

Matthew J. Roelle
Curriculum Vitae

Contact

Phone (650) 283-3971

Email roelle@stanford.edu

Website <http://matthew.roelle.name/>

Address 734 Live Oak Avenue
Apartment 8
Menlo Park, CA 94025

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Education *Ph.D.* Stanford University; Stanford California January 2004 – Present
Doctor of Philosophy in Mechanical Engineering, GPA 3.5

Research Area Estimating Gas Composition and Thermodynamic State in
Internal Combustion Engines with Exhaust Retention

Advisor J. Christian Gerdes

Laboratory Dynamic Design Laboratory, <http://ddl.stanford.edu/hcci>

Courses **Control courses:** Linear Systems, Nonlinear Systems, Hybrid
Systems, System Identification, Classic Control, Modern
Control, Robust Control, Convex Optimization

Other courses: Mechatronics Design (ME218),
Thermodynamics, Combustion Fundamentals

M.S. Stanford University; Stanford, California September 2002 – January 2004
Master of Science in Mechanical Engineering, GPA 3.5

B.S.E. University of Michigan; Ann Arbor, Michigan September 1994 – April 1998
Bachelor of Science in Engineering in Mechanical Engineering, GPA 3.7

Experience *Graduate Student Researcher, Stanford University* September 2002 –
Dynamic Design Laboratory, Stanford, California, USA present

Created a cylinder thermodynamic state estimator. I modeled the four-stroke engine cycle as a non-linear hybrid system in order to correlate combustion timing to the cylinder thermodynamic state and test simple fuel reaction models. The estimator maps state-updates using cylinder pressure and volume measurements. Airflow and exhaust oxygen measurements validate the estimates. Results demonstrating this process have been published in 2007 at the ASME IMECE as “*Estimating Thermodynamic State and Ignition in HCCI with Variable Fuel Injection Timing.*”

Experience
(continued)

Graduate Student Researcher, Stanford University
Dynamic Design Laboratory, Stanford, California, USA

September 2002 –
present

Organized Fifth IFAC Symposium on Advances in Automotive Control. As the point contact for the rest of the organization committee and conference attendees, I covered all details and logistics to enact Chris Gerdes's vision for the Symposium. I was effectively the assistant organizer and distinctly I managed the Symposium website, the credit card gateway and merchant accounts, interfaced with the PaperCept paper submission website and designed the logo and all other artwork.

Validated a simple thermal wall model. I adapted a continuous time model of the engine cycle to include direct fuel injection and the cylinder wall temperature. I modeled the cylinder wall as a single thermal mass to explain experimentally observed slow changes in ignition timing. In simulation, fast cycle-to-cycle dynamics are influenced by the cylinder wall temperature while the relatively sluggish wall dynamics are captured simply in a form directly amenable to control. Published in 2006 as “*A Dynamic Model of Recompression HCCI Combustion Including Cylinder Wall Temperature.*”

Designed and assembled an instrumentation and control system for a single cylinder engine. This included designing several circuits, a piston, a repetitive control algorithm for hydraulic engine valve actuators and a direct-fuel-injection system. I designed custom engine control software in Simulink and translated it with the Matlab Real Time Workshop for execution on multiple xPC target computers. My software provides an interface to command fuel, spark and hydraulic valve actuator profiles as well as measurement of all sensors and engine indication at 20 kHz. The software can diagnose faults in the valve system and enact fail-safe procedures to avoid piston collisions. I completed the instrumentation system with a custom user interface in Simulink. The user interface communicates with multiple targets and is capable of changing pertinent parameters and collecting amalgamated data.

Modeled SI to HCCI mode transition. I matched simulations of a ten-state continuous time engine model developed by Shaver et al. to experimental data of SI and HCCI combustion. The simulation included supervisory control for switching from spark-ignition parameters, including explicitly commanded ignition timing, to HCCI parameters. Transitions from SI to HCCI were simulated to demonstrate the dynamics present when the exhaust from SI is re-inducted to induce HCCI. Published in 2004 as “*Tackling the Transition: A Multi-mode Combustion Model of SI and HCCI for Mode Transition Control*”

Modeled engine exhaust manifold. In order to understand the effect of exhaust re-inducted from the exhaust manifold, I created a continuous-time single-zone thermodynamic model. Coupled with a cylinder model, the system model captures empirical multi-cycle combustion dynamics. Modeling the exhaust from previous combustion cycles is part and parcel to all of the above.

Experience (continued)	<i>OBDII Development Engineer, General Motors Powertrain</i> General Motors Proving Grounds, Milford, Michigan, USA	June 1998 – August 2002
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Initiated cold-start-control-strategy diagnostic. New legislation dictated on-board verification that a vehicle's cold start strategy executes properly. I started a new development team and designed much of a new diagnostic to meet the legal requirement. The diagnostic was patented in 2005 as “*Method for On-Board Diagnosis of Cold Start Emissions Reduction Control Strategy.*”

Designed secondary air injection system diagnostic. New diagnostic legislation for secondary air injection systems required detection of failures that would raise emissions 50% over the applicable standard. I extensively tested failure modes and designed a new diagnostic with a diverse team of other engineers. This was one of the first algorithms to be documented with Simulink block diagrams instead of pseudo-code. The diagnostic method was patented in 2006 as “*Secondary Air Injection Diagnostic System Using Pressure Feedback.*”

Audited internal quality-system. After training in auditing GM Powertrain's QS-9000 quality-system, I performed periodic internal audits to maintain compliance with quality-system standards and prepare for external audits.

Verified OBDII performance on E85 vehicle. GM introduced flex fuel vehicles in the 2000 model-year capable of operating on blends of gasoline and ethanol, up to E85. I was designed and executed studies that confirmed diagnostic compliance on ethanol blends.

<i>Coach, Grand Blanc Water Polo Club</i> Grand Blanc High School, Grand Blanc, Michigan, USA	February 1999 – June 2002
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Coached boys and girls high school water polo teams. As a coach for seven seasons, I helped the Grand Blanc program expand and improve. I coached in the evenings and weekends while also working for General Motors in Milford. Coaching duties included planning and leading practices, directing the team during games, motivating players, incorporating parents and acting as go-between with school officials and referees. I also created and implemented real-time statistics software to aid in coaching and to give constructive feedback to players after games.

Experience (continued)	<i>Engineering Intern, General Motors Powertrain</i> General Motors Powetrain, Flint, Michigan, USA	Summer, 1997
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Correlated evaporative emissions to fuel tank leak size. As a central task, I performed an OBDII related study on fuel tank evaporative emissions and developed a fuel tank deflection model and testing method to aid future fuel tank design. I also assisted a critical part quality study at a manufacturing facility in Virginia with a Shanin consultant.

Updated Process Failure Mode and Effects Analysis documents. I constructed FMEA templates and performed basic research to create documentation for several processes. I also participated in meetings to complete the FMEA documentation and identify operations for preventative maintenance. I also created process quality maintenance documentation to comply with QS-9000 standards.

Created and maintained process logs for constraint processes. I studied the theory of constraint operations and then monitored in detail several suspect operations on an automatic transmission component line to identify constraint processes.

Journal Publications	Gregory M. Shaver, Matthew J. Roelle, J. Christian Gerdes, <i>Modeling Cycle-to-Cycle Dynamics and Mode Transition in HCCI Engines with Variable Valve Actuation</i> , IFAC Journal on Control Engineering Practice (CEP), vol. 14, no. 3, pp. 213-222, March 2006, Advances in Automotive Control (AAC'04), doi: 10.1016/j.conengprac.2005.04.009
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Gregory M. Shaver, Matthew J. Roelle, J. Christian Gerdes, Patrick A. Caton and Christopher F. Edwards, *Dynamic Modeling of Residual-Affected Homogeneous Charge Compression Ignition Engines with Variable Valve Actuation*, ASME Journal of Dynamic Systems, Measurement and Control, vol. 127, no. 3, pp. 374-381, September 2005, doi:[10.1115/1.1979511](https://doi.org/10.1115/1.1979511)

Gregory M. Shaver, Matthew J. Roelle, Patrick A. Caton, Nalu B. Kaahaaina, Nikhil Ravi, Jean-Pierre Hathout, Jasim Ahmed, Aleksander Kojic, Sungbae Park, Christopher F. Edwards and J. Christian Gerdes, *A Physics-Based Approach to the Control of Homogeneous Charge Compression Ignition Engines with Variable Valve Actuation*, International Journal of Engine Research, vol. 6, no. 4, pp. 361-375, July 2005, doi:[10.1243/146808705X30512](https://doi.org/10.1243/146808705X30512)

Conference
Publications

Matthew J. Roelle, Nikhil Ravi, J. Christian Gerdes, *Estimating Thermodynamic State and Ignition in HCCI with Variable Fuel Injection Timing*, accepted to the 2007 ASME International Mechanical Engineering Congress and Exposition, Seattle, Washington, November 11-15, 2007, IMECE2007-42450

Nikhil Ravi, Matthew J. Roelle, J. Christian Gerdes, *Controller-Observer Implementation for Cycle-by-Cycle Control of an HCCI Engine*, accepted to the 2007 ASME International Mechanical Engineering Congress and Exposition, Seattle, Washington, November 11-15, 2007, IMECE2007-42371

Nikhil Ravi, Matthew J. Roelle, Adam F. Jungkunz, J. Christian Gerdes, *Model Based Control of Exhaust Recompression HCCI*, Proceedings of the Fifth IFAC Symposium on Advances in Automotive Control, pp. 295-310, Aptos, California, August 20-22, 2007, AAC07-084

Matthew J. Roelle, Nikhil Ravi, Adam F. Jungkunz, J. Christian Gerdes, *A Dynamic Model of Recompression HCCI Combustion Including Cylinder Wall Temperature*, Proceedings of the 2006 ASME International Mechanical Engineering Congress and Exposition, Chicago, Illinois, November 5-10, 2006, IMECE2006-15125

Nikhil Ravi, Matthew J. Roelle, Adam F. Jungkunz, J. Christian Gerdes, *A Physically Based Two-State Model for Controlling Exhaust Recompression HCCI in Gasoline Engines*, Proceedings of the 2006 ASME International Mechanical Engineering Congress and Exposition, Chicago, Illinois, November 5-10, 2006, IMECE2006-15331

Gregory M. Shaver, Matthew J. Roelle, J. Christian Gerdes, *A Two-Input Two-Output Control Model of HCCI Engines*, Proceedings of the 2006 American Control Conference, pp. 472-477, Minneapolis Minnesota, June 14-16, 2006, doi:[10.1109/ACC.2006.1655401](https://doi.org/10.1109/ACC.2006.1655401)

Gregory M. Shaver, Matthew J. Roelle, J. Christian Gerdes, *Decoupled Control of Combustion Timing and Work Output in Residual-Affected HCCI Engines*, Proceedings of the 2005 American Control Conference, vol. 6, pp. 3871-3876, Portland, Oregon, June, 8-10 2005, doi:[10.1109/ACC.2005.1470578](https://doi.org/10.1109/ACC.2005.1470578)

Matthew J. Roelle, Gregory M. Shaver and J. Christian Gerdes, *Tackling the Transition: A Multi-mode Combustion Model of SI and HCCI for Mode Transition Control*, Proceedings of the 2004 ASME International Mechanical Engineering Congress and Exposition, Anaheim, California, November 13-19, 2004, IMECE2004-62188

Gregory M. Shaver, Matthew J. Roelle, J. Christian Gerdes, *Physics-Based Closed-Loop Control of Phasing, Peak Pressure and Work Output in HCCI Engines Utilizing Variable Valve Actuation*, Proceedings of the 2004 American Control Conference, vol. 1, pp. 150-155, Denver, Colorado, June 30-July 2, 2004

Conference Publications (continued) Gregory M. Shaver, Matthew Roelle and J. Christian Gerdes, *Modeling Cycle-to-Cycle Coupling in HCCI Engines Utilizing Variable Valve Actuation*, Proceedings of the Fourth IFAC Symposium on Advances in Automotive Control, 2004, pp. 244-249, Salerno, Italy, April 19-23, 2004

Patents *Secondary Air Injection Diagnostic System Using Pressure Feedback*, Matthew J. Roelle, Martin L. Hall, Daniel H. Hooker, Gary E. Johnston, Kevin E. Person, Jeffrey M. Polidan, [U.S. Patent Number 6,983,590](#), Awarded January 10, 2006

Method for On-Board Diagnosis of Cold Start Emissions Reduction Control Strategy, Wenbo Wang, Richard B. Jess, Lyle E. Hamilton, Daniel G. Bolstrum, Matthew J. Roelle, John F. Van Gilder, David N. Belton, Richard W. Amann, Fang-Cheng J. Fu, [U.S. Patent Number 6,871,136](#), Awarded March 22, 2005

Method and Apparatus for Monitoring Catalyst Efficiency and Secondary Air Injection, Wenbo Wang, Matthew J. Roelle, Guojun Shi, [U.S. Patent Number 6,802,181](#), Awarded October 12, 2004

Honors Journal of Dynamic Systems, Measurement and Control, Rudolf Kalman Best Paper Award for “*Dynamic Modeling of Residual-Affected Homogeneous Charge Compression Ignition Engines with Variable Valve Actuation*” with Gregory M. Shaver, J. Christian Gerdes, Patrick A. Caton and Christopher F. Edwards

MacDonald Fellowship, Stanford University, September 2002 to December 2003

Magna cum Laude, B.S.E., University of Michigan, 1998

Dean's List and Class Honors, all possible semesters, University of Michigan

Other Interests Swimming, cycling and running
Finished the 2007 San Francisco Marathon and several triathlons

Web and graphic design
Maintain multiple websites and routinely design promotional materials

Network system administration
sudo admin on multiple Linux web/file/backup servers

Community involvement
Coached Grand Blanc High School water polo for seven seasons

References available upon request