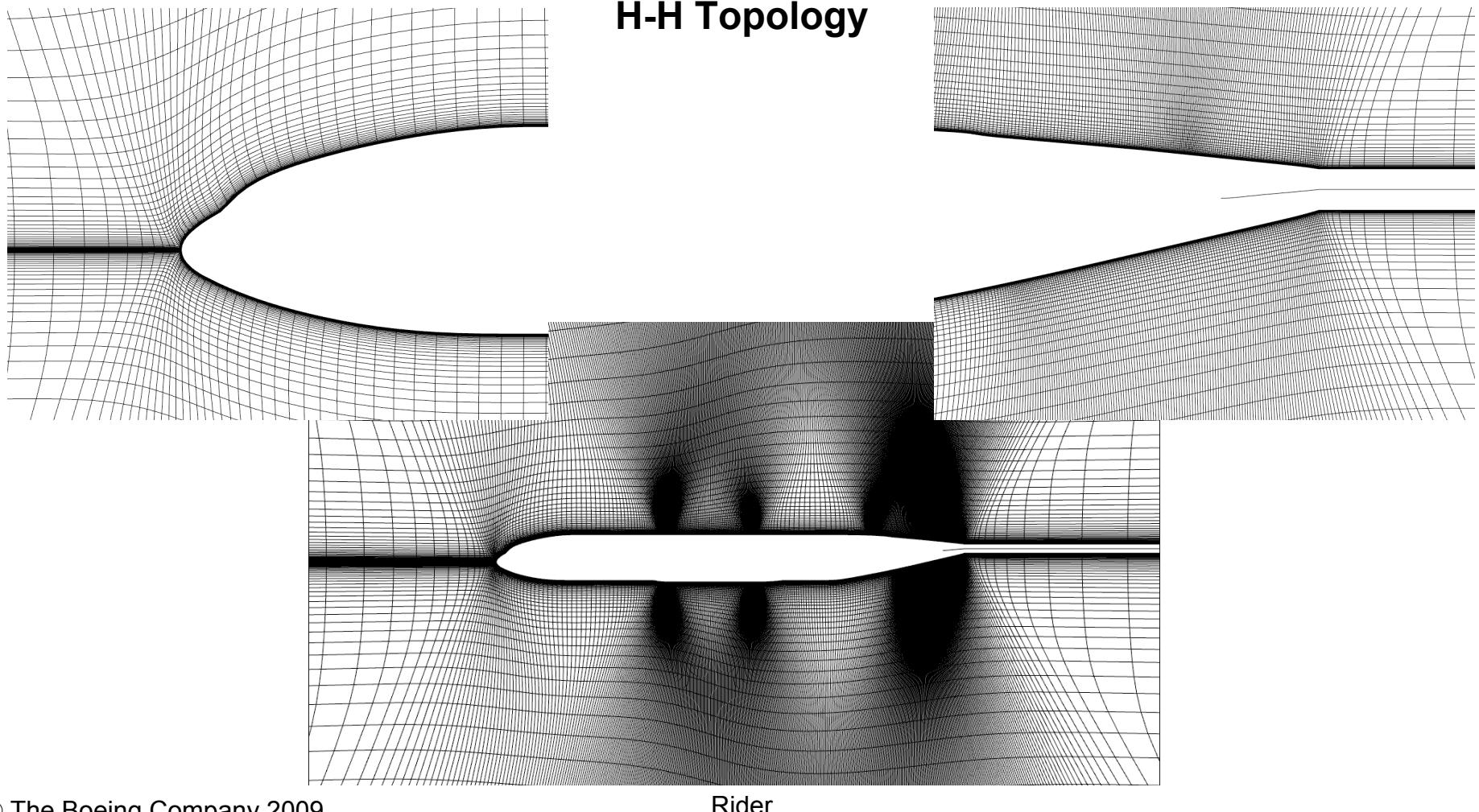


Rider

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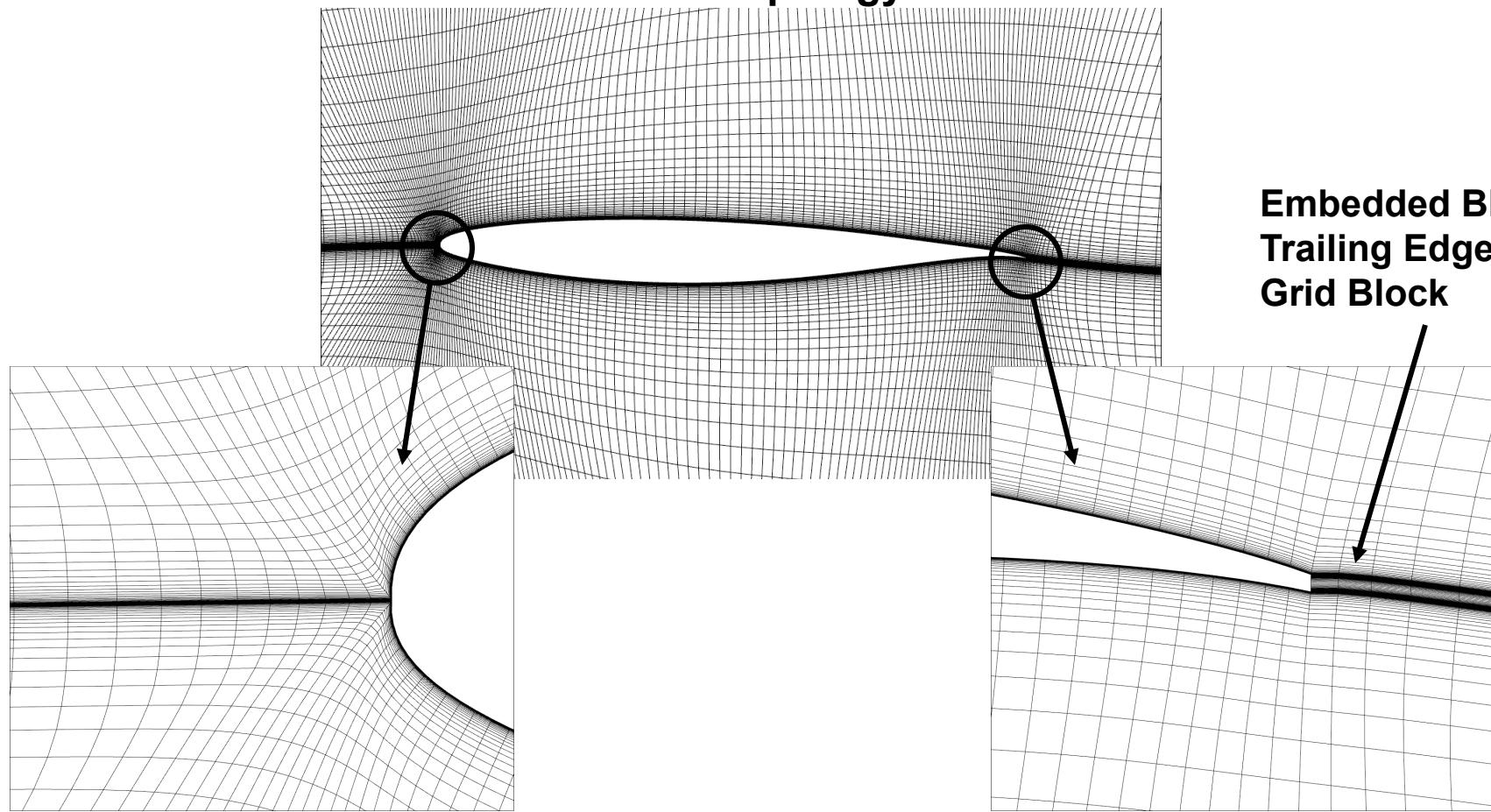
Typical Medium Grid: K-plane cut  
Symmetry plane  
H-H Topology



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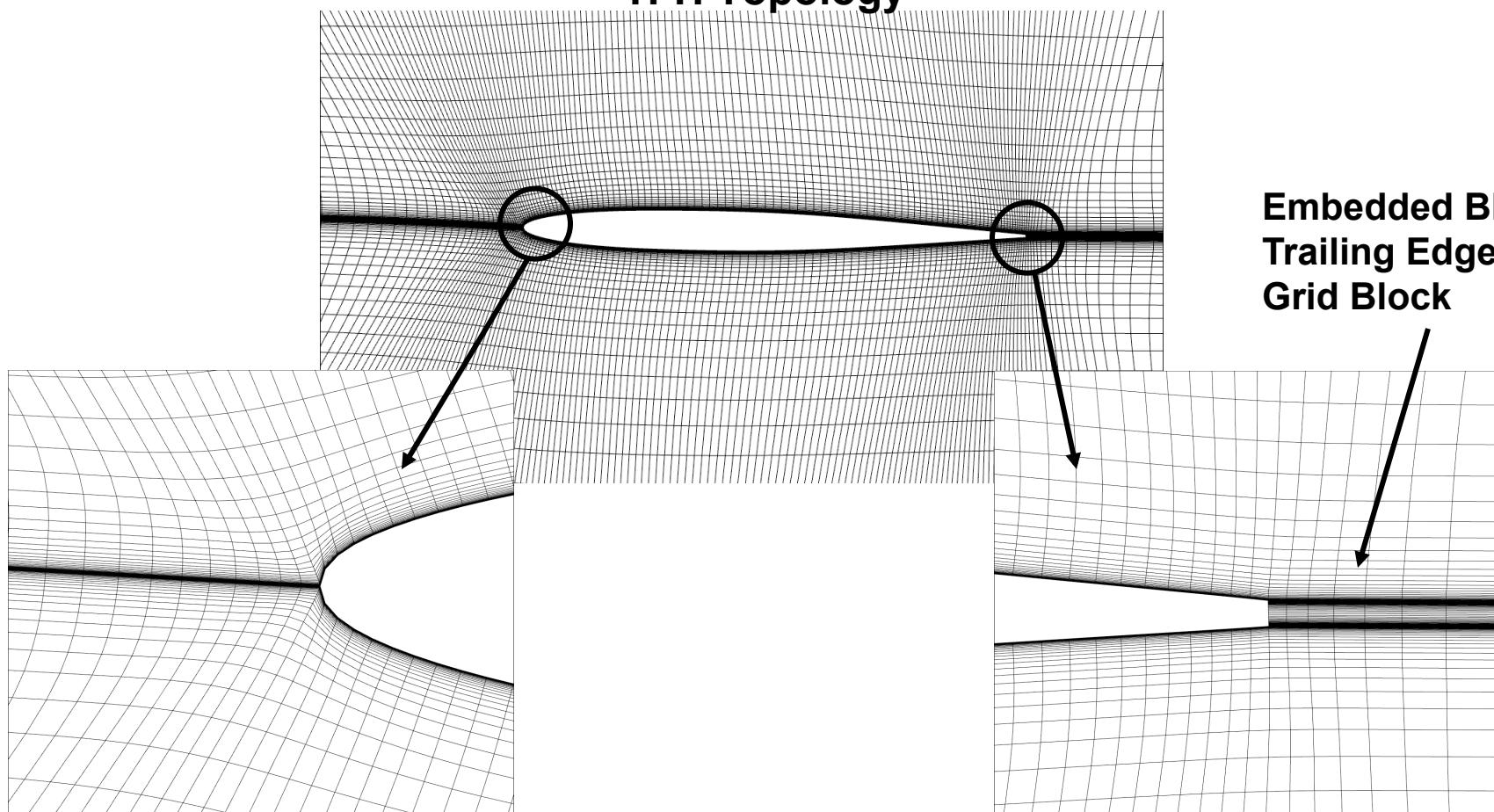
### Typical Medium Grid Wing K-plane cut H-H Topology



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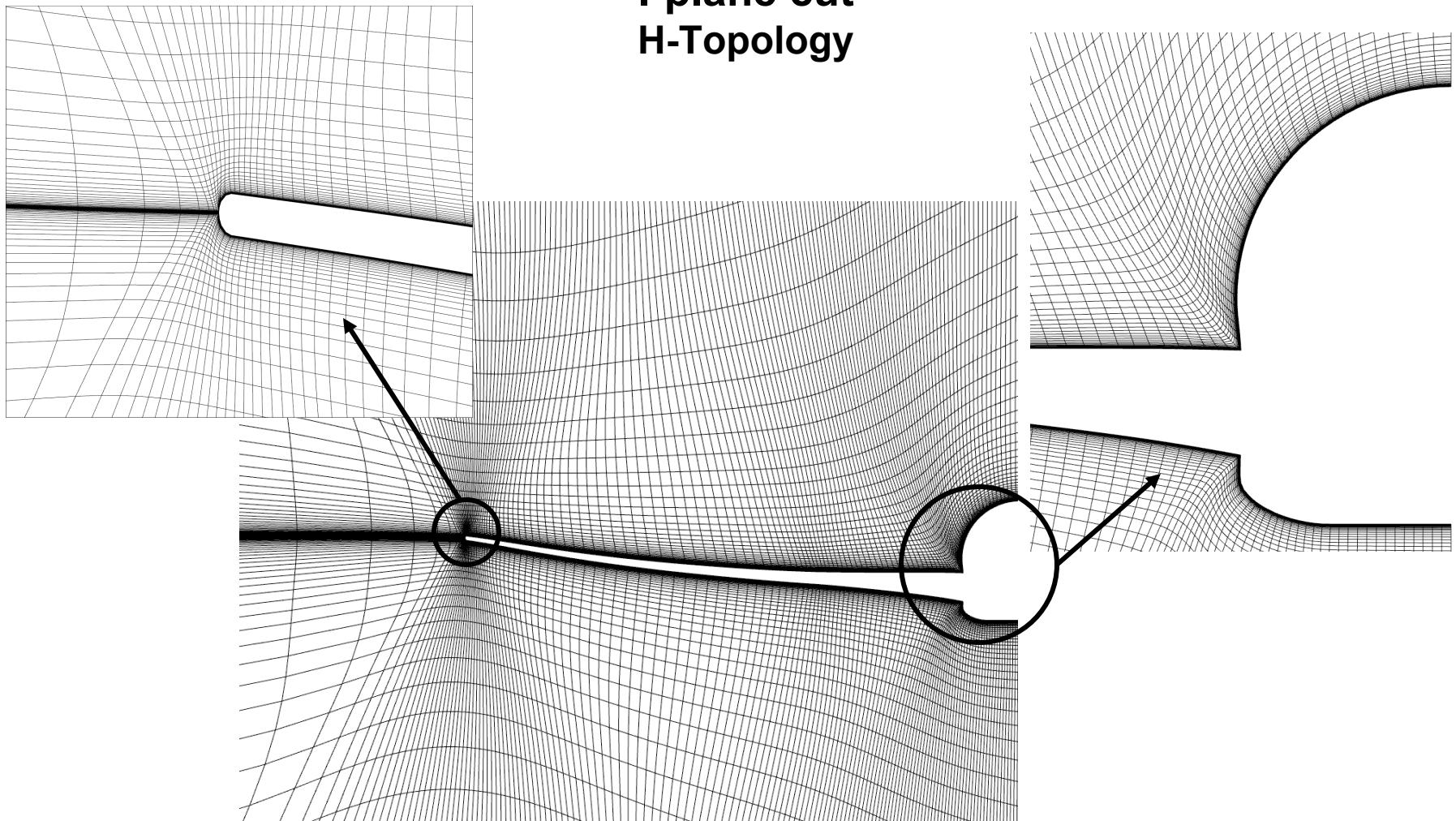
## Typical Medium Grid Horizontal K-plane cut H-H Topology



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Typical Medium Grid  
I-plane cut  
H-Topology

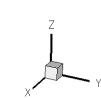
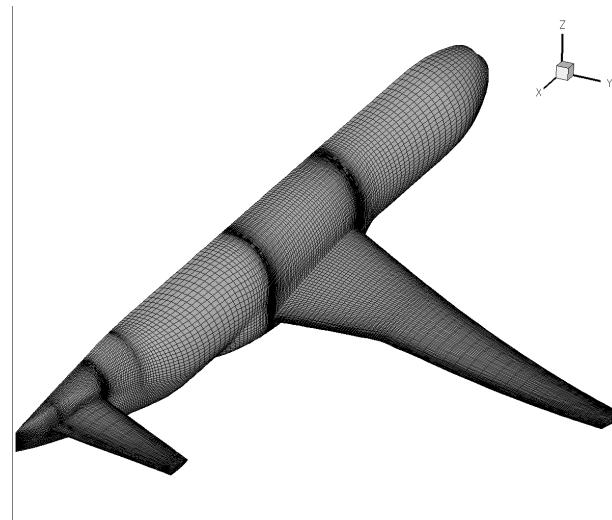


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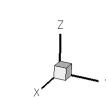
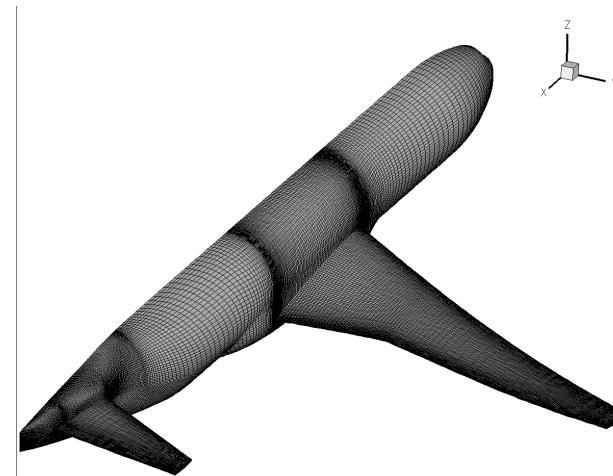
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### Case 1a: Grid Refinement Study

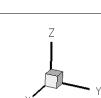
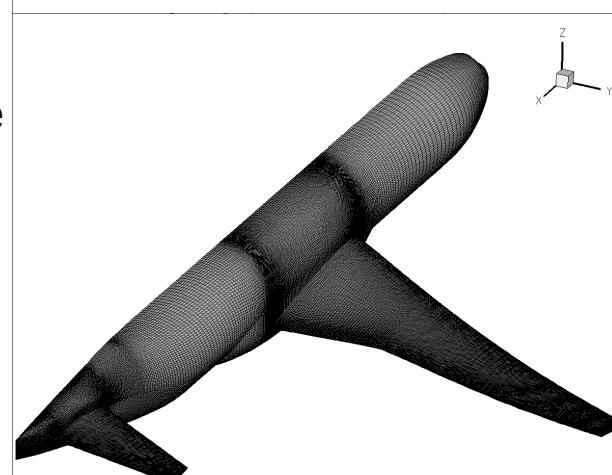
Coarse  
Grid



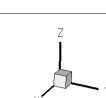
Medium  
Grid



Medium-Fine  
Grid



Fine  
Grid



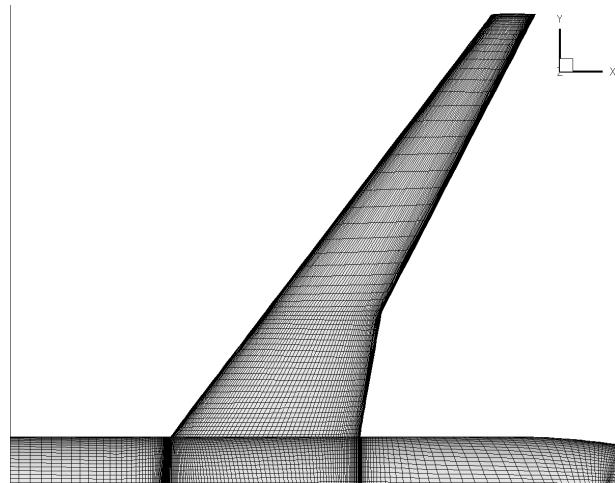
Rider

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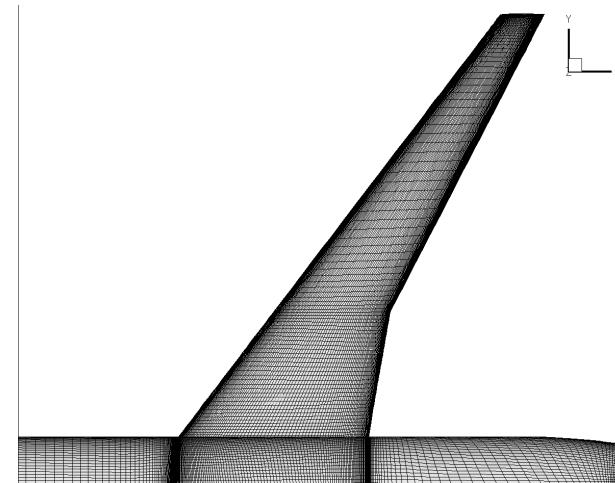
## San Antonio, Texas – June 2009

### Case 1a: Grid Refinement Study

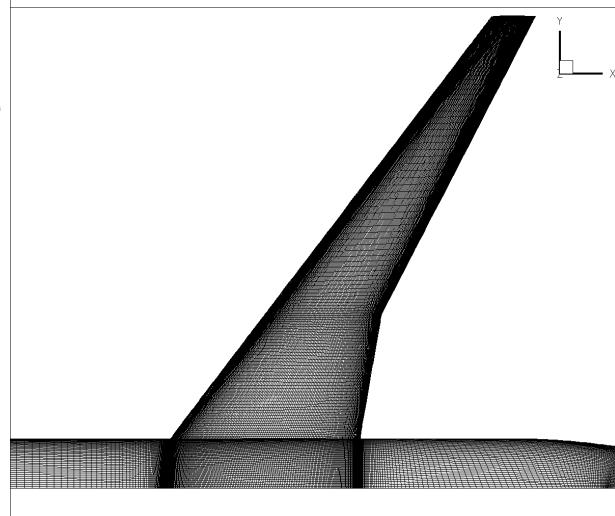
Coarse  
Grid



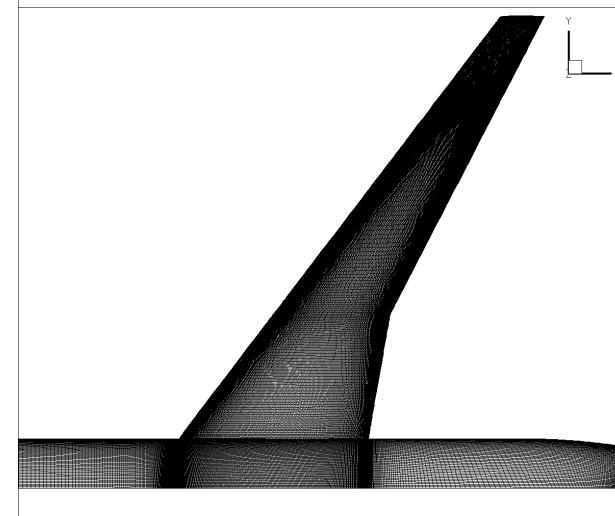
Medium  
Grid



Medium-Fine  
Grid



Fine  
Grid



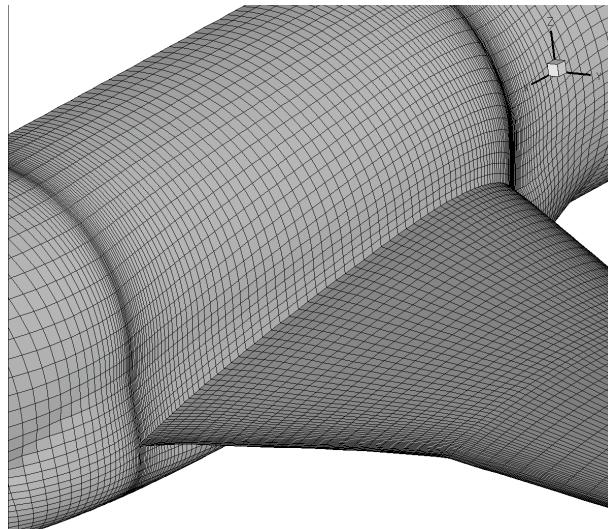
Rider

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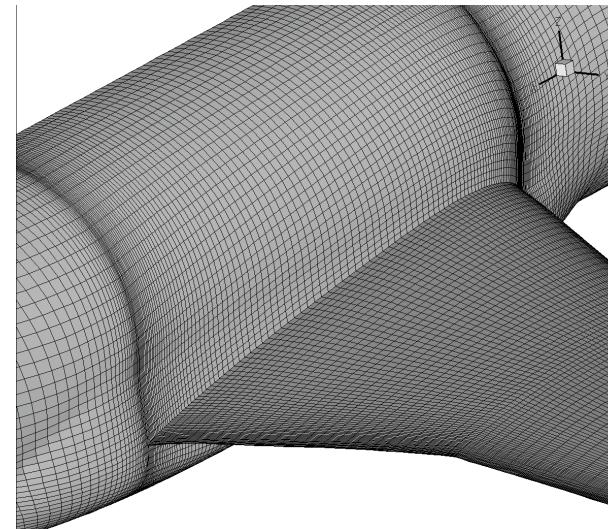
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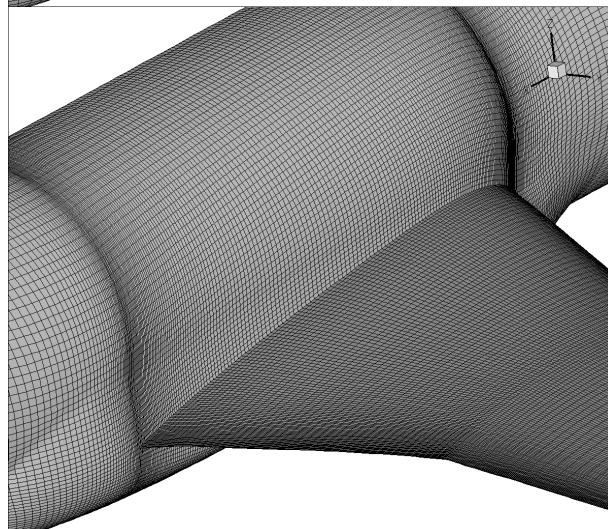
Coarse  
Grid



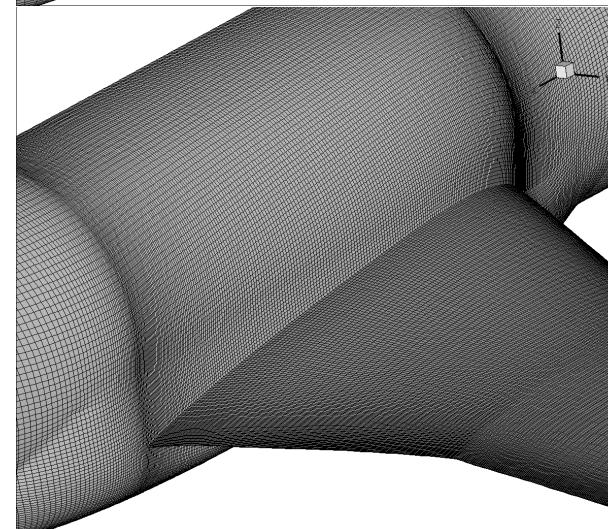
Medium  
Grid



Medium-Fine  
Grid



Fine  
Grid



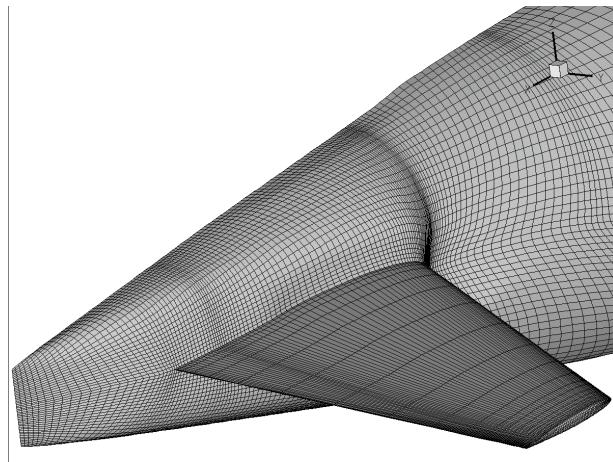
Rider

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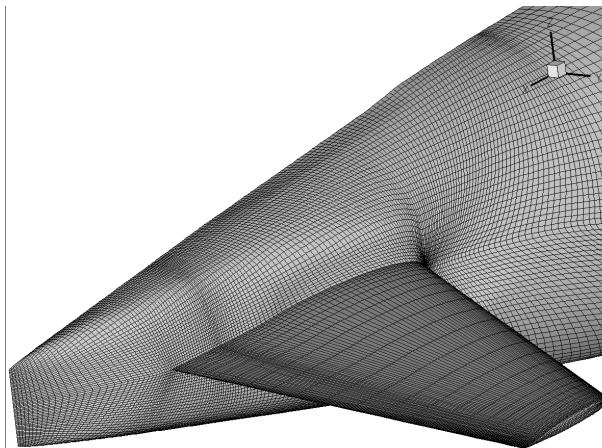
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### Case 1a: Grid Refinement Study

Coarse  
Grid



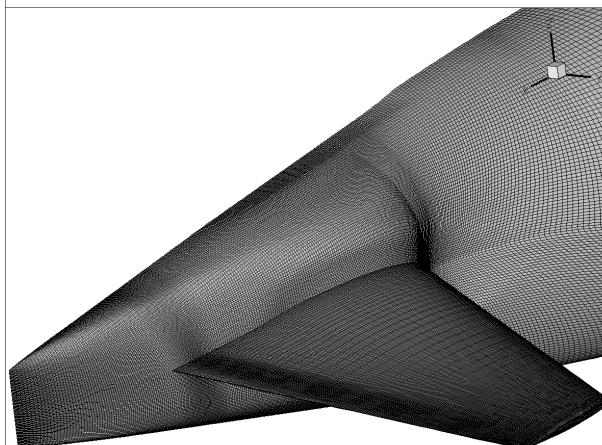
Medium  
Grid



Medium-Fine  
Grid



Fine  
Grid



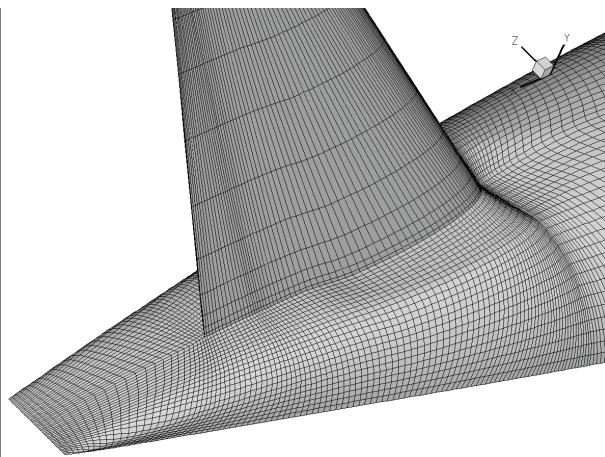
Rider

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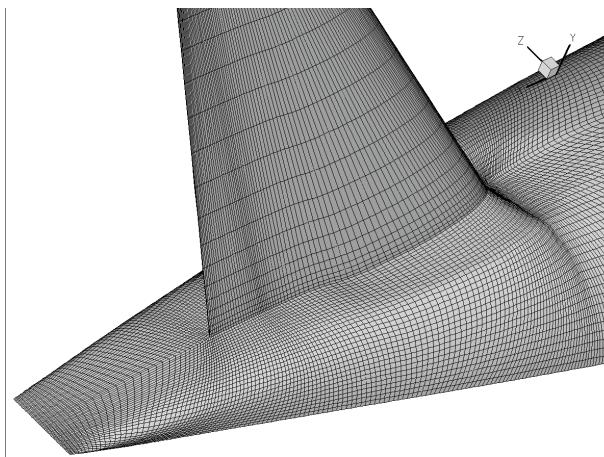
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### Case 1a: Grid Refinement Study

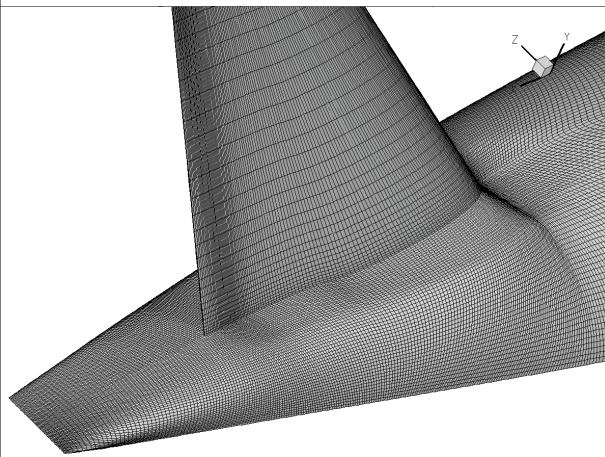
Coarse  
Grid



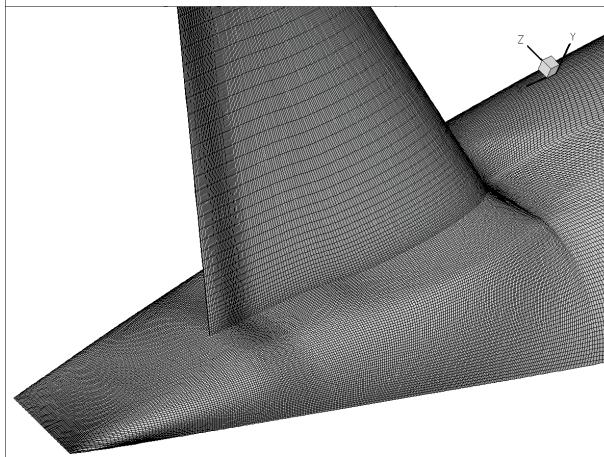
Medium  
Grid



Medium-Fine  
Grid



Fine  
Grid



Rider