# ANDREW B. SHELTON

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**EXPERTISE**

Research, development, and application of computational fluid dynamics (CFD) algorithms, models, and workflows, especially for the characterization of flight vehicle aerodynamics

* Flow solution code development including finite volume (FV) and high-order discontinuous Galerkin (DG) methods
* Implementation of hybrid Reynolds Averaged Navier Stokes (RANS) and Large Eddy Simulation (LES) turbulence models
* Characterization of unsteady aerodynamics due to flight vehicle rigid body motion
* Application of government and commercial meshing, flow solution, and post-processing software

# EDUCATION

### PhD, Georgia Institute of Technology, *Aerospace Engineering*, August 2008

### MS, Auburn University, *Mechanical Engineering*, March 1997

### BS, Auburn University, *Aerospace Engineering*, June 1994

# EMPLOYMENT

#  Leidos, Eglin AFB, FL

2018 – present *Sr Principal Engineer, Computational Fluid Dynamics*, AFRL Munitions Directorate

2016 – 2018 *Principal Engineer, Computational Fluid Dynamics*, AFRL Munitions Directorate

2014 – 2016 *Aeronautics Computational Fluid Dynamics Engineer*, AFRL Munitions Directorate

#  Auburn University, Auburn, AL

2008 – 2014 *Assistant Professor*, Department of Aerospace Engineering

#  Raytheon Missile Systems, Tucson, AZ

2007 – 2008 *Sr Principal Engineer*, Computational Aerodynamics

#  Georgia Institute of Technology, Atlanta, GA

2003 – 2007  *Graduate Research Assistant*, Nonlinear Computational Aeroelasticity Laboratory

#  Lockheed Martin Aeronautics Company*,* Ft. Worth, TX

2002 – 2003 *Aeronautical Engineer Senior*, F-35 Aerodynamics and CFD

#  General Electric Power Systems, Greenville, SC

2001 – 2002 *Lead Engineer*, Aero CFD Development

#  Raytheon Missile Systems, Tucson, AZ and Tewksbury, MA

1999 – 2001 *Engineer II*, Aeromechanics Design

1997 – 1999 *Member Technical Staff*, Aeromechanics and Flight Control

US Citizen, DoD Secret Clearance 1997 – 2012, 2014 – present

**EXPERIENCE DETAILS**

Dr. Shelton has worked aerodynamic efforts for missiles, fixed wing aircraft, rotary wing aircraft, and gas turbines. He has significant industry and academic experience in all aspects of the computational fluid dynamics field, from flight vehicle design and analysis to code development. He has utilized both government and commercial CFD codes for airframe and component design trades, airloads database generation, and six degree of freedom aerodynamic table development. He has authored basic finite volume codes for instructional purposes and authored advanced high order discontinuous Galerkin codes for research purposes.

**Leidos @ Air Force Research Laboratories Munitions Directorate, 2014 – present**

Dr. Shelton currently provides on-site CFD workflow, application, and algorithm development for missile fluid-thermal-structure interaction (FTSI) activities at the AFRL Munitions Directorate. As PI for several contracted efforts, he exercises the flow solvers Cart3D, FUN3D, and Kestrel for aerodynamic characterization of high-speed flows, especially those with high angles of attack, jet interactions, and rigid body motions. Parallel research activities include

* Development of methodology for CFD-based aerodynamic derivative estimation using Walsh function rigid body motion with system identification
* Derivation of a kinetic energy preserving and entropy consistent discontinuous Galerkin scheme for the Euler equations with equilibrium thermochemistry of air
* Implementation of in-house tools to generate classical, supersonic streamline-traced inlets (e.g., Busemann sugar scoop) and bodies (e.g., conical flow waverider)
* Development of in-house tools to track solid rocket propellant grain regression by coupling the level set method, port gas dynamics, and local internal ballistics

**Auburn, 2008 – 2014**

Dr. Shelton's focus was development of a state-of-the-art nonlinear numerical technique that enjoys both high throughput and high accuracy for geometrically complex problems in unsteady, compressible fluid dynamics. This research aims for three orders of magnitude improvement in accuracy/cost for flows involving small-scale, high-mode events that drive system-level response – specifically flows in the wakes of helicopters and ship superstructures. Thrusts include: high-order of accuracy discretization via the discontinuous Galerkin finite element method, unsteady solution adaptivity via wavelet/multiresolution data compression mathematics, and resolution sensitive turbulence modeling via hybrid RANS and LES approaches.

Dr. Shelton advised graduate students on the projects that supported the research on advanced algorithms for CFD:

* Discontinuous Galerkin for 3D wake vortex instability simulation
* Discontinuous Galerkin resolution and boundary placement effects on co- and counter-rotating vortex interactions in a confined domain
* Astrophysical shock-cloud interaction with the discontinuous Galerkin method
* Comparison of viscous regularization of the Euler equations using modal decay and entropy production residual in the discontinuous Galerkin method
* Development of a discontinuous Galerkin level set method as a high-fidelity solid rocket motor modeling tool

Dr Shelton also continued to work in the area of applied CFD:

* External aerodynamics of a DARPA conceptual aircraft using the commercial flow solver STAR-CCM+
* Simulation of the airborne dispersion of a citrus grove pest repellant using the commercial flow solver STAR-CCM+

Dr. Shelton taught courses in aerodynamics and CFD. He was named 2011 “Outstanding Faculty Member” by the Auburn University College of Engineering and 2011 “Most Outstanding Faculty Member” by the AIAA Student Chapter. He was recognized as the top teacher in the Auburn University College of Engineering with the 2012 “William F. Walker Teaching Award for Excellence: Superior.”

**Raytheon, 2007 – 2008**

In the Computational Aerodynamics Department of Raytheon Missile Systems, Mr. Shelton exercised the commercial flow solver CFD++ (arbitrary mesh, density-based) for a variety of analyses including highly visible programs such as Excalibur (XM-982, base cavity blowdown and base drag), Standard Missile (SM-2, SM-3, SM-6, external aerodynamics for 6DoF table development and extension), and Kinetic Energy Interceptor (KEI, base flow heat transfer).

**Georgia Tech, 2003 – 2007**

In the Nonlinear Computational Aeroelasticity Laboratory at Georgia Tech, Mr. Shelton performed research in the area of unsteady, turbulent aerodynamics using CFD. Particular emphasis was placed on improving flow solver algorithms for airfoils and wings at and beyond stall (both static and dynamic angle of attack) with the ultimate goal of enhanced prediction of rotary wing flow separation / wake, loads, and acoustics. This was pursued on several fronts, ranging from the evaluation of empirical transition models to modifications of turbulence models in traditional Reynolds-Averaged Navier Stokes (RANS) solvers to hybridization of RANS and Large-Eddy Simulation (LES) techniques. Significant effort was dedicated to the evolution of the OVERFLOW code (structured / overset grid, density-based) with hybrid RANS/LES turbulence modeling as a component of the DARPA-sponsored Helicopter Quieting Program. Mr. Shelton's PhD thesis research aimed to maximize resolution-to-cost by adaptive data compression of the localized, small-scale, high-mode flowfield events that drive system-level response. This was achieved by appealing to the enabling technologies found in the discontinuous Galerkin finite element method and orthogonal multi-wavelet / multi-resolution operator mathematics on unstructured grids.

**Lockheed Martin, 2002 – 2003**

Within the Aerodynamics and CFD competency at Lockheed Martin, Mr. Shelton supported detailed engineering for the F-35 Lightning II (Joint Strike Fighter) Program utilizing in-house flow solvers Falcon (structured mesh, density-based) and Splitflow (cut-cartesian mesh, density-based). He delivered on-schedule CFD-derived data to extend the airloads database to higher Mach numbers, meeting a critical program milestone. That effort greatly improved the speed, accuracy, and repeatability of the loads solution post-processing resulting in software (Perl and Fortran) to automate the procedures. Mr. Shelton generated CFD predictions for jet plume effects wind tunnel test planning, test supplementation, Reynolds number effects, and preliminary aerodynamic performance. He also supported a companion wind tunnel test entry (AEDC, Tullahoma, TN). He collaborated with the propulsion functional group to ensure accuracy of critical inlet distortion CFD analyses by assessing grid-independence of solutions. Additionally, Mr. Shelton performed the inevitable “quick-and-dirty” type analyses on topics such as wake evolution from an exposed internal weapons bay and ejection seat rocket sled camera mount. Mr. Shelton completed training for solid modeling using the CATIA v5 software and programming using C++.

**General Electric, 2001 – 2002**

Mr. Shelton's principal role in Aero CFD Development at GE Gas Turbines was focal point for analyzing complex gas turbine internal flowfields of the F- and E-class heavy duty gas turbines with the flow solver CFX (arbitrary mesh, pressure-correction). Themes included multi-passage diffuser geometry definition and primary / secondary path flow interactions such as blade attachment leakages and cooling extraction. Having garnered significant demand for efficient solution of such flows, Mr. Shelton championed general accessibility of CFX within the aerodynamic design community through one-on-one mentoring and customizing Unigraphics solid modeling courses. Additional contributions included software development (Fortran) for pitch-averaged radial profiles of blade row flow quantities, elliptic mesh generation of blade row geometry, and utilization metrics for the computing infrastructure. Mr. Shelton successfully completed the GE Six-Sigma Green Belt certification in 2002.

**Raytheon, 1997 – 2001**

Following a Masters degree from Auburn University, Mr. Shelton joined Raytheon Electronic Systems in Tewksbury, MA and – upon the merger of Raytheon and Hughes – relocated with the Aeromechanics Design discipline to Raytheon Missile Systems in Tucson, AZ. At Raytheon, Mr. Shelton became an accomplished user of the structured mesh density-based flow solvers NPARC, TLNS3D-MB, and OVERFLOW (overset grid), and an expert in generating multi-block, structured solution grids utilizing the Gridgen software. In addition to roles in wind tunnel test support (Calspan , Buffalo, NY) and 6DoF aerodynamic table development, he performed various CFD analyses to predict missile static stability, aerodynamic loads, two-body aerodynamic interference, scramjet off-design inlet flow effects, and divert jet plume / airframe interactions. These tasks provided opportunities for Mr. Shelton to create software (Fortran) for grid and boundary condition manipulation and vehicle aerodynamic loads computation. Mr. Shelton earned an Individual Achievement Award in 2000 and an Outstanding Contributor Recognition in 1997.

# AWARDS AND HONORS

William F. Walker Teaching Award for Excellence – Superior 2012

Auburn University, Samuel Ginn College of Engineering

Outstanding Faculty Member 2011

Auburn University, Samuel Ginn College of Engineering

Most Outstanding Faculty Member 2011

Auburn University AIAA Student Chapter

Six Sigma Green Belt Certification 2002

General Electric Company

Individual Achievement Award 2000

Raytheon Missile Systems

Outstanding Contributor 1997

NAVSEA AEGIS LEAP Interceptor Program

Sigma Gamma Tau (National Honor Society for Aerospace Engineering) 1994

Phi Lambda Upsilon (National Honorary Chemical Society) 1992

**SOFTWARE EXPERIENCE**

Government pre-processing: Capstone\*

Commercial pre- and post-processing: Gridgen, Fieldview, Tecplot, ParaView

Government flow solvers: Kestrel\*, FUN3D\*, Cart3D\*, OVERFLOW, CFL3D, TLNS3D, NPARC

Proprietary flow solvers: FALCON, SPLITFLOW

Commercial flow solvers: STAR-CCM+, CFD++ , CFX, FLUENT

Programming: Fortran 90\* (and higher), Matlab\*, Perl, C++

Scientific document preparation: LaTeX\*

(\* = current prowess)

**UNIVERSITY COURSES TAUGHT**

ENGR-2050 Statics

AERO-3110 Aerodynamics I

AERO-4140 Aerodynamics III

AERO-6120 Rotary Wing Aerodynamics

AERO-7140 Computational Fluid Dynamics

AERO-7xxx Discontinuous Galerkin Method (developmental in seminar format)

# PROFESSIONAL MEMBERSHIPS AND SERVICE

American Institute of Aeronautics and Astronautics (AIAA), senior member 1994 – present

AIAA Fluid Dynamics Technical Committee, member 2014 – 2017

American Helicopter Society (AHS) , member 2003 – 2015

National Science Foundation (NSF) Review Panelist, Fluid Dynamics 2013

AIAA Student Chapter Advisor 2012 – 2013

AIAA Journals Peer Reviewer 2011 – 2012

**UNIVERSITY SERVICE**

Auburn Alumni Association Faculty/Staff Campaign, Aerospace Engineering 2013

William F. Walker Teaching Award Committee Chair, College of Engineering 2013

Graduate Student Recruitment Coordinator, College of Engineering 2012 – 2014

Senate Library Committee 2012 – 2014

Administrator Review Committee, Aerospace Engineering 2012

Engineering Poster Judge, University Scholars Forum 2012

Graduate Engineering Research Showcase Judge 2011 – 2014

E-Day Committee, Aerospace Engineering 2011 – 2012

Strategic Planning Committee, Aerospace Engineering 2011

Writing Committee, Aerospace Engineering 2010

**GRADUATE STUDENTS COMPLETED**

Watson, R., “Application of the Discontinuous Galerkin Method to Wake Vortex Flows,” MS Thesis, Auburn University, 2014

Reitz, R., “Resolution and Boundary Placement Effects on Discontinuous Galerkin Simulations of Counter-Rotating Vortex Interactions in a Confined Domain,” MS Thesis, Auburn University, 2013

Favors, J., “Comparison of Artificial Viscosity Sensors for the Discontinuous Galerkin Method,” MS Thesis, Auburn University, 2013

Albarado, K., “Application of the Level Set Method to Solid Rocket Motor Simulation,” MS Thesis, Auburn University, 2012

# PATENT

M. Boyd, R. Neuman, A. Shelton, W. Cauthen, R. Zee, “Methods and Systems to Deliver Volatile Compounds,” U.S. Patent 9,173,389 B2, November 3, 2015.

# AFRL TECHNICAL REPORTS

Shelton, "Implementation Notes for Classical Oswatitsch and Busemann Supersonic Inlet Flows", AFRL Technical Report AFRL-RW-EG-TR-2024-????, submitted October 18, 2024

Shelton, "Solid Rocket Grain Regression via Level Set Method, Port Gas Dynamics, and Local Interior Ballistics", AFRL Technical Report AFRL-RW-EG-TR-2024-????, submitted October 18, 2024

Shelton, "Implementation Notes for Classical Conical Flow Waverider Generation", AFRL Technical Report AFRL-RW-EG-TR-2022-????, submitted February 2, 2022

Shelton, "Aerodynamic Derivative Estimation Using Computational Fluid Dynamics with Walsh Function Rigid Body Motion: The Standard Dynamics Model", AFRL Technical Report AFRL-RW-EG-TR-2021-????, submitted July 26, 2021

# Shelton, "A Kinetic Energy Preserving and Entropy Consistent Discontinuous Galerkin Scheme: Euler Equations with Equilibrium Thermochemistry of Air", AFRL Technical Report AFRL-RW-EG-TR-2020-????, submitted December 3, 2020

Shelton, Perez, Silva, "Aerodynamic Derivative Estimation Using Computational Fluid Dynamics with Walsh Function Rigid Body Motion: The Army-Navy Finner", AFRL Technical Report AFRL-RW-EG-TR-2020-????, submitted November 2, 2020

# PUBLICATIONS AND PRESENTATIONS

Shelton, A., Martin, C., Silva, W., “Characterizing Aerodynamic Damping of a Supersonic Missile with CFD,” AIAA Paper 2018-0535, AIAA Aerospace Sciences Meeting, January 2018, Kissimmee, FL

Ahuja, V., Hartfield, R., Shelton A., “Optimization of Hypersonic Aircraft Using Genetic Algorithms,” Applied Mathematics and Computation, vol 242, 2014, pp 423-434

Albarado, K., Shelton, A., Hartfield, R., “SRM Simulation using the Level Set Method and High Order Integration Schemes,” AIAA Paper 2012-4215, AIAA/ASME/SAE/ASEE 48th Joint Propulsion Conference, July 2012, Atlanta, GA

Shelton, A., Neuman, R., “Vegetation Canopy Airflow Modeling for Airborne Dispersion of Dimethyl Disulfide,” Proceedings of the International Conference on Citrus Greening Disease (Huanglongbing), January 2011, Orlando, FL

Neuman, R., Mills, D., Shelton, A., “Experimental Release Rate Analysis of Dimethyl Disulfide from Wax-Based Dispensers,” Proceedings of the International Conference on Citrus Greening Disease (Huanglongbing), January 2011, Orlando, FL

Shelton, A., “Multi-Resolution for Unsteady Compressible Flows,” Invited Talk, University of Wyoming, October 2009, Laramie, WY

Hall, Z., Ahuja, V., Hartfield, R., Shelton, A., Ahmed, A., “Optimization of a Turbofan Inlet Duct Using Genetic Algorithms and CFD,” AIAA Paper 2009-3775, AIAA 27th Applied Aerodynamics Conference, June 2009, San Antonio, TX

Shelton, A., Braman, K., Smith M.J., Menon S., “Evaluation of an LES-Based Turbulence Model for Rotorcraft”, Journal of the American Helicopter Society, accepted May 2009

Shelton, A., Smith, M.J., Zhou, H.-M., “A Multi-Resolution Discontinuous Galerkin Method for Unsteady Compressible Flows”, AIAA Paper 2008-4140, 38th AIAA Fluid Dynamics Conference, June 2008, Seattle, WA

Shelton, A., Braman, K., Smith M.J., Menon S., “Improved Hybrid RANS-LES Turbulence Models for Rotorcraft”, Proceedings of the 62nd Annual Forum of the American Helicopter Society, 2006

Shelton, A., Tomar, A., Prasad, J.V.R., Smith, M.J., Komerath, N., “Active Multiple Winglets for Improved Unmanned-Aerial-Vehicle Performance”, AIAA Journal of Aircraft, vol 43, 2006, pp 110-116

Shelton, A., Abras, J., Hathaway, B., Sanchez-Rocha, M., Smith, M.J., Menon, S., “An Investigation of the Numerical Prediction of Static and Dynamic Stall”, Proceedings of the 61st Annual Forum of the American Helicopter Society, 2005, pp 1826-1838

Shelton, A., Abras, J., Jurenko, R., Smith, M.J., “Improving the CFD Predictions of Airfoils in Stall”, AIAA Paper 2005-1227, 43rd AIAA Aerospace Sciences Meeting, January 2005, Reno, NV

Shelton, A., Tomar, A., Prasad, J.V.R., Smith, M.J., Komerath, N., “Active Multiple Winglets for Improved UAV Performance”, AIAA Paper 2004-4968, 22nd AIAA Applied Aerodynamics Conference, August 2004, Providence, RI

Srivastava, B., Furtek, J., Shelton, A., Paduano, R., “Role of CFD in Missile Aerodynamic Design: A Review of Recent Efforts at Raytheon”, NATO, RTO Meeting Proceedings on Missile Aerodynamics, RTO-MP-5, Sorrento, Italy, May 1998, pp. 33-1–33-19.