

*Curriculum Vitae*

**Bernard M. Grossman**

***Present Position***

***Vice President for Education and Outreach***

The National Institute of Aerospace  
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Hampton, Virginia 23666

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3501 Brentmoor  
Williamsburg, Virginia 23188  
(757) 636-6302

***Education***

***Polytechnic Institute of Brooklyn***

June 1964 Bachelor of Science (Aerospace Engineering)

June 1965 Master of Science (Astronautics)

Thesis: *Nonsteady Evaporation of Liquid Propellant Drops*

Advisor: V. D. Agosta

June 1969 Doctor of Philosophy (Astronautics)

Dissertation: *Viscous Corner Flows*

Advisor: S. G. Rubin

***Previous Experience***

***Department of Aerospace and Ocean Engineering***

Virginia Polytechnic Institute and State University

January 1982 – present, Professor

January 1989 – July 1993, Associate Dept. Head

July 1993 – July 2002, Department Head

August 2002 – present, on assignment to NASA & NIA

***Director***

Multidisciplinary Analysis & Design (MAD) Center for Advanced Vehicles

October 1993 – July 2002

***Advanced Vehicle Systems Technology***

NASA Langley Research Center August 2002 – November 2002

***ICASE Visiting Scientist***

NASA Langley Research Center January 1990 – March 1990

***NATO Senior Fellow*** *Consiglio Nazionale delle Ricerche*

Università degli studi di Bari, Italy March 1990 – June 1990

***Associate Professor of Mechanical and Aerospace Engineering***

Polytechnic Institute of New York July 1980 – December 1981

***Head, Theoretical Aerodynamics Laboratory***

Grumman Aerospace Corporation

January 1973 – June 1980, Research Department

August 1968 – December 1973, Propulsion Section

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**Research Interests**

*Computational Fluid Dynamics*

The numerical simulation of fluid flows as applied to aerospace vehicle flow fields has had a tremendous growth in the past thirty five years. However, many areas require further development and new strategies in order to produce acceptable accuracies along with practical computer efficiency for problems involving design. Research over the past 15 years has encompassed basic algorithm development in some of these areas including: new flux-split formulations for flows with non-equilibrium chemistry and thermodynamics, formulations based on multidimensional Riemann solvers, kinetic algorithms developed from the Boltzmann equation, novel treatments for surface boundary conditions and confinement methods for accurate resolution of contact surfaces, vortex sheets, shock/vortex interactions and massively separated flows. Innovative applications of CFD to aerodynamic design problems have been made involving adjoint methods, simultaneous analysis and design and utilizing Cartesian grids.

*Multi-disciplinary Design Methods*

Advances in composite material technology and active controls have altered the way that aerodynamics designers approach their subject. Now, more than ever, each discipline, e.g. aerodynamics, structures, controls, propulsion, has a more pronounced effect on each other and the entire design process must be integrated. Research is being performed in the use of numerical optimization in multi-disciplinary design optimization (MDO) with emphasis on combined aerodynamic/structural design as applied to the High-Speed Civil Transport (HSCT), Truss-Braced Transonic Transport and Blended Wing Body. Recent efforts involve the development of response surface techniques and the efficient utilization of parallel computers in the

MDO process. In addition global optimization techniques and the automated protection against modeling and simulation uncertainties in optimization have been investigated.

***NIA Activities***

Member of the corporation (501-3C) and associated fiduciary and management responsibilities. Responsible for the initiation and development of a unique, multi-university graduate program in all fields related to the aerospace industry in Hampton Virginia. Responsible for cross-cutting agreements involving satisfying residency at NIA HQ, 50% course transfer policy and consortium agreement whereby students register and pay tuition through their home institution for courses taken at a host institution. Coordinating activities of resident faculty, now numbering about 12, including six chaired Langley Professors. Secure NASA funding for approximately 30 NIA Rising Star Fellows, (full-time GRAs). Arrange active continuing education program involving 60 seminars, 12 workshops and 12 short courses in FY'04. Develop K-12 outreach program leveraging, NIA and NASA funding with that of our partner universities and Space Grant Consortia.

***Department Head Activities***

*Top 10 Ranking US News and World Report, 1999*

Led Department to prominence through emphasis on design throughout the curriculum for both undergraduate and graduate programs. Reputation for award-winning innovative design projects: more aerospace team design awards than any other university.

*University Exemplary Department, 1999-2000*

Won University-wide competition and 5 year designation as a University Exemplary Department for "effectively linking teaching and research, with particular emphasis on the undergraduate program"

*Number One University in Aerospace Publications, 1994-1998*

Ranked number one of all U.S. Universities in the number of publications and number of citations in Aerospace Journals over the last 5 years. Source: University Science Indicators, Institute for Scientific Information, 2000.

*Alumni Activities*

Established alumni newsletter "The Hokie Flyer" in 1994 and established an alumni and industrial advisory board in 1996. Board meets twice a year and advises on curriculum updates to meet current business trends in the aerospace and ship-building industries.

***Industrial Interactions***

*Industry-University Workshop on Multidisciplinary Aircraft Design, Blacksburg, VA, May 1993*

Co-organized workshop with R. T. Haftka and W. H. Mason, with sponsorship by NSF and NASA. The purpose was to identify the needs of industry in multidisciplinary aircraft design and determine how universities could best address these needs. Industry participation was from Aurora Flight Sciences, Beech, Boeing, Deutsche Aerospace Airbus, Grumman, Lockheed, McDonnell-Douglas, government laboratory participation was from NASA Ames, Lewis and Langley and university participation was from Buffalo, Stanford, Georgia Tech, Mississippi State and University of Washington. A discussion paper from workshop entitled "Multidisciplinary Aircraft Design: An Underutilized Capability" was published on the Issues page of *Aerospace America*, July, 1994, pp. B60.

*Multidisciplinary Analysis and Design (MAD) Center for Advanced Vehicles, 1994-*

Co-founder along with W. H. Mason, R. Kapania, Z. Gurdäl, D. T. Mook, and R. T. Haftka, and served as founding Center Director 1994–2002. Approximately 25 faculty in AOE, ESM, ME, ISE, Math and Computer Science are associated with the center, which serves as a common base for research involving multidisciplinary design optimization (MDO). An Industrial Advisory Board was formed in 1994 which presently includes major aerospace companies: Aurora Flight Sciences, Boeing: Philadelphia, Boeing: Long Beach, Boeing: Seattle, Boeing: St. Louis, Cessna, Ford, General Electric, Hughes, Lockheed-Martin: Palo Alto, Northrop-Grumman, Sikorsky, smaller, aerospace software companies: Aerosoft, Phoenix Integration and Proteus Engineering, along with representatives from government agencies, including: NASA Ames, Langley and Lewis. We have had six meetings in Blacksburg where the board makes recommendations on the research for our students and suggests new areas and problems which need attention.

*NASA Multidisciplinary Analysis and Design Fellowship Program, 1994–1998*

In May 1994, the MAD Center bid for a NASA Headquarters fellowship program for the development of a graduate program in multidisciplinary analysis and design. We had an innovative concept, whereby the industrial board would suggest problems relevant to their companies in multidisciplinary design, the MAD Center members would develop proposals addressing these problems and the industrial advisory board would rank the proposals and select the students who would be funded with NASA fellowship funding. This unique link between academia, industry and government laboratories was accepted and we were one of five winners of this grant, which was worth over \$650k over 5 years. The first industrial advisory board meeting was held in October 1994, and a total of 6 meetings have been held so far. The program supported seven graduate students per year. As part of the MAD fellowship program these graduate students spent from three to six months in an internship in industry.

**Teaching**

*Undergraduate*

Aero/Hydromechanics                      Boundary Layer and Heat Transfer\*  
 Compressible Aerodynamics\*          Numerical Analysis\*

*Graduate*

Laminar Boundary Layers                  Computational Fluid Mechanics\*  
 Transonic Flow\*                              Advanced 3D Aero/Hydromechanics\*  
 Real Gases\*                                      High-Speed Aerodynamics\*

\* created course or restructured curriculum

**Student Evaluations**

SUMMARY OF STUDENT RESPONSES*										
Year	AOE Undergraduate Courses					AOE Graduate Courses				
	3103 3114	3140 3144	4100	4140	4400 4404	5102 5114	5120	5414 (ME)	6100	6110 6145
'82-'83	3.49	3.12	3.19						3.64	
'83-'84	3.28	3.13	3.28						3.75	3.25
'84-'85	3.88	3.32	3.80		3.60					4.00
'85-'86	3.68	3.28	3.49						3.58	
'86-'87			3.50	3.21		3.80				3.19
'87-'88			3.59			4.00	4.00		3.64	3.50
'88-'89					3.32	3.65				3.69
'89-'90										3.88
'90-'91		3.50				3.63				
'91-'92		2.57				3.88				
'92-'93		3.38				3.58				
'93-'94		3.81				3.91				
'94-'95		3.41				3.67				
'95-'96		3.10				3.80				
'96-'97					3.20					3.60
'97-'98						3.70	4.00			3.80
'98-'99						4.00	3.60			3.40
'99-'00	3.40									4.00
'00-'01	3.60					3.90				
'01-'02	3.40					3.8				3.80

\* Teaching effectiveness question; 4-excellent, 3-good, 2-fair, 1-poor.

**Membership/Honors**

Fellow of the American Institute of Aeronautics and Astronautics  
 Society for Industrial and Applied Mathematics  
 American Physical Society  
 American Society for Engineering Education  
 International Society for Structural and Multidisciplinary Optimization  
 Sigma Xi  
 Sigma Gamma Tau  
 Best Paper Award, 1998  
     6th AIAA/NASA/ISSMO Symp. Multidisc. Anal. & Opt.  
 NASA Certificate of Recognition, 1985  
 NASA Predoctoral Fellowship, 1964 – 1967

**Review Activities**

Associate Editor AIAA Journal, 1992 – 1995  
 AIAA Journal                                      J. of Aircraft  
 J. of Computational Physics                  J. of Spacecraft and Rockets  
 Computers and Fluids                          J. of Fluids and Structures  
 ASME Fluids Engineering                      J. Numerical Meth. in Eng.

**Service**

- Faculty Senate, 1986 – 1989
  - Senate Cabinet
  - Committee on Committees
- Commission on Faculty Affairs, 1987 – 1989
  - Secretary, 1987–1988
  - Task Force on Faculty Ethics
  - Task Force on the Evaluation of Teaching
- University Council, 1988 – 1989
  - Task Force on Planning
- Engineering Faculty Organization, 1985 – 1988
  - Vice President, Executive Council
  - Task Force on Graduate Student Recruitment
  - College Planning and Budget Committee 1994 –
- Governing boards, (stakeholders committees), 2000 – 2002
  - Interdisciplinary Center for Applied Mathematics, ICAM, Chair
  - Laboratory for Advanced Scientific Computing and Applications, LASCA
  - Systems Research Center, SRC
  - Alexandria Research Institute, ARI
- Dept. of Aerospace and Ocean Engineering
  - Curriculum Committee, Chair, 1989 – 1993
  - Graduate Committee, Chair, 1987 – 1989
  - Computer Committee
  - Promotion and Tenure Committee
- American Institute of Aeronautics and Astronautics
  - Blue Ridge Council Member, 1986 – 1989
  - Associate Editor AIAA Journal, 1992 – 1995
  - Fluid Dynamics Technical Committee, 1993 – 1996
  - Chair, 12th AIAA CFD Conference, June 1995
  - MDO Technical Committee, 1997 –
  - Hampton Roads Council Member, 2004 –
  - General Chair, 11th AIAA/ISSMO MAO Conference, Sept. 2006
- Industry/University/Government Roundtable on Enhancing Engineering Education (IUGREEE)
  - Balance Team Member, 1996 – 2001
- MARITECH Advanced Shipbuilding Enterprise
  - Technical Advisory Group, 1998
- Aerospace Department Heads Association (ADCA), 1993 – 2002
  - President, 2000 – 2001
  - Secretary/Treas., 1999 – 2000
- Universities Space Research Association (USRA)
  - Virginia Tech representative 1999 – 2002

**Sponsored Research at V.P.I. & S.U.**

“The Computation of Non-Linear Supersonic Flows Using a Stream Function Approach”, NASA Langley, NAG 1-289, 6/82-9/83, \$13,098, Principal Investigator.

“A New Approach to the Computation of Supersonic Rotational Flows”, NASA Langley, NAG 1-337, 2/83-9/85, \$109,208, Principal Investigator.

“Viscous Effects in Supersonic Conical Flows”, NASA Langley, NGT-47-004-808, 6/83-5/85, \$48,000, Principal Investigator.

“Integrated Multi-Disciplinary Aircraft Design”, NASA Langley, NAG 1-505, 8/84-6/87, \$125,141, Co-Principal Investigator with R. T. Haftka.

“Interdisciplinary Research on Aeronautical and Space Vehicles”, NASA Langley, NAG 1-603, 6/85-10/90, \$251,440, Co-Principal Investigator with R. T. Haftka.

“Computational Fluid Dynamics Research in Hypersonic Flow”, NASA Langley, NAG 1-776, 6/87-12/94, \$801,385, Co-Principal Investigator with R. W. Walters.

“Integrated Structural-Aerodynamic Design Optimization”, NSF Grant DMC-8615336, 8/87-1/91, \$189,834, Co-Principal Investigator with R. T. Haftka.

“U.S.-Italy Cooperative Research: Numerical Methods for Multi-dimensional Compressible Flows”, NSF Grant INT-8814895, 2/89-7/92, \$10,710, Principal Investigator.

“Variable Complexity Design Strategy Applied to Supersonic Wing Design”, NASA Langley, NAG 1-1160, 7/90-3/97, \$400,768, Co-Principal Investigator with R. T. Haftka and W. H. Mason.

“Variable-Complexity Design Strategies for Integrated Multidisciplinary Optimization”, NSF Grant DDM-9008451, 4/91-4/94, \$150,071, Co-Principal Investigator with R. T. Haftka and W. H. Mason.

“A Finite-Element Wing Box Modelling for an ENSAERO Based Aeroelastic Analysis”, NASA Ames, NCA 2-625, 6/91-6/93, \$63,989, Co-Principal Investigator with R. K. Kapania.

“Adjoint Methods for Aerodynamic Wing Design NLPN 92-737”, NASA Langley, NAG 1-1466, 12/92-10/95, \$105,108, Principal Investigator.

“A Workshop on Multidisciplinary Aircraft Design for Product Realization - Blacksburg VA May 5-7, 1993”, NSF Grant DDM-9303472, 1/93-6/93, \$10,233, Co-Principal Investigator with R. T. Haftka and W. H. Mason.

“Aeroelastic Analysis of Advanced Wings Using ENSAERO and Detailed Finite-Element Structural Model”, NASA Ames, NCA 2-838, 9/93-9/94, \$30,000, Co-Principal Investigator with R. K. Kapania.

“Multidisciplinary Design & Analysis Fellowship Program”, NASA Headquarters, NGT-10025, 10/93-10/96, \$266,446, Co-Principal Investigator with Z. Gurdäl, R. T. Haftka, R. K. Kapania, W. H. Mason and D. T. Mook.

“Variable Complexity Optimization on Parallel Computers”, NASA Langley, NAG 1-1562, 12/93-12/96, \$599,521, Co-Principal Investigator with R. T. Haftka, W. H. Mason and L.T. Watson.

“Optimization of an ASCT Wing-Body Configuration Using Euler Equations”, NASA Ames, NCC2-5036, 2/94-1/95, \$74,670, Co-Principal Investigator with R. K. Kapania.

“Multidisciplinary Design Investigation of Truss-Braced Aircraft”, NASA Langley, NAG 1-1852, 7/96-6/99, \$300,000, Co-Principal Investigator with R. K. Kapania, W. H. Mason and J. A. Schetz.

“Application of GENESIS-based Structural Optimization Methods to an HSCT Configuration”, Boeing Aerospace Company, PO-ZA-0084, 8/1/96-11/30/96, \$15,532.

“Multidisciplinary Design & Analysis Fellowship Program”, NASA Langley, NGT-1-52155, 11/96-11/98, \$380,930, Co-Principal Investigator with Z. Gurdäl, R. K. Kapania and W. H. Mason.

“Design Space Exploration for MDO on a Teraflop Computer”, NASA Ames, NAG-2-1180, 2/98-2/01, \$102,830, Co-Principal Investigator with W. H. Mason and L. T. Watson.

“Practical Aerodynamic Design Optimization Based on the Navier-Stokes Equations and a Discrete Adjoint Method”, NASA Langley, NCC-1-279, 12/97-11/98, \$30,228, Principal Investigator.

“A Structural and Aerodynamic Investigation of Strut-Braced Aircraft Concept”, Lockheed-Martin Aeronautical Systems, 4/98-9/98, \$140,835, Co-PI with R. K. Kapania, W. H. Mason and J. A. Schetz.

“Aerodynamic Investigations of the Inboard Wing Concept”, NASA Langley, PO L-9624, 6/10/99–10/18/99, \$79,406, Co-Principal Investigator with W. H. Mason and J. A. Schetz.

“Multidisciplinary Design Investigation of Truss-Braced Aircraft: Phase 4”, NASA Langley, NAG 1-2217, 7/1/99–10/31/99, \$50,085, Co-Principal Investigator with R. K. Kapania, W. H. Mason and J. A. Schetz.

“Protection Against Modeling and Simulation Uncertainties in Design Optimization,”NSF Grant DMI-9979711, 9/01/99–8/31/02, \$299,931, Co-Principal Investigator with W. H. Mason and L. T. Watson.

“Vorticity Confinement Research,”Flow Analysis, Inc., 3/1/00–2/28/01, \$25,836, Principle Investigator.

“Aerodynamic Wing Design of a StruT-Braced Wing Flight Demonstrator”, NASA Langley, PO-L-14268, 5/4/01–10/31/01, \$29,946, Co-Principal Investigator with R. K. Kapania, W. H. Mason and J. A. Schetz.

“MDO Investigations of Advanced Design Concepts Applied to the Blended-Wing Body Configuration”, NASA Langley, NAG 1-2024, 1/15/02–1/14/03, \$145,640, Co-Principal Investigator with W. H. Mason and J. A. Schetz.

### ***Thesis Students Supervised***

#### ***Masters Degree***

Sang Keun Choi: “The Computation of Rotational Conical Flows”, Aug. 1984. *Present position:* Executive Director, Taejon R&D center, Daewoo Heavy Industries Ltd., Taejon, Korea.

George J. Carlin: “Transonic Flow Computation of Multi-Element Airfoils Using a Finite-Volume Approach”, Aug. 1984. *Present position:* President, Computational Fluid Dynamic Applications, Inc., PA.

Gregory J. Strauch: “Integrated Multidisciplinary Design of a Sailplane Wing”, Dec. 1985. *Present position:* Engineer, SAIC, Inc., McClean VA.

Joseph H. Morrison: “Efficient Solutions of 2-D Incompressible, Steady, Laminar, Separated Flows”, Feb. 1986. *Present position:* Research engineer, On-site Contactor, NASA Langley, Hampton VA.

David L. Whitaker: “Supersonic Conical Flow Computations Using a Rectangular Finite-Volume Method”, Feb. 1986. *Present position:* Aerospace CFD Specialist, Cray Research Inc., Eagan MN.

William M. Eppard: “Integrated Aerodynamic-Structural Design Optimization”, June 1987. *Present position:* Analyst, Aerosoft Inc., Blacksburg, VA.

Joseph L. Garrett: “A Comparison of Flux-Splitting Algorithms for the Euler Equations with Equilibrium Air Chemistry”, Jan. 1989. *Present position:* Engineer, Pratt & Whitney Corp., W. Palm Beach FL.

David M. Polen: “Integrated Aerodynamic-Structural Design of a Forward-Swept, Transport Wing”, Apr. 1989. *Present position:* Engineer, Atlantic Research Corp., Gainesville VA.

Eric R. Unger: “Computational Aspects of the Integrated Multi-Disciplinary Design of a Transport Wing”, Mar. 1990. *Present position:* Engineer, The Boeing Company, Long Beach CA.

Dale E. MacMurdy: “Aeroelasticity of Wings Coupling Navier-Stokes Aerodynamics with Wing-Box Finite Elements”, (co-chair with R. K. Kapania), June 1994. *Present position:* Engineer, Teledyne Brown, Inc., Arlington VA.

Matthew D. Kaufman: “Variable-Complexity Response Surface Approximations for Wing Structural Weight in HSCT Design”, (co-chair with R. T. Haftka), Feb. 1996. *Present position:* Engineer, Lockheed Martin Company, Palo Alto CA.

Chuck A. Baker: “Parallel Global Aircraft Configuration Design Space Exploration,”June 2000. *Present position:* Engineous Software Inc., Morrisville NC.

#### ***PhD. Degree***

Sang Keun Choi: “A Cartesian Finite-Volume Method for the Euler Equations”, May 1987. *Present position:* Executive Director, Taejon R&D center, Daewoo Heavy Industries Ltd., Taejon, Korea.

David L. Whitaker: "Two-Dimensional Euler Computations on a Triangular Mesh Using an Upwind, Finite-Volume Scheme", Dec. 1988. *Present position:* Aerospace CFD Specialist, Cray Research Inc., Eagan MN.

Pasquale Cinnella: "Flux-Split Algorithms for Flows with Non-equilibrium Chemistry and Thermodynamics", Dec. 1989. *Present position:* Professor, Mississippi State University, Dept. Aerospace Eng.

Changyeol Joh: "Efficient Optimization Procedures for Transonic Airfoil Design", May 1991. *Present position:* Assistant Professor, Dept. of Aerospace Eng., Ulsan University, Ulsan, Korea.

Eric R. Unger: "Integrated Aerodynamic-Structural Wing Design Optimization", Mar. 1992. *Present position:* Engineer, The Boeing Company, Long Beach CA.

Matthew G. Hutchison: "Multidisciplinary Design Optimization of High-Speed Civil Transport Configurations Using Variable-Complexity Modeling", Mar. 1993. *Present position:* Engineer, Aurora Flight Sciences Corp., Manassas, VA.

William M. Eppard: "Advanced Algorithms for Non-equilibrium Gas Dynamics", Apr. 1993. *Present position:* Analyst, Aerosoft Inc., Blacksburg, VA.

Robert P. Narducci: "Selected Optimization Procedures for CFD-Based Shape Design Involving Shock Waves or Computational Noise", May 1995. *Present position:* Engineer, The Boeing Company, Long Beach CA.

Sergei Pevchin: "New, Efficient Contact Discontinuity Capturing Techniques in Supersonic Flow Simulations", Sept. 1996. *Present position:* Sr. Member of Tech. Staff R&D/SpectreRF Group, Cadence Design Systems Inc., Fremont, CA.

Anthony A. Giunta: "Aircraft Multidisciplinary Design Optimization Using Design of Experiments Theory and Response Surface Modeling Methods", May 1997. *Present position:* Research Scientist, Sandia National Laboratories, Albuquerque, NM.

Vladimir Balabanov: "Development of Approximations for HSCT Wing Bending Material Weight Using Response Surface Methodology", (co-chair with R. T. Haftka), July 1997. *Present position:* Research Engineer, VR&D, Inc., Colorado Springs, CO.

Duane Knill: "Implementing Aerodynamic Predictions from Computational Fluid Dynamics in Multidisciplinary Design Optimization of a High-Speed Civil Transport", December 1997. *Present position:* Post-Doc, University of Washington, Dept. of Aeronautics and Astronautics, Seattle, WA

Daryl L. Bonhaus: "A Higher Order Accurate Finite Element Method for Viscous Compressible Flows", (co-chair with W. K. Anderson), December 1998. *Present position:* NASA Langley Research Center, Hampton, VA.

Eric J. Nielsen: "Aerodynamic Design Sensitivities On An Unstructured Mesh Using the Navier-Stokes Equations and a Discrete Adjoint Formulation", (co-chair with W. K. Anderson), December 1998. *Present position:* National Research Council Fellow, NASA Langley Research Center, Hampton, VA.

Guangchu Hu: "The Development and Applications of a Numerical Method for Compressible Vorticity Confinement in Vortex-Dominant Flows," June 2001. *Present position:* Research Assistant Professor, The University of Utah, Dept. Mechanical Eng., Salt Lake City, UT.

William A. Wood: "Fluctuation Splitting for Aerothermodynamics", November 2001. *Present position:* NASA Langley Research Center, Aerothermodynamics Branch, Hampton, VA.

Serhat Hosder: "Clean-Wing Aerodynamic Noise Modeling for Multidisciplinary Design and Optimization", August 2004. *Present position:* Principal Research Engineer, Techsburg, Inc., Blacksburg, VA.

**PUBLICATIONS**

**Book Chapters**

1. Cinnella, P. and Grossman, B., "Flux-Split Algorithms for Hypersonic Flows", Chapter 5 in *Computational Methods in Hypersonic Aerodynamics*, Ed.: T. K. S. Murthy, Kluwer Academic Publishers, Dordrecht, 1991, pp. 153–202.
2. Unger, E. R., Haftka, R. T., Grossman, B. and Mason, W. H., "Integrated Aerodynamic-Structural Design Optimization of Aircraft Wings", Chapter in *Control and Dynamic Systems, Vol. 57, Multidisciplinary Engineering Systems: Design and Optimization Techniques and Their Application*, Ed.: C. T. Leondes, Academic Press, San Diego, 1993, pp. 55–108.
3. Grossman, B., Pevchin, S. V. and Eppard, W. M., "Multidimensional Upwind Euler Algorithms from Kinetic Theory", Chapter 11 in *Frontiers of Computational Fluid Dynamics 1994*, Eds.: D. A. Caughy and M. M. Hafez, John Wiley and Sons, New York, 1994, pp. 169–188.
4. Cinnella, P. and Grossman, B., "Computational Methods for Chemically Reacting Flows", Chapter 22 in *Handbook of Fluid Dynamics and Fluid Machinery*, Eds.: J. A. Schetz and A. E. Fuhs, John Wiley and Sons, New York, 1996, pp. 1541–1590.
5. MacMillin, P. E., Huang, X., Dudley, J., Grossman, B., Haftka, R. T. and Mason, W. H., "Multidisciplinary Design Optimization Techniques of the High-Speed Civil Transport," in *Multidisciplinary Design Optimization State-of-the-Art*, Proceedings in Applied Mathematics 80, Eds.: N. Alexandrov and Y. Hussaini, SIAM, Philadelphia PA, 1997, pp. 153–171.
6. Giunta, A. A., Balabanov, V., Kaufman, M., Burgee, S., Grossman, B., Haftka, R. T., Mason, W. H. and Watson, L. T., "Variable-Complexity Response Surface Design of an HSCT Configuration", in *Multidisciplinary Design Optimization State-of-the-Art*, Proceedings in Applied Mathematics 80, Eds.: N. Alexandrov and Y. Hussaini, SIAM, Philadelphia PA, 1997, pp. 348–367.
7. D. T. Krasteva, C. Baker, L. T. Watson, B. Grossman, W. H. Mason, and R. T. Haftka, "Distributed control parallelism for multidisciplinary design of a high speed civil transport", in *Parallel Numerical Computations with Applications*, T. Yang (ed.), Kluwer Internat. Series in Engrg. and Computer Sci., Vol. 515, Norwell, MA, 1999, 119–140.
8. H. Kim, W.H. Mason, L.T. Watson, B. Grossman, M. Papila and R.T. Haftka, "Protection Against Modeling and Uncertainties in Design Optimization," in *Modeling and Simulation-Based Life Cycle Engineering*, eds.: K. Chung, S. Saigal, S. Thynell and H. Morgan, Spon Press, London and New York, 2002, pp. 231–246.

**Refereed Journal Articles**

1. Grossman, B. and Rubin, S. G., "An Expansion Method for Boundary Layers on Thin Airfoils", *J. App. Math. and Phys. (ZAMP)* **22** 1971, pp. 109–130.
2. Rubin, S. G. and Grossman, B., "Viscous Flow Along a Corner: Numerical Solution of the Corner Layer Equations", *Quart. App. Math.* **29**, July 1971, pp 169–186.
3. Keyfitz, B., Melnik, R. E. and Grossman, B., "An Analysis of the Leading-Edge Singularity in Transonic Small-Disturbance Theory", *Quarterly J. of Mech. and Appl. Math.* **31**, Part 2, May 1978, pp. 137–155.
4. Keyfitz, B., Melnik, R. E. and Grossman, B., "Leading-Edge Singularity in Transonic Small Disturbance Theory: Numerical Resolution", *AIAA J.* **17** 1979, pp. 296–299.
5. Grossman, B., "Numerical Procedure for the Computation of Irrotational Conical Flows", *AIAA J.* **17**, 1979, pp. 828–837.
6. Grossman, B. and Siclari, M. J., "The Nonlinear Supersonic Potential Flow Over Delta Wings", *AIAA J.* **19**, 1981, pp. 573–581.
7. Grossman, B., Gurdal, Z., Strauch, G. J., Eppard W. M. and Haftka, R. T., "Integrated Aerodynamic/Structural Design of a Sailplane Wing", *J. Aircraft*, **25**, No. 9, 1988, pp. 855–860.
8. Grossman, B. and Cinnella, P., "The Computation of Non-Equilibrium, Chemically-Reacting Flows", *Computers and Structures*, **30**, No. 1/2, 1988, pp. 79–93.
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73. Knill, D. L., Grossman, B., Mason, W. H., Watson, L. T. and Haftka, R. T., "Response Surface

- Approximations of Supersonic Euler Aerodynamics Applied to HSCT Design," ISSMO/NASA First Internet Conference on Approximations and Fast Reanalysis in Engineering Optimization, June 14-27, 1998.
74. Grossman, B., Hu, G. and Steinhoff, J., "Vortex Confinement in Compressible Flow," Proceedings of the Third ARO Workshop on Vorticity Confinement and Related Methods, University of Tennessee Space Institute, Tullahoma, TN, Oct. 27, 1998.
  75. Grossman, B., "Multidisciplinary Design Optimization of Aircraft Configurations," Proceedings of International Symposium on Advanced Machinery and Design, Seoul National University, Nov. 1998, pp. 387-415. See also Proceedings of the KSME 1998 Fall Annual Meeting, Volume C, Yeungnam University, Gyongsan, Korea, Nov. 1998, pp. 35-63.
  76. Krasteva, D. T., Baker, C., Watson, L. T., Grossman, B., Mason, W. H. and Haftka, R. T., "Distributed Control Parallelism for Multidisciplinary Design of a High Speed Civil Transport", in *Proc. 7th Symp. on the Frontiers of Massively Parallel Computation*, IEEE Computer Soc., Los Alamitos, CA, 1999, 166-173; also MAD Center Report 98-11-01, Virginia Tech, AOE Dept., Blacksburg, VA, Nov. 1998.
  77. Krasteva, D. T., Baker, C., Watson, L. T., Grossman, B., Mason, W. H. and Haftka, R. T., "Distributed Control Parallelism in Aircraft Design", MAD Center Report 98-11-02, Virginia Tech, AOE Dept., Blacksburg, VA, Nov. 1998.
  78. Krasteva, D. T., Watson, L. T., Baker, C., Grossman, B., Mason, W. H. and Haftka, R. T., "Distributed Control Parallelism for High-Speed Civil Transport MDO", Proceedings of the Ninth SIAM Conference on Parallel Processing for Scientific Computing, San Antonio TX, March 22-24, 1999.
  79. Goel, A., Baker, C. A., Shaffer, C. A., Grossman, B., Mason, W. H., Watson, L. T. and Haftka, R. T., "VizCraft: a problem solving environment for configuration design of a high speed civil transport", MAD Center Report 99-06-01, Virginia Tech, AOE Dept., Blacksburg, VA, June 1999.
  80. Gundlach, J. F., Naghshineh-Pour, A., Gern, F., Tetrault, P.-A., Ko, A., Schetz, J. A., Mason, W. H., Kapania, R. K., Grossman, B. and Haftka, R. T., "Multidisciplinary Design Optimization and Industry Review of a 2010 Strut-Braced Wing Transonic Transport," MAD Center Report 99-06-03, Virginia Tech, AOE Dept., Blacksburg, VA, June 1999.
  81. Grossman, B., Hu, G. and Steinhoff, J., "Vortex Confinement in Compressible Flow," 8th International Symposium on Computational Fluid Dynamics, Bremen, Germany, Sept. 5-10, 1999, pp. 150.
  82. H. Kim, C. Baker, S. Cox, B. Grossman, R.T. Haftka, W.H. Mason, L.T. Watson, "Protection Against Modeling and Simulation Uncertainties in Design Optimization," 2000 NSF Design and Manufacturing Research Conference, Jan. 3-6, 2000, Vancouver, British Columbia, Canada.
  83. Chuck A. Baker, Layne T. Watson, Bernard Grossman, William H. Mason, Steven E. Cox, and Raphael T. Haftka, "Study of a Global Design Space Exploration Method for Aerospace Vehicles," Computational Aerosciences (CAS) Workshop, NASA Ames Research Center, Mountain View, CA, Feb. 15-17, 2000.
  84. Grossman, B., "Multidisciplinary Design Optimization of a Truss-Braced Transonic Transport", Proceedings of the International Symposium of Institute of Advanced Aerospace Technology, Seoul National University, Hoam Convention Center, Seoul, Korea, Mar. 16, 2000, pp. 171-210.
  85. S. E. Cox, R. T. Haftka, C. Baker, B. Grossman, W. H. Mason, L. T. Watson, "Global Optimization for Noise and Multiple Local Optima," Proc. International Workshop on Multidisciplinary Design Optimization, Pretoria, South Africa, August 7-10, 2000, pp. 50-59
  86. A. Ko, B. Grossman, W.H. Mason and R.T. Haftka, "Effects of Constraints in the Multidisciplinary Design Optimization of a Transonic Commercial Transport with Strut-Braced Wing," World Aviation Congress, SAE 2000-01-5609, San Diego, CA, Oct. 10-12, 2000.
  87. Grossman, B., Hu, G. and Dadone, A., "New Developments in Vorticity Confinement for Compressible and Incompressible Flows," Proceedings of the Fourth ARO Workshop on Vorticity Confinement and Related Methods, University of Tennessee Space Institute, Tullahoma, TN, Nov. 2, 2000.
  88. Grossman, B., "Effective Use of Surrogate Models in Aircraft Design," Proceedings of the First International Workshop on Surrogate Modelling and Space Mapping for Engineering Optimization,

Lyngby, Denmark, November 17, 2000.

89. Kim, H., Papila, M., Mason, W. H., Haftka, R. T., Watson, L. T. and Grossman, B., "Detection and Repair of Poorly Converged Optimization Runs," Proceedings CD of 2001 National Science Foundation Design, Service and Manufacturing Grantees and Research Conference, Tampa, FL, January 2001, 14 pages.
90. Grossman, B., "Review of Multimedia Fluid Mechanics," *AIAA J.*, **39**, No. 6, June 2001, pp. 1213-1214.
91. B. Grossman and R.T. Haftka, "Protection Against Modeling and Uncertainties in Design Optimization," National Science Foundation and Sandia National Laboratories Life-Cycle Engineering Program Review, Albuquerque, NM, June 2001.
92. H. Kim, W. H. Mason, L. T. Watson, B. Grossman and R. T. Haftka "Probabilistic Modeling of Optimization Errors," Proceedings CD of 2002 National Science Foundation Design, Service and Manufacturing Grantees and Research Conference, San Juan, PR, January 7-10, 2002.
93. Grossman, B. and Hu, G., "Computation of Vortex-Dominated Flow Using Compressible Vorticity Confinement Methods," Proceedings of the 14th U. S. National Congress of Theoretical and Applied Mechanics, ISBN 0-9721257-0-1, Eds: R. C. Batra and E. G. Henneke, June 23-28, 2002, pp. 502.
94. A. Ko, W. H. Mason, B. Grossman and J.A. Schetz, "A-7 Strut Braced Wing Concept Transonic Wing Design", Report VPI-AOE-275, Virginia Tech, AOE Dept., Blacksburg, VA, July 2002.
95. Hosder, S., Grossman, B., Haftka, R. T., Mason, W. H. and Watson, L. T., "Remarks on CFD Simulation Uncertainties," MAD Center Report 2003-02-01, Virginia Tech, AOE Dept., Blacksburg, VA, Feb. 2003.
96. Dadone, A and Grossman, B., "Efficient fluid dynamic design optimization using Cartesian grids," NIA Report No 2004-07, National Institute of Aerospace, Hampton, VA, and NASA/CR-2004-213036, NASA Langley Research Center, Hampton, VA, 2004

**PRESENTATIONS**

**Short Courses**

1. "Fundamentals of Computational Fluid Dynamics", (7 hours), Short Course on Numerical Gasdynamics: A Designers Tool, Polytechnic University, March 1986.
2. "Finite-Volume Methods for High-Speed Gasdynamics", Short Course (15 hours), *Istituto di Macchina ed Energetica, Università di Bari*, Italy, March 1987.
3. "Basic Hyperbolic Methods" and "Flux-Split Finite-Volume Methods", Short Course, TecnoPolis CSATA, Italy, 7 hours, Mar. 1990.
4. "Finite-Volume Methods", Short Course (9 hours), *Istituto di Macchina ed Energetica, Università di Bari*, Italy, May 1990.
5. "Flux-Split Finite-Volume Methods", Short Course (15 hours), *Istituto di Macchina ed Energetica, Università di Bari*, Italy, June 1991.
6. "Finite-Volume Methods", Short Course (18 hours), *Istituto di Macchina ed Energetica, Politecnico di Bari*, Italy, May 1994.
7. "Design Optimization Using CFD", Short Course (16 hours), *Istituto di Macchina ed Energetica, Politecnico di Bari*, Italy, May 1997.
8. "Real Gas Dynamics", Short Course (16 hours), *Istituto di Macchina ed Energetica, Politecnico di Bari*, Italy, May 2000.

**Major Invited Papers: Keynote or Plenary Presentations**

1. "Multidisciplinary Design Optimization of Advanced Aircraft Configurations", keynote address at the *15th International Conference on Numerical Methods in Fluid Dynamics*, Monterey, CA, June 1996.
2. "Multidisciplinary Design Optimization of Advanced Aircraft", plenary paper, AFOSR Workshop on Optimal Design, Arlington VA, Sept. 30 – Oct. 3, 1997.
3. "Multidisciplinary Design Optimization of Aircraft Configurations", plenary paper, International Symposium on Advanced Machinery and Design, Seoul National University, Seoul Korea, Nov. 3 – 4, 1998.
4. "Multidisciplinary Design Optimization of a Truss-Braced Transonic Transport", invited presentation, International Symposium of Institute of Advanced Aerospace Technology, Seoul National University, Hoam Convention Center, Seoul, Korea, Mar. 16, 2000.
5. "Effective Use of Surrogate Models in Aircraft Design," plenary paper, First International Workshop on Surrogate Modelling and Space Mapping for Engineering Optimization, Lyngby, Denmark, November 17, 2000.
6. "Effective Use of Surrogate Models in MDO of a Supersonic Transport Aircraft," invited presentation, International Workshop on Numerical Simulation Technology for Design of Next Generation Supersonic Transport, Tokyo, Japan, December 3, 2001.
7. "Aerospace Engineering: Enrollment and Employment Trends," invited testimony at the *Commission on the Future of the U. S. Aerospace Industry*, U. S. Department of Commerce, Washington, DC, May 14, 2002.

**Conference Presentations**

1. "Time-Dependent Computation of Transonic Flows", AIAA 7th Annual Meeting, Paper No. 70-1322, Houston TX, October 1970.
2. "A Numerical Procedure to Calculate the Inviscid Flow About a Space Shuttle Orbiter Traveling at a Supersonic/Hypersonic Velocity", Space Shuttle Technology Conference, paper No. 6, NASA TMX-2272, Hampton VA, April 1971.
3. "A Complete Numerical Technique for the Calculation of Three Dimensional Inviscid Supersonic Flows", AIAA 10th Aerospace Sciences Meeting, Paper No. 72-192, San Diego CA, January 1972.
4. "The Numerical Computation of the Transonic Flow Over Afterbodies Including the Effect of Jet Plume and Viscous Interactions", AIAA 13th Aerospace Sciences Meeting, Paper No. 75-62, New Orleans LA, January 1975.

5. "The Numerical Computation of the Transonic Flow Over Two-Element Airfoil Systems", Proceedings of the Fifth International Conference on Numerical Methods in Fluid Mechanics, Enschede, The Netherlands, June 1976.
6. "The Viscous Transonic Flow Over Two-Element Airfoil Systems", AIAA 10th Fluid and Plasma Dynamics Conference, Paper No. 77-688, Albuquerque NM, June 1977.
7. "A Numerical Procedure for the Computation of Supersonic Conical Flows", AIAA 11th Fluid and Plasma Dynamics Conference, Paper No. 78-1213, Seattle WA, July 1978.
8. "A Modern View of Vortical Singularities in Conical Flow", Symposium on Computers in Aerodynamics, Polytechnic Institute of New York, June 1979.
9. "The Nonlinear Supersonic Potential Flow Over Delta Wings", AIAA 18th Aerospace Sciences Meeting, Paper No. 80-269, Pasadena CA, January 1980.
10. "A Study of Shock Fitting in Transonic Potential Flow", NASA Langley Theoretical Aerodynamics Contractors Workshop, Hampton VA, September 1982.
11. "The Clebsch Velocity Potential in Rotational Gasdynamics", Second Symposium on Numerical and Physical Aspects of Aerodynamic Flow, Long Beach CA, January 1983.
12. "The Computation of Inviscid Rotational Gasdynamic Flows Using an Alternate Velocity Decomposition", AIAA 6th Computational Fluid Dynamics Conference, Paper No. 83-1900 CP, Danvers MA, July 1983.
13. "Rotational Supersonic Flow Using a Clebsch Velocity Decomposition", S.I.A.M. 1983 Fall Meeting, Norfolk, VA, November 1983.
14. "The Computation of Rotational Conical Flows", Paper No. 84-025, AIAA 22nd Aerospace Sciences Meeting, Reno NV, January 1984.
15. "Vorticity Effects in Supersonic Conical Flows," NASA Langley Theoretical Aerodynamics Contractors Workshop, Hampton VA, August 1984.
16. "Supersonic Conical Flow Using a Cartesian Finite-Volume Method", AIAA 7th Computational Fluid Dynamics Conference Open Forum, Paper No. 85-1535, Cincinnati OH, July 1985.
17. "Integrated Aerodynamic/Structural Optimization", NASA Langley Theoretical Aerodynamics Contractors Workshop, Hampton VA, August 1985.
18. "Combined Aerodynamic/Structural Optimization of a Sailplane Wing", Society of Engineering Science, 22nd Annual Meeting, Pennsylvania State University, October, 1985.
19. "Supersonic Flow Computations Using a Cartesian Finite-Volume Method", AIAA 24th Aerospace Sciences Meeting, Paper No. 86-0442, Reno NV, January 1986.
20. "Integrated Aerodynamic/ Structural Design of a Sailplane Wing", AIAA Systems Design and Technology Meeting, Paper No. 86-2623, Dayton OH, Oct. 1986.
21. "An Analysis of Flux-Split Algorithms for Euler's Equations with Real Gases", Proceedings of the AIAA 8th Computational Fluid Dynamics Conference, Paper No. 87-1117-CP, Honolulu HI, June 1987.
22. "Flux Split Algorithms for the Multi-Dimensional Euler Equations with Real Gases", Symposium on Physical Aspects of Numerical Gasdynamics, Polytechnic University, Aug. 1987.
23. "Efficient Optimization of Integrated Aerodynamic-Structural Design", Proceedings of The International Conference on Inverse Design Concepts and Optimization in Engineering Sciences - II, Penn. State University, Oct. 1987.
24. "A Flux-Vector Split, Finite-Volume Method for Euler's Equations on Non-Mapped Grids", AIAA 26th Aerospace Sciences Meeting, Paper No. 88-0227, Reno NV, Jan. 1988.
25. "The Development of Flux-Split Algorithms for Flows with Non-Equilibrium Thermodynamics and Chemical Reactions", The 1st National Fluid Dynamics Congress, Paper No. 88-3596, Cincinnati OH, July 1988.
26. "Integrated Structural-Aerodynamic Design Optimization", The 16th Congress of the International Council of Aeronautical Sciences, ICAS-88-1.10R, Jerusalem, Israel, Aug. 1988.
27. "The Computation of Non-Equilibrium, Chemically-Reacting Flows", Symposium on Advances and Trends in Computational Structural Mechanics and Fluid Mechanics, Hampton VA, Oct. 1988.
28. "An Approximate Riemann Solver for Flows with Non-Equilibrium Chemistry and Vibrational Relaxation", 1988 Division of Fluid Mechanics Annual Meeting, American Physical Society, Paper

- DA-4, Buffalo NY, Nov. 1988.
29. "Upwind Methods for Flows with Non-equilibrium Chemistry and Thermodynamics", Proceedings of the Third International Conference on Numerical Combustion, Antibes, France, May 1989.
  30. "A Survey of Upwind Methods for Flows with Equilibrium and Non-equilibrium Chemistry and Thermodynamics", AIAA 24th Thermophysics Conference, Paper 89-1653, Buffalo NY, June 1989.
  31. "Integrated Aerodynamic-Structural Design of a Transport Wing", AIAA/AHS/ASEE Aircraft Design, Systems and Operations Conference, Paper No. 89-2129, Seattle WA, July 1989.
  32. "Gas Dynamics of Non-equilibrium Flows with Multiple Temperature Models", 1989 Division of Fluid Mechanics Annual Meeting, American Physical Society, Paper BE-3, Palo Alto CA, Nov. 1989.
  33. "Flux-Split Methods in Non-Equilibrium Flow", invited paper at the International Conference on Mathematical Models and Numerical Methods in Continuum Mechanics, Novosibirsk, USSR, May 1991.
  34. "Algorithms for Non-Equilibrium Hypersonic Flows", invited paper at the 4th International Symposium on Computational Fluid Dynamics, Davis CA, Sept. 1991.
  35. "Design Optimization of Transonic Airfoils", The International Conference on Inverse Design Concepts and Optimization in Engineering Sciences - III, Washington, D. C., Oct. 1991.
  36. "Incompressible Navier-Stokes Solutions on Unstructured Grids Using a Covolume Technique", The Thirteenth International Conference on Numerical Methods in Fluid Mechanics, Rome, Italy, July 1992.
  37. "Kinetic Flux-Vector Splitting for Flows in Chemical and Thermal Non-Equilibrium", 1992 Division of Fluid Mechanics Annual Meeting, American Physical Society, Tallahassee FL, Nov. 1992.
  38. "Multidimensional Upwind Euler Algorithms from Kinetic Theory", Symposium on Computing the Future: Advances and Prospects for Computational Aerodynamics, Cornell University, Ithaca, NY, Nov. 1994.
  39. "Multidisciplinary Design Optimization of a High-Speed Civil Transport", First Industry/University Symposium on Research for Future Supersonic and Hypersonic Vehicles, North Carolina A&T University, Greensboro NC, Dec. 1994.
  40. "Multidisciplinary Optimization of the High-Speed Civil Transport," Paper No. 94-0124, AIAA 33rd Aerospace Sciences Meeting, Reno NV, Jan. 1995.
  41. "Parallel Variable-Complexity Response Surface Strategies for HSCT Design", NASA Computational Aerosciences Workshop, Moffett Field, CA, March 7-9, 1995.
  42. "Multidisciplinary Design Optimization Techniques for the High-Speed Civil Transport," ICASE/LaRC Workshop on Multidisciplinary Design Optimization, Hampton, VA, March 13-16, 1995.
  43. "Variable-Complexity Multidisciplinary Design Optimization Using Parallel Computers", International Conference on Computational Engineering Science, July 30 - August 3, 1995, Hawaii
  44. "Multidisciplinary Design Optimization for Advanced Aircraft Configurations," Invited (one hour) paper at the IBM STAR Forum, IBM Research Division Headquarters, Yorktown NY, October 25-27, 1995.
  45. "A Discontinuity Confinement Procedure," The Aeronautics and Astronautics Society of Republic of China 37th Annual Symposium, Taipei, Taiwan, Dec. 17, 1995.
  46. "Multidisciplinary Design Optimization of a High-Speed Civil Transport", invited paper, Society of Engineering Science 33rd Annual Technical Meeting, Arizona State University, Tempe, AZ, Oct. 1996.
  47. "Multidisciplinary Design Optimization of Advanced Aircraft Configurations", invited paper, Scalable Parallel Libraries Conference (SPLC), Mississippi State University, Starkeville, MS, Oct. 1996.
  48. "Multidisciplinary Design Optimization of Advanced Aircraft Configurations", invited paper, Korea-U.S. Workshop on Aerospace Sciences, Vienna, VA, May 15-17, 1997.
  49. "Vortex Confinement in Compressible Flow," Third ARO Workshop on Vorticity Confinement and Related Methods, University of Tennessee Space Institute, Tullahoma, TN, Oct. 27, 1998.
  50. "Multidisciplinary Design Optimization of Aircraft Configurations", invited paper, Korean Society of Mechanical Engineers 1998 Fall Annual Meeting, Yeungnam University, Gyongsan, Korea, Nov. 6 - 7, 1998.

51. "Multidisciplinary Design Optimization of Aircraft Configurations", invited presentation, NASA Workshop on Rapid Synthesis & Simulation Tools, Cleveland, Ohio, June 22, 1999.
52. "Vortex Confinement in Compressible Flow," 8th International Symposium on Computational Fluid Dynamics, Bremen, Germany, Sept. 5-10, 1999.
53. "Surrogate Modeling in MDO for Vehicle Design", invited presentation, Air Force Workshop on Energy-Based Vehicle Design Optimization, Wright-Patterson Air Force Base, Ohio, Dec. 16, 1999.
54. "A Numerical Method for Vortex Confinement in Compressible Flow," AIAA 38th Aerospace Sciences Meeting & Exhibit, Reno, NV, Jan. 2000.
55. "New Developments in Vorticity Confinement for Compressible and Incompressible Flows," Fourth ARO Workshop on Vorticity Confinement and Related Methods, University of Tennessee Space Institute, Tullahoma, TN, Nov. 2, 2000.
56. "Efficient Eulerian Computation of Realistic Rotorcraft Flows Using Vorticity Confinement," AIAA 39th Aerospace Sciences Meeting & Exhibit, Reno, NV, Jan. 2001.
57. "Towards a Better Understanding of Vorticity Confinement in Compressible Flow," AIAA 2001 CFD Conference, Anaheim, CA, June 2001.
58. "Protection Against Modeling and Uncertainties in Design Optimization," National Science Foundation and Sandia National Laboratories Life-Cycle Engineering Program Review, Albuquerque, NM, June 2001.
59. "The Computation of Massively Separated Flows Using Compressible Vorticity Confinement Methods," AIAA 40th Aerospace Sciences Meeting & Exhibit, Reno, NV, Jan. 2002.
60. "CFD Issues: Hypersonic Non-Equilibrium Algorithms," TAMU/NASA/NIA Workshop on Hypersonic Flow Research, Hampton, VA, July 8,9, 2004.
61. "The Computation of Massively Separated Flows Using Compressible Vorticity Confinement Methods," invited paper, US-Korea Conference 2004, Symposium on Aerospace Science and Technology, Research Triangle Park, NC, Aug. 12-14, 2004.
62. "Ghost-Cell Method for Inviscid Three-Dimensional Flows on Cartesian Grids," Paper No. AIAA-2005-0874, AIAA 43rd Aerospace Sciences Meeting & Exhibit, Reno, NV, Jan. 2005.

### **Seminars**

1. "Supersonic, Irrotational Conical Flow Fields", invited seminar, Computational Fluid Dynamics Branch, NASA Ames Research Center, July 1978.
2. "Numerical Techniques for Nonlinear Supersonic Potential Flows", invited seminar, Dept. of Aeronautics and Astronautics, M.I.T., December 1979.
3. "Vortical Singularities in Conical Flow", invited seminar, Dept. of Mechanical Eng., Polytechnic Institute of New York, February 1979.
4. "New Approaches to the Computation of High Speed Flows", invited seminar, High-Speed Aeronautics Division, NASA Langley Research Center, June 1981.
5. "Nonlinear Supersonic Flow Fields", invited seminar, Dept. of Aerospace and Ocean Eng., V.P.I. & S.U., July 1981.
6. "The Application of Clebsch Velocity Decompositions in Gasdynamics", Fluid Dynamics Seminar, V.P.I. & S.U., October 1982.
7. "Supersonic Flow Field Computations", invited seminar, Computational Methods Branch, NASA Langley Research Center, June 1983.
8. "Computation of Chemically-Reacting, High-Speed Flows", Fluid Dynamics Seminar, V.P.I. & S.U., September 1987.
9. "A Flux-Splitting Approach for Euler's Equations with Real Gases", presentation for the Center Director, NASA Langley Research Center, September 1987.
10. "Flux-Split Algorithms for Flows with Non-equilibrium Chemistry and Thermodynamics", invited seminar, *Dipartimento di Meccanica e Aeronautica, Università di Roma, Italy*, May 1989.
11. "Computational Methods for Non-equilibrium Flows", invited seminar, *Istituto di Macchina ed Energetica, Università di Bari, Italy*, May 1989.
12. "Anomalous Wave Speeds in Non-equilibrium Flows with Multiple Translational Temperatures", ICASE Seminar, NASA Langley Research Center, Feb. 1990.

13. "Integrated Aerodynamic/Structural Design Optimization", ICASE Seminar, NASA Langley Research Center, Feb. 1990.
14. "Aerodynamic Design Optimization", invited seminar, Interdisciplinary Research Org., NASA Langley Research Center, Feb. 1990.
15. "Anomalous Wave Speeds in Non-equilibrium Flows with Multiple Translational Temperatures", invited seminar, *Dipartimento di Meccanica e Aeronautica, Università di Roma*, Italy, May 1990.
16. "Integrated Aerodynamic/Structural Design Optimization", invited seminar, *Dipartimento di Meccanica e Aeronautica, Università di Roma*, Italy, May 1990.
17. "Aerodynamic Design Optimization", invited seminar, Dept. of Aerospace Eng., *Politecnico di Torino*, Italy, May 1990.
18. "Design Optimization in Computational Fluid Dynamics", invited seminar, *Istituto di Macchina ed Energetica, Università di Bari*, Italy, May 1990.
19. "Chemically- Reacting Flow Computations", invited seminar, *Istituto di Macchina ed Energetica, Università di Bari*, Italy, May 1990.
20. "New Approaches in the Use of CFD in Optimized Design", Fluid Dynamics Seminar, V.P.I. & S.U., Mar. 1991.
21. "Design Optimization Problems Involving Computational Fluid Dynamics", invited seminar, E.R.C. for Comp. Field Simulation, Mississippi State University, Mar. 1991.
22. "Flux-Split Methods for High-Speed Gas Dynamics", invited seminar, Center for Computational Simulation, U.S.S.R. Academy of Sciences, Moscow, May 1991.
23. "Design Problems and Computational Fluid Dynamics", invited seminar, *Istituto di Macchina ed Energetica, Università di Bari*, Italy, June 1991.
24. "Flux-Split Algorithms for Non-Equilibrium Hypersonic Flows", invited seminar, Department of Mathematics, University of North Carolina at Charlotte, Nov. 1991.
25. "Upwind Methods for Non-Equilibrium Hypersonic Flows", invited seminar, Computational Methods Branch Seminar, NASA Langley Research Center, Dec. 1991.
26. "Variable-Complexity Aerodynamic Optimization of an HSCT Wing", invited seminar, Dept. of Aerospace Eng., *Politecnico di Torino*, Italy, Mar. 1992.
27. "Shape Optimization - Transonic Airfoil Design", ICAM Seminar, Interdisciplinary Center for Applied Mathematics, V.P.I. & S.U., May 1992.
28. "Variable-Complexity Optimization of an HSCT Wing", invited seminar, NASA Ames Research Center, Jan. 1993.
29. "Multidisciplinary Design Optimization at Virginia Tech", with R. T. Haftka and W. H. Mason, presentation at Lockheed Aeronautical Systems, Marietta, GA, Dec. 1993.
30. "HSCT Multidisciplinary Design Optimization", with Z. Gurdal, presentation at McDonnell Douglas Aerospace - West, Long Beach, CA, Jan. 1994.
31. "Multidisciplinary Analysis and Design", with R. T. Haftka and R. Kapania, presentation at McDonnell Douglas Aerospace - East, St. Louis, MO, Feb. 1994.
32. "Design Sensitivity Algorithms for an Inverse Design Problem Involving a Shock Wave", invited seminar, *Istituto di Macchina ed Energetica, Politecnico di Bari*, Italy, May 1994.
33. "Design Sensitivity Algorithms for an Inverse Design Problem Involving a Shock Wave", invited seminar, *Dipartimento di Meccanica e Aeronautica, Università di Roma*, Italy, May 1994.
34. "Design Sensitivity Algorithms for an Inverse Design Problem Involving a Shock Wave", invited seminar, Von Karman Institute for Fluid Dynamics, Rhode-Saint-Genèse, Belgium, June 1994.
35. "Multidisciplinary Design Optimization for Advanced Aircraft Configurations," seminar, Aerospace & Ocean Engineering Department, Virginia Tech, Blacksburg VA, Nov. 27, 1995.
36. "A Multi-Dimensional Kinetic-Based Solver for the Euler Equations", invited seminar, Jet Propulsion Institute, 31st Research Institute of the Chinese Aerospace Corporation, Beijing China, Dec. 21, 1995.
37. "A Discontinuity Confinement Procedure", invited seminar, Jet Propulsion Institute, 31st Research Institute of the Chinese Aerospace Corporation, Beijing China, Dec. 21, 1995.
38. "Surface Boundary Conditions for the Numerical Solution of the Euler Equations", invited seminar, Jet Propulsion Institute, 31st Research Institute of the Chinese Aerospace Corporation, Beijing

- China, Dec. 21, 1995.
39. "Flux-Split Algorithms for Non-Equilibrium Hypersonic Flows", invited seminar, Jet Propulsion Institute, 31st Research Institute of the Chinese Aerospace Corporation, Beijing China, Dec. 22, 1995.
  40. "Design Optimization of Transonic and Supersonic Flows", invited seminar, Beijing Aerodynamics Institute, Beijing China, Dec. 25, 1995.
  41. "Multidisciplinary Design Optimization for Advanced Aircraft Configurations", invited seminar, Beijing Aerodynamics Institute, Beijing China, Dec. 25, 1995.
  42. "A Multi-Dimensional Kinetic-Based Solver for the Euler Equations", invited seminar, Institute of Mechanics and Thermophysics, Beijing China, Dec. 27, 1995.
  43. "Flux-Split Algorithms for Non-Equilibrium Hypersonic Flows", invited seminar, Institute of Mechanics and Thermophysics, Beijing China, Dec. 27, 1995.
  44. "Multidisciplinary Design Optimization for Advanced Aircraft Configurations", invited seminar, Beijing University of Aeronautics and Astronautics, Beijing China, Dec. 28, 1995.
  45. "Multidisciplinary Design Optimization of Advanced Aircraft Configurations", with W. H. Mason, presentation at Boeing Commercial Airplane Group, Renton, WA, March 1, 1996.
  46. "Design Sensitivity Algorithms for an Inverse Design Problem Involving a Shock Wave", invited seminar, University of Tennessee Space Institute, Tullahoma, TN, March 22, 1996.
  47. "Multidisciplinary Design Optimization Activities at Virginia Tech", with W. H. Mason, presentation at Northrop Grumman, Hawthorne Beach, CA, April 11, 1996.
  48. "Multidisciplinary Design Optimization Activities at Virginia Tech", with W. H. Mason, presentation at Hughes Space & Communications, Los Angeles, CA, April 11, 1996.
  49. "Multidisciplinary Design Optimization of Advanced Aircraft Configurations", with W. H. Mason, presentation at McDonnell-Douglas, Long Beach CA, April 12, 1996.
  50. "Multidisciplinary Design Optimization of Advanced Aircraft Configurations", with W. H. Mason, presentation at McDonnell-Douglas, St. Louis MO, August 23, 1996.
  51. "Multidisciplinary Design of Advanced Aircraft Using Response-Surface Approximations of Euler Aerodynamics", invited seminar, *Istituto di Macchina ed Energetica, Politecnico di Bari*, Italy, May 30, 1997.
  52. "Multidisciplinary Design of Advanced Aircraft Using Response-Surface Approximations of Euler Aerodynamics", invited seminar, *Dipartimento di Meccanica e Aeronautica, Università di Roma*, Italy, June 4, 1997.
  53. "Multidisciplinary Design Optimization of Advanced Aircraft Configurations", with R. T. Haftka, invited seminar, NASA Ames Research Center, Dec. 14, 1998.
  54. "Computation of Compressible Free Vortical Flows Using Vorticity Confinement", invited seminar, *Institut für Lüft- und Raumfahrt, Rheinisch-Westfälischen Technischen Hochschule*, Aachen, Germany, September 2, 1999.
  55. "Multidisciplinary Design Optimization of Advanced Aircraft", invited seminar, *Institut für Lüft- und Raumfahrt, Rheinisch-Westfälischen Technischen Hochschule*, Aachen, Germany, September 2, 1999.
  56. "Response Surfaces From Detailed CFD", invited seminar, University of Florida, Department of Aerospace Engineering, Mechanics and Engineering Science, Nov. 19, 1999.
  57. "Multidisciplinary Design Optimization of Advanced Aircraft Configurations", invited seminar, Chosun University, Aerospace Eng. Dept., Kwangju, Korea, Mar. 13, 2000.
  58. "Design Optimization of a Transonic Transport with a Strut-Braced Wing", invited seminar, Gyeong-sang National University, Dept. Aero-Mechanical Eng., Chinju, Korea, Mar. 14, 2000.
  59. "MDO Methods Used in Aircraft Design", invited seminar, Hanyang University, Center of Innovative Design Optimization Technology, Seoul, Korea, Mar. 15, 2000.
  60. "Compressible Vorticity Confinement Methods", invited seminar, Seoul National University, Aerospace Eng. Dept., Seoul, Korea, Mar. 17, 2000.
  61. "Multidisciplinary Design Optimization of Advanced Aircraft Configurations", invited seminar, Konkuk University, Aerospace Eng. Dept., Seoul, Korea, Mar. 17, 2000.
  62. "Compressible Vorticity Confinement Methods", invited seminar, *Istituto di Macchina ed Energetica, Politecnico di Bari*, Italy, June 8, 2000.

63. "Compressible Vorticity Confinement Methods", invited seminar, Loughborough University, Aerospace and Automotive Eng. Dept., Loughborough, U. K., June 12, 2000.
64. "Effective Use of Surrogate Models in Aircraft Design," Saab Aerospace, Linköping, Sweden, November 20, 2000.
65. "Effective Use of Surrogate Models in Aircraft Design," Royal Institute of Technology (KTH), Stockholm, Sweden, November 22, 2000.
66. "The Computation of Vortex Dominated Flows Using Compressible Vorticity Confinement Methods," invited seminar, University of Tennessee Space Institute, Tullahoma, TN, Nov. 5, 2001.
67. "The Computation of Vortex Dominated Flows Using Compressible Vorticity Confinement Methods," invited seminar, Arizona State University, Dept. of Mechanical and Aerospace Eng., Tempe, AZ, Mar. 8, 2002.

**Additional Interactions/Presentations**

1. "1st Multidisciplinary Analysis and Design (MAD) Center for Advanced Vehicles Industrial Advisory Board Meeting and Presentations," Virginia Tech, Blacksburg, VA, Oct. 1994.
2. "1st Boeing - University Key Schools Workshop on Enhancing Engineering Education," Boeing Corp., Seattle, WA, Feb. 13-14, 1995.
3. "2nd Multidisciplinary Analysis and Design (MAD) Center for Advanced Vehicles Industrial Advisory Board Meeting and Presentations," Virginia Tech, Blacksburg, VA, Aug. 1995.
4. "2nd Boeing - University Key Schools Workshop on Enhancing Engineering Education," Boeing Corp., Seattle, WA, Feb. 28-29, 1996.
5. "3rd Multidisciplinary Analysis and Design (MAD) Center for Advanced Vehicles Industrial Advisory Board Meeting and Presentations," Virginia Tech, Blacksburg, VA, Aug. 2-3, 1996.
6. "University Strategy Task Force of the Aeronautics Advisory Committee," NASA Headquarters, Washington, DC, July 11-12, 1996.
7. "3rd Aerospace Industry - Government - University Roundtable on Enhancing Engineering Education," Lockheed-Martin Corp., Gaithersburg, MD, Nov. 13-14, 1996.
8. "3rd Boeing - University Key Schools Workshop on Enhancing Engineering Education," Boeing Corp., Seattle, WA, Feb. 17-18, 1997.
9. "Aerospace Industry - Government - University Roundtable on Enhancing Engineering Education," Action Team, Boeing Corp., St. Louis, MD, Sept. 15, 1997.
10. "4th Aerospace Industry - Government - University Roundtable on Enhancing Engineering Education," Boeing Corp., Mesa, AZ, Nov. 10-11, 1997.
11. "4th Multidisciplinary Analysis and Design (MAD) Center for Advanced Vehicles Industrial Advisory Board Meeting and Presentations," Virginia Tech, Blacksburg, VA, Nov. 14-15, 1997.
12. "4th Boeing - University Key Schools Workshop on Enhancing Engineering Education," Boeing Corp., Seattle, WA, Feb. 15-16, 1998.
13. "5th Aerospace Industry - Government - University Roundtable on Enhancing Engineering Education," Worcester Polytechnic Institute, Worcester, MA, May 26-28, 1998.
14. "5th Multidisciplinary Analysis and Design (MAD) Center for Advanced Vehicles Industrial Advisory Board Meeting and Presentations," Virginia Tech, Blacksburg, VA, Nov. 13-14, 1997.
15. "7th Aerospace Industry - Government - University Roundtable on Enhancing Engineering Education," General Electric Aircraft Engines, Cincinnati, OH, May 24-25, 1999.
16. "8th Aerospace Industry - Government - University Roundtable on Enhancing Engineering Education," Rolls-Royce Allison, Indianapolis, IN, Nov. 1-2, 1999.
17. "9th Aerospace Industry - Government - University Roundtable on Enhancing Engineering Education," Iowa State University, Ames, IA, May 22, 2000.
18. "6th Multidisciplinary Analysis and Design (MAD) Center for Advanced Vehicles Industrial Advisory Board Meeting and Presentations," Virginia Tech, Blacksburg, VA, Mar. 24-25, 2000.
19. "10th Aerospace Industry - Government - University Roundtable on Enhancing Engineering Education," Ohio Aerospace Institute, Cleveland, OH, Oct. 30-31, 2000.

20. "Aerospace Engineering: Enrollment and Employment Trends," invited testimony at the *Commission on the Future of the U. S. Aerospace Industry*, U. S. Department of Commerce, Washington, DC, May 14, 2002.
21. "NIA Education and Outreach," College of William and Mary, Williamsburg, VA, March 26, 2003.
22. "Graduate Education at NIA," NASA Langley Graduate School Seminar, Hampton, VA, July 16, 2003.
23. "NIA Research and Education and NASA NESC," at Applied Mechanics Committee, ASME International Congress, Washington, DC, Nov. 2003.
24. "Educational Opportunities at NIA," NASA Langley Graduate School Seminar, Hampton, VA, July 8, 2004.
25. "The Research and Education Program of NIA," in Session 93-EDU-2: Education, Research, and Service Through the National Institute of Aerospace, AIAA/ASME/SAE/ASEE 40th Joint Propulsion Conference and Exhibit, Fort Lauderdale, FL, July 11-14, 2004.
26. "Graduate Education at NIA," at AIAA Student Affairs Committee, AIAA 43rd Aerospace Sciences Meeting & Exhibit, Reno, NV, Jan. 2005.