FUN3D v12.7 Training

Session 2: Welcome and Overview

Eric Nielsen

FUN3D Training Workshop

June 20-21, 2015

Saturday, June 20

Session 1: Meet and Greet	All	8:00-8:30
Session 2 Welcome and Overview	Eric Nielsen	8:30-9:00
Session 3: Compilation and Installation	Bill Jones	9:00-9:15
Session 4: Gridding, Solution, and Visualization Basics	Eric Nielsen	9:15-10:15
BREAK		10:15-10:30
Session 5: Boundary Conditions	Jan-Renee Carlson	10:30-11:00
Session 6: Turbulence Models	Jan-Renee Carlson	11:00-11:30
Session 7: Supersonic / Hypersonic Perfect Gas Simulations	Mike Park	11:30-12:00
CATERED LUNCH: Lightning Talks	Various	12:00-1:15
Session 8: Parameterization Tools	Bill Jones	1:15-2:15
Session 9: Adjoint-Based Design for Steady Flows	Eric Nielsen	2:15-3:45
BREAK		3:45-4:00
Session 10: Feature and Adjoint-Based Error Estimation and Mesh Adaptation	Mike Park	4:00-5:00

FUN3D Training Workshop

June 20-21, 2015

Sunday, June 21

Session 11: Time-Dependent Simulations	Bob Biedron	8:00-8:30
Session 12: Dynamic Grid Simulations	Bob Biedron	8:30-9:00
Session 13: Suggar ++	Ralph Noack	9:00-10:00
BREAK		10:00-10:15
Session 14: Overset Grid Simulations	Bob Biedron	10:15-10:45
Session 15: Adjoint-Based Design for Unsteady Flows	Eric Nielsen	10:45-12:00
LUNCH ON YOUR OWN		12:00-1:00
Session 16: Aeroelastic Simulations	Bob Biedron	1:00-1:45
Session 17: Rotorcraft Simulations	Bob Biedron	1:45-2:45
BREAK		2:45-3:00
Session 18: Current Development Activities, Summary of User Feedback and Requests	All	3:00-4:00
Session 19: High-Energy / Generic Gas Simulations *** Please see important note for this session below ***	Peter Gnoffo	4:00-4:30

Due to security regulations, workshop participants who would like to attend this session will be required to present a valid US passport as proof of US citizenship. There will be no exceptions to this requirement. The FUN3D team apologizes for any inconvenience this may cause.

Administrative Details

- Need to stay on schedule, but please do not hesitate to ask questions
- Please submit your two forms by lunchtime on Sunday to any team member
  - **User Feedback/Requests Form**
    - User feedback and requests will be summarized and discussed in the final session on Sunday
  - **Training Evaluation Form**
    - Very interested in your feedback, good or bad!

All Material Available Online

- For the v12.7 material presented here:
  - Slides online in PDF format
  - Demo content can be downloaded as a tarball
  - Capture hopefully online soon
- A FUN3D v12.7 manual is available as NASA/TM-2015-218761 on the website
  - You should also receive a copy of this with the source code distribution
  - Additional material will continue to be added with new releases
  - Your feedback/suggestions are extremely helpful
- Extensive material from prior training workshops is available on the website
  - Slides in PDF
  - Pro-shot streaming video
- We hope to eventually add an extensive tutorials document

The FUN3D Development Team

fun3d-developers@lists.nasa.gov

- Consists of ~15-20 researchers across several branches at Langley
  - Computational AeroSciences Branch
  - Aerothermodynamics Branch
- Some people are full-time FUN3D, others part-time
  - Spectrum runs from full-time development to full-time applications
- Also external groups such as Georgia Tech, National Institute of Aerospace (NIA)
- Open to other interested parties joining us
  - Remote, real-time, read/write access to FUN3D repository is available

The FUN3D Support Team

fun3d-support@lists.nasa.gov

"Who sees my questions to the support alias?"

- Consists of 14 members of the development team
- All are NASA civil servants
  - Proprietary/sensitive data can be shared/discussed: all are bound by Trade Secrets Act
- Members: Kyle Anderson, Bob Biedron, Jan-Renee Carlson, Peter Gnoffo, Dana Hammond, Bill Jones, Bil Kleb, Beth Lee-Rausch, Steve Massey, Eric Nielsen, Matt O'Connell, Mike Park, Kyle Thompson, Jeff White

Myth: Our job is to develop a production-level tool and support users.

Reality: ***None*** of us are funded at ***any*** level to support users, maintain documentation, keep up a website, run training workshops, etc. The team is funded solely to perform their individual research efforts.

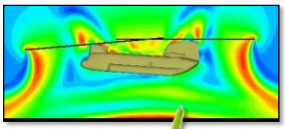
The FUN3D User Community

fun3d-users@lists.nasa.gov

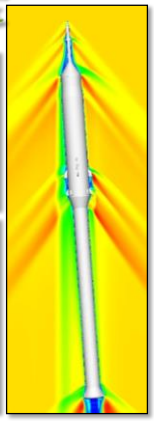
- FUN3D widely used within NASA for projects across the speed range
  - Both engineering and research applications
  - Users routinely running on several thousand cores
- Distributed to hundreds of external organizations across academia, industry, DoD, and OGAs
  - Average about 100 distributions / year
  - Wide range of uses including aerospace, automotive, HPC, etc
  - Wide range of hardware being used
  - From RC enthusiasts on single workstation to groups generating matrices of hundreds of solutions on thousands of HPC nodes

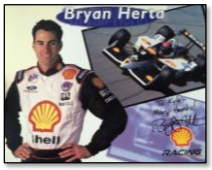
FUN3D Core Capabilities

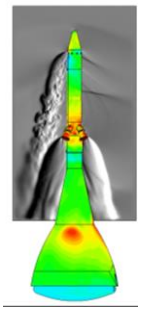
- Established as a research code in late 1980s; now supports numerous internal and external efforts across the speed range
- Solves 2D/3D steady and unsteady Euler and RANS equations on node-based mixed element grids for compressible and incompressible flows
- General dynamic mesh capability: any combination of rigid / overset / morphing grids, including 6-DOF effects
- Aeroelastic modeling using mode shapes, full FEM, CC, etc.
- Constrained / multipoint adjoint-based design and mesh adaptation
- Distributed development team using agile/extreme software practices including 24/7 regression, performance testing
- Capabilities fully integrated, online documentation, training videos, tutorials



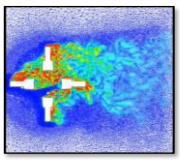
US Army

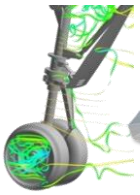


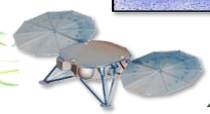


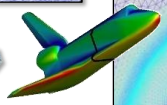


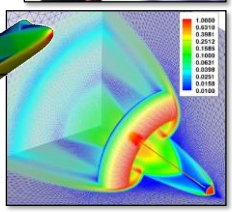
Georgia Tech







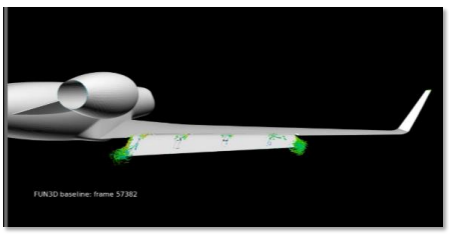


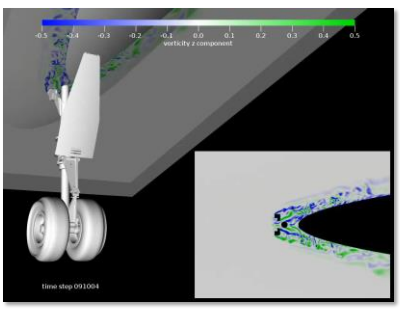


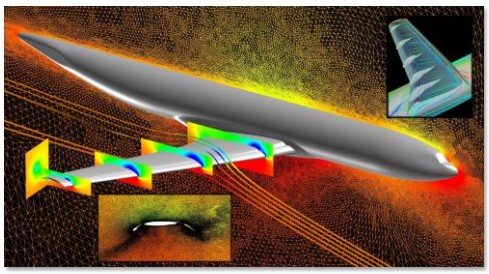
Some Recent NASA Applications

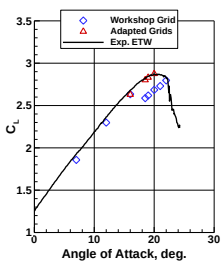
Airframe Noise

Courtesy NASA/Gulfstream Partnership on Airframe Noise Research





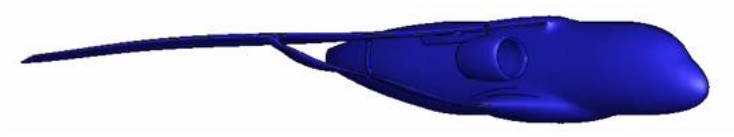




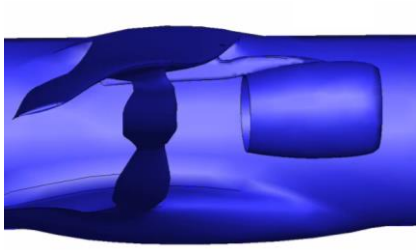
Adjoint-Based Adaptation for High-Lift

10

Some Recent NASA Applications

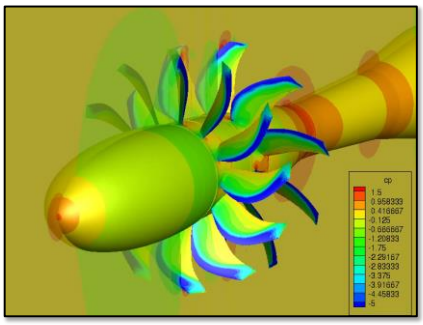


Courtesy Bob Bartels



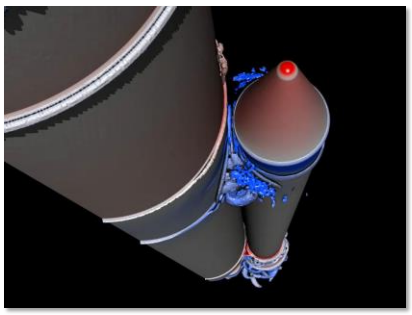
Aeroelastic Analysis of the Boeing SUGAR Truss-Braced Wing Concept

Open-Rotor Concepts



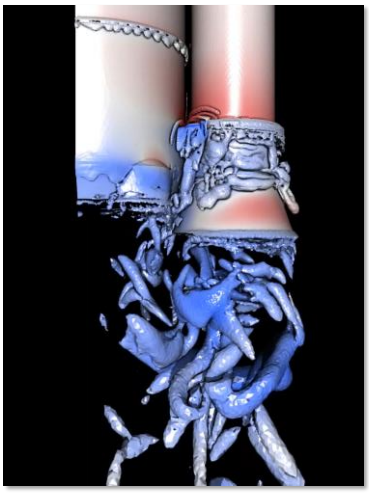
Courtesy Bill Jones

Some Recent NASA Applications



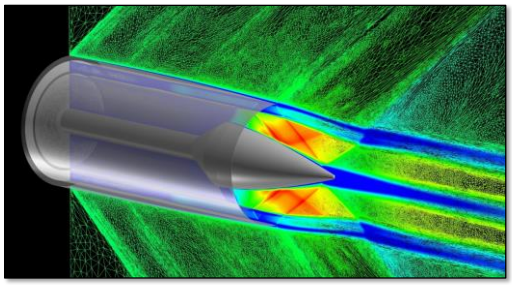
Transonic Buffet Characterization for Space Launch System

Courtesy Greg Brauckmann, Steve Alter, Bil Kleb

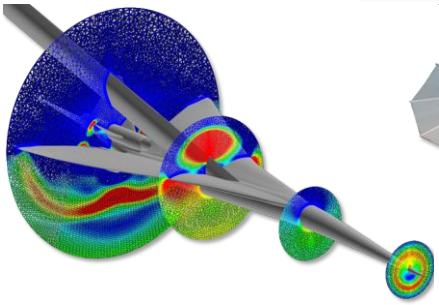


Some Recent NASA Applications

Courtesy Chris Heath



Sonic Boom Mitigation

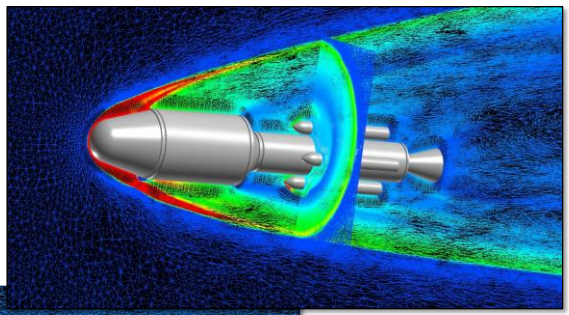


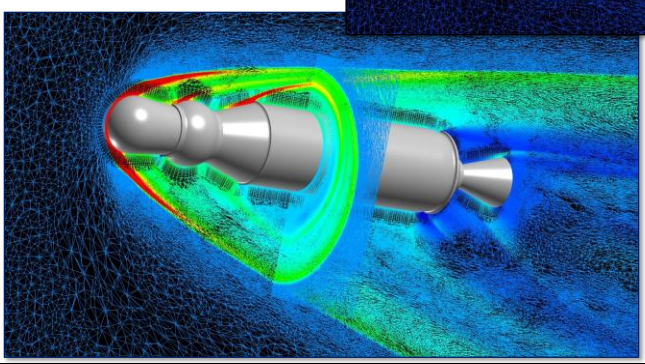
Mars InSight Lander

Some Recent NASA Applications

Mars Ascent Vehicle for Sample Return

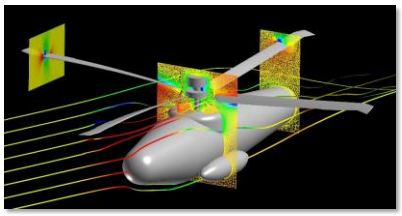
Courtesy Ashley Korzun





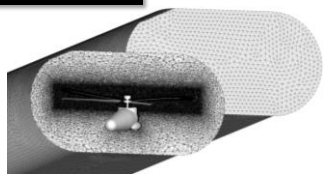
Some Recent NASA Applications

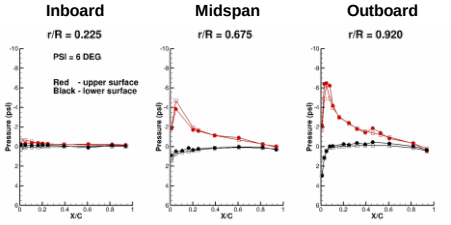
Validation for Full Scale UH60A



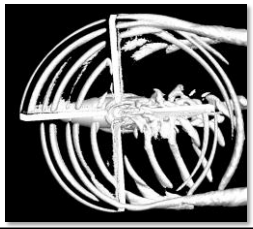
Courtesy
Beth Lee-Rausch,
Bob Biedron

- Structural loads
- Sectional airloads/pressures
- Balance loads
- Control settings
- Blade root motions
- Elastic blade deflections



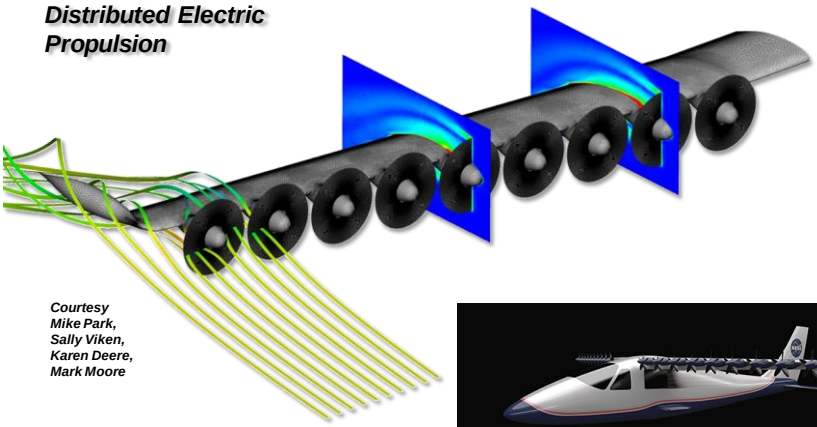


Blade Pressures at High Advance Ratio



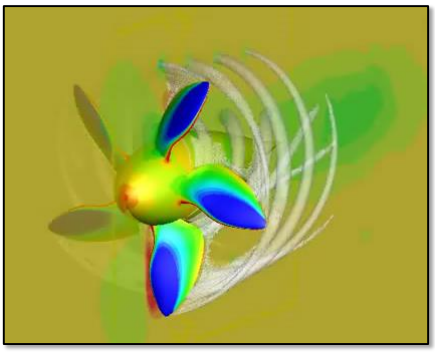
Some Recent NASA Applications

Distributed Electric Propulsion

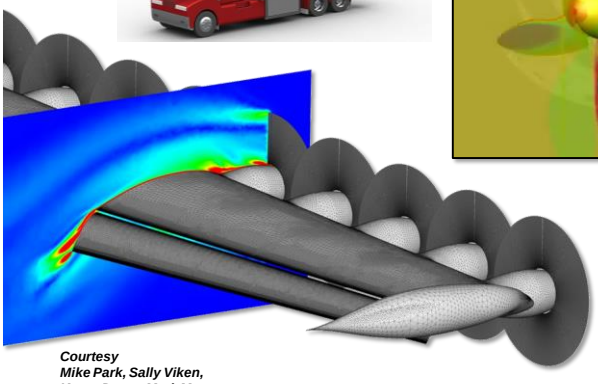


Courtesy
Mike Park,
Sally Viken,
Karen Deere,
Mark Moore

Some Recent NASA Applications



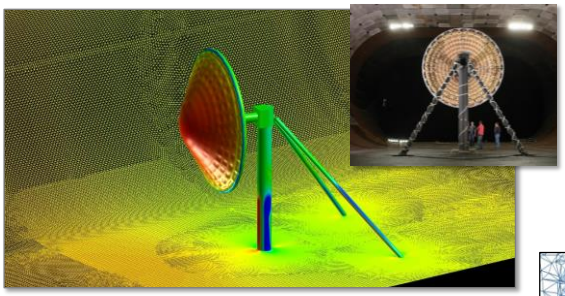
Courtesy Bill Jones



Distributed Electric Propulsion

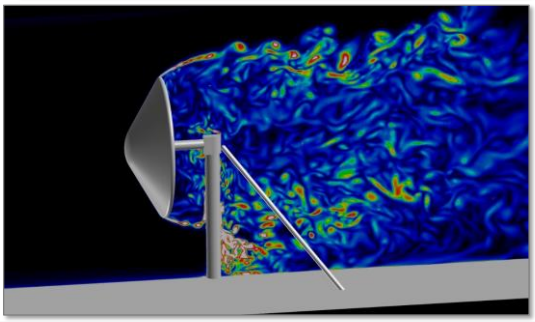
Courtesy
Mike Park, Sally Viken,
Karen Deere, Mark Moore

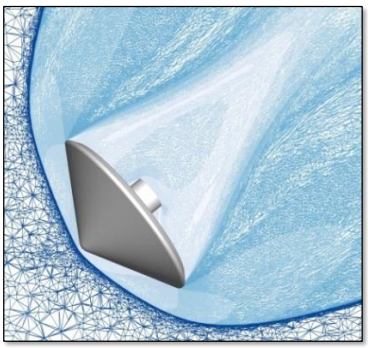
Some Recent NASA Applications



Aeroelastic Analysis of HIADs: Hypersonic Inflatable Aerodynamic Decelerators

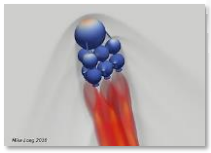
Courtesy Beth Lee-Rausch,
Bob Biedron, and Bil Kleb

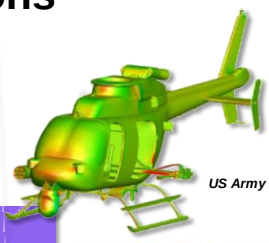




Some User Applications

SPACEX

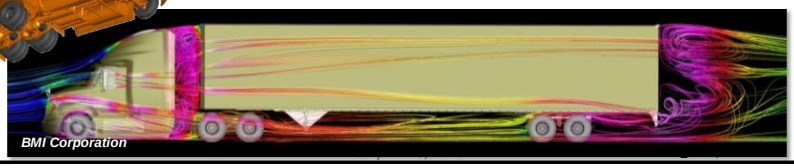




US Army

Mike Long

Georgia Tech

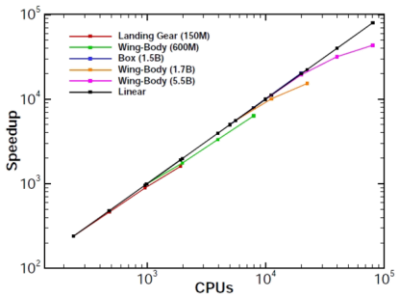


BMI Corporation

FUN3D and High-Performance Computing

FUN3D is used on a broad range of HPC installations around the country

OLCF



Scaled to 80,000 cores on DoE's Cray XK7 'Titan' using grids containing billions of elements

Awarded the Gordon Bell Prize in a past collaboration with Argonne National Lab

Some Final Notes

- The material that will be shown here represents the current recommended best practices for the perfect gas option in FUN3D
- Simulations with real gas effects are covered Sunday afternoon for users who present a valid US passport
- There are always many research and development efforts taking place within the code that are not described here
- If you do not see something, please ask about it