

# Curriculum Vitae

## David Owen Lignell

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### Current Position

**Assistant Professor**, Chemical Engineering Department, Brigham Young University, January 2009 to present.

### Education

**Ph.D. Chemical Engineering**, The University of Utah, May 2008

- *Dissertation*: "Direct numerical simulation of soot formation, flame extinction, and reignition in nonpremixed ethylene jet flames."
- *Advisors*: Philip J. Smith (University of Utah), Jaqueline H. Chen (Sandia National Laboratories)
- *Elective coursework*: numerical solution of PDEs / multigrid methods; advanced scientific computing I, II; high performance computing; fluid dynamical phenomena, boundary layers and turbulence.
- *Cumulative GPA*: 4.0

**B.S. Chemical Engineering**, The University of Utah, May 2001

- *Elective coursework*: combustion; air pollution; C++ programming; nuclear engineering.
- *Cumulative GPA*: 3.6

### Research Interests and Accomplishments

- Modeling and simulation of turbulent, chemically reacting flows, multi-phase flows, and particulate systems using RANS, LES, DNS, and ODT methodologies.
- Fundamental investigation of turbulent nonpremixed combustion, soot formation, and transport to quantify and develop improved subgrid-scale models for practical combustion environments.
- Implemented moment-based soot models into Sandia National Laboratories' massively parallel DNS solver S3D.
- Performed the first ever 3D DNS simulations of nonpremixed combustion with soot formation and realistic combustion chemistry and transport.
- Simulated a 3D nonpremixed planar ethylene jet flame with soot formation on 7920 processors of the ASC Red Storm Cray supercomputer at Sandia National Laboratories at a computational cost of 1.5 million cpu-hrs.
- Performed three parametric simulations of extinction and reignition of nonpremixed ethylene jet flames with varying Damkohler numbers on up to 14112 processors on the Jaguar Cray XT3/XT4 supercomputer at the National Center for Computational Sciences at Oak Ridge National Laboratories at a computational cost of 4 million cpu-hrs.

## Teaching Experience

**Teaching Assistant.** Chemical Engineering Department Senior Laboratory Course

**Teaching Assistant.** Chemical Engineering Department Combustion Course

- Developed and conducted three lectures, graded all homework and one exam, created one original homework assignment, and maintained the course webpage.

## Work Experience

**Post Doctoral Researcher (March-December 2008)**

Reacting Flows Research Department, Combustion Research Facility, Sandia National Laboratories

- Developed a modern, object oriented one dimensional turbulence (ODT) code for investigation of turbulent combustion processes, and implementation of a new turbulence modeling approach autonomous microstructure evolution (AME).

**Graduate Student Intern (year-round), July 2005-March 2008**

Reacting Flows Research Department, Combustion Research Facility, Sandia National Laboratories

- Performed direct numerical simulations of soot formation, and flame extinction and reignition in turbulent nonpremixed flames.
- Participated in proposal preparation, and code development and optimization of S3D.

**Graduate Research Assistant, August 2003-July 2005**

Combustion and Reaction Simulation Group, Chemical Engineering, The University of Utah

- Supported DOE ASC center C-SAFE Firespread team by creating tabulated reaction/mixing models with finite rate chemistry of complex fuels for use in pool fire LES.
- Developed and implemented a heat loss parameterization and implemented a soot model for an unsteady combustion flamelet code.

**Engineer, Engineering Research and Development, May 2001-August 2003**

Reaction Engineering International, 77 W., 200 S., Suite 210, Salt Lake City, UT 84101

- Performed CFD simulations of wall- and tangentially-fired utility boilers, simulations and design of a petcoke furnace, and cold-flow modeling of a windbox, car exhaust plume, and a coal burner.
- Developed one-dimensional, rate-based computer models of an pollution abatement systems of a chemical weapons incinerator including a quench tower, venturi scrubber, and absorption tower for the removal of acid gas species. Created computer models of hot gas cleanup units, an air separation unit, a catalytic combustor, and a water gas shift membrane reactor for a workbench for simulation of IGCC plants.
- Evaluated an ethylene transfer line heat exchanger to quantify energy recovery versus chemical selectivity, requiring detailed chemical kinetic simulations and heat transfer models.
- Performed a design of a carbothermal reduction plant for conversion of sodium hydroxide to sodium metal, for a hydrogen transportation fuel recycle process.
- Developed a computer model of arsenic-fly ash partitioning in the post-combustion zone of coal-fired boilers, and worked on development of homogeneous and heterogeneous mercury oxidation kinetic models.

**Research Assistant, January 2001-May 2001**

Combustion and Reaction Simulation Group, Chemical Engineering, The University of Utah

- Worked with CFD software, Fluent, to evaluate a gas burner design.

**Engineering Intern, Linear Accelerator Group, May-August 2000**

The Boeing Company, 120,000 W. 12<sup>th</sup> St. Ogden UT, 84404

- Performed calibration of the analyzer magnet of a linear accelerator using nuclear activation foils and gamma spectrometry.
- Developed a shielding design of a facility for a cesium-137 radiation source.
- Provided dosimetry support involving the preparation and reading of lithium fluoride thermoluminescent dosimeters for radiation effects testing.

**Research Assistant, February 1998 – May 2000**

Center for Excellence in Nuclear Technology, Engineering, and Research, University of Utah

- Performed bioassays using Fission Track Analysis for plutonium determination.
- Participated in regulatory activity of the 100 kW TRIGA reactor including power calibration, and biannual fuel inspection.

### Computer Proficiency

- Fortran 90/95, C++, Matlab, Tecplot, Fieldview, Fluent
- Parallel programming with MPI. Familiarity with OpenMP
- High performance computing on Linux clusters, Cray XT3/XT4 (Jaguar—NCCS ORNL, Redstorm—Sandia), Dell PowerEdge Cluster (Thunderbird—Sandia)

### Professional Memberships and Service

- Member of the American Institute of Chemical Engineers
- Member of the Combustion Institute
- Reviewer: Environmental Engineering Science, Combustion and Flame

### Academic Awards

- Sandia National Laboratories Graduate Fellowship (July 2005-March 2008)
- John Zink Graduate Scholarship (2004)
- Wayne Brown Graduate Fellowship (2003)
- John Zink Undergraduate Scholarship (2001)
- Nuclear Engineering Program Undergraduate Scholarship (1999)
- Engineering Program Scholarship (1998)
- National Dean's List (1998)
- Materials Science Freshman Scholarship (1996)

### Peer-Reviewed Journal Articles

- **D.O. Lignell**, J.C. Hewson, J.H. Chen, "A-priori analysis of conditional moment closure modeling of a temporal ethylene jet flame with soot formation using direct numerical simulation," *32nd International Symposium on Combustion*, 32(1): 1491-1498 (2009).
- **D.O. Lignell**, J.H. Chen, P.J. Smith, "Three-dimensional direct numerical simulation of soot formation and transport in a temporally-evolving, nonpremixed ethylene jet flame," *Combustion and Flame*, 155(1-2): 316-333 (2008).
- **D.O. Lignell**, J.H. Chen, P.J. Smith, T. Lu, C.K. Law, "The effect of flame structure on soot formation and transport in turbulent nonpremixed flames using direct numerical simulation", *Combustion and Flame*, 151(1-2):2-28 (2007). **Feature (cover) article**
- C.L. Senior, **D.O. Lignell**, A.F. Sarofim, A. Mehta, "Modeling arsenic partitioning in coal-fired

power plants", *Combustion and Flame*, 147(3):209-221 (2006)

- P. Jiang, **D.O. Lignell**, K.E. Kelly, J.S. Lighty, A.F. Sarofim, C.J. Montgomery, "Simulation of the evolution of particle size distributions in a vehicle exhaust plume with unconfined dilution by ambient air", *Journal of the Air and Waste Management Association*, 55(4):437-445 (2005)

## Conference Papers and Presentations

- **D.O. Lignell**, "Direct numerical simulation of turbulence-chemistry interactions in nonpremixed flames," 23<sup>rd</sup> Annual ACERC Conference, Brigham Young University, Provo, UT, February 23-24, 2009.
- J.C. Hewson, **D.O. Lignell**, A.R. Kerstein, S.H. Kim, H. Pitsch, R.O. Fox, "Modelling differential diffusion in nonpremixed combustion: soot transport in mixture fraction space," Center for Turbulence Research Summer Program, Sanford University, July 7-August 1, 2008.
- **D.O. Lignell**, J.H. Chen, E.S. Richardson, "Terascale direct numerical simulations of turbulent combustion: fundamental understanding towards predictive models," **(Invited paper, peer reviewed)** *Scientific Discovery Through Advanced Computing (SciDAC)*, Seattle, WA, July 13-17, 2008.
- **D.O. Lignell**, J.H. Chen, "Investigation of flame extinction and reignition modes in nonpremixed ethylene jet flames using direct numerical simulation," *SIAM 12<sup>th</sup> International Conference on Numerical Combustion*, Monterey, CA, March 31-April 2, 2008.
- J.C. Hewson, A. Ricks, **D.O. Lignell**, A.R. Kerstein, "Modeling differential diffusion with conditional moment closure," *SIAM 12<sup>th</sup> International Conference on Numerical Combustion*, Monterey, CA, March 31-April 2, 2008.
- C.S. Yoo, **D.O. Lignell**, E.S. Richardson, J.H. Chen, "DNS of stabilization of turbulent lifted nonpremixed jet flames in vitiated coflow," *SIAM 12<sup>th</sup> International Conference on Numerical Combustion*, Monterey, CA, March 31-April 2, 2008.
- A. Cuoci, T. Faravelli, E. Ranzi, P.J. Smith, **D.O. Lignell (presenter)**, Effects of Turbulent Fluctuations on the numerical predictions of soot formation and oxidation in turbulent nonpremixed flames using a coupled radiation/flamelet model," *AICHE Annual Meeting*, Salt Lake City, UT, Nov. 4-9, 2007
- **D.O. Lignell**, J.H. Chen, T. Lu, C.K. Law, "Direct numerical simulation of extinction and reignition in a nonpremixed turbulent ethylene jet flame", *2007 Fall Meeting of the Western States Section of the Combustion Institute*, Oct. 16-17, 2007, Livermore, CA, USA
- **D.O. Lignell**, J.C. Hewson, J.H. Chen, "A-priori analysis of CMC modeling of turbulent soot formation using direct numerical simulation", *2007 Fall Meeting of the Western States Section of the Combustion Institute*, Oct. 16-17, 2007, Livermore, CA, USA
- **D.O. Lignell**, P.J. Smith, J.H. Chen, "Simulation and modeling of soot formation in nonpremixed combustion using DNS", *Workshop on Heat Transfer in Fires*, Sep. 20-21, 2007, Salt Lake City, UT, USA
- **D.O. Lignell**, C.S. Yoo, J.H. Chen, R. Sankaran, M. Fahey, "Petascale combustion science, performance and optimization", *Cray Scaling Workshop*, Oak Ridge National Laboratory, July 30-31, 2007, Oak Ridge, TN, USA
- **D.O. Lignell**, P.J. Smith, J.H. Chen, "Validation of mixing and reaction models for sooting nonpremixed turbulent flames using DNS", *NAMF Mixing Conference XXI*, June 17-22, 2007, Park City, UT, USA
- **D.O. Lignell**, J.H. Chen, P.J. Smith, T. Lu, C.K. Law, "Direct numerical simulation of soot formation and transport in nonpremixed ethylene flames", *5th Meeting of the Joint Sections of the Combustion Institute*, March 25-28, 2007, San Diego, CA, USA
- N. Krishnamoorthy, D.R. Yeates, **D.O. Lignell**, J. Spinti, P.J. Smith, "The feasibility of mixture fraction and heat loss mapping for characterizing turbulent nonpremixed flames", *2006 Fall Meeting of the Western States Section of the Combustion Institute*, March 27-28, 2006, Boise ID, USA
- **D.O. Lignell**, P.J. Smith, J.H. Chen, "DNS of soot formation and transport in nonpremixed

ethylene flames in a single vortex-eddy, and two dimensional decaying turbulence configurations", *Fire Model Workshop*, May 8-9, 2006, Albuquerque, NM, USA

- **D.O. Lignell**, P.J. Smith "Verification of heat loss in a steady laminar flamelet reaction model", *Verification Workshop*, March 16-17, 2005, Albuquerque, NM, USA
- C.L. Senior, **D.O. Lignell**, Z. Chen, B. Shiley, A. Sarofim, "Modelling gaseous mercury behavior in practical combustion system", *Air Quality IV: Mercury, Trace Elements, and Particulate Matter*, Sep 22-24, 2003, Arlington, VA, USA.
- C.L. Senior, **D.O. Lignell**, B. Shiley, Z. Chen, A. Sarofim, "Kinetic models for predicting the behavior of mercury in coal-fired power plants", *ACERC Annual Conference*, Feb 19-20, 2003, Salt Lake City, UT, USA
- K. Davis, H. Shim, **D.O. Lignell**, M. Denison, L. Felix, "Evaluation of biomass cofiring injection strategies using CFD simulations: pilot- and full-scale results", *27th International Technical Conference on Coal Utilization and Fuel Systems*, March 4-7, 2002, Clearwater, FL
- C.L. Senior, **D.O. Lignell**, Z. Chen, A.F. Sarofim, T.W. Dixon, "Characterization of reactivity of green and calcined petroleum coke with oxygen for application to combustion systems", *2005 TMS Annual Meeting and Exhibition*, Feb 13-17, 2005, San Francisco, CA, USA