

Kal Monroe

PHD PRE-CANDIDATE · ANN AND H.J. SMEAD AEROSPACE ENGINEERING SCIENCES · CU BOULDER

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Education

University of Colorado Boulder

Boulder, CO

PHD AEROSPACE ENGINEERING

Aug. 2021 - present

- GPA: 4.0
- Research Focus: Hypersonic Aerothermodynamics, Computational Fluid Dynamics, Vehicle Design
- Relevant Coursework: Compressible Flows, Incompressible Flows, Turbulent Flows, Numerical Methods

University of Michigan

Ann Arbor, MI

BSE AEROSPACE ENGINEERING - *Summa Cum Laude*

Aug. 2017 - May 2021

- GPA: 3.98
- Relevant Coursework: Aircraft Design and Optimization, Numerical Methods, Aircraft Dynamics, Aerodynamics

Professional Experience

Sierra Space / Sierra Nevada Corporation

Louisville, CO

HYPERSONIC AERODYNAMICS INTERN

Summer 2021

- Leveraged familiarity with multiple hypersonic flow solvers, such as FUN3D, DPLR, LOCI/CHEM, to benchmark aerodynamic heating and forces on geometries of interest
- Streamlined simulation setup processes for the aerodynamics group by using MATLAB to automate the transformation of GNC re-entry trajectories into desired CFD cases. 30 minute process now takes under 1 min
- Generated structured and unstructured meshes in Pointwise for various hypersonic environments. Verified accurate mesh density and growth rates through the interrogation of heat fluxes and stagnation properties in Paraview and Tecplot.

The Boeing Company

Long Beach CA

ADVANCED CONCEPTS AERODYNAMICS AND CONFIGURATIONS INTERN

Summer 2020

- Quantified the performance of a proposed Boundary Layer Ingestion device for future aircraft. Personally focused on aerodynamic refinement, leading to a streamlined design with a 1.8% reduction in aircraft fuel burn
- Increased the precision of aft fuselage aerodynamic data by generating CFD flow fields using SU2 and HPC clusters. More precise results supported a 0.3% decrease in fuel burn compared to original estimate
- Improved efficiency and power-delivery of a propulsor by developing a MATLAB simulation to explore multiple design variables such as rotation speed, blade count, and size. Final configuration increased propulsive efficiency by 16%

The Boeing Company

Seattle, WA

WIND TUNNEL ANALYSIS AND CONFIGURATIONS INTERN

Summer 2019

- Designed and drafted a translational rail mount, securing a 1000 lb. probe in the 5m Tunnel. Served as a design representative at Test Readiness Reviews to present installation plans to test engineers and answer questions
- Created 6 experimental hardware drawings with installation instructions, ensured release deadlines could be met. Coordinated frequently with machine-shop staff for the rapid manufacturing and implementation of drafted hardware
- Quantified worst-case aerodynamic and structural loads on wind tunnel mechanisms using vortex panel codes and Elfini FEA. Identified structural concerns and proposed modifications to meet wind tunnel safety requirements

University of Michigan Department of Aerospace Engineering

Ann Arbor, MI

INSTRUCTIONAL ASSISTANT - AERODYNAMICS 325

Summer 2020

- Facilitated learning through holding regular office hours, debugging sessions, and review presentations
- Assisted instructor by creating weekly rubrics, performance summaries, and exam solution guides
- Developed video tutorials to introduce students to flow-solver programs such as XFOIL and AVL

Research

Nonequilibrium Gas and Plasma Dynamics Laboratory

Boulder, CO

ADVISOR: DR. IAIN BOYD

August 2021 - present

- Performed high-fidelity simulations of hypersonic bodies, accounting for nonequilibrium effects and turbulent dynamics.
- Developed multiple post-processing tools in python to parse flow data, including stagnation line quantities, surface properties, and turbulent statistics
- Generated unstructured meshes in Pointwise for use in DSMC solvers. Developed a process to map meshes between similar geometries and save on required time.
- Created user guides for commercial distribution of in-house hypersonic flow solver. Documentation includes example cases, mathematical methodologies, and descriptions of known issues.

Computational Multiphase/Multiphysics Flow Laboratory

Ann Arbor, MI

ADVISOR: DR. JESSE CAPECELATRO

March 2020 - July 2021

- Leveraged high performance computing clusters to perform high-fidelity CFD on a variety of turbulent flows, including periodic pipes, pulsatile jets, and human coughs with respiratory particles
- Investigated the aerial transmission mechanisms of COVID-19 by simulating multiphase respiratory events with NGA CFD code. Post-processed results in VisIT, identifying extents of vortical structures and infectious particle contamination
- Recognized insufficient grid spacing in laboratory simulations by cross-referencing against published simulations of similar scope. Implemented higher grid spacing to ensure flow turbulence was fully resolved

Turbulent Mixing and Unsteady Aerodynamics Laboratory

East Lansing, MI

ADVISORS: DR. DAVID OLSON & DR. AHMED NAGUIB

Summer 2018

- Designed and installed an electronic three-axis camera positioning system for use in molecular tagging velocimetry experiments. Manufactured camera harness by hand using an in-house machine shop
- Decreased experimental setup time by a factor of 4 by interfacing new equipment with existing hardware. Expanded tunnel imaging system capabilities to include programmable 3D vector movements and position feedback
- Increased speed and repeatability of camera positioning system with the construction of a user interface through LabVIEW. Positioning resolution increased by a factor of 100 over previous design

Projects

M-Fly - Student SAE Aero Design Team

Ann Arbor, MI

CHIEF ENGINEER / AERODYNAMICS LEAD

Sep. 2017 - July 2021

- Team placed 1st in design against 25+ teams at the national SAE Aero Design 2020 competition
- Conceptualized a research investigation of the influence of propeller placement on flight performance. Oversaw construction and wind-tunnel analysis of a custom test article. Increased spanwise placement saw increased lift to drag ratios.
- Optimized aircraft tail by pairing AVL aerodynamic analysis and modeFRONTIER softwares to iterate through 1500 potential configurations. Final tail minimized trim drag while maintaining takeoff authority
- Introduced use of delta wings on 2020 design - validated higher payload capacity and low speed performance over historical M-Fly wing configurations through aerodynamic analysis in StarCCM+

Healing Haiti

Port Au Prince, Haiti

COMMUNITY VOLUNTEER

Summer 2017

- Managed a high sense of cultural sensitivity and awareness towards the community
- Researched needs for the isolated elderly and maintained a supply chain of basic living necessities
- Supported local orphanages by organizing engaging activities and providing periodic care for children

Publications

Monroe, K., Yao, Y., Lattanzi, A., Raghav, V., Capecelatro, J. (2020) Role of Pulsatility on Particle Dispersion in Expiratory Flows. *Physics of Fluids*. 33, 4, **URL: <https://doi.org/10.1063/5.0048746>**

Presentations

Monroe, K. (2018) Application of a Motion Controlled Positioning System Toward Molecular Tagging Velocimetry, Mid-Michigan Symposium for Undergraduate Research Experiences, East Lansing, MI.

Monroe, K., Lattanzi, A., Yao, Y., Raghav, V., Capecelatro, J. (2020) Role of Pulsatility on Aerosol Dispersion in Expiratory Flows, 73rd Annual Meeting of the APS Division of Fluid Dynamics, Chicago, IL.

Skills

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| Technical | Ham Radio Licensed, Machine Shop, TIG Welding |
| Languages | MATLAB, Python, C++, C, Bash, FORTRAN, L ^A T _E X |
| Software | DPLR, FUN3D, StarCCM+, LociCHEM, SU2, Pointwise, Gmsh, VisIT, AVL, XFOIL, modeFRONTIER MDO, Tecplot, ParaVIEW, CATIAV5, Solidworks, NX, GalilSuite, LabVIEW, Microsoft Office, Photoshop, Illustrator, Lightroom, Blender |

Interests

Cello & piano performance, tennis, skiing, biking, backpacking, astrophotography, ham radios