

# Benjamin S. Kirk

## Curriculum Vitae

Born January 26, 1978  
Married, two children  
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### Education

- 6/2002 – 5/2007 Ph.D. Aerospace Engineering, The University of Texas at Austin. GPA: 3.94  
Thesis: *Adaptive Finite Element Simulation of Flow and Transport Applications on Parallel Computers*, May 2007.
- 8/2000 – 5/2002 Masters of Science, Computational and Applied Mathematics, The University of Texas at Austin. GPA: 3.93
- 8/1996 – 5/2000 Bachelors of Science, Aerospace Engineering, The University of Texas at Austin. GPA: 4.0

### Work Experience

- 12/2003 – Present Aerospace Engineer, NASA Lyndon B. Johnson Space Center, Aeroscience & Flight Mechanics Division, Applied Aeroscience & CFD Branch.
- Aerothermodynamic analysis lead in support of Orion Crew Module design.
  - Supported Orion thermal protection system design by developing aerothermodynamic design environments and overall system requirements.
  - Designed and executed high-enthalpy wind tunnel and arc-jet tests to provide validation data for computational methods.
  - Served as aerosciences lead for Space Shuttle Orbiter Reinforced Carbon/Carbon (RCC) repair activities.
  - Member of the Damage Assessment Team in support of the Space Shuttle Program during STS-114–STS-123. Supported EVAs to execute thermal protection system repair during STS-114 and -117.
- 8/1998 – 12/2003 Research Assistant and System Administrator, The University of Texas at Austin
- Parallel algorithm research and development for adaptive, coupled fluid mechanics and heat transfer applications.
  - Led an international software development effort to produce a finite element framework for high performance parallel computing platforms.
  - Research microgravity fluid mechanics using CFD.
  - Administer a heterogeneous UNIX network.
- 8/1997 – 5/1999 Temporary Professional Co-Op, Lockheed Martin Space Mission Systems & Services

- Researched feasibility of the human exploration of Mars.
- Created programs to analyze Space Shuttle plume heating to the International Space Station.
- Conducted multiphase, chemically reacting supersonic flow analysis of rocket engines.
- Upgraded and documented an orbital debris reentry simulation program for a major revision release.
- Generated and analyzed three dimensional grids for hypersonic reentry vehicles in chemical and thermal non-equilibrium flow regimes.

## Honors and Awards

March 2008	NASA Group Achievement Award, presented to the <i>MH-13 Orbiter Aerothermodynamic Test Team</i> .
January 2008	RCC Repair Team Award, presented to the Reinforced Carbon/Carbon repair team for designing and implementing an on-orbit repair technique suitable to Orbiter nosecone and wing-leading-edge damage.
July 2007	NASA Lyndon B. Johnson Space Center Group Achievement Award, presented to the <i>STS-117 OMS Pod Blanket Repair Team</i> .
August 2006	NASA's Astronauts' Personal Achievement <i>Silver Snoopy</i> Award. Given "for professionalism, dedication, and outstanding support that greatly enhanced space flight safety and mission success."
April 2006	NASA Group Achievement Award, presented to the <i>Orbiter Aerothermodynamics Working Group</i> .
January 2001	US Department of Energy Computational Science Graduate Fellowship.
August 2000	Texas Institute of Computational and Applied Mathematics (TICAM) Fellowship.
August 1999	John C. Westkaemper Award for academic excellence.

## Fellowships and Assistantships

1/2001 – 12/2003	U.S. Department of Energy Computational Science Graduate Fellowship
8/2000 – 12/2002	Graduate Fellowship, Institute for Computational and Engineering Sciences (ICES), The University of Texas at Austin
8/2000 – 12/2003	Graduate Research Assistantship, Aerospace Engineering Department, The University of Texas at Austin.
8/1998 – 5/2000	Undergraduate Research Assistantship, Aerospace Engineering Department The University of Texas at Austin.

## Publications

- Journal Articles
- Benjamin S. Kirk and Graham F. Carey, A Parallel, Adaptive Finite Element Scheme for Modeling Chemotactic Biological Systems. *Communications in Numerical Methods in Engineering*, accepted, July 2008.
- Benjamin S. Kirk, A Multidimensional Thermal Analysis to Assess Modeling Error in High-Speed Wind Tunnel Heat Transfer Data Reduction Schemes. *AIAA Journal of Thermophysics and Heat Transfer*, accepted, April 2008.
- Kirk, B. S., Palmer, G., Tang, C., Wood, W. A., “Urgent Computing in Support of Space Shuttle Orbiter Reentry,” *CTWatch Quarterly*, Volume 4, Number 1, March 2008. <http://www.ctwatch.org/quarterly/articles/2008/03/urgent-computing-in-support-of-space-shuttle-orbiter-reentry/>
- Benjamin S. Kirk and Graham F. Carey, Development and Validation of a SUPG Finite Element Scheme for the Compressible Navier-Stokes Equations using a Modified Inviscid Flux Discretization. *International Journal for Numerical Methods in Fluids*, 57(3):265–293, May 2008.
- Benjamin S. Kirk, *Adaptive Finite Element Simulation of Flow and Transport Applications on Parallel Computers*. PhD thesis, The University of Texas at Austin, May 2007.
- Benjamin S. Kirk, John W. Peterson, Roy H. Stogner, and Graham F. Carey, libMesh: A C++ Library for Parallel Adaptive Mesh Refinement/Coarsening Simulations. *Engineering with Computers*, 22(3):237–254, 2006.
- William S. Kirk and Benjamin S. Kirk, A Biomechanical Basis for Primary Arthroplasty of the Temporomandibular Joint. *Oral and Maxillofacial Surgery Clinics of North America*, 18(3):345–368, 2006.
- Jeremiah J. Marichalar, William C. Rochelle, Benjamin S. Kirk, and Charles H. Campbell, Boundary Layer/Streamline Surface Catalytic Heating Predictions on Space Shuttle Orbiter. *Journal of Spacecraft and Rockets*, 43(6):1202–1215, 2006.
- G. F. Carey, W. Barth, J. A. Woods, B. S. Kirk, M. L. Anderson, S. Chow, and W. Bangerth. Modelling error and constitutive relations in simulation of flow and transport. *International Journal for Numerical Methods in Fluids*, 46:1211–1236, 2004.
- G. F. Carey, M. Anderson, B. Carnes, and B. Kirk. Some aspects of adaptive grid technology related to boundary and interior layers. *J. Comput. Appl. Math.*, 166(1):55–86, 2004.
- B. Kirk, K. Lipnikov, and G. F. Carey. Nested Grid Iteration for Incompressible Viscous Flow and Transport. *International Journal of Computational Fluid Dynamics*, 17(4):253–262, August 2003.
- In Proceedings
- Brian R. Hollis, Karen T. Berger, Thomas J. Horvath, Joseph J. Coblish, Joseph D. Norris, Randolph P. Lillard, and Benjamin S. Kirk, “Aeroheating Testing and Predictions for Project Orion CEV at Turbulent Conditions.” 46<sup>th</sup>

*AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper 2008-1226, Reno, Nevada, January 2008.

D. Boger, R. Noack, A. Amar, B. Kirk, R. Lillard, and M. Olsen, "Overset Grid Applications in Hypersonic Flow Using the DPLR Flow Solver." *46<sup>th</sup> AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper 2008-921, Reno, Nevada, January 2008.

J. Greathouse, B. Kirk, R. Lillard, T. Troung, P. Robinson, and C. Cerimele, "Crew Exploration Vehicle (CEV) Crew Module shape selection analysis and CEV Aeroscience Project Overview ." *45<sup>th</sup> AIAA Aerospace Sciences Meeting and Exhibit*, AIAA Paper 2007-603, Reno, Nevada, January 2007.

Scott A. Berry, Thomas J. Horvath, Amy M. Cassady, Benjamin S. Kirk, K.C. Wang, and Andrew J. Hyatt, "Boundary Layer Transition Results From STS-114." *9<sup>th</sup> AIAA/ASME Joint Thermophysics and Heat Transfer Conference*, AIAA Paper 2006-2922, San Francisco, CA, June 2006.

Catherine B. McGinley, Scott A. Berry, Gerald R. Kinder, Maria Barnwell, Kuo C. Wang, and Benjamin S. Kirk, "Review of Orbiter Flight Boundary Layer Transition Data." *9<sup>th</sup> AIAA/ASME Joint Thermophysics and Heat Transfer Conference*, AIAA Paper 2006-2921, San Francisco, CA, June 2006.

G. F. Carey, W. Barth, B. Kirk, and J. Peterson, "Parallel CFD for Flow and Transport Applications Including Unstructured and Adaptive Grids." in *Parallel Computational Fluid Dynamics - Multidisciplinary Applications*, G. Winter, A. Ecer, J. Periaux, N. Satofuka and P. Fox (Eds), Elsevier Science B.V., Amsterdam, The Netherlands, 2005.

W. Barth, G. Carey, S. Chow, and B. Kirk, "Finite Element Modeling of Generalised Newtonian Flows," in *Proceedings of the 14th Australasian Fluids Conference, Adelaide*, December 2001.

G. F. Carey, R. McLay, W. Barth, S. Swift, and B. Kirk, "Distributed parallel simulation of surface tension driven viscous flow and transport processes," in *Computational Fluid Dynamics: Proceeding of the Fourth UNAM Supercomputing Conference* (E. Ramos, G. Cisneros, R. Fernández-Flores, and A. Santillán-González, eds.), (Mexico City, Mexico), pp. 143–155, UNAM, World Scientific, June 2000.

W. Barth, G. F. Carey, B. Kirk, and R. McLay, "Parallel Distributed Solution Of Viscous Flow With Heat Transfer On Workstation Clusters," in *High Performance Computing '00 Proceedings*, (Washington, DC), April 2000.

#### Presentations

Benjamin S. Kirk, Adam J. Amar, "Orion Reentry: Modeling the Aerothermodynamic Environment and Thermal Protection System Response." The University of Texas at Austin, Austin, TX, May 7 2008.

Benjamin S. Kirk, "The Influence of Shock Layer Instability on Surface Heat Transfer in Hypervelocity Flows and its Relevance in Planetary Entry Vehicle Design." Aberdeen Research Lab, April 1 2008.

- Benjamin S. Kirk, “High-Performance Computing Technology – Hardware Trends, Software Implications, and Multithreading.” Aberdeen Research Lab, March 31 2008.
- Benjamin S. Kirk and Graham F. Carey, “Fully-Implicit, Parallel, Adaptive Finite Element Simulations of Hypersonic Flows.” Sandia National Lab, Albuquerque, NM, May 2007.
- Benjamin S. Kirk, “A Fully-Implicit, Parallel, Adaptive Finite Element Algorithm for the Compressible Navier-Stokes Equations.” PhD Dissertation Defense, The University of Texas at Austin, Austin, TX, May 2007.
- Benjamin S. Kirk, “High-Performance Computing in Support of Space Shuttle Orbiter Damage Assessment.” Urgent Computing Workshop. Argonne National Lab, Argonne, IL, April 25 2007.
- Graham F. Carey and Benjamin S. Kirk, “The SUPG Finite Element Method Applied to the Unsteady Compressible Navier-Stokes Equations.” 14<sup>th</sup> International Conference on Finite Elements in Flow Problems, Santa Fe, NM, March 26–28 2007.
- Benjamin S. Kirk, “Treatment of the Inviscid Flux in SUPG Finite Element Simulations of Transient Hypersonic Flows.” Finite Element Rodeo, Houston, TX, March 2, 2007.
- Benjamin S. Kirk, “SUPG Finite Element Simulations of Compressible Flows for Aerothermodynamic Applications.” MIT ACDL Seminar, Cambridge, MA, February 23 2007.
- B. Kirk, G. F. Carey, “Compressible Flow Studies Using Parallel Adaptive Mesh Refinement.” 8<sup>th</sup> U.S. Congress on Computational Mechanics, Austin, TX, July 25 2003.
- B. Kirk, G. F. Carey, “Algorithms for Compressible Flow with Adaptive Mesh Refinement.” 8<sup>th</sup> U.S. Congress on Computational Mechanics, Austin, TX, July 27, 2003.
- B. Kirk, G. F. Carey, and J. Peterson, “Parallel Data Structures for Finite Element Computations.” SIAM CSE Meeting, Orlando, FL, February 2005.
- G. F. Carey, B. Kirk, J. Peterson, and V. Carey, “Parallel Adaptive Finite Element Simulation- Applications, Error Indicators and Algorithm Efficiency Considerations.” SIAM CSE Meeting, Orlando, FL, February 2005.
- G. F. Carey, W. Barth, S. Iqbal, B. Kirk, and J. Peterson, “Experience with Parallel CFD on Beowulf Clusters.” SIAM Annual Meeting, Portland, OR, July 2004.
- B. Kirk, R. MacKinnon, and G. F. Carey, “A Positivity-preserving Algorithm for Reactive Transport Processes: Discussion and Numerical Experiments.” SIAM Geosciences Conference, March 2003, Austin TX.
- W. Barth and B. Kirk, “PC cluster construction: Lessons learned and friendly advice.” Shortcourse on Cluster Computing and Adaptive Finite Element Methods, The University of Western Australia, Perth, Australia, June 2003.

- W. Barth and B. Kirk, "Message passing for parallel computing via MPI." Shortcourse on Cluster Computing and Adaptive Finite Element Methods, The University of Western Australia, Perth, Australia, June 2003.
- G. F. Carey, W. Barth, B. Kirk, J. Woods, and S. Iqbal, "Advances and Challenges in Finite Element Methods and Algorithms for High Performance Computation." 14<sup>th</sup> Symposium on Computer Architecture and High-Performance Computing (SBAC-PAD 2002), October 2002, Vitoria, Brazil.
- B. Kirk, G. F. Carey, and K. L. Lipnikov, "Nested and Adaptive Mesh Strategies for Coupled Transport Applications." AMFLOW 2001, Heidelberg, Germany, October 2001.
- B. Kirk, K. Lipnikov, and G. F. Carey, "Cascadic Multigrid Simulation of Incompressible Viscous Flow Problems: Performance Analysis and Parallel Workstation and Cluster Implementation." Copper Mountain Conference on Multigrid Methods, Copper Mountain, CO, April 2001.
- G. F. Carey, R. McLay, W. Barth, B. Kirk, and S. Swift, "Parallel Solution of Coupled Viscous Flow and Transport on Parallel Supercomputers and PC Clusters." 2<sup>nd</sup> Brazilian Congress on Computational Mechanics, November 2001.
- G. F. Carey, W. Barth, S. Chow, B. Kirk, R. McLay, and J. Woods, "Recent Research on Finite Element Methodology, Algorithms and Applications." Industrial Affiliates Meeting, The University of Texas at Austin, October 2001.
- W. Barth, G. F. Carey, S. Chow, and B. Kirk, "Finite Element Modeling of Generalized Newtonian Flows." Fourteenth Australasian Fluid Mechanics Conference, Adelaide, Australia, December 2001
- W. Barth, B. Kirk, G. F. Carey, and R. McLay, "Beowulf Clusters for Scientific Computing." Computer Science Department, University of Western Australia, May 2001.
- W. Barth, G. F. Carey, R. McLay, B. Kirk, and J. Bailey, "Parallel Distributed Solution of Viscous Flow with Heat Transfer on Workstation Clusters." CHT'01 Poster Presentation, May 2001.
- G. F. Carey, R. McLay, W. Barth, B. Kirk, and S. Swift, "MGFLO: Viscous Flow, Heat, Species, and Porous Media Transport in Parallel." Poster Presentation, Industrial Affiliates Meeting, University of Texas at Austin, October 2000.
- G. F. Carey, R. McLay, W. Barth, S. Swift, and B. Kirk, "Distributed Parallel Simulation of Surface Tension Driven Viscous Flow and Transport Processes." Fourth UNAM-CRAY Supercomputing Conference, June 2000.
- B. Barth, G. F. Carey, B. Kirk, and R. McLay, "Parallel Distributed Solution of Viscous flow with Heat Transfer on Workstation Clusters." HPC2000 Session on PC Cluster Applications, Washington, D.C., April 2000.

- G. F. Carey, R. McLay, S. Swift, W. Barth, B. Kirk, and H. Swinney, "Parallel Solution of Coupled Viscous Flow and Transport Driven by Surface Tension." Finite Elements in Flow Problems 2000, Thompson Conference Center, The University of Texas at Austin, April 2000.
- W. Barth, G. F. C. A. Ardelea, M. Ma, R. McLay, , and B. Kirk, "Beowulf Systems for Flow and Transport Problems." Poster Presentation, CSM Industrial Affiliates Meeting, UT Austin, October 1998.

## Graduate Courses

- Fluid Mechanics
1. *Foundations of Fluid Mechanics*, Fall 2000.
  2. *Viscous Fluid Flow*, Fall 2001.
  3. *Compressible Fluid Mechanics*, Spring 2001.
  4. *Hypersonic Aerodynamics*, Fall 2001.
  5. *Molecular Gas Dynamics*, Spring 2002.
  6. *Advanced Problems in Compressible Flow*, Fall 2002.
- Numer. Meth.
1. *Finite Element Methods*, Fall 2000.
  2. *Numerical Methods for Flow & Transport Problems*, Fall 2000.
  3. *Advanced Methods in Computational Mechanics*, Spring 2001.
  4. *Grid Generation & Adaptive Grids*, Fall 2001.
  5. *Numerical Analysis: Numerical Linear Algebra*, Fall 2001.
  6. *Numerical Simulation of Transport in Semiconductors*, Summer 2002.
  7. *Lagrangian Methods in Computational Fluid Dynamics*, Fall 2002.
  8. *Advanced Computational Flows & Transport*, Fall 2002.
- Mathematics
1. *Matrices and Matrix Calculations*, Summer 2000.
  2. *Mathematical Methods in Applied Mechanics*, Fall 2000.
  3. *Mathematical Methods in Applied Mechanics II*, Spring 2001.
- Comp. Sci.
1. *High-Performance Graphics & Visualization*, Spring 2002.
  2. *High-Performance & Parallel Computing*, Spring 2002.

## Teaching Experience

- Short Courses     *Parallel and Adaptive Non-Linear Coupled Finite Element Simulation: Methodology, Algorithms and Software*, (PET) Aberdeen Research Lab, Maryland, March 31 & April 1, 2008 (Graham Carey, Varis Carey, Bill Barth, Benjamin Kirk, John Peterson, and Roy Stogner).
- Parallel and Adaptive Non-Linear Coupled Finite Element Simulation: Methodology, Algorithms and Software*, US Army Corps of Engineers' Engineer Research and Development Center, Vicksburg, Mississippi, January 2007 (Graham Carey, Benjamin Kirk, John Peterson, Roy Stogner, and Bill Barth).
- Finite Elements - Introduction and Applications*, Aeroscience & Flight Mechanics Division, NASA Lyndon B. Johnson Space Center, April 2004.
- Adaptive Grid Technology*, (PET) Wright-Patterson Air Force Base, Ohio, April 22, 2004 (Graham Carey and Benjamin Kirk).
- Cluster Computing*, University of Western Australia, Perth, Australia, June 23-25, 2003 (Graham Carey, Benjamin Kirk, Bill Barth, Juliette Woods, Michael Anderson and Varis Carey).
- Grid Generation and Grid Technology*, (PET) Aberdeen Research Lab, Maryland, April 14, 2003 (Graham Carey and Benjamin Kirk).

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July 27, 2008