Nathaniel Trask

CONTACT INFORMATION

Division of Applied Mathematics
182 George St.
Brown University, Providence, RI. 02906

(508) 685-5155
nathaniel_trask@brown.edu
http://www.dam.brown.edu/people/ntrask/index.html

RESEARCH INTERESTS

High order numerical method development for computational fluid dynamics and material science, high performance computing, multiphase flows, numerical optimization, graph theory

EDUCATION

Brown University, Providence, RI

Visiting professor, Dean's Faculty Fellowship **Spring 2016**

- Designed senior undergraduate course using OpenFOAM to introduce CFD and software design principles for navigating components of a large-scale production code (C++, version control, numerical algorithms for PDE/linear equations, etc).

PhD., Division of Applied Mathematics **2010 – Fall 2015**
MSc., Division of Applied Mathematics

- Advisors: Martin Maxey and George Karniadakis
- Thesis: Compatible high-order meshless schemes for viscous fluid flows through ℓ_2-optimization

University of Massachusetts, Amherst, MA

MSc., Mechanical Engineering **2008 – 2010**
Dual BSc., Mechanical Engineering & Mathematics **2004 - 2008**

- Advisor: David Schmidt
- Thesis: Implementation of an Eulerian model to simulate primary atomization

PROFESSIONAL EXPERIENCE

Self-employed, Providence, RI

CFD Consultant **2011 – present**

Provided CFD solutions for customers in HVAC and aerospace industries

- Developed custom solvers to interface with existing codes (Fluent/OpenFOAM).
- Typical applications: heat transfer, turbulence modelling, combustion, fuel injection, evaporation

Brown University, Providence, RI

Graduate research assistant **2010 – 2015**

Fundamental numerical method development in collaboration with staff scientists at national laboratories and professors at academic institutions through DOE grant (Collaboratory on Mathematics for Mesoscopic Modeling of Materials).

- Developed several new numerical methods for CFD/material science using optimization techniques to allow high-order, scalable simulation low Reynolds number flows with multiphysics.
- Implemented massive-scale framework interfacing algebraic multigrid to standard MD codes applicable to general meshless discretizations (scaling to $32k$ processors with $200M$ DOFs).
- Used new techniques to study challenging problems relevant to geophysical flows, suspension flows, and lithium-ion battery development.

Kobe University/Brown University, Kobe, Japan

Instructor **2013 – 2014**

Organized and led two week summer program in Kobe using team projects to teach graduate students fundamentals of HPC on the Kei supercomputer.

- Led teams of 4-5 students to develop parallel code from scratch, run on a node of the Kei computer, and generate 3D visualizations culminating in presentation to school and government officials.
- Students successfully completed implementation of spectral element method on unstructured grids to simulate incompressible flow and particle implementation of peridynamics to simulate fracture mechanics.

University of Massachusetts, Amherst, MA

Graduate research assistant **2008 – 2010**

Developed a finite-volume solver for simulating transonic turbulent fuel injection in collaboration with experimental research group at Air Force Research Laboratory.

- Implemented solvers, boundary conditions, and ray-tracing tools using C++ finite-volume library OpenFOAM.
- Coupled Eulerian primary atomization models with stochastic Lagrangian models to develop pipeline for simulating entire fuel injection process.
- Code currently being used to study diesel fuel injection by groups in Amherst and Polytechnical University of Valencia.

Selected publications

A high-order monolithic meshfree discretization for simulating electrophoretic mobility of arbitrary colloid shapes
N.Trask, M. Maxey (In preparation)

A mixed meshless quasi-divergence free method for the Stokes equations with applications to colloidal suspensions
N.Trask, M. Maxey (In preparation)

A high-order compatible meshless method for elliptic problems
N. Trask, M. Perego, P. Bochev (In review)

Compact moving least squares: An optimization framework for generating high order compact meshless discretizations
N. Trask, M. Maxey, X. Hu (In review)

A scalable consistent second-order SPH solver for unsteady low Reynolds number flows
N. Trask, M. Maxey, K. Kim, M. Perego, M.L. Parks, K. Yang, J. Xu - Computer Methods in Applied Mechanics and Engineering 2015

Smoothed particle hydrodynamics and its applications for multiphase flow and reactive transport in porous media
A.M. Tartakovsky, N. Trask, K. Pan, B. Jones, W. Pan, J.R. Williams - Computational Geosciences 2015

Intercomparison of 3D pore-scale flow and solute transport simulation methods.
X. Yang, N. Trask, et al. Advances in Water Resources 2015

Compressible modeling of the internal two-phase flow in a gas-centered swirl coaxial fuel injector
N. Trask, D.P. Schmidt, M. Lightfoot, S. Danczyk - Journal of Propulsion and Power 2012

Diesel spray CFD simulations based on the $\Sigma - Y$ Eulerian atomization model
J.M. Garcia-Oliver, J.M. Pastor, A. Pandal, N. Trask, E. Baldwin, D.P. Schmidt - Atomization and Sprays 2013

Multidimensional modeling of condensing two-phase ejector flow
M. Colarossi, N. Trask, D.P. Schmidt, M.J. Bergander - International Journal of Refrigeration 2012

Skills

- Programming: C, C++, Matlab, Python, bash scripting
- Libraries, codes and commercial packages: MPI, OpenMP, Charm++, OpenFOAM, LAMMPS, Trilinos, NEKTAR, FFTW, GNU Scientific Library, Fluent, ProEngineer, ANSYS workbench
- Languages: English (native), German (conversational)
- Publishing: LaTeX 2_ε