

BRIAN C. KAUL, PHD

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WORK EXPERIENCE

Oak Ridge National Laboratory, Knoxville, TN

Senior Research Staff—Fuel Science and Engine Technologies Research Group

2012–present

- Served as principal investigator for research related to nonlinear dynamics analysis of abnormal combustion phenomena
- Coordinated multi-lab research activities related to application of machine learning for mitigation of combustion instabilities as a team lead for the Partnership to Advance Combustion Engines (PACE) consortium
- Conducted research on the combustion of alternative low-carbon and net-zero-carbon fuels for marine engine applications
- Conducted research on the effects of lubricants on marine diesel efficiency and durability on a unique single-cylinder, scaled-down, crosshead 2-stroke diesel engine
- Developed, deployed, and maintained in-house LabVIEW-based Oak Ridge Combustion Analysis System (ORCAS)
- Gained extensive experience in setting up engine experiments and data acquisition/control systems and conducting experiments related to engine combustion, efficiency, and emissions: supported carbon capture, buildings experiments
- Communicated findings through publications and presentations and maintained sponsor relationships

Oak Ridge National Laboratory, Knoxville, TN

Postdoctoral Research Associate—Fuels, Engines, and Emissions Research Center

2008–2012

- Conducted second-law thermodynamic analysis of experimental and modeling data for a heavy-duty diesel engine
- Conducted experiments for thermodynamic, material durability, and turbocharger performance studies on a heavy-duty diesel engine
- Oversaw installation and commissioning of a prototype large-bore natural gas single-cylinder research engine
- Designed, installed, and programmed LabVIEW-based engine control system for a single-cylinder natural gas engine
- Designed engine experiments to examine combustion instabilities in lean natural gas engine operation
- Prepared reports and presented results from various studies (largely corporate sponsor proprietary data/unpublished)
- Participated in proposal process for multiple new projects

PROFESSIONAL AFFILIATIONS AND ACTIVITIES

SAE International

Member

2004–Present

- Engine Combustion Committee member
- Lead session organizer and session chair
- Invited symposium presenter
- Paper author and reviewer

American Society of Mechanical Engineers (ASME)

Member

2001–Present

- Paper author and reviewer

Institute of Electrical and Electronics Engineers (IEEE)

Senior Member

2022–Present

- Elevated to Senior Member 2022
- Paper author and reviewer

Southwest Research Institute

Project Technical Advisory Committee Member

2017–2020

- Participated in project titled “Natural gas dedicated exhaust gas recirculation for improved on-highway efficiency,” sponsored by the California Clean Energy Commission
- Provided technical review and advice on project direction and research approach

EDUCATION

Missouri University of Science & Technology, Rolla, MO	
PhD in Mechanical Engineering	2008
Dissertation: <i>Addressing nonlinear combustion instabilities in highly dilute SI engine operation</i>	
Missouri University of Science & Technology, Rolla, MO	
MS in Mechanical Engineering	2003
Thesis: <i>Three-dimensional velocity measurements of three-dimensional turbulent separated flow</i>	
Missouri University of Science & Technology, Rolla, MO	
BS in Mechanical Engineering	2001
Minor: History	
Graduated summa cum laude	

HONORS AND AWARDS

Senior Member, IEEE	2022
Mentor of the Year, Oak Ridge Postdoc Association	2021
Exceptional Effort Award, ORNL Energy & Transportation Science Division	2016
GAANN Fellowship, Missouri University of Science & Technology	2006–2007
Chancellor's Fellowship, University of Missouri – Rolla	2001–2006
TBP Engineering Honor Society Member, Chapter Officer	2000–2001
ΠΤΣ Mechanical Engineering Honor Society Member, Chapter President	1999–2001
ΦΚΦ Honor Society Member	2000–2001

TEACHING EXPERIENCE

Missouri University of Science & Technology, Rolla, MO	
Instructor: "ME 221—Applied Thermodynamics"	2007–2008
Developed syllabus, lectured, administered assignments and grading	

PUBLICATIONS

60+ peer-reviewed articles, 900+ citations, h-index = 16, i10-index = 26

Kaul B, Maldonado B, Michlberger A, Halley S, "Analysis of real-world preignition data using neural networks," *SAE Technical Paper 2023-01-1614*, 2023. doi:10.4271/2023-01-1614

Curran S, Onorati A, Payri R, Agarwal AK, Arcoumanis C, Bae C, Boulouchos K, dal Forno Chuahy F, Gavaises M, Hampson GJ, Hasse C, Kaul B, Kong S-C, Kumar D, Novella R, Pesyridis A, Reitz R, Vaglieco BM, Wermuth N, "The future of ship engines: Renewable fuels and enabling technologies for decarbonization," *International Journal of Engine Research*, 2023. doi:10.1177/14680874231187954

Kaul B, Gillespie T, Curran S, *Hazard and operability study for the ammonia fuel systems at the National Transportation Research Center*, ORNL Report ORNL/TM-2023/2963, 2023. doi:10.2172/1989552

Kaul B, Kass M, Nafziger E, Givens W, Satterfield A, Senzer E, Chen M, "Lubricant impacts on piston deposit formation in the Enterprise marine diesel research engine," *Proceedings of the 30th CIMAC World Congress*. 2023, Busan, Korea.

Sieger M, Turner J, Allu S, Ameen M, Chaudhuri S, Chen J, Chen Y, Chuahy F, Finney C, Gururajan V, Huang H, Kaul B, Klippenstein S, Martin H, Pal P, Peles S, Plotkowski A, Sanyal J, Sengupta M, Som S, Sprague M, *Computational requirements in clean energy and manufacturing: Summary report of the virtual workshop held on June 28–29, 2021*. ORNL Report ORNL/SPR-2023/2707, 2023. doi:10.2172/1971039

Lance MJ, Toops T, Moses-DeBusk M, Kaul BC, Lambert C, Liu X, Luo H, Qu J, Rieth R, Ritchie A, Huff SP, Maricq M, Dobson D, Gangopadhyay A, Chanko T, "Investigation of lubricant additive interactions on gasoline particulate filters," *SAE International Journal of Fuels and Lubricants* 16(3), 2023. doi:10.4271/04-16-03-0019

- Kaul BC, Nafziger EJ, Kass MD, Satterfield AD, Conti R, Prabhakar B, Givens WA, "Measurement of piston deposit thickness using laser profilometer," *SAE International Journal of Fuels and Lubricants* 16(3), 2023. doi:10.4271/04-16-03-0014
- Maldonado BP, Kaul BC, Schuman CD, Young SR, Mitchell JP, "Next-cycle optimal dilute combustion control via online learning of cycle-to-cycle variability using kernel density estimators," *IEEE Transactions on Control Systems Technology* 30(6):2433–2449, 2022. doi:10.1109/TCST.2022.3149423
- Chuahy FDF, Finney CEA, Kaul BC, Kass MD, "Computational exploration of bio-oil blend effects on large two-stroke marine engines," *Fuel* 322, 2022. doi:10.1016/j.fuel.2022.123977
- Kass M, Kaul B, Armstrong B, Szybist J, Lobodin V, "Stability, rheological and combustion properties of biodiesel blends with a very-low sulfur fuel oil (VLSFO)," *Fuel* 316, 2022. doi:10.1016/j.fuel.2022.123365
- Maldonado BP, Kaul BC, Szybist JP, "Artificial neural networks for in-cycle prediction of knock events," *SAE Technical Paper* 2022-01-0478, 2022. doi:10.4271/2022-01-0478
- Maldonado B, Stefanopoulou A, Kaul B, "Chapter 8 – Artificial-intelligence-based prediction and control of combustion instabilities in spark-ignition engines," in *Artificial Intelligence and Data Driven Optimization of Internal Combustion Engines*, Editors: Badra J, Pal P, Pei Y, Som S, Elsevier, 2022, pp 185–212. doi:10.1016/B978-0-323-88457-0.00006-0
- Schuman CD, Young SR, Maldonado BP, Kaul BC, "Real-time evolution and deployment of neuromorphic computing at the edge," *Proceedings of the 12th International Green and Sustainable Computing Workshops (ISGC)*, 2021. doi:10.1109/IGSC54211.2021.9651607
- Curran S, Szybist J, Kaul B, Easter J, Sluder S, "Fuel stratification effects on gasoline compression ignition with a regular-grade gasoline on a single-cylinder medium-duty diesel engine at low load," *SAE International Journal of Advances and Current Practices in Mobility* 4(2):488–501, 2021. doi:10.4271/2021-01-1173
- Lerin C, Edwards K, Curran S, Nafziger E, Moses-Debusk M, Kaul B, Singh S, Allain M, Girbach J, "Exploring the potential benefits of high-efficiency dual-fuel combustion on a heavy-duty multi-cylinder engine for SuperTruck I," *International Journal of Engine Research*, 2021. doi:10.1177/14680874211006943
- Lerin C, Curran S, Moses-Debusk M, Cook A, Colomer V, Kaul B, Deter D, "Hardware-in-the-loop investigation of emissions challenges in hybrid medium- and heavy-duty powertrains using a pre-production diesel-electric parallel hybrid system with and without stop-start operation," *Proceedings of the ASME 2021 Internal Combustion Engine Division Fall Technical Conference*, 2021. doi:10.1115/ICEF2021-68317
- Maldonado BP, Kaul BC, Schuman CD, Young SR, Mitchell JP, "Next-cycle optimal fuel control for cycle-to-cycle variability reduction in EGR-diluted combustion," *IEEE Control Systems Letters* 5(6):2204–2209, 2021. doi:10.1109/LCSYS.2020.3046433
- Maldonado BP, Kaul BC, Schuman CD, Young SR, Mitchell JP, "Dilute combustion control using spiking neural networks," *SAE Technical Paper* 2021-01-0534, 2021. doi:10.4271/2021-01-0534
- Stiffler R, Kaul B, Drallmeier J, "Cyclic dynamics of misfires and partial burns in a dilute spark-ignition engine," *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering* 235(2–3):333–345, 2021. doi:10.1177/0954407020964004
- Maldonado BP, Kaul BC, "Evaluation of residual gas fraction estimation methods for cycle-to-cycle combustion variability analysis and modeling," *International Journal of Engine Research*, 2021. doi:10.1177/1468087420983087
- Maldonado BP, Kaul BC, Schuman CD, Young SR, Mitchell JP, "Next-cycle optimal fuel control for cycle-to-cycle variability reduction in EGR-diluted combustion," *Proceedings of the 2021 American Control Conference (ACC)*, 2021. doi:10.1109/ACC50511.2021.9483128
- Kass MD, Sluder CS, Kaul BC, *Spill behavior, detection, and mitigation for emerging nontraditional marine fuels*, Oak Ridge, Tennessee, USA: Oak Ridge National Laboratory, 2021. ORNL Report No. ORNL/SPR-2021/1837
- Kaul B, Finney C, Stiffler R, Drallmeier J, "Advanced intra-cycle detection of pre-ignition events through phase-space transforms of cylinder pressure data," *SAE International Journal of Advances and Current Practices in Mobility* 3(1):215–222, 2021. doi:10.4271/2020-01-2046
- Schuman CD, Young SR, Mitchell JP, Johnston JT, Rose D, Maldonado BP, Kaul BC, "Low size, weight, and power neuromorphic computing to improve combustion engine efficiency," *Proceedings of the 11th International Green and Sustainable Computing Workshops (IGSC)*, 2020. doi:10.1109/IGSC51522.2020.9291228

Maldonado BP, Kaul BC, "Control-oriented modeling of cycle-to-cycle combustion variability at the misfire limit in SI engines," *Proceedings of the ASME 2020 Dynamic Systems and Control Conference*, 2020. doi:10.1115/DSCC2020-3255

Kass MD, Armstrong BL, Kaul BC, Connatser RM, Lewis S, Keiser JR, Jun J, Warrington G, Sulejmanovic D, "Stability, combustion, and compatibility of high-viscosity heavy fuel oil blends with a fast pyrolysis bio-oil," *Energy & Fuels* 34(7):8403–8413, 2020. doi:10.1021/acs.energyfuels.0c00721

Kass M, Biruduganti M, Kaul B, Storey J, Longman D, Elliott A, Siddel D, "Performance of a printed bimetallic (stainless steel and bronze) engine head operating under stoichiometric and lean spark ignited (SI) combustion of natural gas," *SAE Technical Paper* 2020-01-0770, 2020. doi:10.4271/2020-01-0770

Jatana GS and Kaul BC, "Characterization of temporal variations and feedback timescales of exhaust gas recirculation gas properties using high-speed diode laser absorption spectroscopy for next-cycle control of cyclic variability," *International Journal of Engine Research* 20(8–9), 2019. doi:10.1177/1468087418805654

Kaul B, Nafziger E, Kass M, Givens W, Crouthamel K, Fogarty J, Satterfield A, Brabez N, Jamieson A, Williams M, Blaxill H, Kristensen N, "Enterprise: a reduced-scale, flexible fuel, single-cylinder crosshead marine diesel research engine," *Proceedings of the 29th CIMAC World Congress*. 2019, Vancouver, Canada.

Szybist J, Pihl J, Huff S, Kaul B, "High load expansion of catalytic EGR-loop reforming under stoichiometric conditions for increased efficiency in spark ignition engines," *SAE International Journal of Advances and Current Practices in Mobility* 1(2):588–600, 2019. doi:10.4271/2019-01-0244

Splitter D, Kaul B, Szybist J, Speed L, Zigler B, Luecke J, "Fuel-lubricant interactions on the propensity for stochastic pre-ignition," *SAE Technical Paper* 2019-24-0103, 2019. doi:10.4271/2019-24-0103

Kass MD, Kaul BC, Edwards KD, Noakes MW, "Research activities, challenges, and future directions in UAV propulsion," *Proceedings of the 8th Conference on Propulsion Technologies for Unmanned Aerial Vehicles*, 2019, Haifa, Israel.

Jatana GS, Splitter DA, Kaul BC, Szybist JP, "Fuel property effects on low-speed pre-ignition," *Fuel* 230:474–482, 2018. doi:10.1016/j.fuel.2018.05.060

Szybist JP, Davis S, Thomas JT, Kaul BC, "Performance of a half-Heusler thermoelectric generator for automotive application," *SAE Technical Paper* 2018-01-0054, 2018. doi:10.4271/2018-01-0054

Jatana GS and Kaul BC, "Determination of SI combustion sensitivity to fuel perturbations as a cyclic control input for highly dilute operation," *SAE International Journal of Engines* 10(3):1011–1018, 2017. doi:10.4271/2017-01-0681

Splitter D, Kaul B, Szybist J, Jatana G, "Engine operating conditions and fuel properties on pre-spark heat release and SPI promotion in SI engines," *SAE International Journal of Engines* 10(3):1036–1050, 2017. doi:10.4271/2017-01-0688

Wissink ML, Splitter DA, Dempsey AB, Curran SJ, Kaul BC, Szybist JP, "An assessment of thermodynamic merits for current and potential future engine operating strategies," *International Journal of Engine Research* 18(1–2):155–169, 2017. doi:10.1177/1468087416686698

Lawler B, Splitter D, Szybist J, Kaul B, "Thermally stratified compression ignition: a new advanced low temperature combustion mode with load flexibility," *Applied Energy* 186:122–132, 2017. doi:10.1016/j.apenergy.2016.11.034

Kaul BC, Lawler BJ, Zahdeh A. "Engine diagnostics using acoustic emissions sensors," *SAE International Journal of Engines* 9(2), 2016. doi:10.4271/2016-01-0639

Jatana GS, Kaul BC, Wagner R, "Impact of delayed spark restrike on the dynamics of cyclic variability in dilute SI combustion," *SAE Technical Paper* 2016-01-0691, 2016. doi:10.4271/2016-01-0691

Gao Z, Smith DE, Daw CS, Edwards KD, Kaul BC, Domingo N, Parks JE II, Jones PT. "The evaluation of developing vehicle technologies on the fuel economy of long-haul trucks," *Energy Conversion and Management* 106:766–781, 2015. doi:10.1016/j.enconman.2015.10.006

Wallner T, Sevik J, Scarcelli R, Kaul B, Wagner R. "Effects of ignition and injection perturbation under lean and dilute GDI engine operation," *SAE Technical Paper* 2015-01-1871, 2015. doi:10.4271/2015-01-1871

Daw CS, Finney CEA, Kaul BC, Edwards KD, Wagner RM. "Characterizing dilute combustion instabilities in a multi-cylinder spark-ignited engine using symbolic analysis," *Philosophical Transactions of the Royal Society A* 373(2034), 2015. doi:1098/rsta.2014.0088

- Finney CEA, Kaul BC, Daw CS, Wagner RM, Edwards KD, Green JB. "Invited review: A review of deterministic effects in cyclic variability of internal combustion engines," *International Journal of Engine Research*, 2015. doi:10.1177/1468087415572033
- Kaul BC, Lawler BJ, Finney CEA, Edwards ML, Wagner RM. "Effects of data quality reduction on feedback metrics for advanced combustion control," *SAE Technical Paper 2014-01-2707*, 2014. doi:10.4271/2014-01-2707
- Kaul BC, Finney CEA, Wagner RM, Edwards ML. "Effects of external EGR loop on cycle-to-cycle dynamics of dilute SI combustion," *SAE International Journal of Engines 7(2)*, 2014. doi:10.4271/2014-01-1236
- Storey JM, Theiss TJ, Kass MD, Finney CEA, Lewis SA, Kaul BC, Besmann TM, Thomas JF, Rogers H, Sepaniak M. *Fuel flexibility: landfill gas contaminant mitigation for power generation*, Oak Ridge, Tennessee, USA: Oak Ridge National Laboratory, 2014. Report No. ORNL/TM-2014/44
- Kass MD, Noakes MW, Kaul BC, Edwards KD, Theiss TJ, Love LJ, Dehoff RR, Thomas JF. "Experimental evaluation of a 4-cc glow-ignition single-cylinder two-stroke engine," *SAE Technical Paper 2014-01-1673*, 2014. doi:10.4271/2014-01-1673
- Storey JM, Lewis SA, Szybist JA, Thomas JF, Barone TL, Eibl M, Nafziger E, Kaul BC. "Novel characterization of GDI engine exhaust for gasoline and mid-level gasoline-alcohol blends," *SAE International Journal of Fuels and Lubricants 7(2)*, 2014. doi:10.4271/2014-01-1606
- Kaul BC, Wagner RM, Green JB. "Analysis of cyclic variability of heat release for high-EGR GDI engine operation with observations on implications for effective control," *SAE International Journal of Engines 6(1)*, 2013. doi:10.4271/2013-01-0270
- Kaul BC, Vance JB, Drallmeier JA, Sarangapani J. "A method for predicting performance improvements with effective cycle-to-cycle control of highly dilute spark ignition engine combustion," *Proceedings of the Institution of Mechanical Engineers Part D: Journal of Automobile Engineering 223(3):423–438*, 2009. doi:10.1243/09544070JAUTO943
- Shih P, Kaul BC, Jagannathan S, Drallmeier JA. "Reinforcement-learning-based output-feedback control of nonstrict nonlinear discrete-time systems with application to engine emission control," *IEEE Transactions on Systems, Man, and Cybernetics—Part B: Cybernetics 39(5):1162–1179*, 2009. doi:10.1109/TSMCB.2009.2013272
- Vance JB, Kaul BC, Jagannathan S, Drallmeier JA. "Neuro emission controller for minimising cyclic dispersion in spark ignition engines with EGR levels," *International Journal of General Systems 38(1):45–72*, 2009. doi:10.1080/03081070802193028
- Shih P, Kaul BC, Jagannathan S, Drallmeier JA. "Reinforcement-learning-based dual-control methodology for complex nonlinear discrete-time systems with application to spark engine EGR operation," *IEEE Transactions on Neural Networks 19(8):1369–1373*, 2008. doi:10.1109/TNN.2008.2000452
- Vance JB, Kaul BC, Jagannathan S, Drallmeier JA. "Output feedback controller for operation of spark ignition engines at lean conditions using neural networks," *IEEE Transactions on Control Systems Technology 16(2):214–228*, 2008. doi:10.1109/TCST.2007.903368
- Vance JB, Singh A, Kaul BC, Jagannathan S, Drallmeier JA. "Neural network controller development and implementation for spark ignition engines with high EGR levels," *IEEE Transactions on Neural Networks 18(4):1083–1100*, 2007. doi:10.1109/TNN.2007.899199
- Shih P, Kaul BC, Jagannathan S, Drallmeier JA. "Near optimal output feedback controller of nonlinear discrete-time systems in nonstrict feedback form with application to engines," *Proceedings of the International Joint Conference on Neural Networks*, 2007. doi:10.1109/IJCNN.2007.4370989
- Shih P, Vance JB, Kaul BC, Jagannathan S, Drallmeier JA. "Reinforcement learning based output-feedback control of nonlinear nonstrict feedback discrete-time systems with application to engines," *Proceedings of the 2007 American Controls Conference*, 2007. doi:10.1109/ACC.2007.4283127
- Singh A, Vance JB, Kaul BC, Sarangapani J, Drallmeier JA. "Neural network control of spark ignition engines with high EGR levels," *The 2006 IEEE International Joint Conference on Neural Network Proceedings*, 2006. doi:10.1109/IJCNN.2006.247201
- Vance JB, He P, Kaul BC, Sarangapani J, Drallmeier JA. "Neural network-based output feedback controller for lean operation of spark ignition engines," *Proceedings of the American Controls Conference*, 2006. pp 1898–1905. doi:10.1109/ACC.2006.1656497
- He P, Bui H, Jagannathan S, Kaul BC, Drallmeier JA. "Neuro emission controller for minimizing cyclic dispersion in spark ignition engines with high EGR levels," *Proceedings of ANNIE*, 2004.

SELECTED INVITED PRESENTATIONS, PANELS, AND SEMINARS

Kaul B, "Environmental and safety considerations for potential future fuels," Concawe (The European Fuel Manufacturers Association) FEMG Meeting, Brussels, Belgium, October 2022.

Kaul B, "Environmental and safety considerations for potential future fuels," *Expert Panel on Future Fuels* SAE WCX22, Detroit, MI, April 2022.

Kusnezov D, Davies M, Zjajo, A, Schuman C, Kaul B, *Keynote Panel: The Commercial Case for Using Neuromorphic Computing to Drive Edge AI Innovation*, The Edge AI Summit, Mountain View, CA, November 2021.

Kaul B, "Computing utilization of AI/ML for advanced engine controls and experimental analysis," *LCF-6: Computational Resource Requirements in Clean Energy and Manufacturing*, OLCF Workshop, Oak Ridge, TN, June 2021.

Kaul B, Maldonado B, Schuman C, Young S, Mitchell P, "Abnormal combustion detection and control," U.S. DRIVE Advanced Combustion & Engine Control Tech Team, Southfield, MI, January 2021.

Kaul B, Wagner R, Edwards D, Finney C, Schuman K, Patton R, "Next-cycle controls to mitigate dynamical combustion instabilities," SAE High-Efficiency Engine Symposium, Detroit, MI, April 2019.

Kass M, Kaul B, Nafziger E, "Powering marine cargo vessels: ORNL's role in advancing marine engines," ORNL Transportation Science Seminar Series, Oak Ridge, TN, May 2018.

Kaul BC, Jatana GS, Wagner RM, Finney CEA, Edwards KD, Daw CS, "Deterministic cyclic variability: characterization and control," VERIFI 2017 Workshop: Understanding Cyclic Variability (CCV) in Internal Combustion Engines, Argonne, IL, November 2017.