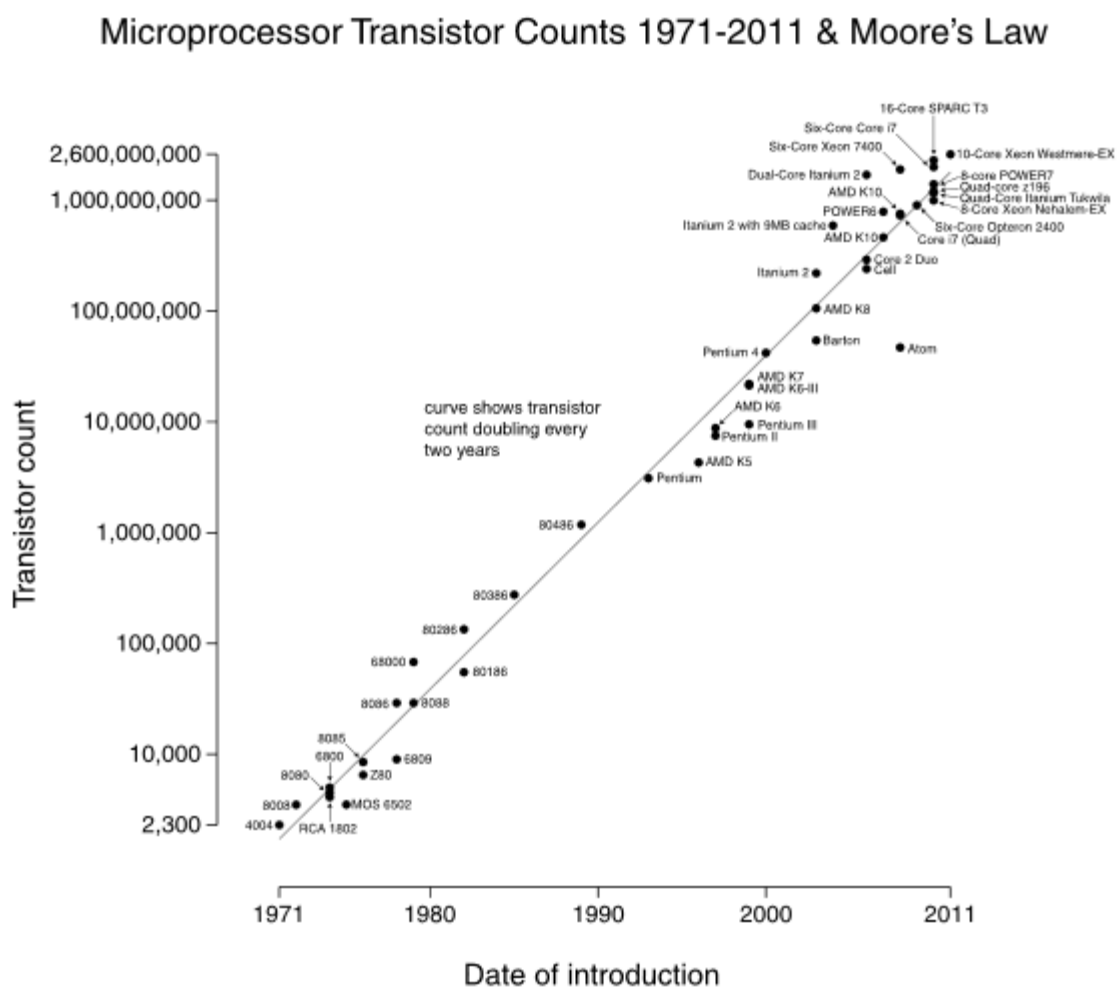
Reduce Post-Processing time and improve understanding of complex Physical Phenomena with Tecplot 360

Dr. Scott Imlay CTO
Dr. Durrell Rittenberg VP Product Management

Agenda For Tutorial

- Complexity in modern computational results exploration?
- What's driving the additional complexity?
- Methods of feature identification
  - Vortex cores
  - Shock surfaces
  - Flow Separation
- Plan for large data support
- Hands on use case with Tecplot 360 2012 R1
- Question and Comments

Driving Force is Moore's Law



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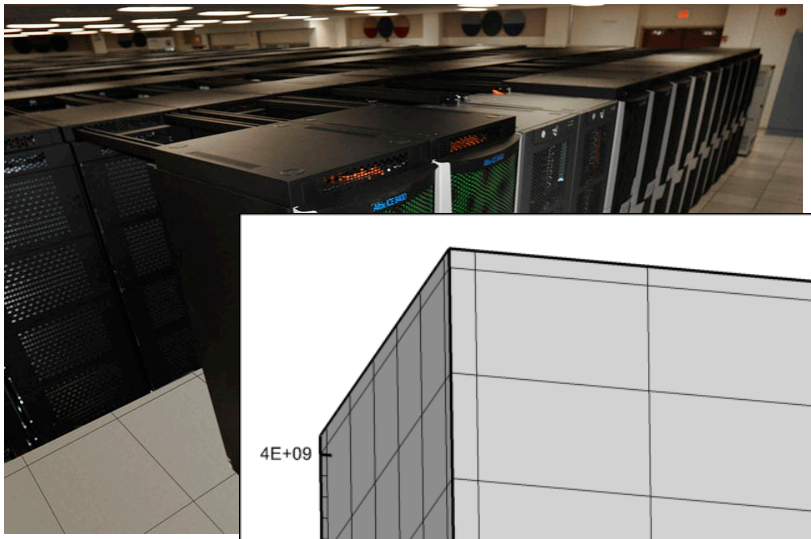
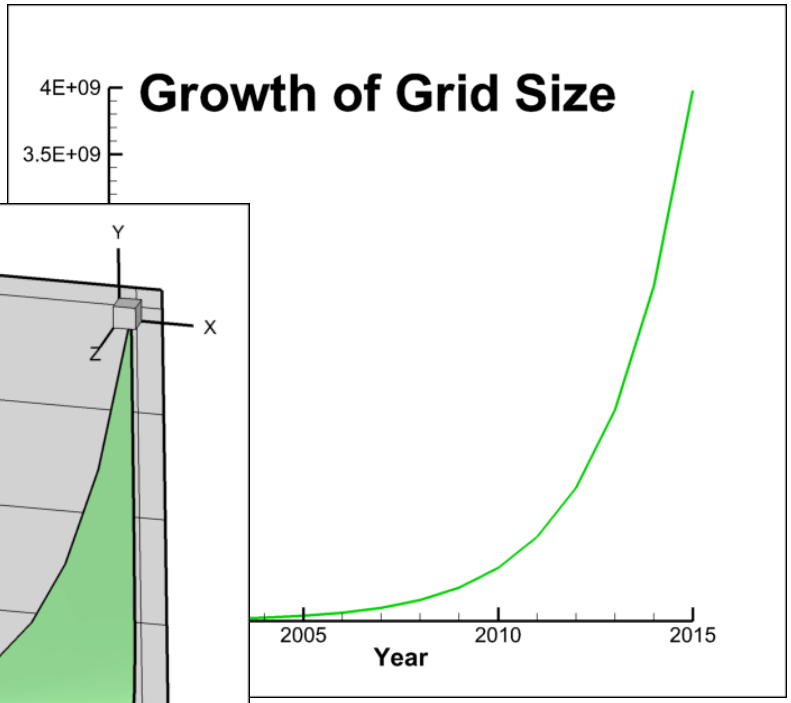
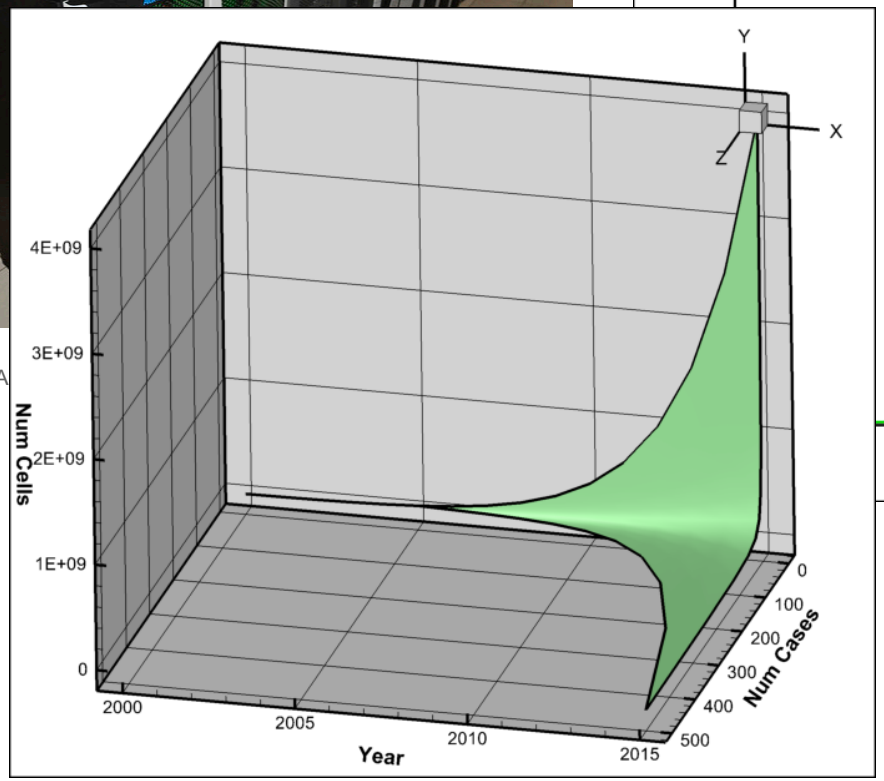
Impact of Low Cost Computational Resources



NAS: NASA Ames (CA

Growing with Moore's Law





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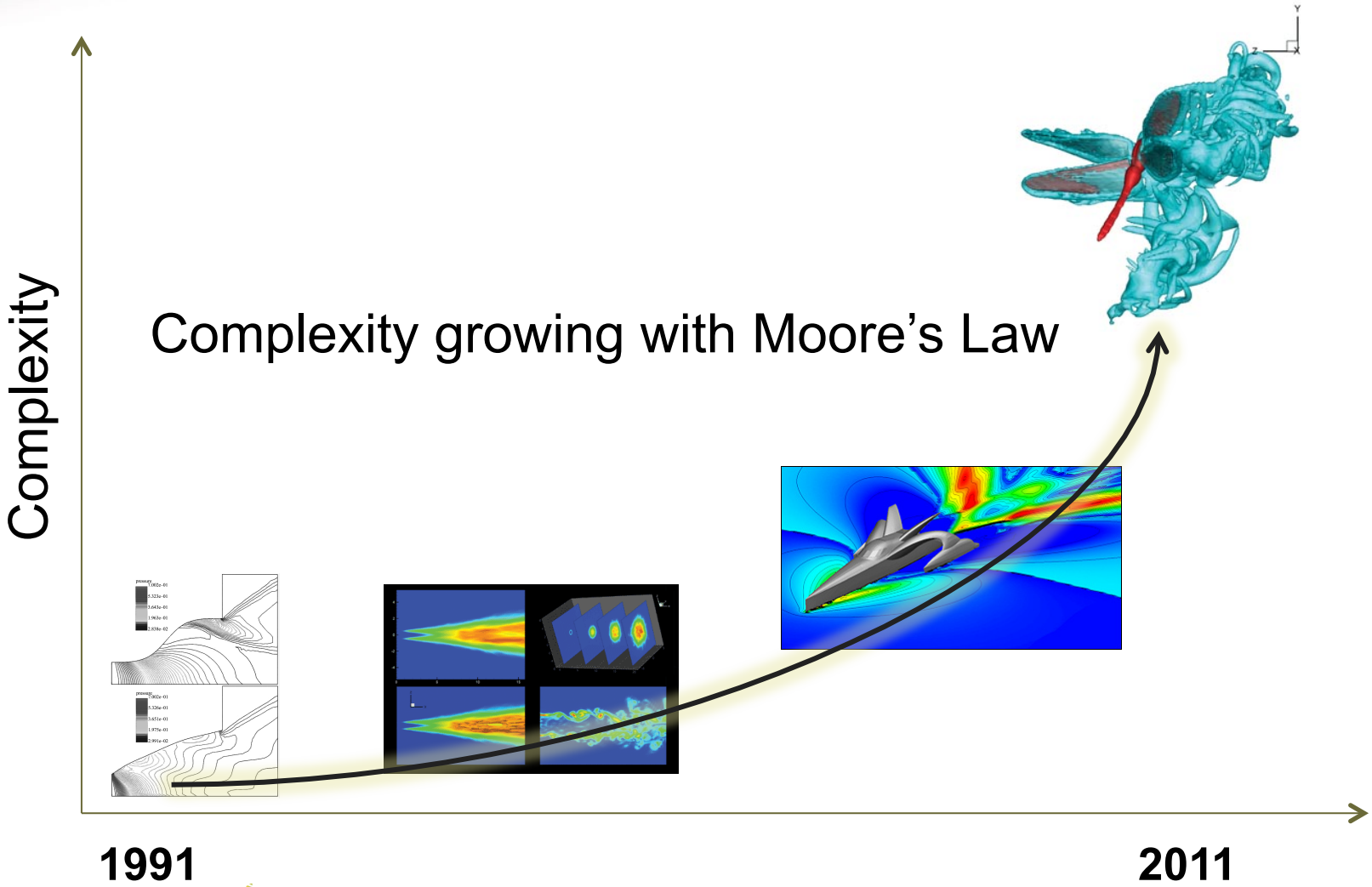
CFD Solutions Are Getting Complex



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Complex Solutions Require Better Strategies

Solution Hunting Methods

- Pros:
  - Develop a narrative of the results
  - You know where you are looking
- Cons:
  - Could miss something important
  - Time consuming

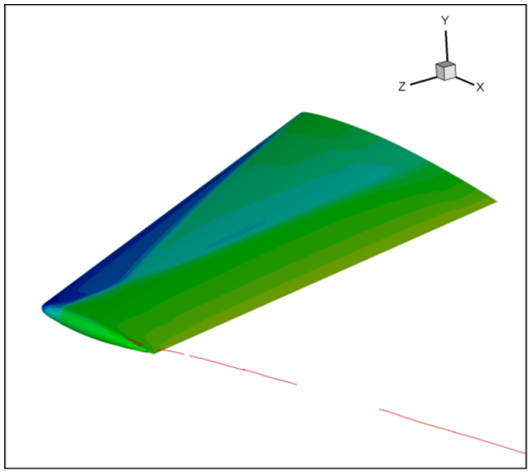
Flow Feature Identification

- Pros:
  - Reduce time to identify key features in flow
  - Provides good start points for additional interrogation
- Cons:
  - Computationally intense and may be slow
  - May end up with a lot of clutter hard to see what's important

Methods For Vortex Identification

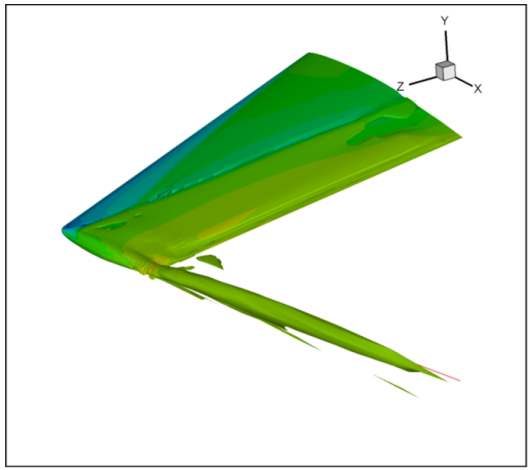
Line Extraction Methods

- Streamtraces (hit or miss method)
- Line Extraction
  - Parallel vectors
  - FX Feature extraction
- Others



Regional Identification Methods

- $\lambda\downarrow 2$ method
- Q-criteria
- Vorticity Magnitude (hit or miss)



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Lambda-2 (λ_2) Method

- Jeong & Hussain, "Identification of a Vortex" J. Fluid Mech, 1995.
- λ_2 is second eigenvalue of $S^2 + \Omega^2$
  - S is the symmetric part of ∇u
  - Ω is the antisymmetric part of ∇u
- Vortex where λ_2 is negative
- In Tecplot
  - use Data->Alter->Specify Equations to compute $S^2 + \Omega^2$
  - Compute eigensystem using Tools->Tensor Eigensystem
  - Turn on isosurface, using EgnVal2 as the isosurface variable
    - Isosurface value of zero (sometimes negative)

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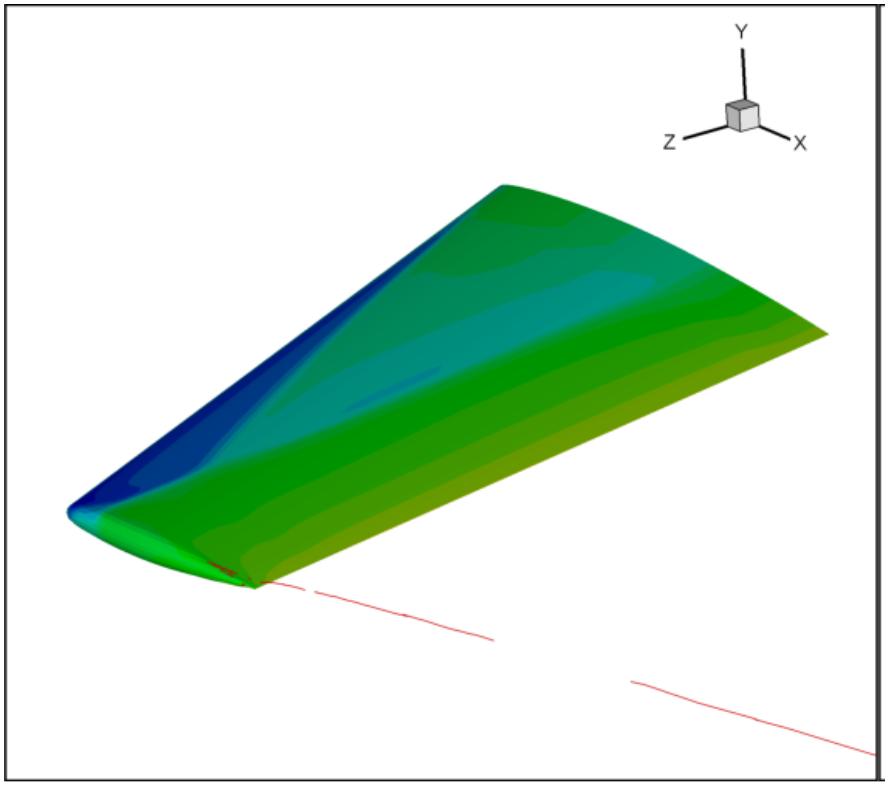
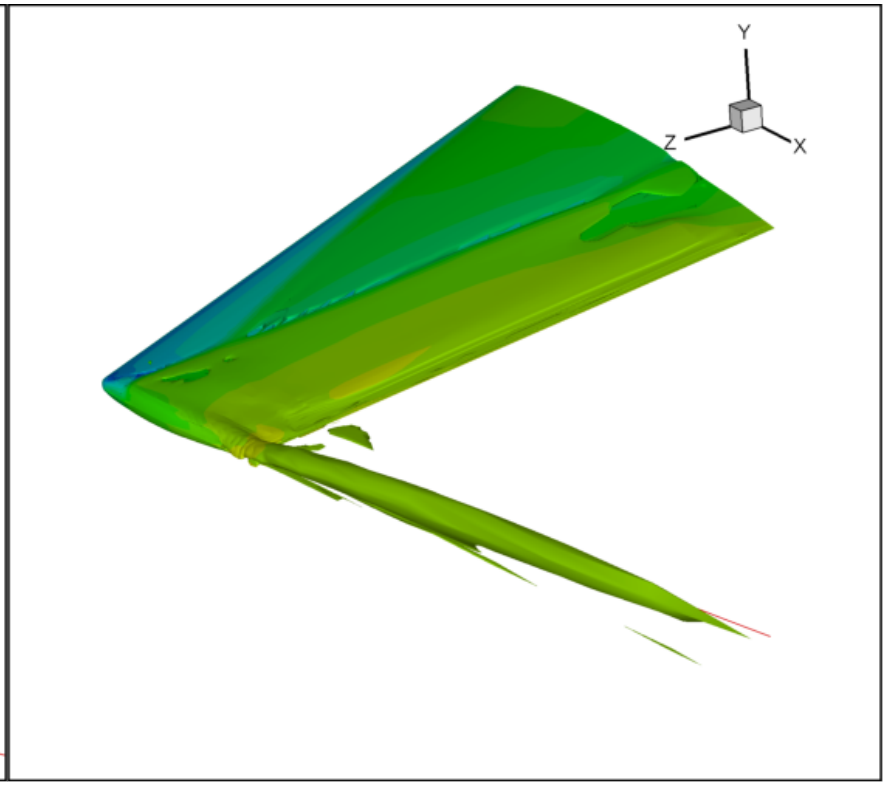
Lambda-2 For Onera M6 Wing



Vortex Core Extraction



Isosurface of Lambda-2

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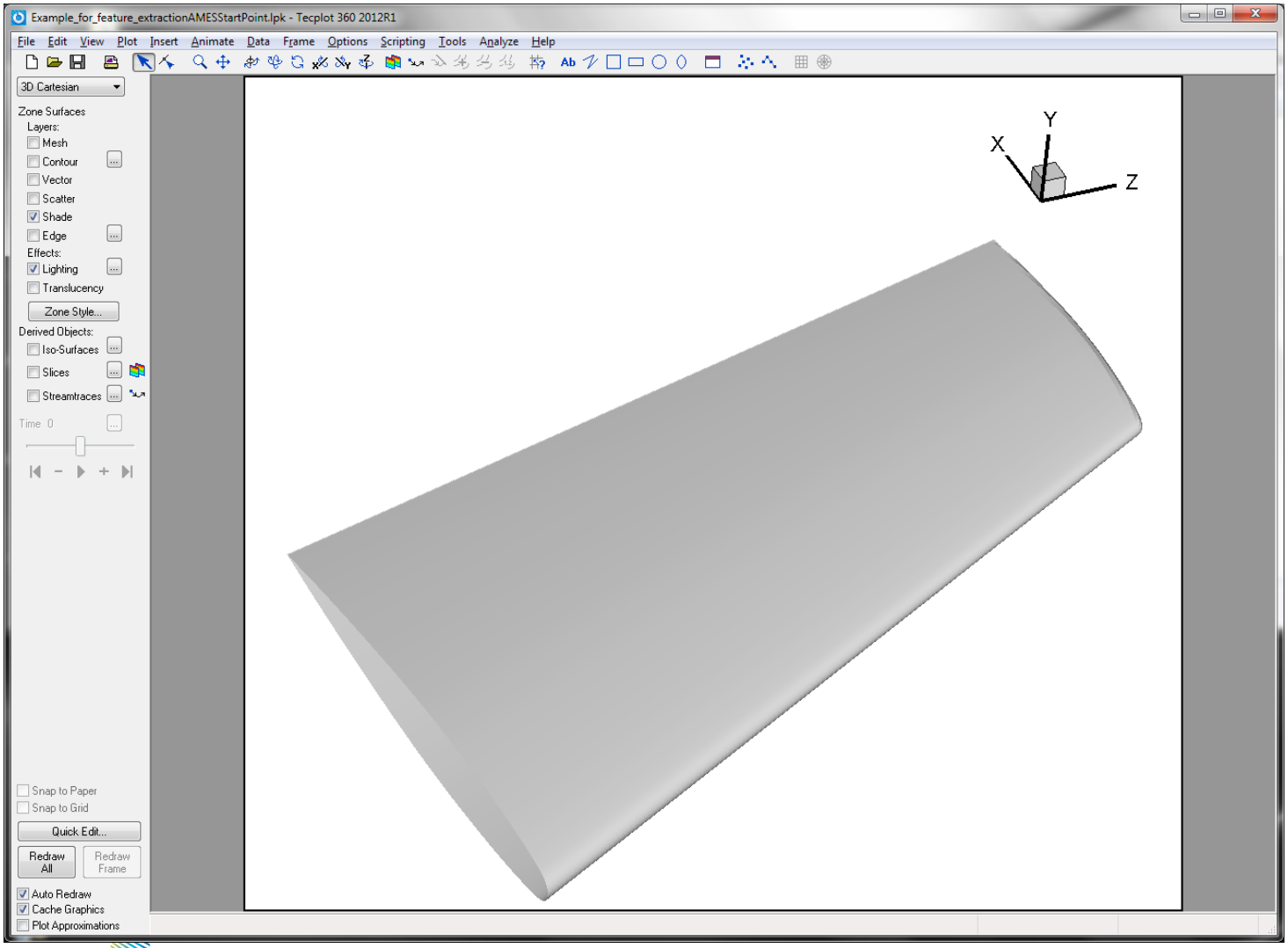
Tutorial on Using λ_2 and Q-Criterion



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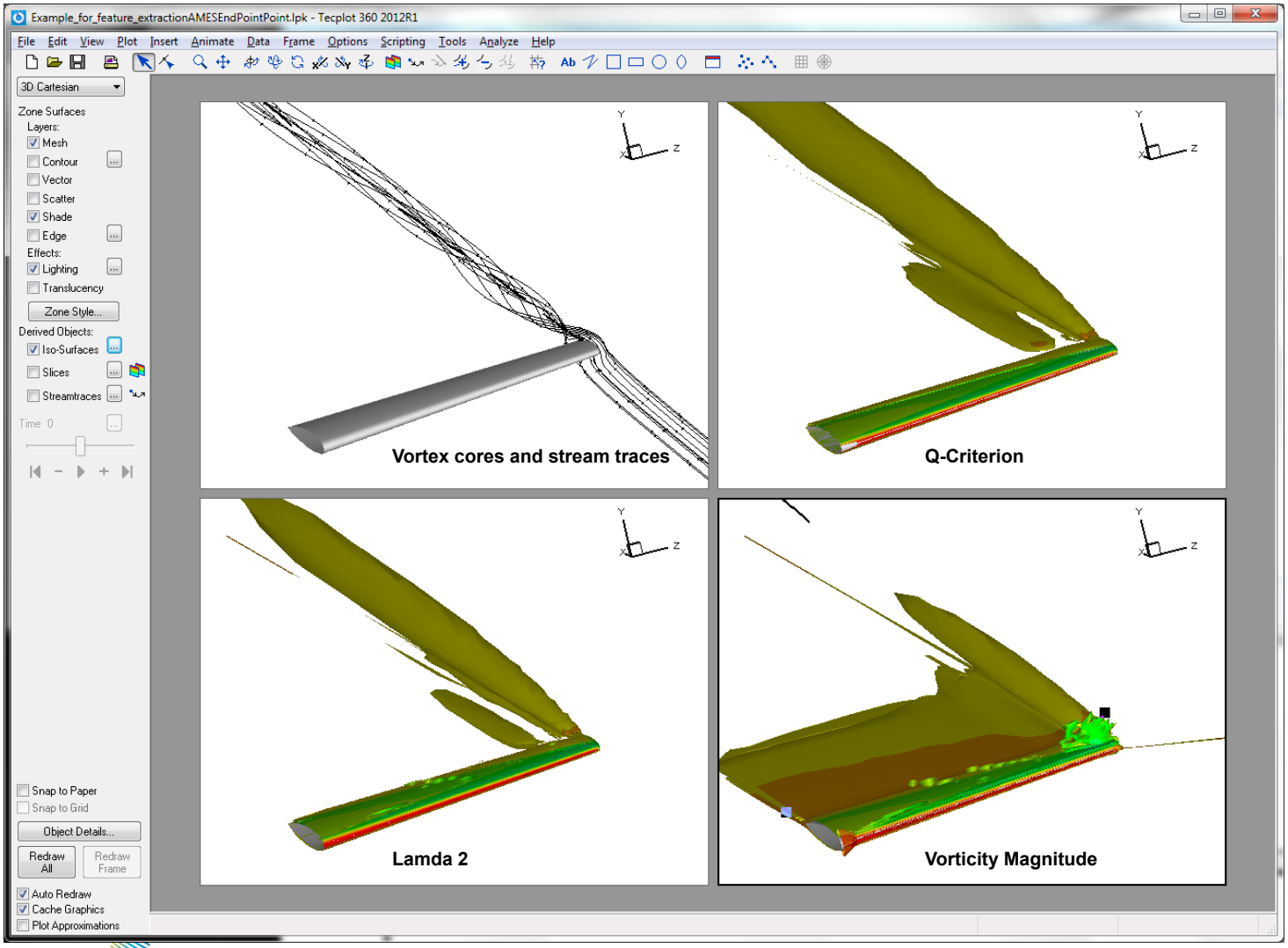
Comparison of vortex identification methods



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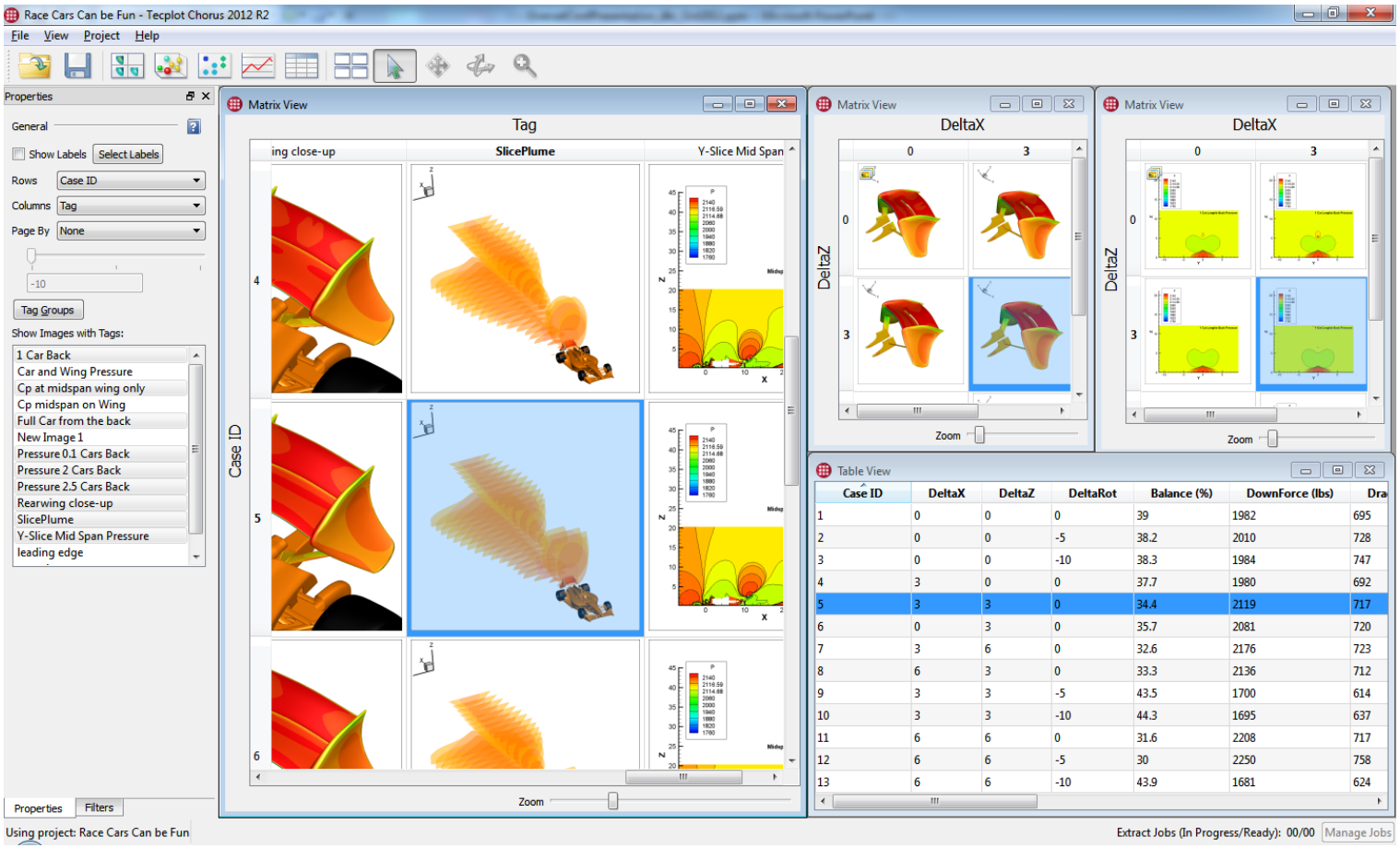
Tecplot Chorus For Collections of CFD Results



Case ID	DeltaX	DeltaZ	DeltaRot	Balance (%)	DownForce (lbs)	Dra
1	0	0	0	39	1982	695
2	0	0	-5	38.2	2010	728
3	0	0	-10	38.3	1984	747
4	3	0	0	37.7	1980	692
5	3	3	0	34.4	2119	717
6	0	3	0	35.7	2081	720
7	3	6	0	32.6	2176	723
8	6	3	0	33.3	2136	712
9	3	3	-5	43.5	1700	614
10	3	3	-10	44.3	1695	637
11	6	6	0	31.6	2208	717
12	6	6	-5	30	2250	758
13	6	6	-10	43.9	1681	624

Evaluating overall system performance and allowing engineers to compare results quickly

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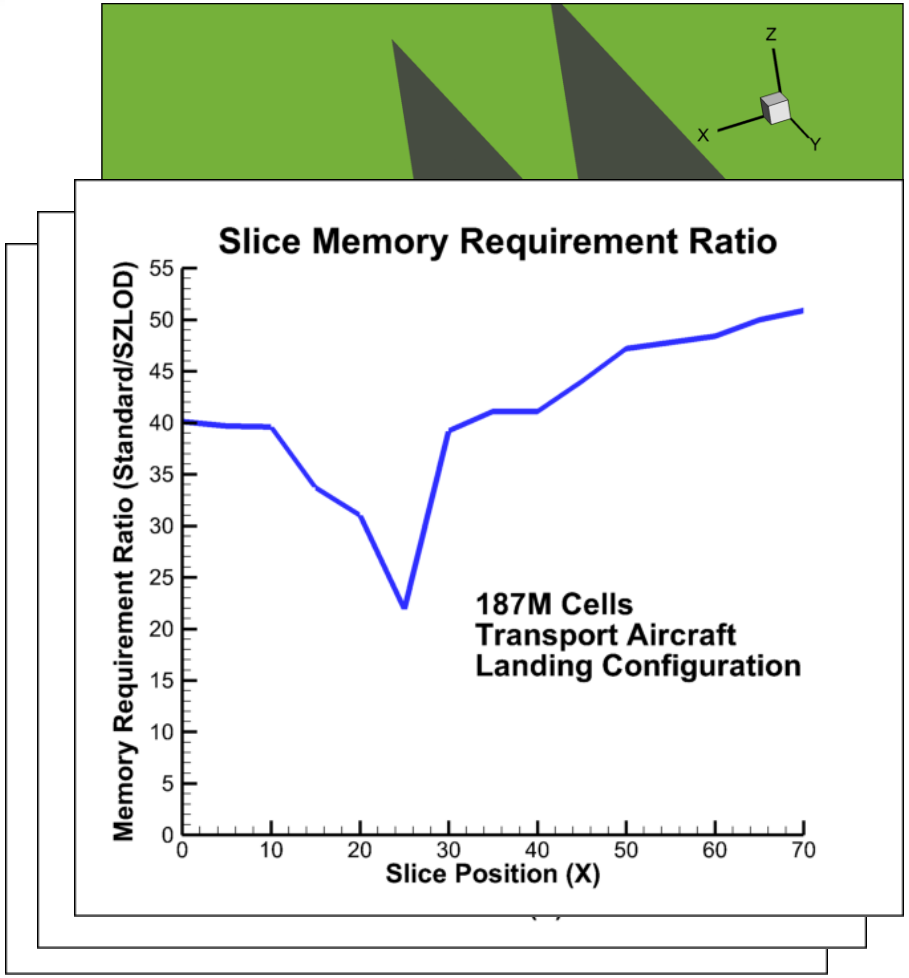
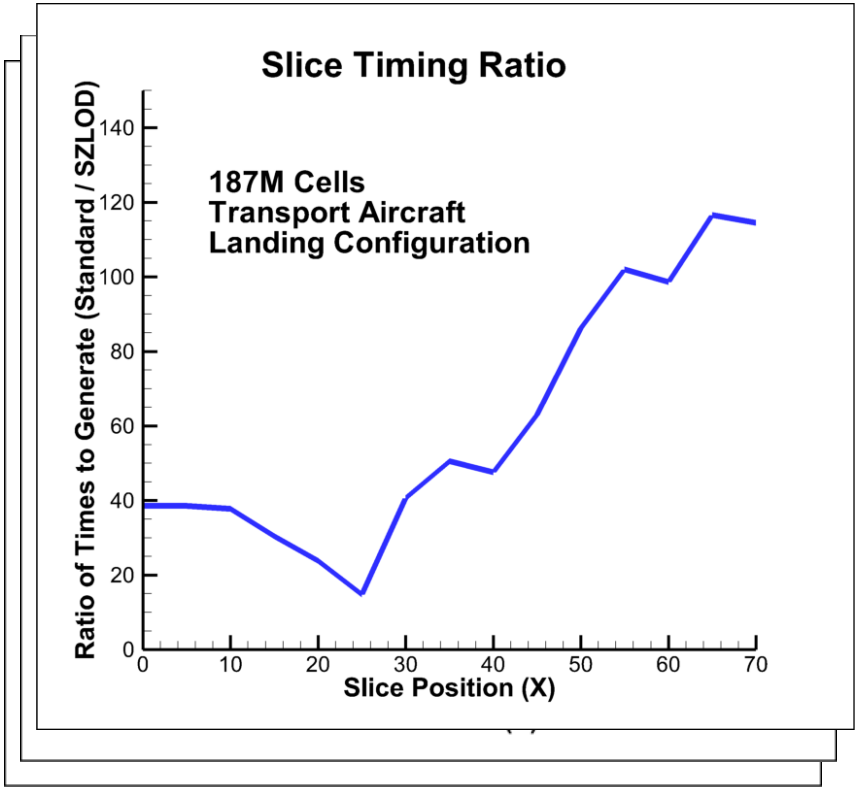
Field-Data Operations for Parametric Data

- Common Field-Data Operations
  - Comparative analysis (what has changed)
  - Integrations (forces and moments)
  - Extractions (snapshots)
  - Aggregations (statistics, box-plots)
- Operations over enormous amounts of data
  - Example: Aero database development
    - Thousands of 100M Cell CFD solutions
  - Some aggregations require data from all solutions to be loaded simultaneously
    - If not clever, work through equivalent of 100B Cells

Work on Large Data Performance





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