Russell Keanini, PhD
Abridged, Annotated CV

✉ rkeanini@uncc.edu

Education

University of California at Berkeley   **PhD, 1992**
Mechanical Engineering

University of Colorado at Denver   **MS, 1987**
Mechanical Engineering

Colorado School of Mines   **BSc, 1983**
Chemical Engineering

Professional Experience

University of North Carolina at Charlotte   **1992-present**

○ Assistant Professor, 1992-98; Associate Professor, 1998-2007; Professor, 2007-present

NASA Graduate Student Researcher, NASA Ames Research Center   **1988-89**

○ Photophysics Group; Experimental development of laser diagnostic for velocity and density measurements in Mach 10 hypersonic windtunnel flow

Grad. Research Assist., Mechanical Engineering, University of California, Berkeley   **1987-92**

○ Application of nonlinear dynamics to acoustic combustion instability in ramjets
○ Finite element and numerical modeling of materials processing and bioengineering problems
○ Theoretical modeling of thermocapillary and buioyancy-driven flow in fluid collars

Grad. Research Assist., Mechanical Engineering, University of Colorado, Denver   **1986-87**

○ Experimental studies of stress-induced growth responses of large, single-cell organisms: Phycomyces

Member US Navy, Inactive Ready Reserve   **1984-90**

Technical Consulting [abridged list with outcomes]

During the first 15 years of my career, most of my research derived from short term consultancies, working on a fairly wide range of (interesting) problems:

Technical Expert, Picadio Sneath Miller & Norton, Pittsburgh, PA   **2010-2013**

○ Assessed technical claims concerning ultrasonic fluid flow meters [outcome subject to NDA]

A2 Wind Tunnel, Mooresville, NC   **2006-2008**

○ Assisted in flow modeling and design of the A2 (low speed) wind tunnel [A2 Wind Tunnel]

NASA Marshall Spaceflight Center, Huntsville, AL   **2001-2007**

○ Modelled altitude-dependent turbulent boundary layer separation and attendant random rocket dynamics in Saturn-V-scale rockets [Nozzle paper 1; Nozzle paper 2; Rocket dynamics paper 1; Rocket dynamics paper 2; Rocket dynamics paper 3]

Department of Biomaterials, Baylor College of Dentistry, Dallas, TX   **1994-2006**

○ Modelled dental casting processes and specie transport due dental amalgam degradation [Dental amalgams paper 1; Dental amalgams paper 2; Dental amalgams paper 3; Dental amalgams paper 4]

Electric Power Research Institute, Charlotte, NC   **1997-2000**

○ Designed forced-air curtain device enabling in-air quality underwater welding/ship repair at large depths (U.S. Navy contract to EPRI) [U.S. Patent, Keanini et al.]

Alcoa Technical Center, Pittsburgh, PA   **1995-1998**

○ Developed theoretical and inverse methods for predicting and monitoring heat transfer during high-speed metal rolling processes [Metal rolling paper 1; Metal rolling paper 2]

Catawba Nuclear Power Plant, Duke Power, Charlotte, NC   **1995-1997**

○ Supervised MS and PhD projects that modeled and optimized post-accident flow and heat transfer to the auxiliary cooling pond at the Catawba nuclear power plant [Post-accident cooling pond paper]

Center for Marine Science Research, UNC Wilmington, Wilmington, NC　　　　　1992-1995

○ Developed first predictive model of circulation-driven, in-bone nutrient/mass transfer (in chicken embryos) [Bone fluid flow paper]

Center for Precision Metrology, UNC Charlotte, Charlotte, NC　　　　　1992-present

○ Modelled high-precision, packed-bed thermal attenuators/controllers [Precision temperature control paper 1; Precision temperature control paper 2]

○ Modelled and applied PIV velocimetry to vibratory finishing processes [Vibrational finishing paper 1; Vibrational finishing paper 2; Vibrational finishing paper 3]

Principle Scientific Contributions

Since 2005, working on fundamental fluid physics and math problems, with teams of engineers and scientists at UNC Charlotte, I've made three significant contributions:

Physical Modeling of Single Molecule Dynamics in Nonpolar Liquids　　　　　2012-present

○ Focusing on liquid state, single molecule dynamics taking place on microsecond to femtosecond $(10^{-6}\text{ s} - 10^{-15}\text{ s})$ time-scales, this work uses nonequilibrium statistical and quantum mechanical arguments to expose, for the first time: a) viscosity emergence, and b) (phonon-driven) self-diffusive (random) molecular hopping in liquids. The work also presents and tests a self-consistent Langevin model of single molecule, liquid state dynamics, applicable over all time-scales. The physical and mathematical models explain and successfully predict temperature-dependent self-diffusion and viscosity emergence in non-metallic, nonpolar liquids, thus potentially solving centuries-old problems in fundamental liquid state physics. [2021 Scientific Reports paper; 2021 Non-technical overview]

Bootstrap technique for (stochastically) estimating Green's functions　　　　　2005-present

○ This project introduces a new, potentially powerful technique for solving physical problems governed by linear partial differential equations. Famous examples include Schrodinger's equation (quantum mechanics), Maxwell's equations (classical electromagnetism) and the linearized Navier-Stokes equations (fluid mechanics). In principle, such problems can be solved using Green's (impulse-response) functions, which when combined with boundary and initial conditions/data, provide the space-time response, e.g., the electric field, at a given point and time, produced by the given data. Historically, however, use of Green's function techniques has been limited due to the immense difficulties of constructing GF's. This project solves this problem by using stochastic processes (random walkers) to estimate high-accuracy, non-problem-specific Green's functions, applicable in any geometry. For a reverse chronological picture of the steps taken, see: [2023 Applied Mathematics and Computation paper]; [2011 paper connecting (mathematical) random walkers to fluid and quantum (physical) entities]; [2007 paper geometrically interpreting stochastic solutions of problems governed by linear partial differential equations]

Development of an accessible, dynamically equivalent molecular hydrodynamic analog　2013-19

○ A series of experimental and theoretical studies carried out at UNC Charlotte demonstrated that vibrated beds of high restitution (ceramic) grains - from short interparticle collision time and length scales to long, multiparticle flow scales - are dynamically equivalent to dense (liquid state) molecular hydrodynamic systems. This means that experimentally accessible vibrating grain systems can be used to *rigorously* study difficult-to-measure single molecule- to collective molecule-scale dynamics in liquids. The theoretical framework is laid out and tested here: [Macroscopic liquid-state molecular hydrodynamics, 2017]. Experimental methods are described here, [Macroscopic molecular hydrodynamics: experimental methods 1, 2017] and here, [Macroscopic molecular hydrodynamics: experimental methods 2, 2016] Application of the theoretical framework to predict observed grain flow patterns is described here, [Kinematic viscosity measurement of granular flows, 2019], and here [Application of computational fluid dynamics to vibratory finishing processes, 2017]

Other Contributions

For details on the following, please see my Google Scholar or ResearchGate pages.

○ **Physical modeling of environmentally-driven fracture processes in rock (in collaboration with Professor Missy Eppes, UNC Charlotte) 2013-present**

○ **Development of computational and theoretical, direct and inverse models of various materials processing operations, 1992-2004**

○ **Analytical modeling of (continuum) fluid flow problems, including secondary streaming flow, thermocapillary and buoyancy driven flow in fluid collars, linear and nonlinear waves on cylindrical menisci, supersonic and hypersonic flows in various geometries, shock train evolution in supersonic nozzles, and turbulent boundary layer separation in rocket nozzles, 1992-present**

○ **Analytical modeling of (continuum) mass and heat transfer problems, 1992-present**

○ **Development (in collaboration with others) of experimental methods for studying fluid mechanic and heat transfer problems, including a non-infrared, visible imaging CCD for measuring dynamic surface temperature fields, a temperature resistant pitot tube sensor for measuring velocities in liquid metal flows, and an infrared technique for monitoring subdermal blood flow 1995-2015**

○ **Early application of computational optimization for planning noninvasive cryosurgeries, 1992**

Research, Teaching and Academic Awards

Research Achievement

- **Kirk Bryan Award (2020)**, with Professor Missy Eppes, given by the Geological Society of America, to "...the author or authors of a published paper of distinction advancing the science of geomorphology or some related field, such as [Pleistocene] Quaternary geology." For: M Eppes and R G Keanini (2017) "Mechanical weathering and rock erosion by climate-dependent subcritical cracking," Reviews of Geophysics, 55, pp. 470-508.
- **Finalist, Melosh Medal Competition in Finite Element Analysis (1993)**, Duke University. For: R G Keanini and B. Rubinsky (1993), "Three-dimensional simulation of the plasma arc welding process" Int. J Heat Mass Transfer, 36, pp. 3283-3298.

Research and Academic Development

- **Research Initiation Grant, Engineering Foundation & American Soc.Mechanical Engineers (1993-94)**
- **Oak Ridge Associated Universities Junior Faculty Enhancement Award (Engineering) (1995-96).** This and previous awarded for development of numerical and experimental tools for studying materials joining processes.
- **NASA Graduate Student Researcher Fellowship (1988-89)**, NASA Ames Research Center, Experimental development of laser diagnostic for hypersonic velocity and density measurements in Mach 10 Hypersonic Windtunnel Facility.
- **Colorado Scholars Scholarship, Colorado School of Mines, 1981-83**

Teaching

- **Nominee William States Lee College of Engineering Excellence in Teaching Award (2006, 2010, 2012)**, UNC Charlotte, for excellence in undergraduate or graduate teaching

Funded Research (Last 10 Years)

- **Engaging Military Veterans to Increase Engineering Enrollment and BS, MS, and PhD Degrees Awarded**, $750,000, DOD Office of Naval Research, PT Tkacik, PI, RG Keanini et al., co-PI's (9/04/2018-9/30/21)
- **Quantifying climate-dependent mechanical weathering and subcritical cracking over geological time**, $300,000, NSF-U.S.-Israel Binational Science Foundation (BSF), M Eppes, PI, RG Keanini et al., co-PI's (1/1/2019-12/31/22)
- **Engaging Military Veterans to Increase STEM Enrollment and Degrees Awarded**, $600,000, DOD Department of the Navy, PT Tkacik, PI, RG Keanini et al., co-PI's (10/1/2014-12/31/17)

Thumbnail Sketch of Research Productivity & Grad Student Supervision

- **53 refereed journal publications; 44 refereed conference papers, book chapters and abstracts**
- **Google Scholar: citations: 1310, h-index = 19, i10-index=27**
- **US Patent: "Apparatus and Method for Creating Dry Underwater Welds," 1999, U.S. Patent No. 5,981,896. RG Keanini, M Newman, G Lowery and G Fredericks**
- **Dissertation Supervisor to 5 PhD students**
- **Thesis or Project Supervisor to 28 Masters students**

Internet Resources

- Wikipedia Entry
- UNC Charlotte Homepage
- Google Scholar
- ResearchGate
- Competitive Cycling

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○ **Colorado Scholars Scholarship, Colorado School of Mines, 1981**-83

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○ **Nominee William States Lee College of Engineering Excellence in Teaching Award (2006, 2010, 2012)**, UNC Charlotte, for excellence in undergraduate or graduate teaching

Journal Publications

1. Shaanan, U., Mushkin, A., Rasmussen, M., Sagy, A., Meredith, P., Nara, Y., Keanini, R. and Eppes, M. C. (2024) "Progressive fracturing in alluvial clasts," *Bulletin of the Geological Society of America,* **136**, 1097-1110.

2. Keanini, R.G., Dahlberg, J., Brown, P., Morovati, M., Moradi, H., Jacobs, D. and Tkacik, P.T. (2023) "Stochastic estimation of Green's functions with application to diffusion and advection-diffusion-

reaction problems," *Applied Mathematics and Computation*, **457**, 128186.

3. Shaanan, U., Mushkin, A., Rasmussen, M., Sagy, A., Meredith, P., Nara, Y., Keanini, R. and Eppes, M.-C. (2023) "Progressive fracturing in alluvial clasts," *GSA Bulletin,* https://doi.org/10.1130/B36670.1.

4. Eppes, M. C., Aldred, J., Berberich, S., Dahlquist, M. P., Evans, S. G., Keanini, R., Moser, F., Morovati, M., Porson, S., Rasmussen, M., Rinehart, A. and Shaanan, U. (2023) "Standardized field methods for fracture-focused surface processes research," *Earth Surf. Dynam.,* in press, https://doi.org/10.5194/esurf-2022-61.

5. Keanini, R.G., Dahlberg, J. and Tkacik, P.T. (2021) "On the physical mechanisms underlying single molecule dynamics in simple liquids," *Sci. Rep.,* 11*, 2528, https://doi.org/10.1038/s41598-021-82112-8.*

6. Fleischhauer,E., Dahlberg, J.L., Solomon, J.M., Keanini, R.G. and Tkacik, P.T. (2019) "Kinematic viscosity measurement of granular flows via low Reynolds number cylinder drag experiment," *Measurement Science and Technology,* **30**, 055904, https://dx.doi.org/10.1088/1361-6501/ab08cf.

7. Keanini, R. G., Tkacik, P. T., Fleischhauer, E., Shahinian, H., Sholar, J., Azimi, F. and Mullany, B. (2017) "Macroscopic liquid-state molecular hydrodynamics," *Scientific Reports,* **7,** 41658.

8. Eppes, M. and Keanini, R.G. (2017) "Mechanical weathering and rock erosion by climate-dependent subcritical cracking," *Reviews of Geophysics,* **55**, 470-508, https://doi.org/10.1002/2017RG000557

9. Mullany, B., Shahinian, H., Navare, J., Azimi, F., Fleischhauer, E., Tkacik, P. and Keanini, R. G. (2017) "The application of computational fluid dynamics to vibratory finishing processes," *CIRP Annals - Manufacturing Technology,* **66**, 309-312.

10. Dahlberg, J., Tkacik, P. T., Mullany, B., Fleischhauer, E., Shahinian, H., Azimi, F., Navare, J., Owen, S., Bisel, T., Martin, T. and Keanini, R.G. (2017) "An analog macroscopic technique for studying molecular hydrodynamic processes in dense gasses and liquids," *J. of Visualized Experiments,* **130**, e56632, doi:10.3791/56632.

11. Fleischhauer, E., Azimi, F., Tkacik, P., Keanini, R. and Mullany, B. (2016). "Application of particle image velocimetry (PIV) to vibrational finishing," *Journal of Materials Processing Technology,* **229,** pp. 322-328.

12. Keanini, R. G., Tkacik, P., Srivastava, N., Thorsett-Hill, K., and Tomsyck, J. (2014) "Millisecond-scale shock-train evolution in high pressure ratio rocket nozzles: schlieren imaging and qualitative analysis of shock-boundary layer interaction," *Proc. Inst. Mech. Engrs. G, J. Aerospace Engrg.,* **228**, pp. 1076-1082.

13. Mullany, B., Mainuddin, M., Williams, W., and Keanini, R. G. (2013) "Experimental and analytical investigation into the effects of process vibrations on material removal rates during polishing," *J. Applied Phys.,* **113,** 224902.

14. Kennedy, B., Weggel, D. C., and Keanini, R.G. (2013) "Experimental program and simplified nonlinear design expression for glass curtain walls with low-level blast resistance," *Int. J. Computational Meths. and Experimental Measurements,* **1,** pp. 1-23.

15. Srivastava, N., Tkacik, P., and Keanini, R. G. (2012) "Ascending rockets as self-propelled Brownian oscillators," *Proc. Royal Society A,* **468,** pp. 3965-3994.

16. Keanini, R. G. (2011) "Green's function-stochastic methods framework for probing nonlinear problems: Burgers' equation, nonlinear Shrodinger's equation, and hydrodynamic organization of near-molecular-scale vorticity," *Annals of Physics,* **326,** pp. 1002-1031.(Also, arXiv:1007.2125.)

17. Keanini, R. G., Srivastava, N. Tkacik, P., Weggel, D. C., and Knight P. D. (2011) "Stochastic rocket dynamics under random nozzle side loads: Ornstein-Uhlenbeck boundary layer separation and its course grained connection to side loading and rocket response," *Annalen der Physik,* **523,** pp. 459-487.

18. Srivastava, N., Tkacik, P. and Keanini, R. G. (2010) "On the influence of nozzle random side loads on launch vehicle dynamics," *J. Applied Physics,* **108**, pp. 044911-044919.

19. Tkacik, P. , Keanini, R. G., Srivastava, N. and Tkacik, M. P. (2011) "Color Schlieren imaging of high pressure rocket nozzle flow using a simple, low cost test apparatus," *J. of Visualization,* **14,** pp. 11-14.

20. Keanini, R.G. (2007) "Random Walk Methods for Scalar Transport Problems Subject to Dirichlet, Neumann, and Mixed Boundary Conditions," *Proc. Royal Soc. A: Math., Phys., and Engrg.,* **453,** pp. 435-460.

21. Keanini, R. G. and Brown, A. (2007) "Scale Analysis and Experimental Investigation of Compressible Turbulent Boundary Layer Separation in Nozzles," *Euro. J. Mech. B - Fluids,* **26,** pp. 494-510.

22. Keanini, R.G., Thompson, J., and Gona, K. (2007) "Linear and Nonlinear Waves on Fiber Coating Entrance Menisci," *Far East J. Appl. Math,* **28,** pp.173-182.

23. Keanini, R.G., Watkins, G., Koike, M., and Okabe, T. (2007) "Theoretical study of alpha case formation during titanium casting," *Metallurgical and Materials Transactions B,* **38,** pp. 729-732.

24. Keanini, R.G., Watanabe, K. and Okabe, T. (2005) "Theoretical Model of the Two-Chamber Pressure Casting Process," *Metallurgical and Materials Transactions B,* **36,** pp. 283-292.

25. Ling, X., Keanini, R.G. and Cherukuri, H.P. (2005) "An Implicitly Regularized Noniterative Finite Element Method for Parabolic Inverse Heat Conduction Problems," *Computational Mechanics,* **36,** pp. 117-128.

26. Ling, X., Keanini, R.G., Cherukuri, H.P. and Smelser, R. (2004) "An Inverse Method for Estimating Surface heat Fluxes with Application to a Quenching Problem," *AIP Conference Proceedings,* **712,** pp. 1191-1196.

27. Lawton, K.M., Patterson, S. and Keanini, R.G. (2003) "Direct Contact Packed Bed Thermal Gradient Attenuators: Theoretical Analysis and Experimental Observations," *Rev. Scientific Instruments,* **74,** pp. 2886-2893.

28. Ling, X., Keanini, R.G. and Cherukuri, H.P. (2003) "A Noniterative Finite Element Method for Inverse Heat Conduction Problems," *Int. J. Numerical Methods in Engrg.,* **56,** pp. 1315-1334.

29. Okabe, T., Elvebak, B., Carrasco, L., Ferracane, J.L., Keanini, R.G. and Nakajima, H. (2003) "Mercury Release from Dental Amalgams into Continuously Replenished Liquids," *Dental Materials,* **19,** pp. 38-45.

30. Phan, S., Hocken, R.J., Smith,, S.T., and Keanini, R.G. (2002) "Simultaneous Measurement of Spatially Separated Forces Using a Dual-Cantilever Resonance-Based Touch Sensor," *Rev. Sci. Instrum.,* **73**, 318-322.

31. Lawton, K.M., Patterson, S., and Keanini, R.G. (2001) "Precision Temperature Control of High-Throughput Fluid Flows: Experimental and Theoretical Analysis," *J. of Heat Transfer,* **123**, 796-802.

32. Keanini, R.G., Ferracane, J., and Okabe, T. (2001) "Theoretical Models of Mercury Dissolution from Dental Amalgams in Neutral and Acidic Flows," *Metallurgical and Materials Transactions B,* **32B**, 409-416.

33. Keanini, R. G. (2000) "Structure and Particle Transport in Second-Order Stokes Flow," *Phys Rev. E,* **61**, 6606-6620.

34. Keanini, R.G., Phan, S., Smith, S.T., and Hocken, R.J. (2000) "Resonance-based Pressure Measurement and Anemometry for High Temperature Flows: Design Principles and Preliminary Results," *Int. Comms. Heat Mass Transfer,* **27**, 273-284.

35. Schweikert, R.J. and Keanini, R.G. (1999) "Finite Element and Order of Magnitude Analysis of Cryosurgery in the Lung," *Int. Comms. Heat and Mass Transfer,* **26**, 1-12.

36. Keanini, R.G. (1999) "An Implicit Method for Reconstructing Dynamic Three-dimensional Phase Boundaries Under Low Peclet Number Conditions," *Int. J. Heat and Mass Transfer,* **42**, 1863-1884.

37. Keanini, R.G. (1998) "Inverse Estimation of Surface Heat Flux Distributions During High Speed Rolling Using Remote Thermal Measurements," *Int. J. Heat and Mass Transfer,* **41,** pp. 275-285.

38. Johnson, R.E. and Keanini, R.G. (1998) "An Asymptotic Model of Work Roll Heat Transfer in Strip Rolling," *Int. J. Heat and Mass Transfer,* **41,** pp. 871-879.

39. Keanini, R.G. (1997) "Review: Reconstruction and Control of Phase Boundaries during Fusion Welding," *Trends in Heat, Mass & Momentum Transfer,* **3,** pp. 139-145.

40. Keanini, R.G. and Desai, N.N. (1996) "Inverse Finite Element Reduced Mesh Method for Predicting Multi-dimensional Phase Change Boundaries and Nonlinear Solid Phase Heat Transfer," *Int. J. Heat and Mass Transfer,* **39,** pp. 1039-1051.

41. Keanini, R.G. and Desai, N.N. (1996) "Inverse-based Reconstruction of Internal Solid-liquid Phase Boundaries and Associated Solid Phase Temperature Fields," *Inverse Problems in Engrg.,* **3,** pp. 93-114.

42. Keanini, R.G. and Allgood, C.A. (1996) "Measurement of Time Varying Surface Temperature Fields Using High Frame Rate Visible Imaging CCD Cameras," *Int. Comm. Heat and Mass Transfer,* **23,** pp. 305-314.

43. Keanini, R.G. (1995) "Electron Collisionless Layers near Evaporating Plasma-heated Anodes," *Phys. Rev. E,* **52,** pp. 4572-4575.

44. Keanini, R.G., Roer, R.D. and Dillaman, R.M. (1995) "A Theoretical Model of Circulatory Interstitial Fluid Flow and Species Transport within Cortical Bone," *J. Biomechanics,* **28,** pp. 901-914.

45. Keanini, R.G. (1994) "Thermocapillary, Buoyancy and Shear-driven Flow within Annular Fluid Collars," *Int. J. Heat and Mass Transfer,* **37,** pp. 1579-1591.

46. Keanini, R.G. and Rubinsky, B. (1994) "An Inverse Finite Element Minimization -Based Method for Solution of Multi-Dimensional Material- and Phase Boundary Shapes," *Int. J. Num. Meths. Engrg.,* **37,** pp. 1125-1140.

47. Keanini, R.G. and Rubinsky, B. (1993) "Three-dimensional Simulation of the Plasma Arc Welding Process," *Int. J. Heat and Mass Transfer,* **36,** pp. 3283-3298.

48. Keanini, R.G. (1993) "Simulation of Weld Pool Flow and Capillary Interface Shapes Associated with

Plasma Arc Welding," *Finite Elements in Analysis and Design,* **15,** pp. 83-92.

49. Keanini, R.G. and Rubinsky, B. (1992) "Optimization of Multi-Probe Cryosurgery," *J. Heat Transfer,* **114,** pp.796-801.

50. Keanini, R.G. and Rubinsky, B. (1990) "Plasma Arc Welding Under Normal and Zero Gravity," *Welding J.,* **69,** no. 6, pp.41-50.

51. Ortega, J.K.E., Zehr, E. G. and Keanini, R. G. (1989) "In Vivo Creep and Stress Relaxation Experiments to Determine the Wall Extensibility and Yield Threshhold for the Sporangiophores of Phycomyces," *Biophysical J.,* **56,** pp.465-475.

52. Ortega, J.K.E., Manica, K.J. and Keanini, R.G. (1988) "Phycomyces: Turgor Pressure Behavior During the Light and Avoidance Growth Responses," *Photochemistry and Photobiology,* **48,** pp.697-703.

53. Ortega, J.K.E., Keanini, R.G. and Manica, K.J. (1988) "Pressure Probe Technique to Study Transpiration in Phycomyces Sporangiophores," *Plant Physiology,* **87,** pp.11-14.

Book Chapters

1. Keanini, R.G., Nortey, T.D., Thorsett-Hill, K., Srivastava, N., Hellman, S., Tkacik, P.T. and Knight, P.D. (2011) "Shock-Induced Turbulent Boundary Layer Separation in Overexpanded Rocket Nozzles: Physics, Models, Random Side Loads, and the Diffusive Character of Stochastic Rocket Ascent," in *Mass Transfer - Advanced Aspects,* ISBN 978-953-307-636-2. InTech Open Access Publishers.

2. Watkins, T., Redford, J., Green, F., Dahlberg, J., Tkacik, P. and Keanini, R. (2022) "Hypersonic Flow over Closed and Open Nose Missile Bodies: Raw and SVD-Enhanced Schlieren Imaging, Numerical Modeling, and Physical Analysis," in *Boundary Layer Flows - Modelling, Computation, and Applications of Laminar, Turbulent Incompressible and Compressible Flows,* DOI: 10.5772/intechopen.105617. InTech Open Access Publishers.

Patent

Apparatus and Method for Creating Dry Underwater Welds, 1999, U.S. Patent No. 5,981,896. (Keanini, Newman, Lowery and Fredericks).

Refereed Conference Proceedings, Poster Presentations, and Abstracts

1. Keanini, R. and the US, Israel, UK, Japan, France Rock Fracture Collaboration (2024) "Equilibrium (reversible) and nonequilibrium (permanent) fracture in rock: equilibrium statistical mechanics theory and experiments, and physical/intuitive analysis of common nonequilibrium fracture modes," 2024 European Geophysical Union Annual Meeting, No. EGU24-7023, Copernicus Meetings.

2. Eppes, M. C., David, C., Heap, M., Baud, P., Bonami, T., Dahlquist, M., Keanini, R., Lacroix, C., Rasmussen, M., Rinehart, A. and El Alaoui, Y., and Windenberger, A. (2024) "Temperature "Memory" and Natural Rock Fracture at Earth's Surface," 2024 European Geophysical Union Annual Meeting, No. EGU24-9825, Copernicus Meetings.

3. Rinehart, A., Dewers, T., Fichera, M., Rasmussen, M., Morovati, M., Keanini, R. and Eppes, M.C. (2024) "Role of Progressive Rock Fatigue and Failure in Fluid Flow Self-Focusing and Associated Weathering in the Critical Zone," GSA Connects 2024 Meeting, Anaheim, California, 13-29 September 2024, Vol. 56, id.405215.

4. Dahlberg, J.L., LaMattina, B., Keanini R.G. and Brothers, E.L. (2023) "Shaping Experiential Research for Veteran Education (SERVE), A Multi-University Summer Research Exchange Program for Veterans," 2023 ASEE Annual Conference & Exposition, Baltimore, Maryland. https://peer.asee.org/44209.

5. Brown, P.T., Keanini, R.G., Dahlberg, J.L. and Tkacik, P.T. (2023), "A Method for Deducing the Self-Diffusion Coefficient of a Single Analog Molecule within a Liquid-State Flow," 2023 ASEE Annual Conference & Exposition, Baltimore, Maryland. https://peer.asee.org/42427

6. Meredith, P.A., Yuan, Y., Rasmussen, M., Hofer Apostolidis, K., Nara, Y., Webb, P., Mitchell, T., Xu, T., Keanini, R., Mushkin, A., Shaanan, U., Dahlquist, M., Rinehart, A, and Eppes, M. (2023) "Evidence for increase in crack damage in rocks with duration of exposure at Earth's surface," EGU General Assembly Conference Abstracts, https://ui.adsabs.harvard.edu/abs/2023EGUGA..25.7101M.

7. Eppes, M.-C., Heap, M., Baud, P., Bonami, T., Dahlquist, M., Keanini, R., LaCroix, C., Rasmussen, M., Rinehart, A., El Alaoui, Y., and Windenberger, A. (2023) "Testing natural fracture growth-fracturing resilience feedbacks in rock," EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-5158, https://doi.org/10.5194/egusphere-egu23-5158.

8. Bisel, T.T., Dahlberg, J.L., Martin, T.R., Owen, S.S., Keanini, R.G., Tkacik, P.T., Narayan, N. and Goudarzi, N. (2017) "A Comparison of Flat White Aerosol and Rhodamine (R6G) Fluorescent Paints

and Their Effect on the Results of Tomographic PIV Measurements." Proceedings of the ASME 2017 International Mechanical Engineering Congress and Exposition. Volume 7: Fluids Engineering. Tampa, Florida, USA. November 3–9, 2017. V007T09A018. ASME. https://doi.org/10.1115/IMECE2017-71507.

9. Eppes, M.C., Keanini, R. and Hancock, G.S. (2016) "Subcritical crack growth and mechanical weathering: a new consideration of how moisture influences rock erosion rates," European Geosciences Union (EGU) General Assembly Conference Abstracts 18, 10760.

10. Keanini, R. and Eppes, M.C. (2016)"Extending non-fatigue Mode I subcritical crack growth data to subcritical fatigue crack growth: Demonstration of the equivalence of the Charles' law and Paris law exponents," European Geosciences Union (EGU) General Assembly Conference Abstracts 18, 11136.

11. Eppes, M.C., Magi, B.I. and Keanini, R. (2015) "Real-time observations of rock cracking and weather provide insights into thermal stress-related processes of mechanical weathering," American Geophysical Union (AGU) Fall Meeting Abstracts.

12. Mainuddin, M., Keanini, R., and Mullany, B. (2015) "Utilizing small external vibrational sources to increase polishing material removal rates." In ASME 2015 International Manufacturing Science and Engineering Conference, pp. V001T02A002-V001T02A002, American Society of Mechanical Engineers.

13. Azimi, F., Fleischhauer, E., Tkacik, P., Keanini, R. and Mullany, B., (2015) "Correlations between media-workpiece contact modes occuring during vibrational finishing and the resulting workpiece topography," presented 15th International Conference on Metrology and Properties of Engineering Surfaces, Charlotte, USA.

14. Case, J., Young, M., Keanini, R. and Trammell, S. (2014). "Using LED sources to selectively heat blood for enhanced mid-IR imaging of vascular structures," In Biomedical Optics (pp. BS5A-1). Optical Society of America.

15. Ling, X., Cherukuri, H.P. and Keanini, R.G. (2002) "A New Method for the Estimation of Heat Transfer Coefficients in Quenching Problems," 14th US National Congress of Theoretical and Applied Mechanics Proceedings, p. 551.

16. Brown, A., Keanini, R., Ruf, J., Reed, D. and D'Agostino, M. (2002) "Characterization of Side Load Phenomena using Measurement of Fluid/Structure Interaction," presented at the 38th Joint Propulsion Conference, AIAA Paper 2002-3999.

17. Phan, S., Hocken, R., Smith, S. and Keanini, R.G. (1999) "Resonance-based Force Measurement: Prelude to High-Resolution Anemometry for Liquid Metal Flows," *Proc. ASME Heat Transfer Division - 1999 Vol. 4,* HTD Vol. 364-4, pp. 3-14.

18. Keanini, R.G. (1999) "Particle Transport in Quasistatic Stokes Flow," *Proc. ASME Fluids Engineering Division - 1999,* FED Vol. 250, pp. 75-80.

19. Johnson, R.E. and Keanini, R.G. (1997) "An Asymptotic Multiple-Time-Scale Model of Work Roll Heat Transfer," in Manufacturing and Materials Processing, ASME Proceedings of the 32nd National Heat Transfer Conference, vol. 9, HTD V. 347, pp. 163-169.

20. Keanini, R.G. (1997) "Implicit Reconstruction of Dynamic Three-Dimensional Phase Boundaries," in Inverse Problems in Heat Transfer and Fluid Flow, ASME Proceedings of the 32nd National Heat Transfer Conference, Vol. 2, HTD V. 340, pp. 59-68.

21. Saxon, G. B, Kim, R., and Keanini, R.G. (1997) "A Two-Dimensional Model of the Catawba Nuclear Station Service Water Pond During a Hypothetical Accident," in Inverse Problems in Heat Transfer and Fluid Flow, ASME Proceedings of the 32nd National Heat Transfer Conference, Vol. 2, HTD V. 340, pp. 127-133.

22. Keanini, R.G. (1996) "Inverse Method for Estimating Surface Heat Flux Distributions during High Speed Rolling," Proc. 1996 Int. Mech. Engrg. Conf. & Expo., ASME MED vol. 4, pp. 339-344.

23. Keanini, R.G. and Allgood, C.A. (1996) Measurement of Time Varying Surface Temperature Fields Using Visible Imaging CCD Cameras," Proc. 1996 Int. Mech. Engrg. Conf. & Expo., ASME HTD vol. 332, pp. 239-243.

24. Keanini, R.G. and Daily, J.W. (1996) "Chaotic Dynamics Underlying the Acoustically-Convectively Coupled Ramjet Instability," Developments in Theoretical and Applied Mechanics. Proc. 18th Southeastern Conf. Theoretical and Applied Mechanics, pp. 522-535.

25. Desai, N.N., Patterson, S., Estrada, H. and Keanini, R.G. (1995) "A Numerical Study of the Effects of Substrate Roughness, Evaporation Rate and Solute Concentration on Coat Smoothness during Spin Coating," in Numerical Methods in Thermal Problems 1995, ed. R. W. Lewis and P. Durbetaki, Pineridge Press, Swansea, U.K., pp. 1136-1146.

26. Keanini, R.G. (1995) "Feasibility of Photothermal Deflection Velocimetry in Low-Density Hypersonic Flow," Proc. Fifteenth Canadian Cong. Appl. Mech., pp. 500-501.

27. Keanini, R.G. (1995) "Kinetic Analysis of the Electron Knudsen Layer and Plasma Sheath Adjacent

Evaporating Plasma Heated Anodes," Proc. Fifteenth Canadian Cong. Appl. Mech., pp. 432-433.

28. Keanini, R.G. (1994) "Theoretical Model of Fluid Flow and Species Transport in Porous Cortical Bone," Bull. Amer. Phys. Soc., **39,** p. 1933 (abs).

29. Desai, N.N. and Keanini, R.G. (1994) "Planarization of a Spin-Coated Substrate," Bull. Amer. Phys. Soc., **39,** p. 1964 (abs).

30. Keanini, R.G. (1994) "Perturbation Solution for Stress-Induced Fluid Flow within Anisotropic Non-homogeneous Osteons," Proc. 16th Int. Conf. IEEE Engrg. in Medicine and Biology Soc., pp. 293-294.

31. Keanini, R.G. (1994) "The Effect of Anisotropic Permeability on Fluid Flow and Species Transport within Cortical Bone," Proc. 16th Int. Conf. IEEE Engrg. in Medicine and Biology Soc., pp.1148-1149.

32. Keanini, R.G. (1994) "Cortical Bone Fluid Flow and Species Transport Induced by an Array of Blood Vessels," Proc. 16th Int. Conf. IEEE Engrg. in Medicine and Biology Soc., pp. 1146-1147.

33. Keanini, R.G. (1993) "Effect of Micro-architecture on Flow and Species Transport in Cortical Bone, Bull. Amer. Phys. Soc., **38**, p. 2294 (abs).

34. Keanini, R.G. (1992) "Perturbation Model of Capillary Surface Shape and Thermocapillary Driven Flow within a Hanging Drop," Bull. Amer. Phys. Soc., **37,** p. 1745 (abs).

35. Keanini, R.G. and Rubinsky, B. (1990) "Keyhole and Weld Shapes for Plasma Arc Welding Under Normal and Zero Gravity," in Heat Transfer in Space Systems, ASME HTD-Vol. 135.

36. Keanini, R.G. Yu, K. and Daily, J.W. (1989) "Evidence of a Strange Attractor in Ramjet Combustion," AIAA paper 89-0624.

37. Yu, K. Trouve, A., Keanini, R.G., Bauwens, L. and Daily, J.W. (1989) "Low frequency Pressure Oscillations in a Model Ramjet Combustor - The Nature of Frequency Selection," AIAA paper 89-0623.

38. Ortega, JKE, EG Zehr and RG Keanini (1989) In vivo creep experiments to study extensibility and yield threshold of the cell wall. Fifth Cell Wall Meeting (Edinburgh, UK). Book of Abstracts and Program: 2 (abstract).

39. Ortega, JKE, RG Keanini and KJ Manica (1988) Pressure probe technique to study transpiration in single plant cells. Plant Physiology Supplement, 86: 74 (abstract).

40. Ortega, JKE, KJ Manica and RG Keanini (1987) Phycomyces: Turgor pressure during the light growth response. Plant Physiology Supplement, 83: 156 (abstract).

41. Ortega, JKE and RG Keanini (1987) Phycomyces: Expansion rate vs. changes in turgor pressure. Plant Physiology Supplement, 83: 42 (abstract).

42. Keanini, R.G. and Ortega, J.K.E. (1987) "Phycomyces: Turgor Pressure Behavior During the Light and Avoidance Growth Responses," Suppl. Plant Physiology, 83, abstract nos. 252 and 940.

Teaching and Curriculum Development Activities

○ **Development of Graduate Statistical Mechanics Course (ongoing):**
The graduate course combines statistical physics and quantum mechanics at a level suitable for both engineering and physics graduate. Taught Spring, 2013, 2015, 2017, 2019, 2023.

○ **Graduate Curriculum Development (older, but in some courses, ongoing):**
Reorganized graduate level Convective Heat Transfer course emphasizing turbulent transport (2012), Introduced new graduate courses in Advanced Viscous Flow II (2001), Numerical Methods (1995-1998), and Fundamentals of Fluid Flow and Heat Transfer (1995-1998). Reorganized graduate courses in Advanced Viscous Flow I (1994-2012) and Compressible Flow (1995-1998; 2006).

○ **Educational Research, Educational Outreach, and Teaching Enhancement Activities (old and discontinued):**
Faculty participant in UNC Charlotte Summer Outreach Program for High School Science and Math Teachers (1993,1994,1996). Faculty participant in Wild Acres Retreat (North Carolina, 1994) and American Society of Engineering Education Symposium (Washington D.C., 1994) on Active Learning Strategies. Coordinated development (as team leader, Thermal-Fluids stem) of undergraduate teaching objectives and measures for meeting ABET accreditation criteria (2001-2003).

○ **Undergraduate Lab Development (old and discontinued):**
Developed core undergraduate Mechanical Engineering Thermal-Fluids Lab course; wrote lab manual (available on request); acquired instructional equipment to outfit the lab, (funding from NSF and the College of Engineering); developed tutorials on computational fluid dynamics and error analysis (1995-1998).

○ **Human Powered Engineering (old and discontinued):**
Faculty Co-advisor (with Prof. Patterson) to UNC Charlotte's Human Powered Vehicle Team (1998-2003); Co-advisor (with Prof. Hocken) to UNC Charlotte's Human Powered Helicopter Project (2003-2005); developed an informal undergraduate course on Human Powered Engineering (2003; rough course notes

available on request); organized 2006 East Coast ASME Human Powered Vehicle Competition, UNC Charlotte host.

- o **Courses Taught:**

  Fluid Mechanics (UG); Thermodynamics I (UG); Thermodynamics II (UG); Thermal-Fluids Laboratory (UG); Intermediate Fluid Mechanics (UG); Human Powered Engineering (UG); Compressible Flow (G); Advanced Fluid Mechanics (G); Advanced Fluid Mechanics II (G); Fundamentals of Fluid Flow and Heat Transfer (G); Turbulence (G); Numerical Methods in Engineering (G); Convective Heat Transfer (G); Statistical Mechanics (G).

Research and Education Grants (incl. Computer Time and Equipment Donations)

1. "Engaging Military Veterans to Increase Engineering Enrollment and BS, MS, and PhD Degrees Awarded," DOD Office of Naval Research, PT Tkacik, PI, RG Keanini, J. Dahlberg, J.H. Lim, J. Tarbutton, co-PI's (9/04/2018-9/30/21), $750,000.
2. "Quantifying climate-dependent mechanical weathering and subcritical cracking over geological time," NSF-U.S.-Israel Binational Science Foundation (BSF), M Eppes, PI, RG Keanini, P. Meredith (Univ College London), Y. Nara (U Kyoto), A, Mushkin (Isreal Geol. Survey) co-PI's (1/1/2019-12/31/22), $300,000.
3. "Engaging Military Veterans to Increase STEM Enrollment and Degrees Awarded," DOD Department of the Navy, PT Tkacik, PI, K.A. Day, R.G. Keanini, J.H. Lim, P.A. Tolley, M. Uddin, co-PI's (10/1/2014-12/31/17), $600,000.
4. "NASA Student Launch Team Competition," Jan. - June, 2014 (K. Thorsett-Hill, R.G. Keanini), NASA, $5,000.
5. "NASA Student Launch - Senior Design Project," Jan. - June, 2014 (K. Thorsett-Hill, R.G. Keanini), NASA, $5,000.
6. "Hydrokinetic Energy System," 2011-2012 (P.T. Tkacik, M. Uddin, A. Sleiti, M. Evans, R.G. Keanini) Coastal Studies Institute, $ 47,000.
7. "Computational Fluid Dynamic Modeling of the Aerodyn Windtunnel," 2006-2007 (G. K. Watkins, J. Cuttino, R.G. Keanini), Aerodyn Inc., $ 15,400.
8. "Design and Testing of Low Speed Rotors for Human Powered Helicopters," 2004-2005 (R.G. Keanini and H. Estrada), Faculty Research Grant, University of North Carolina at Charlotte, $ 11,861.
9. "Integrated Process Models to Predict Thermal Distortion and Residual Stress," 1999-2003 (H.P. Cherukuri, R.E. Johnson, R.G. Keanini), National Science Foundation, $ 330,221.
10. "The Role of Boundary Layer Separation in Rocket Nozzle Side Loads," 2000-2001 (R.G. Keanini), NASA, Marshall Space Flight Center, $ 30,000.
11. "Development of a High Resolution Resonance-based Anemometer for High Temperature Liquid Metal Flows," 1997-98 (R.G. Keanini, R. Hocken, S.T. Smith), National Science Foundation, $ 50,000.
12. "Welding Research Collaboration," 1997-2003 (R.G. Keanini), Electric Power Research Institute, $ 20,490.
13. "Development of an Inverse-based Reconstruction Method for Imaging Internal, Unsteady, Optically Opaque Phase Boundaries," 1996-97 (R.G. Keanini), Engineering Foundation and American Society of Mechanical Engineers, $ 5,000.
14. "Science Support Grant, Inverse Methods in Materials Processing," 1995-96 (R.G. Keanini), Alcoa Foundation, $ 7,500.
15. "Vertical Integration of Just-in-Time Experimentation," 1995-1997 (N. Bodur, H. Estrada, R.G. Keanini), National Science Foundation, $ 186,710 (includes $ 83,355 UNC Charlotte matching funds).
16. "Higher Education Visualization Initiative," 1997 (R.G. Keanini, K.R. Subramanian, J. Raja), North Carolina Supercomputing Center and Cray Research, $ 10,000 (est., included SGI workstation and training and support at NCSC).
17. "Oak Ridge Junior Faculty Enhancement Award," 1995-96 (R.G. Keanini), Oak Ridge Associated Universities, $ 10,000 (includes $ 5,000 University match).
18. "Welding Research Development," 1995 (R.G. Keanini), College of Engineering, UNC Charlotte, $ 24,900.
19. "Summer Outreach for Secondary Science and Math Teachers," 1995 (G. Mohanty, P. DeHoff, R. Janardhanam, Y. Kakad, R. G. Keanini), Eisenhower Foundation, $ 35,000.
20. "Welding Equipment Donation," 1995 (R.G. Keanini), Electric Power Research Institute, $ 2,500.
21. "Numerical and Experimental Investigation of Fluid Interaction with Aortic Heart Valves," 1995 (R.G. Keanini) Carolinas Medical Center, $ 3,000.
22. "Travel Grant - Canadian Congress Applied Mechanics," 1995 (R.G. Keanini), College of Engineering,

UNC Charlotte, $ 750.

23. "Engineering Research Initiation Grant," 1993-94 (R.G. Keanini), Engineering Foundation and American Society of Mechanical Engineers, $ 17,400.
24. "Cray Research Grant Optimization of Multi-Probe Cryosurgery," 1994 (R.G. Keanini), $ 44,500 (includes $ 7,000 Cray Graduate Student Fellowship and $ 37,500 computer time at the North Carolina Supercomputing Center).
25. "Development of Welding Research Laboratory," 1994 (R.G. Keanini), Engineering Research Grant, College of Engineering, UNC Charlotte, $ 9,000.
26. "Variable Polarity Plasma Arc Welder Equipment Donation," 1994 (R.G. Keanini), Hobart Welding, $ 69,000.
27. "Inverse Solution for Three-Dimensional Phase Change Boundaries and Material Temperature Fields," 1993-94 (R.G. Keanini), North Carolina Supercomputing Center, $ 5,000 (computer time).
28. "Faculty Development Grant: Pilot Development of an Ultrasonic-Imaging Cryoprobe," 1993 (R.G. Keanini and H. Estrada), University of North Carolina at Charlotte, $ 8,600.
29. "Modeling Flow and Species Transport in Cortical Bone," 1993-94 (R.G. Keanini), North Carolina Supercomputing Center, $ 40,000 (computer time).

Graduate Student Supervision (with present/last known positions noted)

1. Mehdi Morovati (Ph.D., 2024 "The equilibrium and nonequilibrium statistical mechanics of rock fracture")
2. Tyler Watkins (M.S., 2022 "Experimental and numerical validation of a forward facing cavity as a passive thermal protection system of a hypersonic body," Ph.D. student at the University of Tennessee Space Institute)
3. Ashish Pujari (M.S. 2019 "Stochastic solution to solve thermal conduction and boundary layer problems," Ph.D. student UNC Charlotte)
4. Kapil Gaur (M.S. 2017 "Experimental investigation of solid-liquid phase change in vibrated granular media and comparison with theoretcially predicted phase change in hard sphere systems")
5. Thomas Nortey (Ph.D. 2015 "Green's Function-Stochastic Approach to Solving Linear, Nonlinear and Nonhomogeneous Evolution Transport problems," Chair, ME Technology Dept., Gaston Community College)
6. Karen Thorsett-Hill (Ph.D. 2012 "A Semi-Quantitative Schlieren High-Speed Flow Diagnostic: Analysis of High-Pressure-Ratio, Overexpanded Planar Flow in Rocket Nozzles," Associate Department Head for Undergraduate Studies and Professor, Mechanical Engineering, Colorado State University)
7. Andrew Huffman (M.S. 2007*, Areva)
8. Ashish Verma (M.S. 2007 "Shock wave assessment for high speed compressible flows")
9. John Kalyanapu (M.S. 2007, non-thesis project, Catapillar)
10. Craig Schmeising (M.S. 2006*, GE Nuclear)
11. Nathan Andreu (M.S. 2006 "Stochastic Solutions to Thermal Conduction and Thermal Boundary Layer Problems," Areva)
12. Kiran Gona (M.S. 2006, "Linear and Nonlinear Waves on Fiber Coating Entrance Menisci*")
13. Justin Thompson (Ph.D. 2005 "Physical Investigation and Analytical Modeling of Coating Application Process Used in Optical Fiber Ribbon Manufacturing," Dow-Corning)
14. Courtney Pruette (M.S. 2005 "Investigation of Vehicle Aerodynamics as a Function of Fender Width and Yaw," Joe Gibbs Racing)
15. Mike McGuire (M.S. 2005*, Pace-PME)
16. Vijay Gopalakrishnan (M.S. 2005 Hypersonic flow modeling*, Salesforce)
17. Aravind Arcot (M.S., 2004*)
18. James (Ty) Miller (M.S. 2004*, Project Manager, Lash Group)
19. Derek Overcash (M.S. 2003 "An Integral-Method Based Inverse Solution for Predicting Surface Heat Fluxes and Solid-Liquid Interface Locations in One-Dimensional Phase Change Problems for Rectangular, Cylindrical and Spherical Domains," Oak Ridge National Laboratory)
20. Carolyn Genzale (*nee* Dougan) (M.S. 2003 (non-thesis), Associate Professor, Georgia Tech)
21. Danny Ammons (M.S. 2002 non-thesis project, Proctor Gamble)
22. Chris Cope (M.S. 2001 "The Experimental Analysis of the Affects of Hairline Cracks in Clay Flue Liner on the Safety of a Masonry Chimney," self-employed)
23. David DeHart (M.S.2001 "The Gasification and Combustion of Rice Hulls as an Alternative Fuel Source for Generating Electricity," TriGen)
24. Son (Jack) Phan (Ph.D 2000 "Studies in Heat Transfer and Fluid Flows: [part One] High Resolution, Resonance-Based Anemometry for High Temperature Flows - Preliminary Development and Testing;

[part Two] a Three Dimensional Model of the Catawba Nuclear Power Plant Service Water Pond During a Hypothetical Accident," Post-doc University of Michigan)

25. Kelly Hannon (M.S. 2000 "Preliminary Development of a Real-Time Powder Mass Flow Controller and Feeder for Powder Welding Applications," Lockheed Martin)

26. Curtis Ayers (M.S., 1998, non-thesis project, John Deere)

27. Dean Pennell (M.S. 1998 Design and Construction of an Electric Car*)

28. Robert Schweikert (M.S. 1998 "A Finite Element Analysis of Cryosurgery in the Lung," ANSYS)

29. Greg Saxon (M.S. 1997 "Two-Dimensional Model of the Catawba Nuclear Station Service Water Pond During a Hypothetical Accident," Project Manager, Duke Power)

30. Mark Huffstetler (M.S. 1997 "The Welding Process: a Study of Heat Transfer and Weld Pool Formation," Okuma)

31. Nehal Desai (M.S. 1995 " Numerical Study of the Effects of Substrate Roughness, Evaporation Rate, Surface Tension and Solute Concentration on Coat Smoothness During Spin Coating," Los Alamos National Laboratory)

32. Chris Allgood (M.S. 1995 "Measurement of Time Varying Surface Temperature Fields Using High Frame Rate Visible Imaging CCD Cameras*," AMP)

33. Matt Warnke (M.S. 1995*)
    *Incomplete information available

Research and Industrial Collaboration

1. **NASA Marshall Spaceflight Center, Huntsville, AL (2001-2007)**
   Developed a predictive theoretical model of altitude-dependent (compressible, turbulent) boundary layer separation in Saturn-V-scale rocket nozzles. Collaborated on development of an inverse method for diagnosing nozzle boundary layer separation based on measured nozzle vibration response.

2. **Rocket Dynamics Research - University of North Carolina at Charlotte and Mitchell Aerospace (2009-2015):**
   Experimental, numerical, and theoretical approaches were used to study the dynamic response of rockets to various stochastic loads; investigated shock-boundary layer interactions in high pressure ratio rocket nozzles. Two graduate students, several undergraduates, and five faculty participated.

3. **Technical Expert, Picadio Sneath Miller & Norton, Pittsburgh, PA (2010-2013):**
   Assessed technical claims concerning ultrasonic fluid flow meters [outcome subject to NDA].

4. **A2 Wind Tunnel, Mooresville, NC (2006-2008):**
   Assisted in flow modeling and design of the A2 (low speed) wind tunnel.

5. **Department of Civil Engineering, University of North Carolina at Charlotte (2011-2017):**
   Modeled blast load structural response. The collaboration employed a variety of experimental, numerical, and theoretical approaches for studying blast physics and blast-structure interactions.

6. **Electric Power Research Institute (1997-2000):**
   Work focused on welding-related research. Starting in 1998, three Masters students were supported through tuition waivers and part-time (academic year) and full-time summer work at EPRI. Two masters degree projects and a U.S. Patent ["Apparatus and Method for Creating Dry Underwater Welds," Keanini et al., No. 5,981,896 (1999)] resulted from the collaboration.

7. **Baylor College of Dentistry - Department of Biomaterials (1994-2006):**
   Work focused on dental materials and process modeling; four journal articles resulted from the collaboration.

8. **University of North Carolina at Wilmington - Department of Biology (1994-1996):**
   Work focused on modeling fluid flow and solute transport in cortical bone; a journal paper and three conference proceedings were published.

9. **Alcoa Technical Center, Pittsburgh, PA (1995-1998):**
   Developed theoretical and inverse methods for predicting and monitoring heat transfer during high-speed metal rolling processes.

10. **Catawba Nuclear Power Plant, Duke Power, Charlotte, NC (1995-1997):**
    Supervised MS and PhD projects that modeled and optimized post-accident flow and heat transfer to the auxiliary cooling pond at the Catawba nuclear power plant.

11. **University of North Carolina at Charlotte - Department of Mechanical Engineering & Engineering Science and Department of Geography & Earth Science (1994-present):**
    Collaborations have been established with a number of ME and Earth Science faculty, resulting in 23 journal articles and 22 (refereed) abstracts, conference proceedings and book chapters.

12. **Carolinas Medical Center (1994-1996):**
    Work focused on measuring prosthetic heart valve function.