

January 2009

## CURRICULUM VITAE

### Jeffrey Todd Borggaard

#### Mathematics Office

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#### Education

1986	B.S.,	Mechanical Engineering	Worcester Polytechnic Institute
1988	M.S.,	Mechanical Engineering	Worcester Polytechnic Institute
1990	M.S.,	Applied Mathematics	Worcester Polytechnic Institute
1995	Ph.D.,	Mathematics	Virginia Tech

#### Ph.D. Dissertation

“The Sensitivity Equation Method for Optimal Design.” Major Professor–John A. Burns

#### Professional Experience

1986–1988	Teaching and Research Assistant,	Worcester Polytechnic Institute, Worcester, MA
1988–1990	Mechanical Engineer,	Naval Underwater Systems Center, New London, CT
1990–1994	Teaching and Research Assistant,	Virginia Tech, Blacksburg, VA
1991	Consultant,	Cadkey, Inc., Manchester, CT
1995–1996	Research Assistant Professor,	Virginia Tech, Blacksburg, VA
1997–1998	NSF Post-Doctoral Associate,	Cornell University, Ithaca, NY
1998–2002	Assistant Professor,	Virginia Tech, Blacksburg, VA
2002–2006	Associate Professor,	Virginia Tech, Blacksburg, VA
2003	Visiting Scientist,	Air Force Research Laboratory, Dayton, OH
2006–present	Professor,	Virginia Tech, Blacksburg, VA
2007	Visiting Scientist,	Air Force Research Laboratory, Dayton, OH

#### Research Interests

Applied and Computational Mathematics, Computational Fluid Dynamics, Control Theory, Numerical Analysis, Optimization, Reduced-Order Modeling, Scientific Computing, Sensitivity Analysis

## Honors

Pi Tau Sigma (Mechanical Engineering Honor Society, 1984)  
Pi Mu Epsilon (Mathematics Honor Society, 1986)  
Graduation with Distinction (Worcester Polytechnic Institute, 1986)  
Performance Award (Naval Underwater Systems Center, 1989)  
Letter of Commendation (Naval Underwater Systems Center, 1990)  
Air Force AASERT Fellowship (Virginia Tech, 1992–1994)  
National Science Foundation Post-Doctoral Fellow (Cornell University, 1997–1998)  
Air Force Presidential Early Career Award for Scientists and Engineers (Virginia Tech, 2000)  
National Research Council Summer Faculty Fellowship (Virginia Tech, 2003)  
Virginia Tech Math Club Professor of the Year (Virginia Tech, 2004)  
American Society of Engineering Education Summer Faculty Fellowship (Virginia Tech, 2007)

## Sponsored Research

“Control and Optimization Tools for Systems Governed by Nonlinear Partial Differential Equations,” Air Force Office of Scientific Research, 2000-2005, \$500,000.

“Southeastern Atlantic Regional Conference on Differential Equations,” National Science Foundation, 2000-2001, \$7,000 (used for student/new Ph.D. travel reimbursement).

“Industrial Applications of Flow Sensitivity Calculations,” AeroSoft, Inc., 2000, \$5,000.

“Analysis and Design Tools for Active Control of Combustion,” (with E. Cliff), STTR to AFOSR with AeroSoft, Inc., 2000-2001, \$15,000.

“A Study of Geometric Sensitivities in Turbulent Flows,” (with E. Cliff), STTR to AFOSR with AeroSoft, Inc., 2002, \$33,000.

“Computational Methods for Design, Control and Optimization of Micro Air Vehicles,” (with J. Burns, E. Cliff and T. Iliescu), Air Force Office of Scientific Research, 2003-2006, \$600,000.

“Scientific Computing Research Environments in Mathematical Sciences (SCREMS),” (with T. Iliescu), National Science Foundation, 2003-2005, \$153,000.

“Computation and Analysis of Reduced-Order Models for Distributed Parameter Systems,” (with C. Beattie, S. Gugercin and T. Iliescu), National Science Foundation, 2005-2008, \$431,342.

“High Performance Parallel Algorithms for Improved Reduced-Order Modeling,” (with C. Beattie, S. Gugercin and T. Iliescu), Air Force Office of Scientific Research, 2005-2007, \$552,369.

“Reduced-Order Modeling for Optimization and Control of Complex Flows,” (with T. Iliescu), Air Force Office of Scientific Research, 2007-2010, \$391,021.

## Proceedings Edited

**Optimal Design and Control**, Edited by J.T. Borggaard, J.V. Burkardt, M.D. Gunzburger and J.M. Peterson, Birkhäuser, Boston, 1995, xii+286 pages.

**Computational Methods for Optimal Design and Control**, Edited by J. Borggaard, J. Burns, E. Cliff and S. Schreck, Birkhäuser, Boston, 1998, xii+460 pages.

## Refereed Journal Articles

1. Boundary Element Implicit Differentiation Equations for Design Sensitivities of Axisymmetric Structures (with S. Saigal and J.H. Kane), *International Journal of Solids and Structures*, Vol. 25, No. 5, pages 527–538 (1989).
2. Highly Accurate Evaluation of System Matrices for Curved Boundary Elements (with J.H. Kane and J. Turi), *Computers and Structures*, Vol. 40, No. 4, pages 885–892 (1991).
3. A PDE Sensitivity Equation Method for Optimal Aerodynamic Design (with J. Burns), *Journal of Computational Physics*, Vol. 136, pages 366–384, (September 1997).
4. A Continuous Sensitivity Equation Approach to Optimal Design in Mixed Convection (with D. Pelletier and É. Turgeon), *Numerical Heat Transfer, Part A: Applications*, Vol. 38, No. 8, pages 869–885 (2000).
5. On Efficient Solutions to the Continuous Sensitivity Equation Using Automatic Differentiation (with A. Verma), *SIAM Journal on Scientific Computing*, Vol. 22, No. 1, pages 39–62 (2001).
6. Parametric Uncertainty Analysis for Thermal Fluid Calculations (with D. Pelletier and É. Turgeon), *Journal of Nonlinear Analysis: Series A, Theory and Methods*, Vol. 47, pages 4533–4543 (2001).
7. Reduced Order Controllers for Burgers' Equation with a Nonlinear Observer (with J. Atwell and B.B. King), *International Journal of Applied Mathematics and Computational Science*, Vol. 11, No. 6, pages 1311–1330 (2001).
8. A General Continuous Sensitivity Equation Formulation for Complex Flows (with É. Turgeon and D. Pelletier), *Numerical Heat Transfer: Part B, Fundamentals*, Vol. 42, No. 6, pages 485–498 (2002).
9. Adaptivity, Sensitivity, and Uncertainty: Toward Standards of Good Practice in Computational Fluid Dynamics (with D. Pelletier, É. Turgeon and D. Lacasse), *AIAA Journal*, Vol. 41, No. 10, pages 1925–1933 (2003).
10. A General Continuous Sensitivity Equation Formulation for the  $k - \epsilon$  Model of Turbulence (with É. Turgeon and D. Pelletier), *International Journal of Computational Fluid Dynamics*, Vol. 18, No. 1, pages 29–46 (2004).
11. Simulating the Fate of Subsurface-Banded Urea (with S.B. Shah and M.L. Wolfe), *Nutrient Cycling in Agroecosystems*, Vol. 70, pages 47–66 (2004).
12. A Second-order Sensitivity Equation Method for Laminar Flows (with S. Étienne, J.-N. Mahieu and D. Pelletier), *International Journal of Computational Fluid Dynamics*, Vol. 19, No. 2, pages 143–157 (2005).
13. Application of a Sensitivity Equation Method to Turbulent Flows with Heat Transfer (with E. Colin, S. Étienne and D. Pelletier), *International Journal of Thermal Sciences*, Vol. 44, No. 11, pages 1024–1038 (2005).
14. A Continuous Sensitivity Equation Method for Time-dependent Incompressible Laminar Flows (with H. Hristova, S. Étienne, and D. Pelletier), *International Journal for Numerical Methods in Fluids*, Vol. 50, No. 7, pages 817–844 (2006).
15. A General Sensitivity Equation Formulation for Turbulent Heat Transfer (with E. Colin, S. Étienne and D. Pelletier), *Numerical Heat Transfer: Part B, Fundamentals*, Vol. 49, No. 2, pages 125–153 (2006).

16. Approximate Deconvolution Boundary Conditions for Large Eddy Simulation (with T. Iliescu), *Applied Math Letters*, Vol. 19, pages 735–740 (2006).
17. An Improved Continuous Sensitivity Equation Method for Optimal Shape Design in Mixed Convection (with R. Duvigneau and D. Pelletier), *Numerical Heat Transfer: Part B, Fundamentals*, Vol. 50, No. 1, pages 1–24 (2006).
18. Interval-Based Reduced-Order Models for Unsteady Fluid Flow (with A. Hay and D. Pelletier), *International Journal of Numerical Analysis and Modeling*, Vol. 4, No. 3, pages 353–367 (2007).
19. A Continuous Second Order Sensitivity Equation Method for Time-Dependent Incompressible Laminar Flows (with F. Ilinca and D. Pelletier), *International Journal for Numerical Methods in Fluids*, Vol. 55, No. 6, pages 537–564 (2007).
20. Application of a Sensitivity Equation Method to the  $k - \epsilon$  Model of Turbulence (with S. Etienne, D. Pelletier and É. Turgeon), *Optimization and Engineering*, Vol. 8, No. 3, pages 341–372 (2007).
21. The Sensitivity Equation Method in Fluid Mechanics (with S. Etienne, A. Hay and D. Pelletier), *European Journal of Computational Mechanics*, Vol. 17, No. 1–2, pages 31–61 (2008).
22. A Two-Level Discretization Method for the Smagorinsky Model (with T. Iliescu, H. Lee, J.-P. Roop and H. Son), *SIAM Journal of Multiscale Modeling and Simulations*, Vol. 7, No. 2, pages 599–621 (2008).
23. An Improved Penalty Method for Power-Law Stokes Problems (with T. Iliescu and J.-P. Roop), *Journal of Computational and Applied Mathematics*, Vol. 223, No. 2, pages 646–658 (2009).
24. A Bounded Artificial Viscosity Large Eddy Simulation Model (with T. Iliescu and J.-P. Roop), *SIAM Journal on Numerical Analysis*, to appear.

### Refereed Proceedings Chapters

1. Computational Fluid Dynamics using Optimum Cray Techniques (with C.A. Wagner, D.C. Brondum, A. Zachary and L.J. Alperi), in *Proceedings of AIAA 9th Computational Fluid Dynamics Conference*, Buffalo, NY, pages 353–358, AIAA Paper 89-1965 (June 1989).
2. Sensitivity Calculations for a 2D, Inviscid, Supersonic Forebody Problem (with J. Burns, E. Cliff and M. Gunzburger), in *Identification and Control in Systems Governed by Partial Differential Equations*, H.T. Banks, R.H. Fabiano and K. Ito editors, SIAM, Philadelphia, pages 14–25, (1993). (Also appeared as ICASE Report No. 93-13)
3. On Control Design for a Fluid-Structure Interaction Problem (with T.L. Herdman and J. Turi), in *Proceedings of 1993 IEEE Conference on Aerospace Control Systems*, pages 236–242 (May 1993).
4. A Sensitivity Equation Approach for the Optimal Design of Nozzles (with J. Burns), in *Proceedings of AIAA 5th Symposium on Multidisciplinary Analysis and Optimization*, pages 232–241, AIAA Paper 94-4274 (September 1994).
5. On an Application of the Boundary Element Method to Study Flow Induced Vibrations (with T.L. Herdman and J. Turi) in *Applied Mechanics in the Americas*, L.A. Godoy, S.R. Idelsohn, P.A.A. Laura and D.T. Mook editors, Vol. 2, Sanre Fi, Argentina, pages 317–321 (January 1995).
6. On the Presence of Shocks in Domain Optimization of Euler Flows, in *Flow Control*, M. Gunzburger editor, Springer-Verlag, pages 35–48 (1995).

7. A Sensitivity Equation Approach to Shape Optimization in Fluid Flows (with J. Burns), in *Flow Control*, M. Gunzburger editor, Springer-Verlag, pages 49–78 (1995). (Also appeared as ICASE Report No. 94-8)
8. Algorithms for Flow Control and Optimization (with J. Burkardt, J. Burns, E. Cliff, M. Gunzburger, H. Kim, H. Lee, J. Peterson, A. Shenoy and X. Wu) in *Optimal Design and Control*, J. Borggaard, J. Burkardt, M. Gunzburger and J. Peterson editors, Birkhäuser, pages 97–116 (April 1995).
9. On Active Control of Flow Induced Vibrations (with T. L. Herdman and J. Turi) in *Proceedings of the 34th IEEE Conference on Decision and Control*, pages 3725–3729 (December 1995).
10. Computing Design Sensitivities Using an Adaptive Finite Element Method (with D. Pelletier) in *Proceedings of the 27th AIAA Computational Fluid Dynamics Conference*, AIAA Paper 96-1938 (June 1996).
11. Asymptotically Consistent Gradients in Optimal Design (with J. Burns), in *Multidisciplinary Design Optimization: State of the Art*, N. Alexandrov and M. Hussaini editors, SIAM, Philadelphia, pages 303–314, (1997).
12. On Optimal Design Using an Adaptive Finite Element Method (with D. Pelletier) in *Proceedings of the First International Conference on Nonlinear Problems in Aeronautics and Aerospace*, S. Sivasundaram editor, Embry-Riddle Aeronautical University Press, pages 33–40 (1997).
13. Optimal Shape Design in Forced Convection Using Adaptive Finite Elements (with D. Pelletier) in *Proceedings of the 36th AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 98-0908 (January 1998).
14. Observations in Adaptive Refinement Strategies for Optimal Design (with D. Pelletier), in *Computational Methods for Optimal Design and Control*, J. Borggaard, J. Burns, E. Cliff and S. Schreck editors, Birkhäuser, pages 59–76, (1998).
15. A Continuous Sensitivity Equation Approach to Optimal Design in Mixed Convection (with D. Pelletier and É. Turgeon), in *Proceedings of the 1999 AIAA Thermophysics Conference*, AIAA Paper Number 99-3625 (June 1999).
16. A Two-Dimensional Model for Simulating the Fate of Subsurface-Banded Nitrogen (with S. Shah and M.L. Wolfe), in *Proceedings of the 1999 ASAE Annual International Meeting*, ASAE Paper Number 99-2140 (July 1999).
17. A Continuous Sensitivity Equation Method for Conduction and Phase Change Problems (with D. Pelletier and J.-F. Héту), in *Proceedings of the 38th AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 2000-0881 (January 2000).
18. A Study of Optimal Cooling Strategies in Thermal Processes (with D. Pelletier and É. Turgeon), in *Proceedings of the 38th AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 2000-0563 (January 2000).
19. Recent Advances in Numerical Techniques for the Design and Analysis of COIL Systems (with W. Eppard, W. McGrory, A. Godfrey and E. Cliff), in *Proceedings of the 31st AIAA Plasmadynamics and Lasers Conference*, AIAA Paper Number 2000-2576 (June 2000).
20. A General Continuous Sensitivity Equation Formulation for Complex Flows (with D. Pelletier and É. Turgeon), in *Proceedings of the 8th AIAA/USAF/NASA/ISSMO Symposium on Multidisciplinary Analysis and Design*, AIAA Paper Number 2000-4732 (September 2000).

21. A Continuous Sensitivity Equation Method for Flows with Temperature Dependent Properties (with D. Pelletier and É. Turgeon), in *Proceedings of the 8th AIAA/USAF/NASA/ISSMO Symposium on Multidisciplinary Analysis and Design*, AIAA Paper Number 2000-4821 (September 2000).
22. Sensitivity Analysis for Chemical Laser Design: A Model Problem (with E. Cliff), in *Proceedings of the 2000 IEEE International Conference on Control Applications*, pages 519–523 (September 2000).
23. Sensitivity and Uncertainty Analysis for Variable Property Flows (with D. Pelletier and É. Turgeon), in *Proceedings of the 39th AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 2001-0140 (2001).
24. Adaptivity, Sensitivity and Uncertainty: Towards Standards in CFD (with D. Lacasse, D. Pelletier and É. Turgeon), in *Proceedings of the 39th AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 2001-0192 (2001). (appeared in *AIAA Journal* in 2003)
25. A Sensitivity Equation Method for Conduction and Phase Change Problems (with D. Pelletier), in *Nonsmooth/Nonconvex Mechanics: Modeling, Analysis and Numerical Methods*, (Nonsmooth Optimization and Applications Series, Volume 45), D. Gao, R. Ogden and G. Stavroulakis, editors, Kluwer Academic, pages 43–68 (2001).
26. Application of a Sensitivity Equation Method to the  $k-\epsilon$  Model of Turbulence (with É. Turgeon and D. Pelletier), in *Proceedings of the 15th AIAA Computational Fluid Dynamics Conference*, AIAA Paper Number 2001-2534 (2001).
27. A General Continuous Sensitivity Equation Formulation for the  $k-\epsilon$  Model of Turbulence (with É. Turgeon and D. Pelletier), in *Proceedings of the 15th AIAA Computational Fluid Dynamics Conference*, AIAA Paper Number 2001-3000 (2001).
28. Sensitivity Analysis with Sliding Boundary Conditions (with E. Cliff and A. Godfrey), in *Proceedings of the 40th AIAA Aerospace Sciences Meeting and Exhibition*, AIAA Paper Number 2002-0100 (2002).
29. Sensitivity and Uncertainty Analysis for Turbulent Flows (with S. Étienne, D. Pelletier and É. Turgeon), in *Proceedings of the 40th AIAA Aerospace Sciences Meeting and Exhibition*, AIAA Paper Number 2002-0985 (2002).
30. Reliable Sensitivity Analysis via an Adaptive Sensitivity Equation Method (with D. Pelletier, É. Turgeon and S. Étienne), in *Proceedings of the 3rd Theoretical Fluid Mechanics Meeting*, AIAA Paper Number 2002-2758 (2002).
31. A Continuous Control Design Method (with J. Burns), in *Proceedings of the 3rd Theoretical Fluid Mechanics Meeting*, AIAA Paper Number 2002-2989 (2002).
32. On Sensitivity Analysis for Problems with Numerical Noise (with D. Pelletier and K. Vugrin), in *Proceedings of the 9th AIAA Multidisciplinary Analysis and Optimization Meeting*, AIAA Paper Number 2002-5553 (2002).
33. Parametric Uncertainty Analysis in a Phase Change Model (with J.-F. Hétu and D. Pelletier), in *Proceedings of the 9th AIAA Multidisciplinary Analysis and Optimization Meeting*, AIAA Paper Number 2002-5601 (2002).
34. Second-Order Sensitivity Analysis for Conjugate Phase-Change Problems (with D. Pelletier and C. Winter), in *Proceedings of the 41st Aerospace Sciences Meeting and Exhibition*, AIAA Paper Number 2003-0512 (2003).

35. A Second Order Sensitivity Equation Method for Laminar Flows (with S. Étienne, J.-N. Mahieu and D. Pelletier), in *Proceedings of the 10th Annual Conference of the CFD Society of Canada*, (2003).
36. Sensitivity Analysis of Transient Non-Linear Heat Conduction (with S. Étienne, H. Hristova, J.-N. Mahieu and D. Pelletier), in *Proceedings of the 10th Annual Conference of the CFD Society of Canada*, (2003).
37. A Sensitivity Equation Method for Turbulent Heat Transfer (with E. Colin, S. Étienne and D. Pelletier), in *Proceedings of the 36th AIAA Thermophysics Conference*, AIAA Paper Number 2003-3636 (2003).
38. Optimization of an Integrated Actuator Placement and Robust Control Scheme for Distributed Parameter Processes Subject to Worst-Case Spatial Disturbance Distribution (with M. Demetriou), in *Proceedings of the 2003 American Control Conference*, (2003).
39. Application of a Sensitivity Equation Method to Transient Non-Linear Heat Conduction (with H. Hristova, S. Etienne and D. Pelletier), in *Proceedings of the 42nd AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 2004-0495 (2004).
40. Second Order Sensitivity and Uncertainty Analysis of Laminar Airfoil Flows (with J. Mahieu, D. Pelletier and J. Trepanier), in *Proceedings of the 42nd AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 2004-0742 (2004).
41. Application of a Sensitivity Equation Method to Turbulent Flows with Heat Transfer (with E. Colin, S. Etienne and D. Pelletier), in *Proceedings of the 42nd AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 2004-1290 (2004).
42. Sensitivity Equations for the Design of Control Systems (with J. Vance), in *Proceedings of the Sixth IASTED International Conference on Control and Applications*, IASTED Paper Number 441-050 (2004).
43. Computational Challenges in Control of Partial Differential Equations (with J. Burns and L. Zietsman), in *Proceedings of the 2nd AIAA Flow Control Conference*, AIAA Paper Number 2004-2526 (2004).
44. Optimization of a joint sensor placement and robust estimation scheme for distributed parameter processes subject to worst case spatial disturbance distributions (with M. Demetriou), in *Proceedings of the 2004 American Control Conference*, (2004).
45. A Continuous Sensitivity Equation Method for Time-Dependent Incompressible Laminar Flows (with H. Hristova, S. Etienne and D. Pelletier), in *Proceedings of the 34th AIAA Fluid Dynamics Conference and Exhibit*, AIAA Paper Number 2004-2630 (2004).
46. On Strong Convergence of Feedback Operators for Non-Normal Distributed Parameter Systems (with J. Burns, E. Vugrin and L. Zietsman), in *Proceedings of the 43rd IEEE Conference on Decision and Control*, IEEE Paper Number WeA04.5, pages 1526–1531, (2004).
47. Application of a Sensitivity Equation Method to Turbulent Conjugate Heat Transfer (with E. Colin, S. Etienne and D. Pelletier), in *Proceedings of the 43rd AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 2005-0186 (2005).
48. Design of Worst Spatial Distribution of Disturbances for a Class of Parabolic Partial Differential Equations (with M. Demetriou), in *Proceedings of the 2005 American Control Conference*, (2005).
49. Optimal Shape Design in Mixed Convection using a Continuous Sensitivity Equation Approach (with R. Duvigneau and D. Pelletier), in *Proceedings of the 38th AIAA Thermophysics Conference*, AIAA Paper Number 2005-4823 (2005).

50. A Sensitivity Equation Method for Compressible Subsonic Laminar Airfoil Flows (with P. Edmond, D. Pelletier and S. Etienne), in *Proceedings of the 23rd AIAA Applied Aerodynamics Conference*, AIAA Paper Number 2005-4601 (2005).
51. A Continuous Second Order Sensitivity Equation Method for Time-Dependent Incompressible Laminar Flows (with F. Ilinca and D. Pelletier), in *Proceedings of the 17th AIAA Computational Fluid Dynamics Conference*, AIAA Paper Number 2005-5252 (2005).
52. Application of a Sensitivity Equation Method to Compressible Subsonic Impinging Jets (with P. Edmond, D. Pelletier, S. Etienne, and A. Hay), in *Proceedings of the 44th AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 2006-0909 (2006).
53. Optimal Reduced-Order Modeling for Nonlinear Distributed Parameter Systems, in *Proceedings of the 2006 American Control Conference*, Paper WeB13.3 (2006).
54. A Domain Decomposition Approach to POD (with C. Beattie, S. Gugercin and T. Iliescu), in *Proceedings of the 45th IEEE Conference on Decision and Control*, Paper FrIP14.12, pages 6750–6756 (2006).
55. A Penalty Method Approach to LQR Control for Saddle Point Problems (with M. Stoyanov and L. Zietsman), in *Proceedings of the International Conference on Nonlinear Problems in Aviation and Aerospace 2006*, Cambridge Scientific Publishers, Chap. 64, 67–74 (2007).
56. Optimal Design of Airfoils Using NURBS and a Continuous Sensitivity Equation Method (with J. Cori, S. Étienne, A. Hay, D. Pelletier and J. Trépanier), in *Proceedings of the 45th AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper Number 2007-1129 (2007).
57. Reduced-Order Models for Optimal Control of Vortex Shedding (with I. Akhtar and J. Burns), in *Proceedings of the 4th AIAA Flow Control Conference*, AIAA Paper Number 2008-4083 (2008).
58. On the Use of Sensitivity Analysis to Improve Reduced-Order Models (with A. Hay and D. Pelletier), in *Proceedings of the 4th AIAA Flow Control Conference*, AIAA Paper Number 2008-4192 (2008).
59. Model-Based Computation of Functional Gains for Feedback Control of Vortex Shedding (with I. Akhtar, J. Burns and L. Zietsman), in *Proceedings of the 2008 ASME International Mechanical Engineering Congress & Exposition*, Paper Number IMECE2008-68950 (2008).
60. An Efficient Long-Time Integrator for Chandrasekhar Equations (with M. Stoyanov), in *Proceedings of the 47th IEEE Conference on Decision and Control*, Paper Number ThTA07.1 (2008).
61. A Reduced Order Solver for Lyapunov Equations with High Rank Matrices (with M. Stoyanov), in *Proceedings of the 18th International Symposium on Mathematical Theory of Networks and Systems*, Blacksburg, VA (2008).
62. Reduced-Order Modeling of Turbulent Flows (with A. Duggeby, A. Hay, T. Iliescu and Z. Wang), in *Proceedings of the 18th International Symposium on Mathematical Theory of Networks and Systems*, Blacksburg, VA (2008).

### **Other Publications**

1. Axisymmetric Boundary Element Design Sensitivity Analysis (with S. Saigal), Third International Conference on CAD/CAM, Robotics and FOF, Southfield, MI (August 1988).
2. Torpedo Drag Disk Analysis (with M. A. Turchio, A. D. Carlson, R. A. Lafreniere, R. S. Munn and C. A. Wagner), NUSC Technical Memorandum (TM 881208) (November 1988).
3. Computational Fluid Dynamics Analysis of Sail-Hull Junction Modifications (with C. A. Wagner, D. C. Brondum and L. S. Langston), NUSC Technical Report (TR 8641) (June 1990).
4. Iterative Matrix Solvers in Incompressible Computational Fluid Dynamics, NUSC Technical Memorandum (TM 901153) (August 1990).

### **Invited Short Courses**

- 2005 Reduced-Order Model Development and Control Design (with K. Kunisch),  
2005 SIAM Annual Meeting and SIAM Activity Group on Control and Systems Theory (July).
- 2008 Large Scale Optimization & Design, for the DoD High Performance Computing Program Office,  
University of Tennessee Space Institute, Arnold AFB, TN (February).

### **Plenary Lectures**

- 2005 MOPTA 05, Modeling and Optimization: Theory and Applications,  
Windsor, ON, Canada, July.
- 2007 SEARCDE, Southeastern-Atlantic Regional Conference on Differential Equations,  
Murray, KY, October.

## Invited Conference Presentations

- 1995 SIAM Annual Meeting, Charlotte, NC, October.
- 1995 AMS Fall Southern Sectional Meeting, Greensboro, NC, November.
- 1996 First International Conference on Nonlinear Problems in Aeronautics and Aerospace, Daytona, FL, May.
- 1997 18th IFIP TC7 Conference on System Modelling and Optimization, Detroit, MI, July.
- 1997 Conference on Optimal Design and Control, Washington, DC, October.
- 1998 Fourth SIAM Conference on Control and its Applications, Jacksonville, FL, May.
- 1998 Society of Engineering Science 35th Annual Technical Meeting, Pullman, WA, September.
- 1999 SIAM Conference on Optimization, Atlanta, GA, May.
- 1999 1999 Annual Meeting of the Canadian Applied and Industrial Mathematics Society, Québec City, Québec, June.
- 1999 International Symposium on Nonsmooth/Nonconvex Mechanics, Blacksburg, VA, June.
- 2000 Third International Conference on Non-Linear Problems in Aviation and Aerospace, Daytona Beach, FL, May.
- 2000 CFD2K, 8th Annual Conference of the CFD Society of Canada, Montréal, Québec, June.
- 2000 2000 American Control Conference, Chicago, IL, June.
- 2000 3rd World Congress on Nonlinear Analysis, Catania, Italy, July.
- 2001 SIAM Control Conference, San Diego, CA, July.
- 2001 Sensitivity Analysis Workshop 2001, Livermore, CA, August.
- 2001 Center for Turbomachinery and Compressor Design Annual Review, Blacksburg, VA, September.
- 2002 3rd AIAA Theoretical Fluids Meeting, 1st AIAA Flow Control Meeting, St. Louis, MO, June. (1 hour invited lecture)
- 2002 SIAM Annual Meeting, Philadelphia, PA, July.
- 2002 Fifteenth International Symposium on Mathematical Theory of Networks and Systems, South Bend, IN, August.
- 2003 IMA Workshop on Optimization in Simulation-Based Models, Minneapolis, MN, January.
- 2003 SIAM Conference on Computational Science and Engineering, San Diego, CA, February.
- 2003 27th Annual Conference of the South African Society for Numerical and Applied Mathematics, Stellenbosch, South Africa, March.
- 2003 First Joint CAIMS/SIAM Annual Meeting, Montréal, Québec, June.
- 2003 SciCADE 2003, International Conference on Scientific Computation and Differential Equations, Trondheim, Norway, June.
- 2003 7th US National Congress on Computational Mechanics, Albuquerque, NM, July.
- 2003 Computation, Control and Biological Systems VIII, Bozeman, MT, July.
- 2003 AMS 2003 Fall Southeastern Sectional Meeting, Chapel Hill, NC, October.
- 2004 CSIT Workshop on Emerging Methods for Numerical Solution of PDEs, Tallahassee, FL, March.
- 2004 2004 Advanced Simulation Technologies Conference, Alexandria, VA, April.
- 2004 IFIP Workshop on Shape Optimization and Control, Lisbon, Portugal, June.
- 2004 2nd AIAA Flow Control Conference, Portland, OR, June.
- 2004 AMS 2004 Fall Southeastern Sectional Meeting, Pittsburgh, PA, November.

- 2004 IFIP Workshop on Free and Moving Boundaries, Analysis, Simulation and Control, Houston, TX, December.
- 2005 International Conference on Approximation Methods for Design and Control, Buenos Aires, Argentina, March.
- 2005 SIAM Annual Meeting, New Orleans, LA, July.
- 2005 Workshop on Large-Scale Robust Optimization, Sante Fe, NM, September.
- 2005 Austrian Mathematical Society, Klagenfurt, Austria, September.
- 2006 6th International Conference on Cooperative Control and Optimization, Gainesville, FL, February.
- 2006 SIAM Annual Meeting, Boston, MA, July.
- 2006 7th World Congress on Computational Mechanics, Los Angeles, CA, July.
- 2007 14th International Conference on Finite Elements in Flow Problems, Santa Fe, NM, March.
- 2007 CMMSE 2007 (Computational and Mathematical Methods in Science and Engineering), Chicago, IL, June.
- 2007 SIAM Control Conference, San Francisco, CA, June.
- 2007 IFIP TC7 Conference on System Modelling and Optimization, Kraków, Poland, July.
- 2008 Inverse Problems: Modeling and Simulation, Fethiye, Turkey, May.
- 2008 4th AIAA Flow Control Conference, Seattle, WA, June.
- 2008 2008 ASME International Mechanical Engineering Congress & Exposition, Boston, MA, November.
- 2008 47th IEEE Conference on Decision and Control, Cancun, Mexico, December.

## Invited Colloquia

- 1993 University of Texas at Dallas, Mathematics Seminar, Richardson, TX, July.
- 1995 Oregon State University, Mathematics Department Colloquium, Corvallis, OR, February.
- 1996 Virginia Tech, Mathematics Department Colloquium, Blacksburg, VA, May.
- 1997 Industrial Materials Institute, Montréal, Québec, March.
- 1997 Cornell University, Stability, Transition and Turbulence Seminar, Ithaca, NY, October.
- 1997 University of Texas at Arlington, Mathematics Colloquium, Arlington, TX, November.
- 1997 University of Texas at Dallas, Mathematics Seminar, Richardson, TX, November.
- 1998 University of Pittsburgh, Mathematics Colloquium, Pittsburgh, PA, February.
- 1998 Washington State University, Mathematics Seminar, Pullman, WA, February.
- 1998 Virginia Tech, Mathematics Seminar, Blacksburg, VA, February.
- 1998 Iowa State University, Mathematics Seminar, Ames, IA, March.
- 1998 University of California at Davis, Mathematics Seminar, Davis, CA, March.
- 1998 Virginia State University, Mathematics Seminar, Petersburg, VA, November.
- 1999 University of North Carolina Greensboro, Mathematics Colloquium, Greensboro, NC, April.
- 1999 University of Pittsburgh, Mathematics Colloquium, Pittsburgh, PA, June.
- 2000 Montana State University, Mathematics Colloquium, Bozeman, MT, March.
- 2000 United Technologies Research Center, East Hartford, CT, July.
- 2001 Sandia National Labs, CSRI Seminar Series, Livermore, CA, March.
- 2001 Virginia Tech, Aerospace and Ocean Engineering Seminar, Blacksburg, VA, April.
- 2001 University of Trier, Numerical Analysis Seminar, Trier, Germany, November.
- 2002 Iowa State University, Mathematics Colloquium, Ames, IA, March.
- 2002 Worcester Polytechnic Institute, Mechanical Engineering Colloquium, Worcester, MA, September.
- 2003 Virginia Tech, Mathematics Colloquium, Blacksburg, VA, January.
- 2003 Montana State University, Applied Mathematics Seminar, Bozeman, MT, February.
- 2003 University of Louisville, Mathematics Colloquium, Louisville, KY, February.
- 2003 United States Air Force Academy, Seminar in Closed Loop Flow Control, Colorado Springs, CO, July.
- 2003 Wright-Patterson Air Force Base, National Research Council Summer Faculty Seminar, Wright-Patterson Air Force Base, OH, August.
- 2003 Ohio State University, Collaborative Center for Control Science, Columbus, OH, September.
- 2003 Florida State University, School of Computational Science and Information Technology, Tallahassee, FL, November.
- 2003 George Mason University, Mathematics Colloquium, Alexandria, VA, November.
- 2004 University of Florida Graduate Education Research Center, Seminar, Destin, FL, March.
- 2004 Argonne National Laboratories, Wilkinson Visitor Program, Argonne, IL, October.
- 2005 George Mason University, Fairfax, VA, February.
- 2005 Florida State University, Tallahassee, FL, November.
- 2006 Florida State University, Tallahassee, FL, January.
- 2006 INFORMS Student Seminar, Industrial Systems Engineering, Blacksburg, VA, March.
- 2007 Wright-Patterson Air Force Base, American Society of Engineering Education Summer Faculty Seminar, Wright-Patterson Air Force Base, OH, July.
- 2007 MIT, Model Order Reduction Seminar, Cambridge, MA, October.
- 2008 Clemson University, Clemson, SC, April.
- 2008 Department of Scientific Computing, Florida State University, Tallahassee, FL, October.
- 2009 Auburn University, Auburn, AL, January.

## Other Presentations

- 1992 Worcester Polytechnic Institute, Worcester, MA, March.
- 1992 IMA Period of Concentration on Flow Control, Minneapolis, MN, November.
- 1994 5th AIAA/USAF/NASA/ISSMO Symposium on Multidisciplinary Analysis and Optimization, Panama City, FL, September.
- 1995 34th IEEE Conference on Decision and Control, New Orleans, LA, December.
- 1996 27th AIAA Computational Fluid Dynamics Conference, New Orleans, LA, June.
- 1997 Air Force Contractors Meeting, Dayton, OH, May.
- 1998 36th AIAA Aerospace Sciences Meeting and Exhibition, Reno, NV, January.
- 1999 SIAM Southeast Regional Mathematics in Industry Workshop, Raleigh, NC, October.
- 2000 38th AIAA Aerospace Sciences Meeting and Exhibition, Reno, NV, January.
- 2000 AD2000 (Automatic Differentiation 2000), Nice, France, June.
- 2000 AFOSR Workshop on Dynamics and Control, Pasadena, CA, August.
- 2000 8th AIAA/USAF/NASA/ISSMO Symposium on Multidisciplinary Analysis and Optimization, Long Beach, CA, September.
- 2000 Boeing Seminar on Control and Design, Boeing Aerospace, Seattle, WA, September.
- 2000 United Technologies Research Center, Project Summary, East Hartford, CT, December.
- 2001 31st AIAA Fluid Dynamics Conference and Exhibit, Anaheim, CA, June.
- 2001 AFOSR Workshop on Dynamics and Control, Dayton, OH, July.
- 2002 AFOSR Workshop on Dynamics and Control, Pasadena, CA, August.
- 2002 9th AIAA Symposium on Multidisciplinary Analysis and Optimization, Atlanta, GA, September.
- 2002 9th AIAA Symposium on Multidisciplinary Analysis and Optimization, Atlanta, GA, September.
- 2002 22nd Annual Southeastern-Atlantic Regional Conference on Differential Equations, Knoxville, TN, October.
- 2003 36th AIAA Thermophysics Conference, Orlando, FL, June.
- 2003 AFOSR Workshop on Dynamics and Control, Destin, FL, September.
- 2003 23rd Annual Southeastern-Atlantic Regional Conference on Differential Equations, Atlanta, GA, October.
- 2004 SIAM Parallel Processing for Scientific Computing, San Francisco, CA, February.
- 2004 Optimization Days, Montreal, Canada, May.
- 2004 SIAM Annual Meeting, Portland, OR, July.
- 2004 10th AIAA Symposium on Multidisciplinary Analysis and Optimization, Albany, NY, September.
- 2004 American Physical Society, 57th Annual Meeting of the Division of Fluid Dynamics, Seattle, WA, November.
- 2005 American Control Conference, Portland, OR, June.
- 2005 AFOSR Workshop on Computational Mathematics, Long Beach, CA, August.
- 2006 30th Annual Conference of the South African Society for Numerical and Applied Mathematics, Stellenbosch, South Africa, April.
- 2006 AFOSR Joint Program Review, Atlanta, GA, August.
- 2006 27th Annual Southeastern-Atlantic Regional Conference on Differential Equations, Greensboro, NC, October.
- 2007 2007 SIAM Conference on Computational Science and Engineering, Costa Mesa, CA, February.
- 2007 AFOSR Joint Program Review, Long Beach, CA, August.
- 2008 AFOSR Computational Mathematics Program Review, Arlington, VA, August.
- 2008 12th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference, Victoria, British Columbia, Canada, September.

## Conferences Organized

- 2000 20th Southeast-Atlantic Regional Conference on Differential Equations – SEARCDE, Blacksburg, VA, October.
- 2002 Workshop in honor of Gene Cliff (with J. Burns and T. Herdman) Blacksburg, VA, October.

## Organized Sessions and Minisymposia

- 1999 *Optimal Design* at the SIAM Southeast Regional Mathematics in Industry Workshop, Raleigh, NC, October.
- 2000 *Optimal Design and Control* at the 3rd International Conference on Nonlinear Problems in Aviation and Aerospace, Daytona, FL, May (with T. Herdman and J. Turi)
- 2000 *Optimal Design* at the World Congress of Nonlinear Analysis 2000, Catania, Italy, July (with T. Herdman and E. Cliff).
- 2003 *Control of Distributed Parameter Systems: Computation and Optimization* at the 2003 American Control Conference, Denver, CO, June (with M. Demetriou).
- 2004 *Computational Issues in Control of Complex Flows: I-IV* at the SIAM Annual Meeting, Portland, OR, July (with T. Iliescu).
- 2007 *Emerging Finite Element Methods for Complex Flow* at the 2007 SIAM Conference on Computational Science and Engineering, Costa Mesa, CA, February (with T. Iliescu).
- 2007 *Model Reduction Methods for Flow in Porous Media* at the 2007 SIAM Conference on Mathematical and Computational Issues in the Geosciences, Santa Fe, NM, March (with E. Gilden and H. Klie).

## Professional Societies

- American Physical Society (APS)
- Institute of Electrical and Electronics Engineers (IEEE)
- Mathematical Association of America (MAA)
- Society for Industrial and Applied Mathematics (SIAM)

## Professional Service

### Editorial Boards

Associate Editor, Optimization and Engineering, Springer, 2008–present.

( <http://www.springer.com/math/journal/11081> )

### Other Professional Service

Refereed Proposals for AFOSR and NSF

Panel Member for NSF Focused Research Group Review: 2004

Panel Member for DOE Multiscale Mathematics and Optimization: 2008

Refereed Journal Submissions for: AIAA Journal, AIAA Journal of Thermophysics and Heat Transfer, Computational Optimization and Applications, Optimization and Engineering, SIAM Journal on Control and Optimization, and SIAM Journal on Optimization

Refereed Conference Proceedings Papers for: 1998 American Control Conference

2003 Conference on Decision and Control

Refereed Book for SIAM

Panel Member for the SIAM Student Paper Competition: 1999, 2001, 2002, 2003

Chair, Steering Committee for the Southeast Atlantic Regional

Conference on Differential Equations, 2000

Member of IEEE Technical Committee on Distributed Parameter Systems, 2003-present.

Organizing Committee of the 2009 SIAM Conference on Control and its Applications, Denver, CO.

Reviewer for Mathematical Reviews, 2008-2009.

## University Service

### Department Service

Teaching Committee, 1999-2000

Graduate Program Committee (graduate admissions and recruitment), 2001-2005

Analysis Search Committee, 2001-2002

Personnel Committee, 2002-2003

Numerical Analysis Search Committee, 2002-2003

Computational Science Search Committee (Chair), 2003-2004

Colloquium Committee (Chair), 2006-2007

Computational Mathematics Search Committee, 2007-2008

Graduate Program Committee (Chair), 2007-present

### College Service

College of Science Research Advisory Committee, 2003-2004

College of Science Cluster Committee, 2004-2005

College of Science Faculty Diversity Sub-committee, 2007-2008

## Teaching Experience

Worcester Polytechnic Institute: Performed classroom teaching, bi-weekly problem sessions, office hours and grading.

Virginia Tech: Experience with distance learning technology which was used to broadcast MA4414 and MA5484 to graduate students at Virginia State University and the Northern Virginia Graduate Center. I have experience teaching the following courses:

MA1114	Elementary Linear Algebra	MA2214	Introduction to Differential Equations
MA2224	Multivariable Calculus	MA3214	Vector Calculus
MA4245	Intermediate Differential Equations	MA4254	Chaos and Dynamical Systems
MA4414	Issues in Scientific Computing	MA4425-6	Fourier Series & PDEs
MA4564	Operational Methods	MA5245-6	Differential Equations
MA5465-6	Numerical Analysis	MA5474	Finite Difference Methods
MA5484	Finite Element Methods	MA5515	Mathematical Modeling in Biology

Supervised Undergraduate Research Projects at Virginia Tech:

Jeffry Hall & Jarrod Raines, (Spring 1999), "Study of Gibbs Phenomena."

Claude Cundiff, (Spring 2001), "Nonlinear ODEs and RPM."

Firmin Ndegés, (Summer 2003), joint with T. Herdman, "Parameter Dependent Discontinuities."

Grant Boquet, (Spring 2004), joint with T. Iliescu, "Scientific Computing for LES."

David Cross, (Fall 2007), joint with L. Zietsman, "Improved Reduced-Order Models for Control."

Supervised several Undergraduate Independent Study Projects

## Students

### Ph.D. Students

Kay Vugrin, Mathematics, (Ph.D. 2005), Ph.D. Dissertation:

"On the Effects of Noise on Parameter Identification Optimization Problems."

Currently working for Sandia National Laboratories in Albuquerque, NM.

### Masters Students

Greta Soechting-Garcia, Mathematics, (M.S. 1999), Masters Project:

"Sensitivity Analysis for a Soil Moisture Infiltration Model."

Currently working for Experian in Atlanta, GA.

Peter Hou, Mathematics, (M.S. 2005), Masters Project:

"Nodal Reordering Strategies to Improve Preconditioning for Finite Element Systems."

Current an actuary for Mercer Consulting in New York.

Denis Kovacs, Mathematics, (M.S. 2005), joint with C. Beattie, Masters Thesis:

"Inertial Manifolds and Nonlinear Galerkin Methods."

Currently working for NVidia Corporation, Santa Clara, CA.

Jerri Sayers, Mathematics, (M.S. 2001), Masters Project:

“Investigating Numerical Methods for Approx. Functional Gains for the 1D Heat Equation.”  
Currently pursuing a Ph.D. in Math Education at Virginia Tech.

Miroslav Stoyanov, Mathematics, (M.S. 2006), Masters Thesis:

“Optimal Linear Feedback Control for Incompressible Fluid Flow.”  
Currently pursuing a Ph.D. in Math at Virginia Tech.

Daniel Sutton, Mechanical Engineering, (M.S. 2005), Masters Thesis:

“Improved Reduced Order Modeling Strategies for Coupled and Parametric Systems.”  
Currently pursuing a Ph.D. in Math at Virginia Tech.

Kay Vugrin, Mathematics, (M.S. 2003), Masters Thesis:

“On the Effect of Numerical Noise in Simulation-Based Optimization.”

Christoph Winter, Mathematics, (M.S. 2003), Masters Project:

“Finite Element Simulation of Phase Change.”  
Currently at Technische Universität Munich.

### Current Students

Vitor Liete Nunes, Mathematics, (Ph.D. Student).

Kevin Pond, Mathematics, (Ph.D. Student).

Miroslav Stoyanov, Mathematics, (Ph.D. Student).

Darrell Wells, Mathematics, (Ph.D. Student).

### **Post-Docs**

#### Current

Imran Akhtar (Ph.D. Engineering Science and Mechanics, Virginia Tech)

#### Former

Alexander Hay

Currently a Mechanical Engineer at the Industrial Materials Institute, Boucherville, QC.

John-Paul Roop (Ph.D. Mathematics, Clemson University)

Currently in the Department of Mathematics at North Carolina A&T State University.