

FEDERICO PERINI

summary

Current position

Principal Engineer Wisconsin Engine Research Consultants, LLC. 2018-

Past positions

Visiting Scholar University of Wisconsin-Madison 2018-2019

Associate Scientist University of Wisconsin-Madison 2017-2018
Engine Research Center

Post-doc research associate University of Wisconsin-Madison 2013-2017
Engine Research Center

Post-doc research associate University of Modena 2011-2012

Education

Mechanical and Automotive Engr. Ph.D. University of Modena 2008-2011

Automotive Engineering M.Sc. University of Modena 2005-2007

(*magna cum laude* and honorary mention of the graduation committee)

Mechanical Engineering B. Sc. University of Modena 2002-2005
(*magna cum laude*)

Main Interests

- Advancing internal combustion engines via CFD modeling
 - o Diesel combustion physics in collaboration with Sandia National Laboratories
 - o Development of advanced spray and chemistry models for CI engines
 - o Development of advanced models for SI engines (G-Equation)
- Developing high-performance codes for advanced combustion
 - o SpeedCHEM, an open-source fast chemistry solver for combustion kinetics (2011-)
 - o FRESCO, a fast, object-oriented CFD code for internal combustion engine simulations (2014-)

Major industry collaborations

- **FAWDE WuXi Diesel Engine Works:** intake port geometry optimization for medium duty diesel engines, 2019;
- **General Motors:** development of fast chemistry and spray solvers for multicomponent modelling of diesel combustion, 2018;
- **Mitsubishi Heavy Industries:** development of a methodology to simulate dual-fuel combustion and torch jet ignition in marine engines, including ignition, flame propagation and large eddy simulation models, 2013-2017;
- **John Deere Corporation:** development of fast chemistry solvers for diesel engine modelling;
- **HERA S.p.A.,** life-cycle and environmental sustainability study of the car, light and heavy truck fleet, through hybrid or alternative-fuel powered vehicles, 2012;
- **VM Motori,** study and one-dimensional modeling of lubrication and cooling circuits on mid-duty automotive diesel engines, 2009-2012;
- **Ducati:** study and simulation of lubrication circuits for high performance 4-stroke motorbike engines, 2009;

Selected Journal Publications (<http://www.federicoperini.info/publications> for additional)

1. F. Perini, K. Zha, S. Busch, E. Kurtz, R.C. Peterson, A. Warey, R.D. Reitz, "Piston geometry effects in a light-duty, swirl-supported diesel engine: Flow structure characterization", *Int. J. Engine Res.* 2017, Online First, doi:10.1177/1468087417742572
2. F. Perini and R.D. Reitz, "Improved atomization, collision and sub-grid scale momentum coupling models for transient vaporizing engine sprays", *International Journal of Multiphase Flows* 79(2016), 107-123. doi:10.1016/j.ijmultiphaseflow.2015.10.009
3. F. Perini, E. Galligani, R.D. Reitz, "A study of direct and Krylov iterative solver techniques to approach linear scaling of the integration of Chemical Kinetics with detailed combustion mechanisms", *Combustion and Flame* 161(5), 1180-1195, 2014.

Memberships

SAE, ASME, Combustion Institute

Peer Reviewer for international journals in the fields of Combustion, Energy, Engines

FEDERICO PERINI, Ph. D.

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Personal Information

Born in Mantova (Italy) on April 19th, 1984.

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Vita

Graduated B.Sc. in Piano from the State Conservatory “L. Campiani” of Mantova, 1994-2005. Graduated *cum laude* B.Sc. in Mechanical Engineering at the University of Modena and Reggio Emilia in 2005, defending “Performance study and mechanical design of a variable-configuration transmission for a Formula SAE car”, advisor prof. Carlo Innocenti. Graduated *magna cum laude* and with honorary mention of the committee, M.Sc. in Automotive Engineering at the University of Modena and Reggio Emilia in 2007, defending “Mathematical modeling and development of a computer code for simulating an engine intake air treatment unit”, advisor prof. Paolo Tartarini, with Ferrari Gestione Sportiva. Awarded the “2008 ing. Vincenzo Ganzerli” prize for best M.Sc. thesis, established by APMI (Association for small and medium enterprises of Modena). Also awarded among the students with highest GPA for five consecutive years from 2003 to 2007.

Defended his Ph. D. thesis in “Advanced Mechanics and Automotive Design and Technology” on April 4th 2011, at the University of Modena and Reggio Emilia, “Optimally reduced reaction mechanisms for internal combustion engines running on biofuels” under the supervision of prof. Giuseppe Cantore. Awarded the 2011 “Barsanti and Matteucci” prize for best Ph.D. thesis established by the Italian Association of Fluid Machinery and Energy Systems professors, judged by an international committee.

Since 2010, he collaborates with the University of Wisconsin-Madison (USA), which he visited during march-august 2010, April-May 2011, April-October 2012, working under the supervision of prof. Rolf D. Reitz. He developed adaptive techniques for reaction mechanism reduction, and accurate numerics for coupling detailed chemical kinetics in internal combustion engine simulations, where he started the development, in 2011, of his SpeedCHEM code, distributed open-source and currently adopted in a variety of institutions in America, Europe and Asia.

He spent two years as a post-doctoral researcher at the University of Modena, where he collaborated with the Numerical Analysis group, developing techniques for the efficient integration of combustion kinetics ordinary differential equations.

From January 2013 to August 2017 he has been a post-doctoral Research Associate at the Engine Research Center, University of Wisconsin-Madison (USA), working under the guidance of prof. Rolf D. Reitz, where he is studying the accuracy of computer models for spray development, mixture preparation and combustion in a light-duty optically accessible diesel engine, in collaboration with

Paul C. Miles' and Stephen Busch's light-duty optical engine laboratory at the Sandia National Laboratories, as part of a U.S. Department of Energy EERE (Energy Efficiency and Renewable Energy) program. He has also been studying numerics for the incorporation of very large reaction mechanisms in engine CFD simulations, parallel object-oriented methods for fast reactive flow calculations. From October 2017 to January 2018 he joined the University of Wisconsin as a Scientist.

From February 2018 to April 2019 he has been a honorary associate at the University of Wisconsin-Madison Engine Research Center, where he worked on open-source codes for simulating internal combustion engine on high-performance computing platforms. He spent a 3-month intern at Cineca for an EU-funded project, HPCEuropa3, incorporating HPC solvers in the FRESKO platform to speed up fluid dynamics simulations of diesel engine combustion.

Since February 2018, he is a free-lance consultant and principal engineer at Wisconsin Engine Research Consultants, llc, where he is performing advanced computer modelling of internal combustion engines in collaboration with both research institutions (Sandia) as well as OEM engine manufacturers.

He is currently author of 16 papers appeared on international Journals (14 as a main author) and 17 papers presented at international, peer-reviewed conferences (12 as a main author). He has been acting as a reviewer for international Journals in the fields of Combustion, Engines, computational chemistry, and Energy fields. Since 2007, he has been participating in teaching activities, seminars and Thesis reviewing in Italy and abroad.

His research interests currently include the development of parallel object oriented solver for multi-physics engine simulations, predictive models for capturing spray dynamics and vaporization, gas-phase mixture formation, turbulent transport and ignition in multi-dimensional CFD codes; ODE integration methods for large stiff systems; algorithms for incorporating realistic chemical kinetics in multi-dimensional domains, including on-the-fly model reduction and preconditioning approaches.

Research Interests

The graduate and post-doctoral training and the related interdisciplinary research are setting the path to pursue a career in numerical combustion, which focuses on advancing the efficiency and environmental sustainability of energy systems by developing advancements in numerics and simulation, and using them for practical technology development.

- Study of advanced numerics for large-scale calculations of compressible reacting flow problems, including high dimensional cell clustering and remapping methods; parallel object oriented flow solvers for future large-scale computations; development of FRESKO, an open-source object-oriented combustion simulation platform;
- Development of SpeedCHEM, a computer code for the efficient simulation of chemical kinetics with large combustion mechanisms. Package extension to the simulation of reactor networks, and flame configurations with detailed transport property calculations; Exploitation of modern Fortran standard with full object orientation;
- Development of algorithms for the solution of large stiff ODE systems, including Rosenbrock-Krylov solvers of arbitrary order;

- Computer modelling of fuel-efficient, sustainable combustion strategies in internal combustion engines, including partially premixed combustion, homogeneous-charge compression ignition combustion;
- Development of computer models for complex fuel multi-component liquid spray development and vaporization;
- Development of chemistry-based preconditioners for stiff chemical kinetics Jacobian matrices;
- Algorithms for the automatic reduction of reaction mechanisms; Quasi-dimensional modeling of injection, breakup, vaporization and combustion in spark ignition engines running on conventional and alternative fuels;
- Development of optimization techniques for combustion applications based on response surface methods (RSM) and genetic algorithms (GAs).

Current position

- **Combustion CFD consultant and software developer**, February 2018 – present.
Working on advanced diesel combustion and high-performance computational fluid-dynamics simulations to predict mixture preparation and combustion in engines.

Past positions

- **Visiting Scholar**, University of Wisconsin-Madison, Engine Research Center, February 2018-April 2019. Supervisor: prof. Christopher J. Rutland.
Collaborating to the project: development of high-performance computational fluid-dynamics codes for spray and combustion simulations to predict mixture preparation and combustion in engines, in collaboration with Dr. Stephen Busch, Sandia National Laboratories, Livermore, CA.
- **Associate Scientist**, University of Wisconsin-Madison, Engine Research Center, October 2017 – January 2018. Supervisor: prof. Rolf D. Reitz.
Collaborating to the project: development of high-performance computational fluid-dynamics codes for spray and combustion simulations to predict mixture preparation and combustion in engines, in collaboration with Dr. Stephen Busch, Sandia National Laboratories, Livermore, CA.
- **Post-doctoral Research Associate**, University of Wisconsin-Madison, Engine Research Center, January 2013 – August 2017. Supervisor: prof. Rolf D. Reitz.
Collaborating to the project: development of computational spray and combustion models for predicting mixture preparation and combustion in light duty diesel engines operated in partially-premixed combustion modes, in collaboration with Sandia National Laboratories, Livermore, CA. Developing algorithms for combustion numerics, and parallel turbulent reactive flow calculations.
- **Honorary Associate**, University of Wisconsin-Madison, Engine Research Center, April – October 2012. Supervisor: prof. Rolf D. Reitz.

Collaborating to the projects: validation of a sparse solver for the integration of initial value problems in combustion chemistry; development of advanced grid treatment algorithms for an Arbitrary Lagrangian-Eulerian code for engine simulations.

- **Post-doctoral Fellow**, University of Modena and Reggio Emilia, Mechanical and Civil Engineering Department, January 2011 – December 2012. Supervisor: prof. G. Cantore. Collaborating to the projects: development of adaptive techniques for the reduction of combustion mechanisms for internal combustion engine simulations. Development of a sparse solver for the integration of initial value problems in combustion chemistry.

Education

- **Ph. D., High Mechanics and Automotive Design and Technology**, University of Modena and Reggio Emilia, January 2008 - April 2011
Dissertation: "Optimally reduced reaction mechanisms for internal combustion engines running on biofuels";
- **Visiting Scholar**, Engine Research Center, University of Wisconsin-Madison, Madison WI, USA, under the supervision of prof. Rolf D. Reitz., march - august 2010;
- **M.Sc., Automotive Engineering**, *magna cum laude*, University of Modena and Reggio Emilia, 2005-2007
Dissertation: "Development of a mathematical model and of a computer code for simulating air treatment units for high performance engines test benches", in collaboration with Ferrari Gestione Sportiva;
- **B.Sc., Mechanical Engineering**, *cum laude*, University of Modena and Reggio Emilia, 2002-2005
Dissertation: "Performance analysis and design of a variable configuration transmission for a Formula SAE car";
- **B. Mus. (Diploma), Piano**, State Conservatory "Lucio Campiani" of Mantova, 1994-2005.

Academic Honors and Awards

- **Associate Professorship Qualification** ("Abilitazione Scientifica Nazionale", Seconda Fascia), section 9/C1 "Fluid Machinery and Sustainable Energy Systems", Italian Ministry for University and Research, March 2017
- **Presentation contribution recognition**, SAE Commercial Vehicles Engineering congress, Rosemont IL, October 2-3, 2012
- **Ph. D. Award "Barsanti e Matteucci"**, for best Ph.D. dissertation in the field of Internal Combustion Engines research, international selection committee, 2011
- **"Vincenzo Ganzerli" Award**, for best M.Sc. thesis dissertation, established by APMI Modena - Small and medium enterprises of Modena, 2008

- **University of Modena Scholarships**, for students with best grade point averages, 5 times, 2003-2007
- **Prize for High School students' merit**, 41st edition, 2002, established by the "Young Entrepreneurs Group" of the Entrepreneurs Association of the province of Mantova

Journal Publications

Submitted

1. F. Perini and R.D. Reitz, "A universal mesh optimization and rezoning method for Arbitrary Lagrangian-Eulerian Simulations", submitted to Journal of Computational Physics, under review, 2017

Accepted

1. S. Busch, F. Perini, "Progress toward understanding vortex generation in stepped-lip diesel engine combustion chambers", Results in Engineering 1(2019), 100004, doi:10.1016/j.rineng.2019.100004, 2019.
2. F. Perini and R.D. Reitz, "Fast approximations of exponential and logarithm functions combined with efficient storage/retrieval for combustion kinetics calculations", submitted to Combustion and Flame, under review, 2017
3. F. Perini and R.D. Reitz, "A nearest-neighbor constrained, kd-tree accelerated k-means algorithm for fast high-dimensional model reduction, with application to engine combustion", submitted to Journal of Computational Physics, under review, 2017
4. F. Perini, K. Zha, S. Busch, E. Kurtz, R. Peterson, A. Warey, R.D. Reitz, "Piston geometry effects in a light-duty, swirl-supported diesel engine: flow structure characterization", submitted to International Journal of Engine Research OnlineFirst, Dec 2017, doi:10.1177/1468087417742572 .
5. F. Perini and R.D. Reitz, "Improved atomization, collision and sub-grid scale momentum coupling models for transient vaporizing engine sprays", International Journal of Multiphase Flow 79, 107-123, 2016. doi:10.1016/j.ijmultiphaseflow.2015.10.009
6. F. Perini, Y. Ra, K. Hiraoka, K. Nomura, A. Yuuki, Y. Oda, C.J. Rutland, R.D. Reitz, "An Efficient Level-Set Flame Propagation Model for Hybrid Unstructured Grids Using the G-Equation", SAE International Journal of Engines 9(3) 2016, 1409-1424, doi:10.4271/2016-01-0582.
7. F. Perini, P.C. Miles, R.D. Reitz, "A comprehensive modeling study of in-cylinder fluid flows in a high-swirl, light-duty optical diesel engine", Computers & Fluids 2014(105):113-124, doi:10.1016/j.compfluid.2014.09.011.

8. F. Perini, D. Sahoo, P.C. Miles, R.D. Reitz, "Modeling the Ignitability of a Pilot Injection for a Diesel Primary Reference Fuel: Impact of Injection Pressure, Ambient Temperature and Fuel Mass" , SAE Int. J. Fuels Lubr. April 2014(7):48-64; doi:10.4271/2014-01-1258.
9. F. Perini, B. Das Adhikary, J.H. Lim, X. Su, Y. Ra, H. Wang, R.D. Reitz, "Improved Chemical Kinetics Numerics for the Efficient Simulation of Advanced Combustion Strategies", SAE Int. J. Engines 7(1):2014, doi:10.4271/2014-01-1113.
10. F. Perini, A. Krishnasamy, Y. Ra, R.D. Reitz, "Computationally efficient simulation of multi-component fuel combustion using a sparse analytical Jacobian chemistry solver and high-dimensional clustering", ASME J. Eng. Gas Turbines Power 136(9), 091515, 2014. doi: 10.1115/1.4027280
11. F. Perini, E. Galligani, R.D. Reitz, "A study of direct and Krylov iterative solver techniques to approach linear scaling of the integration of Chemical Kinetics with detailed combustion mechanisms", Combustion and Flame 161(5), 1180-1195, 2014.
12. F. Perini – "High-dimensional, unsupervised cell clustering for computationally efficient engine simulations with detailed combustion chemistry", Fuel 106(2013), 344-356.
13. F. Perini, E. Galligani, R. D. Reitz "An analytical Jacobian approach to sparse reaction kinetics for computationally efficient combustion modelling with large reaction mechanisms", Energy & Fuels (2012), doi: 10.1021/ef300747n
14. F. Perini, J.L. Brakora, G. Cantore, Rolf D. Reitz - "Development of reduced and optimized reaction mechanisms based on genetic algorithms and element flux analysis", Combustion and Flame 159 (2012), 1:103-119, doi:10.1016/j.combustflame.2011.06.012
15. F. Perini and E. Mattarelli - "Development and Calibration of an enhanced quasi-dimensional combustion model for HSDI diesel engines", International Journal of Engine Research 12(2011), 311-335, doi: 10.1177/1468087411401285
16. F. Perini, F. Paltrinieri, E. Mattarelli - "A quasi-dimensional combustion model for performance and emissions of SI engines running on hydrogen–methane blends", International Journal of Hydrogen Energy 35 (2010), 4687 - 4701
17. E. Mattarelli, F. Perini, C.A. Rinaldini - "Optimization of a Supercharged Single Cylinder Engine for a Formula SAE Racing Car", SAE International Journal of Engines October 2009, vol. 2 no. 1, 199-210

Conference papers

1. F. Perini, S. Busch, E. Kurtz, A. Warey, R.C. Peterson, R.D. Reitz, "Limitations of sector mesh geometry and initial conditions to model flow and mixture formation in direct-injection diesel engines," SAE Technical Paper 2019-01-0204, 2019, doi:10.4271/2019-01-0204.

2. F. Perini, S. Bna, E. Pascolo, I. Spisso, R.D. Reitz, "Robust preconditioning techniques for iterative solvers in scalable engine simulations using FRESKO", 29th International Multidimensional Engine Modeling User's Group Meeting at the SAE Congress, Detroit, MI, April 8, 2019.
3. S. Busch, K. Zha, F. Perini, R.D. Reitz et al., "Bowl Geometry Effects on Turbulent Flow Structure in a Direct Injection Diesel Engine," SAE Technical Paper 2018-01-1794, 2018, doi:10.4271/2018-01-1794.
4. F. Perini, K. Hiraoka, Y. Oda, A. Yuuki, C.J. Rutland, R.D. Reitz, "A Triangulated Lagrangian Ignition Kernel Model with Detailed Kinetics for Modeling Spark Ignition with the G-Equation - Part I: Geometric Aspects", SAE Technical Paper 2018-01-0195, SAE 2018 World Congress and Exhibition 2018, Detroit, MI, April 10-12, 2018, doi:10.4271/2018-01-0195.
5. G. Zhu, K. Pattabiraman, F. Perini, C.J. Rutland, "Modeling Ignition and Combustion in Spark-Ignition Engines Based on Swept-Volume Method", SAE Technical Paper 2018-01-0188, SAE 2018 World Congress and Exhibition 2018, Detroit, MI, April 10-12, 2018, doi:10.4271/2018-01-0188.
6. F. Perini and R.D. Reitz, "FRESKO - an object-oriented, parallel platform for internal combustion engine simulations", 28th International Multidimensional Engine Modeling User's Group Meeting at the SAE Congress, Detroit, MI, April 9, 2018.
7. F. Perini, S. Busch, K. Zha, R.D. Reitz, "Comparison of Linear, Non-linear and Generalized RNG-based k-epsilon models for turbulent diesel engine flows", SAE Technical Paper 2017-01-0561, 2017 SAE World Congress and Exhibition, Detroit, MI, April 4-6, 2017.
8. F. Perini, K. Zha, S. Busch, A. Warray, R. Peterson, R.D. Reitz, "Modeling the effects of pilot injection strategies on combustion noise and soot emissions in a light-duty optical diesel engine", THIESEL 2016 Conference on Thermo- and Fluid Dynamic Processes in Direct Injection Engines, Valencia, Spain, 2016.
9. F. Perini, K.Zha, S. Busch, P.C. Miles, R.D. Reitz, "Principal Component Analysis and study of port-induced swirl structures in a light-duty optical diesel engine", SAE Technical paper 2015-01-1696, SAE 2015 World Congress & Exhibition 2015, Detroit, MI, April 21-23 2015.
10. F. Perini, K. Zha, D. Sahoo, S. Busch, P.C. Miles, R.D. Reitz, "Effects of in-cylinder non-uniformities on mixture preparation in a light-duty Diesel engine operating a light-load Partially Premixed Combustion strategy" - THIESEL 2014 Conference on Thermo- and Fluid Dynamic Processes in Direct Injection Engines, Valencia, Spain, 2014.
11. F. Perini, A.B. Dempsey, R.D. Reitz, D. Sahoo, B. Petersen, P.C. Miles, "A Computational Investigation of the Effects of Swirl Ratio and Injection Pressure on Mixture Preparation and Wall Heat Transfer in a Light-Duty Diesel Engine", SAE Technical paper 2013-01-1105, SAE 2013 World Congress & Exhibition 2013, Detroit, MI, 2013.
12. F. Perini, G. Cantore, E. Galligani, R. D. Reitz, "Validation of a sparse analytical Jacobian chemistry solver for heavy-duty Diesel engine simulations with comprehensive reaction

mechanisms", SAE technical paper 2012-01-1974, presented at SAE Commercial Vehicles congress, October 2-3 2012, Rosemont IL (USA).

13. F. Perini, G. Cantore, Rolf D. Reitz - "An Analysis on Time Scale Separation for engine simulations with detailed chemistry", SAE technical paper 2011-24-0028, SAE ICE2011 Conference, September 2011.
14. F. Perini, E. Mattarelli, F. Paltrinieri - "Development and validation of predictive emissions schemes for quasi-dimensional combustion models", SAE technical paper 2010-01-0148, presentato al Congresso "SAE 2010 World Congress & Exhibition", April 2010, Detroit, MI, USA
15. E. Mattarelli, F. Paltrinieri, F. Perini, C.A. Rinaldini, M. Wilksch - "2-Stroke Diesel engine for light aircrafts: IDI vs. DI combustion systems", SAE technical paper 2010-01-2147, "SAE 2010 Powertrains Fuels & Lubricants Meeting", October 2010, San Diego, USA
16. G. Cantore, F. Paltrinieri, F. Perini, C.A. Rinaldini - "A Lumped Parameter Approach for Simulation of ICE Cooling Systems", SAE technical paper 2009-01-2760, SAE 2009 Powertrains Fuels and Lubricants Meeting, November 2009, San Antonio, TX, USA
17. M. Meldi and F. Perini - Reduced Interaction between numerical and model errors through anisotropic filtering, "Quality and Reliability of Large-Eddy Simulation II", september 9-11 2009, Pisa, Italy, Ed. Springer, ISBN: 978-94-007-0230-1.

Technical reports and other publications

1. E. Galligani, F. Perini, "Numerical studies on semi-implicit and implicit methods for reaction-diffusion equations" University of Modena Numerical Analysis Technical Report TR NA-UniMoRE-6-2014, April 2014.
2. J.H. Lim, F. Perini, R.D. Reitz, "High load (21 bar IMEP) dual fuel RCCI combustion optimization", International Multidimensional Engine Modeling User's Group Meeting at the SAE Congress (IMEM) Detroit, MI, April 15, 2013.
3. E. Galligani, F. Perini, "A note on the Rosenbrock formulae", University of Modena Numerical Analysis Technical Report TR NA-UniMoRE-5-2013, 2013.
4. G. Cantore, F. Perini, "Approcci all'incorporazione di meccanismi di combustione dettagliati per la simulazione multidimensionale dei motori a combustione interna", Giornata di Studio in memory of Prof. Roberto Bettocchi, Cento, Italy, 2012.
5. F. Perini, G. Cantore, "Simulazione quasi-dimensionale del processo di combustione di motori a combustione interna alimentati ad idrogeno", proceedings of "Giornata di Studio - Il motore alternativo alimentato ad idrogeno", Pisa, Italy, November 2009

Invited Lectures and Talks

1. F. Perini, S. Bna, E. Pascolo, I. Spisso, R.D. Reitz, "Leveraging HPC technology for faster simulations of engine combustion", Workshop HPC for Industry 4.0, Milano, May 23, 2019.
2. F. Perini, R.D. Reitz, "Better models for better engines: towards multi-physics modelling", Free University of Bozen, December 13th, 2018.
3. F. Perini, S. Busch, R.D. Reitz, "Automatic optimal mesh handling for Internal Combustion Engine Simulations", DOE AEC Program Review Meeting – USCAR – Southfield, MI, Aug 21-23, 2017
4. F. Perini, S. Busch, K. Zha, R.D. Reitz, "Characterizing the mixture formation mechanism in a light duty engine with a re-entrant or stepped-lip piston", IEA Combustion Agreement Fuel Spray Workshop 2017, Detroit, 3 Apr 2017
5. F. Perini, R.D. Reitz, K. Zha, S. Busch, "Mixture formation in a light-duty engine with a re-entrant or stepped-lip piston – a computational study", DOE AEC/HCCI Program Review Meeting – Sandia National Laboratories – Livermore, CA, Jan 30-Feb 2, 2017
6. F. Perini, R.D. Reitz, K. Zha, S. Busch, "Flow structure characterization in a light-duty engine with a re-entrant or stepped-lip piston – a computational study", DOE AEC/HCCI Program Review Meeting – USCAR – Southfield, MI, Aug 15-18, 2016
7. F. Perini, K. Zha, S. Busch, R.D. Reitz, "Piston bowl geometry effects on squish-swirl flow interaction in a light duty diesel engine", DOE AEC/HCCI Program Review Meeting – Sandia National Laboratories – Livermore, CA, Feb 8-11, 2016
8. F. Perini, S. Busch, R.D. Reitz, "Modeling pilot injections in a light-duty optical research engine: preliminary study", IEA Combustion Agreement Fuel Spray Workshop 2016, Detroit, 11 April 2016
9. F. Perini, R.D. Reitz, "Introducing FRESCO: a fast, reliable engine simulation code", DOE AEC/HCCI Program Review Meeting – USCAR – Southfield, MI, Aug 18-20, 2015
10. F. Perini, R.D. Reitz, "Computationally efficient dimension reduction of combustion chemistry via Principal Components Analysis based domain partitioning", 2nd Frontiers in Computational Physics - Energy Sciences conference, Zurich, June 3-5, 2015.
11. F. Perini, R.D. Reitz, "Towards improved spray models for handling complex engine geometries", IEA Combustion Agreement Fuel Spray Workshop 2015, Detroit, MI, Apr 20th, 2015.
12. F. Perini, K. Zha, S. Busch, P.C. Miles, R.D. Reitz, "Principal Component Analysis and study of Port-induced swirl structures in a light-duty optical diesel engine", DOE AEC/HCCI Program Review Meeting – Sandia National Laboratories – Livermore, CA, Feb 9-12, 2015
13. F. Perini, "Better models for better engines. Speeding up chemistry & The impact of engine geometry on port-induced swirl structure", John Deere corporation, Cedar Falls, IA, December 1st, 2014
14. F. Perini, K. Zha, P.C. Miles, R.D. Reitz, "Towards Detailed Modeling of the Sandia Light-Duty optical Diesel engine: Update", DOE AEC/HCCI Program Review Meeting – USCAR – Southfield, MI, Aug 19-21, 2014
15. F. Perini, P.C. Miles, R.D. Reitz, "Improving spray models for advanced combustion strategies", IEA 36th Task Leaders Meeting 2014 "Energy Conservation and Emission Reduction in Combustion", Stavanger (Norway), June 9-13, 2014.
16. F. Perini, P.C. Miles, R.D. Reitz, "Advancing Spray Models for PPC injection strategies", IEA Combustion Agreement Fuel Spray Workshop 2014, Detroit, MI, Apr 7, 2014.

17. F. Perini, P.C. Miles, R.D. Reitz, "Recent progress modeling the Sandia light-duty optical diesel engine facility: ignitability of pilot injections using a Diesel Primary Reference Fuel", DOE AEC/HCCI Program Review meeting – Sandia National Laboratories – Livermore, CA, Feb 11-13, 2014.
18. F. Perini, "Importance of internal flow and geometry modelling in the GM 1.9L light duty engine", University of Wisconsin Engine Research Center, November 19th, 2013
19. F. Perini, P.C. Miles, R.D. Reitz, "Modeling Internal Flows and Pilot Injection Ignitability in the Sandia Light Duty Optical Engine", DOE AEC/HCCI Working Group Meeting, USCAR – Southfield, MI, Aug 21, 2013
20. F. Perini, "A computational investigation of the effects of swirl ratio and injection pressure on mixture preparation and wall heat transfer in a light-duty diesel engine", Engine Research Center, University of Wisconsin-Madison, January 22nd, 2013
<http://mediasite.egr.wisc.edu/Mediasite/SilverlightPlayer/Default.aspx?peid=9bd70295afd8401cb293baa40aa98a221d>
21. F. Perini, "SpeedCHEM - A Sparse Analytical Jacobian Chemistry code for Engine Simulations with Detailed Chemistry", Engine Research Center, University of Wisconsin-Madison, October 9th, 2012,
<http://mediasite.egr.wisc.edu/Mediasite/Viewer/?peid=8dda23aa91634d35baa123640ce882cf1d>
22. F. Perini, "Approaches to the incorporation of realistic chemical kinetics in multidimensional engine combustion simulations", Michigan State University, May 14th, 2012

Posters

- F. Perini, R.D. Reitz, "An improved sub-grid scale flow model for transient fuel sprays", ERC Symposium, Madison WI, June 3-4, 2015.
- F. Perini, P.C. Miles, R.D. Reitz, "Study of In-cylinder Swirl Flow Structures using Principal Component Analysis", ERC Symposium, Madison WI, June 3-4, 2015.
- F. Perini, P.C. Miles, R.D. Reitz, "Modeling Partially Premixed Combustion in a Light Duty Optical Diesel Engine", ERC Symposium, Madison WI, June 5-6, 2013.
- F. Perini, G. Cantore, E. Galligani, R.D. Reitz, "Advanced Numerics for Detailed Chemical Kinetics in Internal Combustion Engine Simulations", ERC Symposium, Madison WI, June 5-6, 2013.

Teaching and Courses

- "Tips and Tricks for good (and fast) scientific programming", University of Wisconsin Engine Research Center, 11/27-12/11/2013.
- "Modern Fortran for Scientific Computing and Engineering Applications" [in Italian], University of Modena, Italy, December 11-12, 2012.
<https://groups.google.com/d/forum/minicorsofortran2012>

- Teaching Assistant, University of Modena and Reggio Emilia, for the classes of Motori Endotermici Alternativi A, Motori Endotermici Alternativi B (Internal Combustion Engines A-B), Macchine A, Macchine B, Macchine C (Fluid Machinery A-C), Turbomacchine ed Oleodinamica (Turbo machinery and Fluid Power), Dinamica e Controllo delle Macchine (Machine system dynamics and control) S.S.D. ING-IND/08, 2007-2012.
- Thesis supervisor and assistant, University of Modena and Reggio Emilia, S.S.D. ING-IND/08, in System dynamics and control, Internal combustion engines, Automotive Hydraulics, 2008-2012.

Scientific Software Projects

- **SpeedCHEM**, a fast, computationally efficient software package for combustion Chemical Kinetics, 2010-
- **FRESCO**, a parallel, object-oriented code for reliable engine combustion simulations, 2014-

Active and past scientific collaborations

- Dr. Stephen Busch, Dr. Kan Zha, Sandia National Laboratories (USA), 2015-, study of the effect of in-cylinder flows and squish-swirl interaction on turbulence, mixture preparation and combustion in a light duty diesel engine;
- Dr. Paul C. Miles, Dr. Dipankar Sahoo, Sandia National Laboratories (USA), 2012-, validation of computational models for high-speed light duty diesel engines operating low-temperature combustion modes;
- Dr. Youngchul Ra, Bishwadipa Das Adhikary, Jae Hyung Lim, Xingyuan Su, Prof. Rolf D. Reitz, Engine Research Center University of Wisconsin-Madison, development of algorithms for the efficient incorporation of realistic chemical kinetics for internal combustion engine simulations with multiple injections, multiple and multi-component fuel surrogates, 2012-;
- Dr. Anand Krishnasamy, Indian Institute of Technology (Madras, India), 2012-, efficient simulation of diesel engines using a multicomponent fuel surrogate representation;
- Dr. Stephen Busch, Dr. Paul C. Miles, Sandia National Laboratories (USA), 2013-, computational modeling of mixture preparation and ignition of pilot injections and close-coupled pilot-main injection events;
- Dr. Kan Zha, Dr. Paul C. Miles, study of in-cylinder flows and the effects of engine geometrical features on local mixture formation propensity, Sandia National Laboratories (USA), 2014-;
- Dr. Adam Dempsey, Oak Ridge National Laboratories (USA), Mr. N. Ryan Walker, University of Wisconsin, 2013-, study of the influence of temperature, velocity field and compositional non-uniformities on the ignition of homogeneous-charge compression ignition at lean limits and variable PRF compositions, in a light duty diesel engine;
- Dr. Jian Gao, Dr. Alberto Vassallo, Dr. Kelly Senecal, Dr. Paul C. Miles, General Motors (USA), Sandia National Laboratories (USA), Convergent Science (USA), validation of computer models for predicting turbulent intake flows in high swirl light duty engines with variable-swirl intake ports, 2013-;

- Prof. Emanuele Galligani, Dipartimento di Ingegneria “Enzo Ferrari”, Università di Modena e Reggio Emilia, 2011-, study of systems of ordinary differential equations (ODEs) describing combustion chemical kinetics;
- Prof. Song-Chang Kong, Iowa State University (2013-), Implementation of the SpeedCHEM code for efficient chemical kinetics simulations;
- Dr. Jessica L. Brakora, prof. Rolf Reitz, Engine Research Center University of Wisconsin-Madison (USA), 2010-2012, automatic generation of skeletal reaction mechanisms for biofuels;
- Dr. Marcello Meldi, Institut Jean Le Rond d'Alembert, Université Pierre et Marie Curie (Paris, France), 2009, study of propagation of errors in Large Eddy Simulation of turbulent gaseous jets at high Reynolds numbers;

Peer-reviewing activity

- **Peer reviewer**, Combustion and Flame, Fuel, Combustion Theory and Modelling, Proceedings of the Combustion Institute, Energy Conversion and Management, International Journal of Engine Research, International Journal of Hydrogen Energy, Energy & Fuels, Applied Energy, Chemical Engineering Journal, International Journal of Multiphase Flow, ASME Journal of Engineering for Gas Turbines and Power, The Canadian Journal of Chemical Engineering, Chemical Engineering Journal, SAE International technical papers, ASME conferences, Latin American Applied Research, 2010-present

Other professional and consulting activities

- **Faw Jiefang Automotive, LTD.** Wuxi Diesel Engine Works (FAWDE). Optimization of intake port design for a medium-duty diesel engine, 2019.
- **General Motors**: development of fast chemistry and spray solvers for multicomponent modelling of diesel engines, 2018;
- **Mitsubishi Heavy Industries and Wisconsin Engine Research Consultants**: development of a methodology to simulate dual-fuel Reactivity Controlled Compression Ignition (RCCI) combustion and torch jet ignition in marine engines, 2013-2017;
- **John Deere Corporation**: development of fast chemistry solvers for diesel engine modelling, 2014;
- **HERA S.p.A.**, life-cycle and environmental sustainability study of the car, light and heavy truck fleet for a waste displacement and local energy company, through introduction of hybrid electric or alternative-fuel powered vehicles, 2012;
- **VM Motori Cento (FE)**, study and one-dimensional modeling of lubrication and cooling circuits on mid-duty automotive diesel engines, 2009-2012;
- **Professional Engineers Association of the province of Modena** (Albo degli Ingegneri della Provincia di Modena): teaching in preparation of the PE licensure examination, 2011;
- **Ducati**: study and simulation of lubrication circuits for high performance 4-stroke motorbike engines, 2009;
- **Delphi**: teacher, electronic systems for combustion development control, Molinella (BO), 2008;
- **CIS School of Entrepreneurship**, Reggio Emilia: Fluid Power Systems, 2008;

- **University Textbook** (Co-author): “Fondamenti di Motori Endotermici Alternativi, con cenni di controllo” (Internal Combustion Engine Fundamentals, including control basics), Casa Editrice Esculapio – Progetto Leonardo, Bologna, 2008.

Volunteering

- **Festivaletteratura**, light logistics team leader at international literature festival, 1999-2006.

Professional affiliations

- **Society of Automotive Engineers (SAE)**, since 2008
- **American Society of Mechanical Engineers (ASME)**, since 2013
- **Combustion Institute**, since 2013
- **Italian Professional Engineer licensure**, since 2007

Academic Rankings

- **Scopus (author ID 56984159200)**
 - h-index 10
 - # documents 30
 - # citations 371
 - # citing documents: 275
- **Google scholar:** <http://scholar.google.com/citations?user=WnfbZlgAAAAJ>
 - h-index 11
 - i10-index 12
 - # citations 529
- **Academia.edu:** <http://wisc.academia.edu/FedericoPerini>
 - Ranked in Top 4%
- **ResearchGate:** http://www.researchgate.net/profile/Federico_Perini2
 - RG-score: 19.27