FUN3D v12.4 Training

Session 1: Welcome and Overview

Eric Nielsen

FUN3D Training Workshop

March 24-25, 2014

Monday, March 24

Meet and Greet	All	8:00-8:30
Session 1: Welcome and Overview	Eric Nielsen	8:30-9:00
Session 2: Compilation and Installation	Bill Jones	9:00-9:15
Session 3: Gridding, Solution, and Visualization Basics	Eric Nielsen	9:15-10:15
BREAK		10:15-10:45
Session 4: Boundary Conditions	Jan-Renee Carlson	10:45-11:15
Session 5: Turbulence Models	Jan-Renee Carlson	11:15-11:45
LUNCH		11:45-1:00
Session 6: Supersonic/Hypersonic Simulations (Perfect Gas)	Mike Park	1:00-1:30
Session 7: Code Development	Mike Park	1:30-3:30
BREAK		3:30-4:00
Session 8: Parameterization Tools	Bill Jones	4:00-5:00

FUN3D Training Workshop

March 24-25, 2014

Tuesday, March 25

Session 9: Adjoint-Based Design for Steady Flows	Eric Nielsen	8:00-9:30
BREAK		9:30-10:00
Session 10: Time-Dependent Simulations	Bob Biedron	10:00-10:30
Session 11: Dynamic Grid Simulations	Bob Biedron	10:30-11:00
Session 12: Suggar ++	Bob Biedron	11:00-12:00
LUNCH		12:00-1:15
Session 13: Overset Grid Simulations	Bob Biedron	1:15-1:45
Session 14: Adjoint-Based Design for Unsteady Flows	Eric Nielsen	1:45-3:15
BREAK		3:15-3:45
Session 15: Aeroelastic Simulations	Bob Biedron	3:45-4:15
Session 16: CFD/CSD Coupling	Jamshid Samareh (Remote from LaRC)	4:15-4:45
Session 17: Rotorcraft Simulations	Bob Biedron	4:45-5:00

All Material Available Online

- A formal FUN3D manual is available for the first time with the release of v12.4
  - NASA/TM-2014-218179
  - Subsequent releases will be accompanied by an updated manual
  - This first revision covers much of the basics
    - Quick Start
    - Installation
    - BC's, Grids, Solvers, Adaptation, Design Optimization
    - Troubleshooting
    - Extensive appendices for the major namelists, now extracted in real-time from source code
  - Additional material will continue to be added
- Eventually hope to add an accompanying document with tutorials
- A complete set of training material for FUN3D v11.1 is available at the FUN3D website
  - A bit dated, but majority of the content is still relevant
  - PDF copies of training slides
  - Pro-shot streaming video for all content in Quicktime and Flash formats
  - Video also available for Langley-developed parameterization packages
- The material presented here for v12.4 will be online at FUN3D website within a couple of days
  - Sessions chosen based on AFRL input

The FUN3D Development Team

fun3d-developers@lists.nasa.gov

- Consists of ~15 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 11 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: Bob Biedron, Jan-Renee Carlson, Peter Gnoffo, Dana Hammond, Bill Jones, Bil Kleb, Beth Lee-Rausch, Steve Massey, Eric Nielsen, Mike Park, 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.

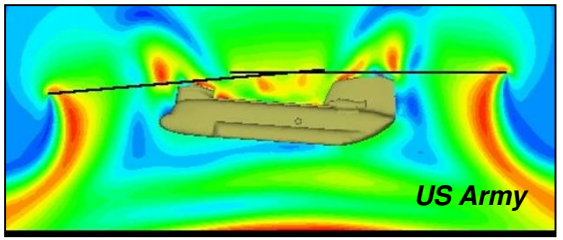
The FUN3D User Community

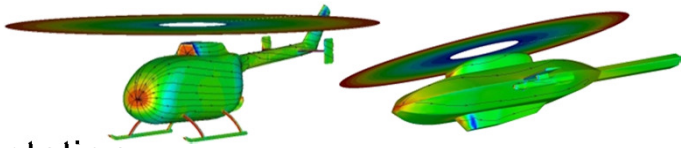
fun3d-users@lists.nasa.gov

- 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 OGA's
  - Average about 100 distributions / year
  - Wide range of uses including aerospace, automotive, HPC, etc
    - Many problems as complex, if not more so, than NASA's
  - 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

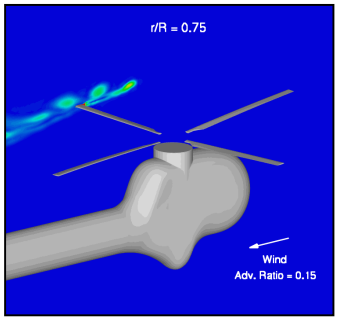
FUN3D Core Capabilities

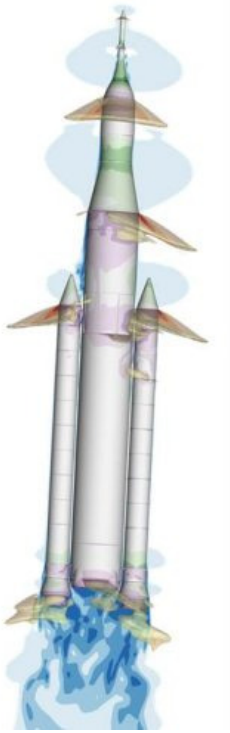
- Established as a research code in late 1980's; now supports numerous internal and external efforts across the speed range
- Solves 2D/3D steady and unsteady Euler and RANS equations on node-based mixed element grids for compressible and incompressible flows
- Highly-scalable execution (80,000 cores on Cray XK7)
- 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 and performance testing
- Capabilities fully integrated, online documentation, training videos, tutorials



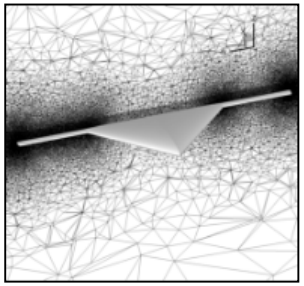


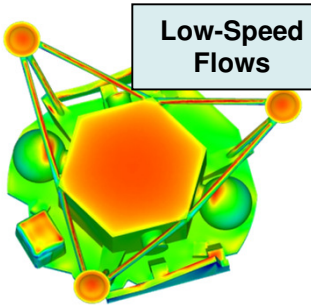
Rotorcraft





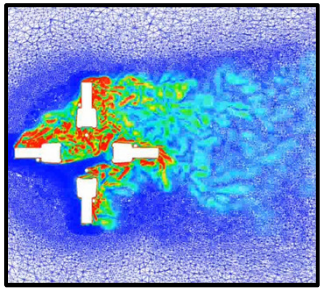
Launch Vehicles

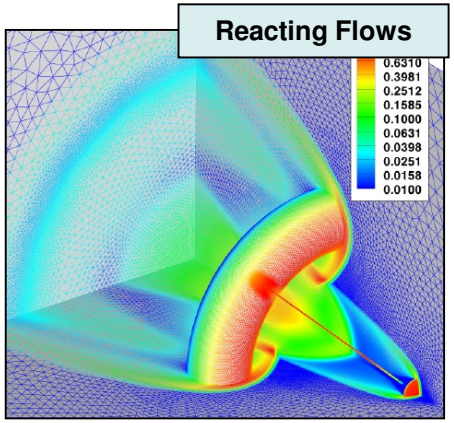




Low-Speed Flows

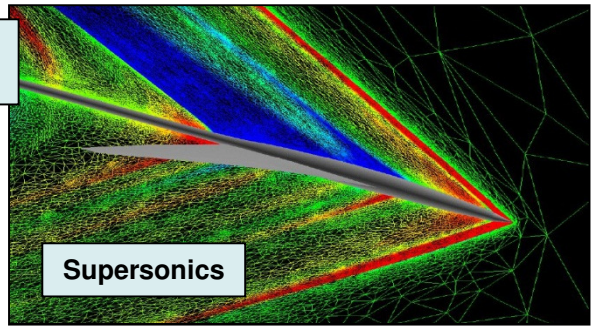
Georgia Tech



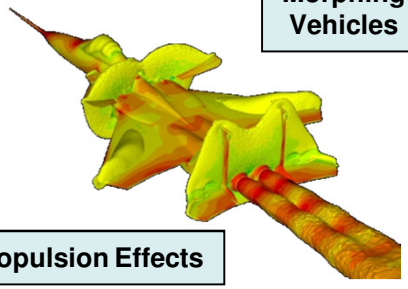


Reacting Flows

Morphing Vehicles

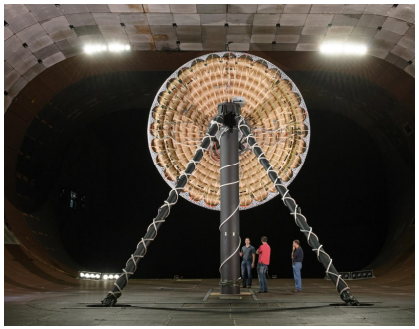


Supersonics

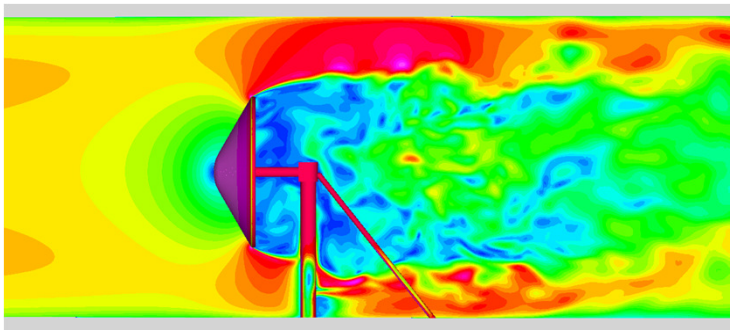


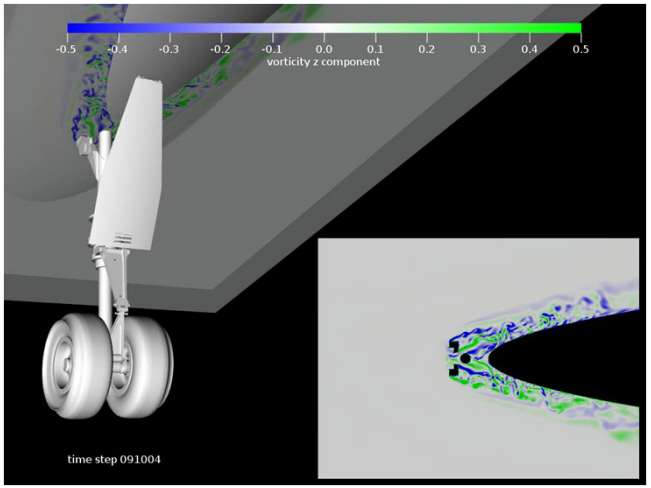
Propulsion Effects

Some Recent NASA Applications

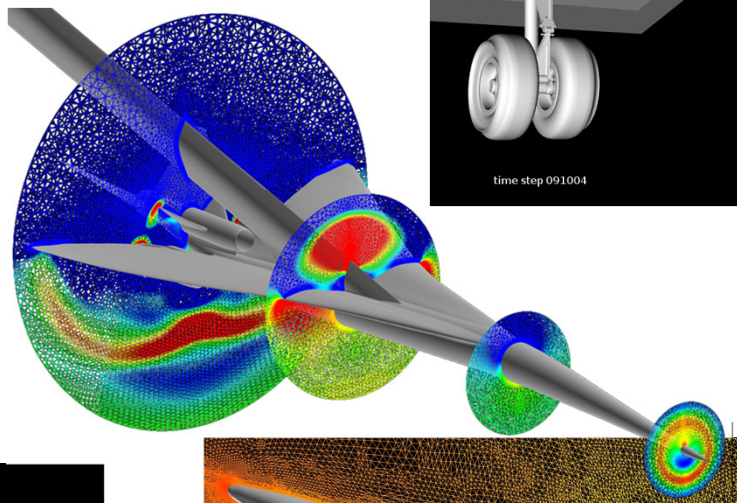


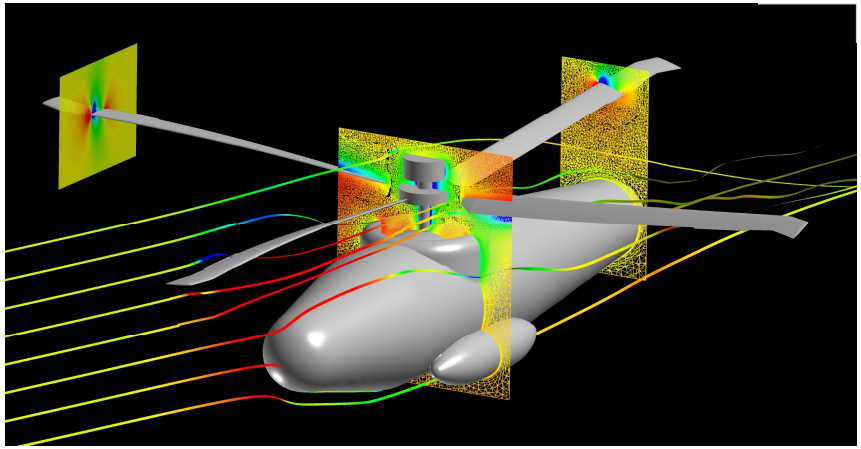
Mike Lindell, John van Norman

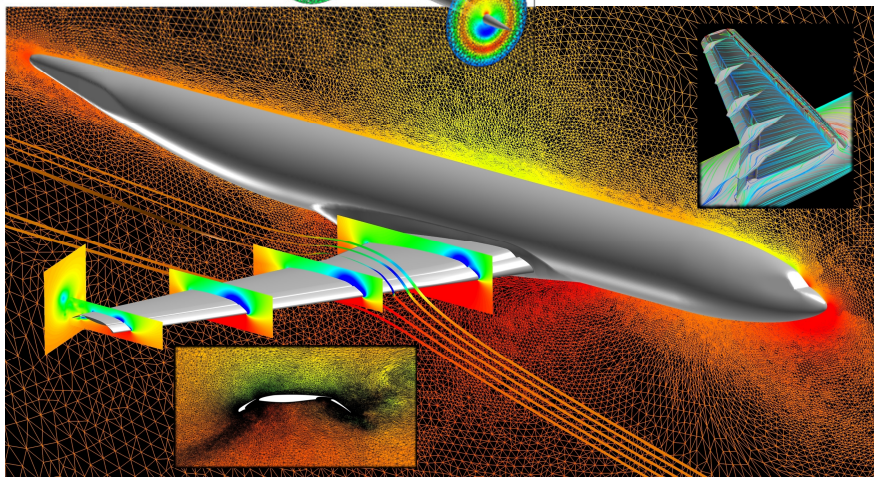




NASA/Gulfstream Partnership on Airframe Noise Research

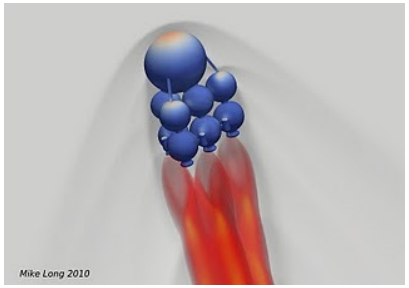


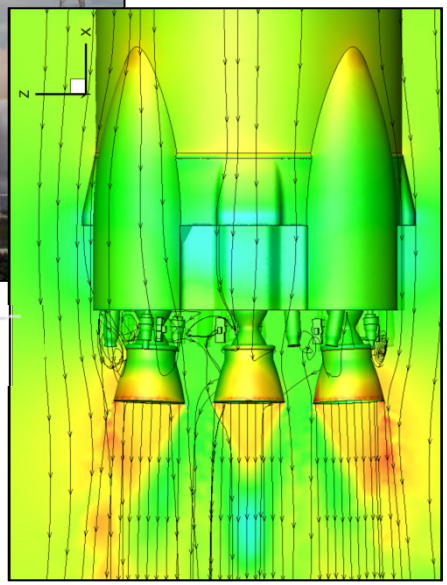


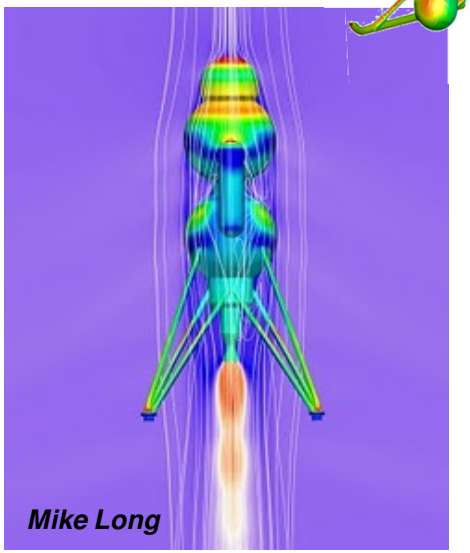


Some User Applications

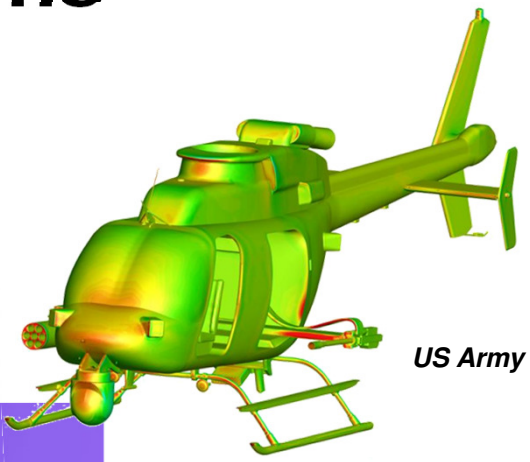
SPACEX





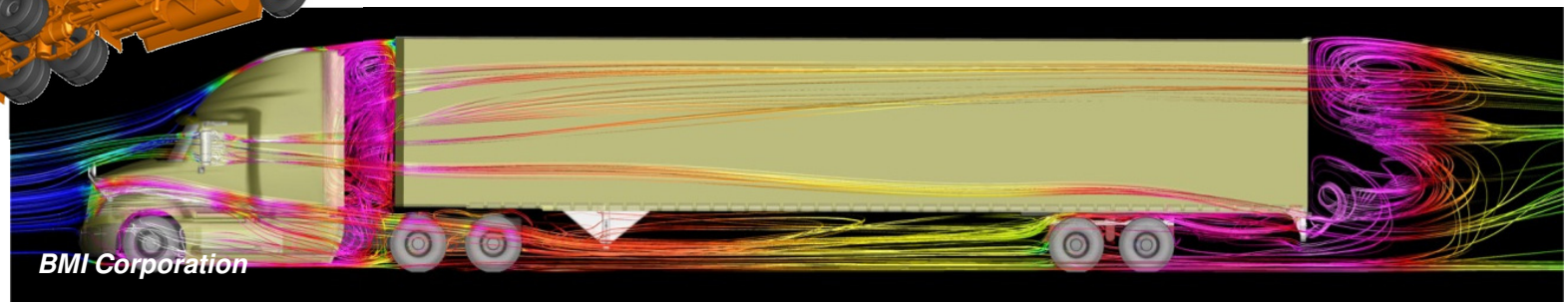


Mike Long



US Army

Georgia Tech

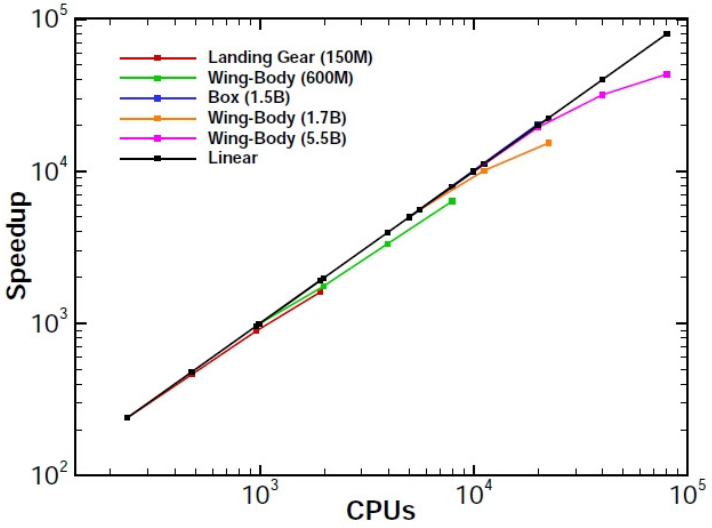


BMI Corporation

FUN3D and High-Performance Computing

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

OLCF
Oak Ridge Leadership Computing Facility



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

- 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 not covered
- There are many capabilities in FUN3D that will not be covered here – if you do not see something, please ask about it
- There are always many research and development efforts also taking place within the code that are not described here

Questions?