

## Will Northrop – Curriculum Vitae

Professor  
Department of Mechanical Engineering  
University of Minnesota  
111 Church St. SE  
Minneapolis, MN, 55540

### PROFESSIONAL APPOINTMENTS

Department of Mechanical Engineering – University of Minnesota	
Professor	2022-present
Director, Thomas E Murphy Engine Research Laboratory	2017-present
Director of Undergraduate Studies in Mechanical Engineering Department	2020-2022
Engineering Co-op Program Director	2021
Associate Professor	2017-2022
Richard and Barbara Nelson Assistant Professor	2011-2017
Aza Power Systems, LLC	
Co-Founder, Senior Technical Advisor	2021-present
Exergi Predictive, LLC	
Co-Founder, Chief Executive Officer/Chief Technology Officer	2020-present
General Motors Research and Development, Warren, MI	
Senior Researcher, Propulsion Systems Research Lab	2010-2011
Postdoctoral Visiting Researcher, Propulsion Systems Research Lab	2009-2010
Department of Mechanical Engineering – University of Michigan - Ann Arbor	
Graduate Research Assistant	2006-2009
Department of Chemical Engineering – University of Michigan - Ann Arbor	
Graduate Research Assistant	2003-2005
Nuvera Fuel Cells, Cambridge, MA	
Lead Research Mechanical Engineer	1998-2003
Chrysler Corporation, Auburn Hills, MI	
Chrysler Institute of Engineering Candidate, Vehicle Platform Engineering	1997-1998

### EDUCATION

Ph.D. Mechanical Engineering, University of Michigan - Ann Arbor	2009
Dissertation: <i>Particulate and gas-phase hydrocarbon emissions from partially premixed low temperature compression ignition combustion of biodiesel</i>	
M.S. Mechanical Engineering, University of Michigan - Ann Arbor	2005
Thesis: <i>Heat integration strategy for a natural gas fuel processor for PEM fuel cell applications</i>	
B.S. Mechanical Engineering, Carnegie Mellon University	1997

## HONORS AND AWARDS

### University of Minnesota

Robert C. Johns Research Partnership Award	2021
McKnight Land Grant Professorship	2015
Center for Transportation Studies Scholar	2013

### External Sources

Fulbright Scholars Award, Spain	2019
SAE Engineering Events Outstanding Oral Presentation Award	2019
Society of Automotive Engineers, Harry L. Horning Award	2018
Society of Automotive Engineers, Ralph Teetor Award	2016
Society of Automotive Engineers, Forest McFarland Award	2016
NSF CAREER Award, Combustion Fire and Plasma Systems	2014
Engineering Graduate Symposium Competition 1 <sup>st</sup> Prize, University of Michigan	2008

### Visiting Scholar Positions

Fulbright Scholar, <i>Centro Universitario de la Defensa, Marin Spain/ Universidad de Vigo, Vigo Spain</i> <i>Topic: Teaching advanced thermodynamics and research in particulate emissions from biomass combustion.</i>	September 2019 – December 2019
Visiting Scholar, <i>Sandia National Laboratory, Combustion Research Facility</i> <i>Topic: Diagnostics of in-cylinder reforming during the negative valve overlap period in low temperature gasoline combustion regimes.</i>	Feb 2015 – April 2015

## PUBLICATIONS

### Summary

Google Scholar – Citations: 1522, h-index:21

Web of Science – Citations: 617, h-index: 15

### 10 Recent Journal Publications

1. Wadkar, C., Kumar, A., Lee, H., Rollins, B., Grosjean, N., Singh, S., and Northrop W.F. (2023) Computational Study on the Effect of Thermal Boundary Conditions and Axial Aspect Ratio on Catalytic Oxidative Coupling of Methane, *Industrial & Engineering Chemistry Research*, <https://doi.org/10.1021/acs.iecr.3c02285>.
2. Reggeti, S.A., Kane, S.P., and Northrop, W.F. (2023) Experimental Investigation of Spark-Assisted Compression-Ignition with Ammonia-Hydrogen Blends, *Journal of Ammonia Energy*, 1(1), DOI: 10.18573/jae.21.
3. Kane, S.P., and Northrop, W.F. (2023) A Quasi-Dimensional Model of Heat Transfer between Multi-Concentric Monolith Structures. *Thermo*, 3(4): 515-536. <https://doi.org/10.3390/thermo3040031>.

4. Reggeti, S.A., Kane, S.P., and Northrop W.F. (2023) Hydrogen Production in Ammonia-Fueled Spark Ignition Engines, *Applications in Energy and Combustion Science*, 14, 100136, <https://doi.org/10.1016/j.jaecs.2023.100136>.
5. Atakan, B., Northrop, W.F., and Kaiser, S.A. (2023) Special Issue on “Piston Engines as Chemical Reactors”, *Applications in Energy and Combustion Science*, 14, 100133, <https://doi.org/10.1016/j.jaecs.2023.100133>.
6. Cho, S., Lee, H., Lin, Y., Singh, S., and Northrop W.F. (2022) Products of catalytic oxidative coupling of methane to improve thermal efficiency in natural gas engines, *Energy Conversion and Management*, 268, 116030, <https://doi.org/10.1016/j.enconman.2022.116030>.
7. Thomas, D.E., Shrestha, K.P., Mauss, F., Northrop, W.F., (2022) Extinction and NO Formation of Ammonia-Hydrogen and Air Non-Premixed Counterflow Flames, *Proceedings of the Combustion Institute*, <https://doi.org/10.1016/j.proci.2022.08.067>.
8. Paykani, A., Chehrmonavaria, H., Tsolakis, A., Alger, T., Northrop, W.F., Reitz, R., (2022) Synthesis Gas as a Fuel for Internal Combustion Engines in Transportation, *Progress in Energy and Combustion Science*, 90, 100995, <https://doi.org/10.1016/j.pecs.2022.100995>.
9. Bock, N., Kittelson, D.B., Northrop, W.F., (2022) Impacts of Engine Lubrication Oil-Derived Ash on Soot Oxidative Reactivity on a Catalytic Gasoline Particulate Filter, *Journal of Aerosol Science*, 162, 105960, <https://doi.org/10.1016/j.jaerosci.2022.105960>.
10. Eagon, M.J., Kindem, D., Paneer Selvam, H. Northrop, W.F., (2022) Neural Network-Based Electric Vehicle Range Prediction for Smart Charging Optimization, *Journal of Dynamic Systems, Measurement, and Control*. <https://doi.org/10.1115/1.4053306>.

## 10 Recent Peer Reviewed Conference Papers

1. Jayaprakash, B., Wilmer, B., and Northrop, W.F. (2023) Initial Development of a Physics-Aware Machine Learning Framework for Soot Mass Prediction in Gasoline Direct Injection Engines, SAE Technical Paper 2023-24-017, <https://doi.org/10.4271/2023-24-0174>.
2. Yang, M., Jayaprakash, B., Jung, H., Northrop, W.F., and Shekhar, S. (2023) Data Mining Challenges and Opportunities to Achieve Net Zero Carbon Emissions: Focus on Electrified Vehicles, Proceedings of the 2023 SIAM International Conference on Data Mining (SDM), <https://doi.org/10.1137/1.9781611977653.ch108>
3. Li, Y., Yang, M., Farhadloo, M., Xie, Y., Northrop, W.F., and Shekhar, S. (2023) Eco-PiNN: A Physics-informed Neural Network for Eco-toll Estimation, Proceedings of the 2023 SIAM International Conference on Data Mining (SDM), <https://doi.org/10.1137/1.9781611977653.ch94>.
4. Badheka, A., Eagon, M., Fakhimi S., Wringa, P., Miller, E., Kotz, A., Northrop, W.F. (2023) Development of a Heavy-Duty Electric Vehicle Integration and Implementation (HEVII) Tool, SAE Technical Paper. 2023-01-0708.
5. Jung, H., Yang, M., Eagon, M., and Northrop, W.F. (2022), Revolutionizing electric vehicle management: spatial computing challenges and opportunities. *Proceedings of the 15th ACM SIGSPATIAL International Workshop on Computational Transportation Science (IWCTS '22)*. Association for Computing Machinery, New York, NY, USA, Article 11, 1–4. <https://doi.org/10.1145/3557991.3567785>
6. Swift, E., Wadkar, C., Lee, H., Singh, S., & Northrop, W.F. (2022) Exploring the Benefits of Oxidative Coupling of Methane on Natural Gas Engine Efficiency Through One-Dimensional Simulation, Proceedings of the ASME 2022 ICE Forward Conference. ASME 2022 ICE Forward Conference. Indianapolis, Indiana, USA. October 16–19, 2022. V001T02A012. ASME. <https://doi.org/10.1115/ICEF2022-91822>.

7. Swift, E., Kane, S., & Northrop, W.F. (2022) Operating Range and Emissions from Ammonia-Hydrogen Mixtures in Spark-Ignited Engines, Proceedings of the ASME 2022 ICE Forward Conference. ASME 2022 ICE Forward Conference. Indianapolis, Indiana, USA. October 16–19, 2022. V001T02A013. ASME. <https://doi.org/10.1115/ICEF2022-91825>.
8. Hicks, M.D., Northrop, W.F., Potratz, D., & Kittelson, D.B. (2022) Temperature Dependent Removal Efficiency of Crankcase Control Devices, Proceedings of the ASME 2022 ICE Forward Conference. ASME 2022 ICE Forward Conference. Indianapolis, Indiana, USA. October 16–19, 2022. V001T04A007. ASME. <https://doi.org/10.1115/ICEF2022-92020>.
9. Eagon, M., Fakhimi, S., Lyu, G. Yang, A., Lin, B., Northrop, W.F., (2022) Model-Based Framework to Optimize Charger Station Deployment for Battery Electric Vehicles, 2022 *IEEE Intelligent Vehicles Symposium (IV)*, 1639-1648, doi:10.1109/IV51971.2022.9827442.
10. Eagon, M., Fakhimi, S., Pernsteiner, A., Northrop, W.F., (2022) Mass Detection for Heavy-Duty Vehicles using Gaussian Belief Propagation, 2022 *IEEE Intelligent Vehicles Symposium (IV)*, 1655-1661, doi: 10.1109/IV51971.2022.9827370.

### **Patent Applications**

1. Northrop, W.F., Kane, S.P. (2022) Reactor Systems and Methods for Thermally Decomposing Ammonia, US17/248433.
2. Northrop, W.F., Wang, P., Kotz, A. (2019) Physical Model-Guided Machine Learning Framework for Energy Management of Range-Extended Hybrid Electric Delivery Vehicles US0200108732.

### **Granted Patents**

1. Northrop, W.F. (2020) Engine Fuel-Reforming Reactors, Systems, and Methods, US Patent 10,815,123.
2. Northrop, W., Kittelson, D., Kotz, A. (2020) Automated Passenger Counter Systems and Methods, US Patent 10,850,588.
3. Pollica, D., Northrop, W.F., Qi, F.C, Hagen M.R., Smith, A. and Clawson, L. (2009) Preferential oxidation reactor temperature regulation. US Patent 7,507,384
4. Zhao, J.L., Northrop, W.F., Bosco, T., Rizzo, V. and Kim, C. (2005) Startup burner. US Patent 7,575,614
5. Zhao, J.L. and Northrop, W.F. (2005). Device for cooling and humidifying reformat. US Patent 7,354,465.
6. Northrop, W.F. (2002). Perforated fin heat exchangers and catalytic support, US Patent 7,063,131.
7. Clawson, L.G., Hagan, M.R., Qi, F.C. and Northrop, W.F. (2001). Heat transfer optimization in multi-shelled reformers. US Patent 7,367,996.

### **10 Recent Conference Presentations, Posters, and Short Communications**

1. Reggeti, S., Kane, S., and Northrop, W.F. (2023) Pre-Chamber Turbulent Jet Ignition for an Ammonia Internal Combustion Engine, 2nd Ammonia Energy Symposium, Orleans, FR. *ASME ICE-Forward Conference*, Pittsburgh, PA.
2. Reggeti, S. and Northrop, W.F. (2023) Pre-Chamber Turbulent Jet Ignition for an Ammonia Internal Combustion Engine, 2<sup>nd</sup> *Ammonia Energy Symposium*, Orleans, FR.
3. Northrop, W.F. (2023) Ammonia as a Fuel for Internal Combustion Engines: Advanced Combustion Modes and Emissions Challenges, *Ammonia Combustion Workshop, ASPACC*, Taiwan (virtual).

4. Reddy Challa, D., Eagon, M., Wringa, P., and Northrop, W.F. (2023) Impact of Snowfall on CO<sub>2</sub> & NO<sub>x</sub> Emissions of Snow Maintenance Vehicles, *CRC Real-World Emissions Workshop*, Long Beach, CA.
5. Goertemiller, C., Kane, S., and Northrop, W.F. (2023) Preliminary Emissions and Stability Data from a Turbulent Ammonia-Hydrogen Swirl Burner, *13th U.S. Combustion Institute National Meeting*, College Station, TX.
6. Reggeti, S., Kane, S., and Northrop W.F. (2023) Performance and Emissions of Ammonia Spark-Assisted Compression Ignition in a Single-Cylinder Engine, *13th U.S. Combustion Institute National Meeting*, College Station, TX.
7. Northrop, W.F., Kane, S., and Reggeti, S. (2023) Ammonia Combustion in Spark Ignited Engines: Rich Operation and Spark-Assisted Compression Ignition, *Advanced Engine Combustion Review Meeting*, Livermore, CA.
8. Lee, H., Cho, S., and Northrop W.F. (2022) Fuel modification using oxidative coupling of methane for natural gas engines, *ACS Spring 2022 Meeting*, San Diego CA.
9. Thomas, D.E., Wadkar, C., Goertemiller, C.F.W., and Northrop, W.F. (2022) Structure and nitric oxide formation in laminar diffusion flames of ammonia-hydrogen and air, *Spring Technical Meeting of the Central States Section of the Combustion Institute*, Detroit, MI.
10. Goertemiller, C.F., Thomas, D.E., and Northrop, W.F. (2022) Experimental and Computational Structural Evaluation of Ammonia-Hydrogen and Air Non-Premixed Counterflow Diffusion Flame, *Spring Technical Meeting of the Central States Section of the Combustion Institute*, Detroit, MI.

## INVITED LECTURES/SYMPOSIA/PANELS

### 10 Recent Invited Panels, Webinars, and Workshops:

1. Panel: Future Fuels: Electrification Opportunities in Queensland, *RACQ/QUT/UQ Electric Transport Industry Forum*, Brisbane, Queensland, Australia, March 17, 2023
2. Panel: Opportunities in Green Ammonia Fueling of Internal Combustion Engines. *SAE 2022 Sustainable Low Impact Combustion Engine Symposium (SLICES)*, *WCX*, Detroit, MI, April 14, 2022.
3. Webinar: Engineering Workforce – Educating for the EV and AV Industry, *ASME Monthly Webinar Series*, May 9, 2022.
4. Webinar: Decarbonizing Engines using Green Ammonia and e-Fuels, *ASME IC Engines Division Webinar Series*, *The Future of the Internal Combustion Engine*, April 13, 2022.
5. Panel: Connectivity and Data-Science for Advancing Electrified Commercial Vehicles, CV502: Electrified Powertrains Panel, *SAE COMVEC Conference*, Virtual, September 15, 2020.
6. Workshop: Funding Collaborative Cross-Atlantic Research Projects in Science and Engineering, *Fulbright Research Seminar*, Madrid, Spain, November 2019.
7. 3<sup>rd</sup> RCM Workshop, *36<sup>th</sup> International Symposium on Combustion*, Seoul, South Korea, August 2016.
8. ARPA-E Powertrain Innovations Workshop, *ARPA-E*, Denver, CO, May 14, 2015.
9. Technical Expert Panel Discussion: Current Understanding of Particulate Matter from Low Temperature Combustion Modes, *SAE World Congress*, Detroit, MI, April 21, 2015.
10. Panel: A Voyage through Combustion, *Combustion Institute National Meeting*, Cincinnati, OH, May 19, 2015.

## 10 Recent Invited Lectures

1. Opportunities in Green Ammonia Fueling of Internal Combustion Engines, *John Deere Corporation APSE Presentation Series*, Cedar Falls, IA, June 3, 2022.
2. Physics-Guided Machine Learning for Engines and Vehicles, *TPSRG Seminar Series*, Oxford University, Virtual, March 14, 2022.
3. Connected Commercial Electric Vehicle Research, *SAE Twin Cities Section presentation*, November 16, 2021.
4. Post-Pandemic Transportation Trends: Vehicle Technology, *Minnesota State Legislature Transportation Subcommittee*. January 19, 2021.
5. Vehicle Powertrain and Routing Co-Optimization for Energy Management of Electrified Vehicles, *Minnesota Freight Advisory Council (MFAC) Annual Meeting*, Minneapolis, MN, March 27, 2020.
6. Catalytic Fuel Pretreatment Reactors for Improving Thermal Efficiency and Enabling Alternative Fuel Use in Internal Combustion Engines, *Johnson Matthey Research and Development Invited Seminar*, Sonning, United Kingdom, November 12, 2019.
7. Vehicle Powertrain and Routing Co-Optimization for Energy Management of Electrified Vehicles, *UMN Center for Transportation Studies Executive Committee Meeting*, Minneapolis, MN, May 9, 2019.
8. Gasoline Direct Injection Engine Solid Nanoparticle Emissions: Linkage Between Number and Mass Measurements to In-Cylinder Diagnostics, *U.S. Department of Energy ACEC Meeting*, Southfield, MI, March 7, 2019.
9. Vehicle Powertrain and Routing Co-Optimization Research Overview, *ITS Minnesota Annual Meeting*, St. Paul, MN, December 6, 2018.
10. Thermochemical Recuperation for Dual Fuel Off-Highway Engines, *CCEFP Summit*, Minneapolis, MN, October 17, 2018.

## 10 Recent Departmental Seminars

1. Physics-Guided Machine Learning for Solving Critical Transportation Problems, *Ohio State University CAR Research Seminar Series*, Columbus, OH, September 26, 2023.
2. Ammonia as a Fuel for Internal Combustion Engines: Advanced Combustion Modes and Emissions Challenges, *University of Bologna Seminar Series*, Bologna, IT, June 18, 2023.
3. Physics-Guided Machine Learning for Engines and Vehicles, *University of Minnesota Mechanical Engineering Department Graduate Seminar Series*. Minneapolis, MN. March 23, 2022.
4. Internal Combustion Engines and Data Science to Enhance Electrified Vehicles of the Future. *University of Minnesota College of Science and Engineering Golden Medallion Lecture*. Minneapolis, MN. May 9, 2019.
5. Rule-Based Energy Management Strategy for Improving Fuel Economy of Range Extended Hybrid Electric Vehicles, *University of Michigan Energy Institute Seminar*, Ann Arbor, MI, October 10, 2018.
6. Connected Engines and Vehicles: Data-Oriented Approaches for Improving Emissions and Fuel Economy, *University of Iowa Mechanical Engineering Seminar Series*, Iowa City, IA, October 12, 2017.

7. Minimizing the Environmental Impact of Internal Combustion Engines: Nanoparticles, Fuel Reactivity and Connectivity *University of Minnesota Mechanical Engineering Department Graduate Student Seminar Series*. Minneapolis, MN. September 26, 2016.
8. Semi-Volatile Nanoparticle Emissions from Low Temperature Combustion, *Carnegie Mellon University Center for Atmospheric Particle Studies Seminar Series*, Pittsburgh, PA, April 28, 2016.
9. Improving engine emissions and efficiency with premixed compression ignition combustion. *Stony Brook University Mechanical Engineering Seminar Series*, Stony Brook, NY, November 16, 2012.
10. Activities at Center of Diesel Research, University of Minnesota. *Karlsruhe Institute of Technology, Institute for Reciprocating Engines Seminar*, Karlsruhe, Germany, May 11, 2012.

## **SERVICE AND PUBLIC OUTREACH**

### ***Committee memberships***

American Society of Mechanical Engineers, Internal Combustion Engines Division  
 Executive Committee Member, 2016-present  
 Division Chair, 2021-2022  
 Clean Energy Technology Group Member, 2022-present

Central States Section of the Combustion Institute  
 Advisory Board Member, 2016-present

Society of Automotive Engineers  
 Powertrain Fuels and Lubricants Committee, Fall 2017-present  
 2020 COMVEC Planning: Powertrain Committee, Fall 2019-present  
 Horning Award Review Committee, Spring 2019-present  
 Fuel Cell Vehicle Standards Committee, 1999-2002

### ***Organization of conferences, workshops, panels, symposia***

American Society of Mechanical Engineers, Internal Combustion Engines Division  
 Division Nominations Chair, 2023-present  
 Division Strategic Planning Chair, 2022-2023  
 Division Past Chair, 2022-2023  
 Division Chair, 2021  
 Division Co-Chair, 2020  
 Chair, Fall Technical Conference, Chicago, IL, 2019  
 Co-Chair, Technical Expert Panel, Engines for Electrification at Fall Technical Conference, San Diego, CA, 2018  
 Co-Chair, Fall Technical Conference, San Diego, CA, 2018  
 Chair, Undergraduate Student Presentation Competition, Fall Technical Conference, 2011- 2016

Society of Automotive Engineers  
 Session Co-Organizer, PFL 260-Dual Fuel Combustion, SAE World Congress 2013-2019  
 Organizer, Technical Expert Panel Discussion: Current Understanding of Particulate Matter from Low Temperature Combustion Modes, SAE World Congress, Detroit, MI, April 21, 2015.

Central States Section of the Combustion Institute  
 Hosted Spring Technical Meeting, Minneapolis MN, May 20-22, 2018

International Energy Agency – Clean Combustion TCP  
 Soot Task Chair 2019-present