

Senior R&D Engineer
Fluent High Performance Computing
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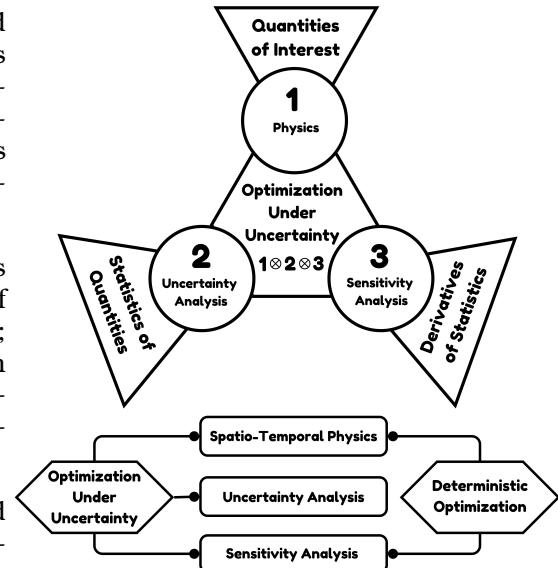
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Research Objectives

My objective is to develop a scalable computational aerosciences infrastructure for **multidisciplinary optimization under uncertainty** through foundational research cutting through physics, mathematics and computing.

Research Triad : Computational Aerosciences

- Mathematical Sciences:** stochastic partial differential equations; discretization principles for spatial-, temporal-, and probabilistic coordinates; linear and nonlinear system solvers and preconditioners; semi-analytical sensitivity analysis; uncertainty quantification; surrogate models and neural networks; multi-dimensional numbers and algebra; synthesis of numerical and analytical methods; unified probabilistic-space-time algebra
- Computational Sciences:** software architecture, standards and interfaces for UQ, OUU, MDOUU; orthogonalization of hardware, geometry, physics, and algebra implementations; scalable data structures and algorithms; heterogeneous high performance computing; parallel-partitioners and assemblers; graph schedulers; contextual reflection of abstract interfaces
- Physical Sciences:** flexible multibody dynamics and fluid mechanics (standalone and coupled); stochastic and deterministic physics; generalized governing laws for mechanics



Education

Doctor of Philosophy in Aerospace Engineering

Fall 2015–Summer 2020

* Georgia Institute of Technology

Atlanta, Georgia, United States

- Thesis: **Adjoint Based Design Optimization of Systems with Time Dependent Physics and Probabilistically Modeled Uncertainties**
- Advisor: **Dr. Graeme J. Kennedy**

Master of Science in Aerospace Engineering

Fall 2012–Spring 2014

* University of Dayton

Dayton, Ohio, United States

- Thesis: **Uncertainty Quantification and Optimization Under Uncertainty Using Surrogate Models**
- Advisor: **Dr. Markus P. Rumpfkeil**

Bachelor of Technology in Aerospace Engineering

2008–2012

* SRM University

Chennai, Tamilnadu, India

- Gold medalist for Rank I and final year at the University of Dayton under dual-degree Program
- Project: Estimation of Aerodynamic Forces on Wright Flyer II Pedestal
- Advisor: **Dr. Nikolai V. Khartchenko**

Professional Service and Membership

AIAA Technical Committees

Non-Deterministic Approaches (full member); Multidisciplinary Design Optimization (friend member).

Peer Review

Structural and Multidisciplinary Optimization; AIAA Journal.

Publications & Conference Proceedings

10. 2024 — **K. Boopathy** and G.J. Kennedy, “Semi-Intrusive Stochastic Galerkin Finite Element Method for Adjoint-Based Optimization Under Uncertainty”, Journal of Aerospace Information Systems. Vol. 21, No. 9, pp. 684–697, 2024, DOI: [10.2514/1.I011254](https://doi.org/10.2514/1.I011254)
9. 2020 — **K. Boopathy** and G. J. Kennedy, “Semi-Intrusive Uncertainty Propagation and Adjoint Sensitivity Analysis Using the Stochastic Galerkin Method”, 22nd AIAA Non-Deterministic Approaches Conference at SciTech 2020, Orlando, Florida, Jan 2020. AIAA Paper 2020-1146.
8. 2019 — **K. Boopathy** and G.J. Kennedy, “Parallel Finite Element Framework for Rotorcraft Multi-body Dynamics and Adjoint Sensitivities”, AIAA Journal, Vol. 57, No. 8, pp. 3159–3172, 2019, DOI: [10.2514/1.J056585](https://doi.org/10.2514/1.J056585).
7. 2017 — **K. Boopathy** and G. J. Kennedy, “Adjoint-based derivative evaluation methods for flexible multi-body systems with rotorcraft applications”, 55th AIAA Aerospace Sciences Meeting, Grapevine, Texas, Jan 2017. AIAA Paper 2017-1671.
6. 2016 — G. J. Kennedy and **K. Boopathy**, “A Scalable Adjoint Method for Coupled Flexible Multibody Dynamics”, 57th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, San Diego, California, Jan 2016. AIAA Paper 2016-1907.
5. 2015 — **K. Boopathy** and M.P. Rumpfkeil, “Unified Framework for Training Point Selection and Error Estimation for Surrogate Models”, AIAA Journal, Vol. 53, No. 1, pp. 215–234, 2015, DOI: [10.2514/1.J053064](https://doi.org/10.2514/1.J053064).
4. 2015 — **K. Boopathy**, M.P. Rumpfkeil and R. M. Colonay, “Robust Optimization of a Wing Under Structural and Material Uncertainties”, 17th AIAA Non-Deterministic Approaches Conference, Kissimmee, Florida, Jan 2015. AIAA Paper 2015-0920.
3. 2014 — **K. Boopathy** and M.P. Rumpfkeil, “Robust Optimizations of Structural and Aerodynamic Designs”, 15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference, Atlanta, Georgia, June 2014. AIAA Paper 2014-2595.
2. 2013 — **K. Boopathy** and M.P. Rumpfkeil, “A Multivariate Interpolation and Regression Enhanced Kriging Surrogate Model”, 21st AIAA Computational Fluid Dynamics Conference, San Diego, California, June 2013. AIAA Paper 2013-2964.
1. 2013 — **K. Boopathy** and M.P. Rumpfkeil, “Building Aerodynamic Databases Using Enhanced Kriging Surrogate Models”, AIAA Region III Student Conference, Chicago, Illinois, April 2013.

Non-Refereed Publications & Presentations

8. 2016 — **K. Boopathy**, “Adjoint-Based Derivative Evaluation Methods for Flexible Multibody Systems”, AE Seminar Series, Georgia Institute of Technology, Atlanta, Georgia, Nov 2016.
7. 2014 — **K. Boopathy** and M.P. Rumpfkeil, “Design Optimization Under Uncertainty Using Surrogate Models”, Brother Joseph W. Stander Symposium, University of Dayton, Dayton, Ohio, April 2014.
6. 2014 — **K. Boopathy**, “Uncertainty Quantification and Optimization Under Uncertainty Using Surrogate Models”, Master’s Thesis, University of Dayton, Dayton, Ohio, March 2014.
5. 2014 — **K. Boopathy** and M.P. Rumpfkeil, “Practices for Deterministic and Stochastic Design Optimization”, Oral Presentation, 39th AIAA Dayton – Cincinnati Aerospace Sciences Symposium, Dayton, Ohio, March 2014.

4. 2013 — **K. Boopathy** and M.P. Rumpfkeil, “Surrogate models and their applications in aerospace engineering”, Oral Presentation, Brother Joseph W. Stander Symposium, University of Dayton, Dayton, Ohio, April 2013.
3. 2013 — **K. Boopathy** and M.P. Rumpfkeil, “A Multivariate Interpolation and Regression Enhanced Kriging Surrogate Model”, Oral Presentation, 38th AIAA Dayton – Cincinnati Aerospace Sciences Symposium, Dayton, Ohio, March 2013.
2. 2012 — **K. Boopathy**, K. Doyle, E. Getter and V.M. Kotha, “Estimation of Aerodynamic Forces on Wright Flyer II Pedestal – Wright Image Group”, Innovation Center Capstone Design Symposium, University of Dayton, Dayton, Ohio, April 2012.
1. 2011 — **K. Boopathy**, B. Shepherd, D. Garcher, J. Andras, K. Connolly, L. Jespersen and S. Dobbertin, “A Humanitarian Response Unmanned Aircraft System (HR-UAS)”, University of Dayton, Dayton, Ohio, Nov 2011.

Technical Skills

Programming Languages	Fortran, Python, C/C++, LLVM, Java, Matlab, shell tools.
High-Performance Computing	Parallel applications with MPI, OpenMP, Coarray Fortran, CUDA.
Simulation & Optimization	Ansys Fluent, ASTROS, Abaqus, Ipopt, in-house adjoint solvers.
Data & Visualization	Matplotlib/PyPlot, gnuplot, Tecplot, ParaView.
Platforms	Linux only!
Documentation	L <small>A</small> T <small>E</small> X, B <small>I</small> B <small>T</small> E <small>X</small> , beamer.
Version Control	git, Subversion, Mercurial.

Research Experience

■ Georgia Institute of Technology	Atlanta, Georgia, United States
* Research Assistant (Graduate)	Aug 2015 – July 2020
• Project Title: Development of Discrete Adjoint Capability for Rotorcraft Comprehensive Code	
• Funding: National Institute of Aerospace, NASA Langley Research Center	
• Brief: The implementation of time-dependent discrete adjoint capabilities in TACS and DYMORE flexible multibody dynamics frameworks for the purpose of rotorcraft optimization	
• Creation of Structural Solver Abstraction Layer (SSAL) to act as an interface for flexible multibody dynamics implementations. The evaluation of residuals of governing Euler–Lagrange equations, their machine-accurate state-variable derivatives (Jacobians), their design-variable derivatives; and corresponding implementations from functions of interest used in rotorcraft structural optimization. The SSAL interfaces with CFD solvers for coupled-aeroelastic simulations or standalone dynamics of helicopter blade hub assembly	
• Source: https://github.com/smdogroup/tacs	
• Modular implementation of implicit time-marching schemes for solving differential-algebraic equations from multibody dynamics, and time-dependent adjoint sensitivity analysis equations for evaluating gradients of functions with respect to the design variables to drive the optimization of rotorcraft designs. The implementation contains multistep schemes: Backward Differences, Adams–Bashforth–Moulton, Newmark; and multistage Diagonally-Implicit Runge–Kutta time-integrators, and their discrete adjoint formulations for time-dependent sensitivity analysis.	
• Source: https://github.com/komahanb/time-marching-adjoint	
• A general-purpose algebra library with classical and Krylov iterative solvers for linear systems, eigenvalue problem solvers, and nonlinear system solvers.	
• Source: https://github.com/komahanb/linear-nonlinear-algebra	

- A [Probabilistic-Space](#) library to provide quadrature sampling nodes and basis functions corresponding to normal, uniform, and exponential probability distributions; and tensorization schemes for higher-dimensional calculations, intended for usage in the context of uncertainty quantification.
 - Source: <https://github.com/komahanb/pspace>
- The creation of Stochastic-TACS finite element and adjoint derivative framework tailored for optimization under uncertainty (OUU) applications. The OUU framework supports different options for uncertainty propagation such as non-intrusive stochastic sampling, projection, and intrusive Galerkin projection, through a surgical application of the principle of sampling at different hierarchical levels to naturally extend deterministic finite-element framework as stochastic finite-element frameworks. The conceptual demonstrations are carried out on static and time-dependent differential equations in the context of flexible multibody dynamics and an aerospace application motivated by the [Canadarm-II](#).
 - Source: <https://github.com/komahanb/stacs>

■ University of Dayton Dayton, Ohio, United States

* **Research Assistant (Graduate)** May 2012 – May 2015

- Devised an adaptive training and validation framework for surrogate models that utilizes data from local surrogate models constructed within sub-domains of a primary surrogate model – a synthesis of concepts like multigrid and domain decomposition in the context of surrogate modeling. The incorporation of low and high-fidelity training data in model construction, along with first- and second-order derivatives if available in the training matrix to mitigate the curse of dimensionality.
- Implemented adaptively trained kriging and polynomial chaos surrogate models to supply function outputs and their derivatives for mixed aleatory and epistemic optimization under uncertainty applications such as aerodynamic shape optimization and structural sizing of wing-box.
 - Kriging model: <https://github.com/komahanb/kriging>
 - Polynomial chaos model: <https://github.com/komahanb/pchaos>

■ Alagappa University Karaikkudi, Tamilnadu, India

* **Student Researcher** May 2006

- Topic: Anti-bacterial Activity of Traditional Herbs Against Enteric Pathogens
- Funded by the Department of Biotechnology, Govt. of India
- Advisor: Dr. S. Karutha Pandian
- Screening of herbal extracts for anti-bacterial activity against enteric pathogens using Kirby-Bauer antibiotic susceptibility test, and authored a technical report of the findings.

Teaching Experience

■ Georgia Institute of Technology Atlanta, Georgia, United States

* **Teaching Assistant** Aug 2015 – Dec 2015, Aug 2018 – May 2019

- Classes : AE 3145 Structures Laboratory, AE2610 Experimental Methods
- Conducted lab sessions, graded reports

■ University of Dayton Dayton, Ohio, United States

* Conducted two lectures in graduate CFD class Jan 2014

* **Teaching Assistant** Aug 2013 – Dec 2013

- Class : MEE 308 Fluid Mechanics, EGR 202 Thermodynamics
- Instructor : Dr. Andrew Henrick
- Substituted lectures, conducted help sessions, graded assignments and exams, prepared test questions

Work Experience

■ ANSYS Inc.	Lebanon, New Hampshire, United States
* Senior R&D Engineer	Aug 2020 – Current
<ul style="list-style-type: none"> Implementation of mathematical models of physics, discretization methods, and CFD algorithms for execution on heterogeneous CPU & GPU hardware platforms: <ul style="list-style-type: none"> Abstracted mechanism for data exchange between CPU and GPU Implementation of the physics of moving reference frames for simulating mixing tanks and turbo-machinery Customization infrastructure to support spatio-temporal and expressions-based user input data for physical fields 	
■ Indus Valley Consultants Inc.	Dayton, Ohio, United States
* Systems Analyst	July 2014 – May 2015
<ul style="list-style-type: none"> Participated in the development of Java-based web environment authentication and authorization framework applying object-oriented programming principles 	
■ Hindustan Aeronautics Limited	Koraput, Orissa, India
* Intern	Jun 2010
<ul style="list-style-type: none"> Observation and documentation of processes involved in the functioning of jet engines, including the fitting of compressor and turbine blades onto discs, testing their weight balance, and identifying flaws in blades. Authored a summary report titled “Components and Functions of Jet Engine”. 	
■ University of Dayton	Dayton, Ohio, United States
* Admissions Assistant	May 2012 – Aug 2013
<ul style="list-style-type: none"> Assistance in application processing and responding to prospective students 	

Awards & Achievements

■ University of Dayton	2011–2013
<ul style="list-style-type: none"> Graduate Student Summer Fellowship Awardee 	
<ul style="list-style-type: none"> II place for Technical paper, Master's category, AIAA Region III student Conference, Illinois Institute of Technology, Chicago 	
<ul style="list-style-type: none"> Academic Scholarship holder 	
■ SRM University	2008–2011
<ul style="list-style-type: none"> Gold medalist for University Rank I in Aerospace Engineering 	
<ul style="list-style-type: none"> Consecutive recipient of merit scholarship offered to top 3 students in the department 	
<ul style="list-style-type: none"> Winner of ‘Aerocypher’ during Chakravyuha – a Technical Festival of the School of Mechanical Engineering 	
■ Miscellaneous	
<ul style="list-style-type: none"> Candidate for government sponsored research programme, “Vacation Training Programme on Bio-Resources” at Alagappa University 	
<ul style="list-style-type: none"> “Award of Academic Excellence” from the Academic Council of Principals of Matric. Schools, Coimbatore & Nilgiris, India 	
<ul style="list-style-type: none"> Winner in several state & district level chess tournaments 	

Extra-Curricular Certifications

■ Diploma in Information Technology	2003
<ul style="list-style-type: none"> Tamilnadu Computer Development Education Centre 	
■ Diploma in Computer Applications	
<ul style="list-style-type: none"> Tamilnadu Computer Development Education Centre 	

Leadership

■ SRM Aerospace Engineers' Association

SRM University, Chennai, India

* Joint Secretary

Dec 2009 – Jul 2011

- Assisted in organizing expert seminars from Indian Space Research Organisation, DRDO and IIT Madras
- Organization of technical events and workshops
- Maintenance of member database, administrative duties, and technical support during events

List of References

Dr. Graeme J. Kennedy

- Associate Professor, School of Aerospace Engineering, Georgia Institute of Technology
- E-mail: graeme.kennedy@aerospace.gatech.edu
- Relationship: Ph.D advisor

Dr. Marilyn J. Smith

- Professor, School of Aerospace Engineering, Georgia Institute of Technology
- E-mail: marilyn.smith@ae.gatech.edu
- Relationship: Ph.D committee member

Dr. Boris Diskin

- Senior Research Scientist, Computational AeroSciences Branch, NASA Langley Research Center
- E-mail: boris.diskin@nasa.gov
- Relationship: Ph.D committee member

Dr. Markus P. Rumpfkeil

- Professor and Chair, Dept. of Mechanical and Aerospace Eng., University of Dayton
- E-mail: markus.rumpfkeil@udayton.edu
- Relationship: Master's advisor

Dr. Raymond M. Kolonay

- Multidisciplinary Science and Technology Center, Air Force Research Laboratory, Wright-Patterson AFB, Ohio
- E-mail: raymond.kolonay@us.af.mil
- Relationship: Master's thesis committee