# Tommaso Lucchini

## Scientific and teaching curriculum vitae

Tommaso Lucchini,
Born in Piacenza, May $30^{th}$ 1977
Currently employed as Associate Professor at Energy Department of Politecnico di Milano.
Office address: Politecnico di Milano, Department of Energy, Via Lambruschini 4, 20156 Milan
e-mail: tommaso.lucchini@polimi.it

# Education

2006 - Ph.D. in Energetics at Energy Department of Politecnico di Milano. Thesis Title: "Prediction of Combustion and Pollutant Emissions in Internal Combustion Engines". Thesis supervisor: Prof. Giancarlo Ferrari. Thesis opponent: Prof. Tiziano Faravelli.

2002 - M.Sc. in Mechanical Engineering at Politecnico di Milano (mark: 95/100). Thesis Title: "1D Simulation of Unsteady Flows in Internal Combustion Engines with Exhaust Gas Recirculation". Thesis supervisor: Prof. Giancarlo Ferrari.

# Professional employments

2015-now: Associate Professor at the Energy Department of Politecnico di Milano. Research and teaching activities on thermal and fluid machines, mainly focused on internal combustion engines.

2008-2015: permanent researcher at the Energy Department of Politecnico di Milano. Research and teaching activities on thermal and fluid machines, mainly focused on internal combustion engines.

2007-2008 : temporary researcher at the Energy Department of Politecnico di Milano. Project title: "CFD modeling of high-performance and low emission direct-injection engines for motorcycle applications".

2006-2007 : Post-Doc researcher at the Energy Department of Politecnico di Milano. Project title: "1D and CFD simulation of turbocharged common-rail diesel engines for marine applications".

# Research activities

Tommaso Lucchini's research is focused on numerical simulation of thermal and fluid dynamic processes in internal combustion engines. In particular, he works on multi-dimensional modeling (CFD) of in-cylinder flow processes such as gas-exchange, fuel-air mixing and combustion. He provided new contributions to the aforementioned research areas and published the most important results in international journals and conference papers. His work has an international reputation which was

gained over the years by a constructive discussion with the experts and consolidated by the different industrial and academic collaborations he has been carrying out. To achieve the proposed objectives, Tommaso Lucchini develops specific libraries and solvers (Lib-ICE) using the OpenFOAM technology since 2004. The choice of OpenFOAM is motivated by the fact that it is an open-source code, written in object-oriented C++ and includes important pre-implemented capabilities (finite volume method, thermodynamics, numerics, polyhedral mesh support) which are fundamental pre-requisites for the simulation of IC engines. These are three important aspects promoting in turn collaborative research (in academia and industries) and allow reliable model development tailored to the specific purposes. Tommaso Lucchini's work covers the following research areas:

1. **Mesh management for simulation of internal combustion engines**: development of mesh motion algorithms supporting polyhedral grids and preserving their quality during motion. The combined use of automatic mesh motion and topological changes (addition or removal of cells, faces, points) was demonstrated to be a flexible and effective solution for mesh handling of IC engines, successfully applied to different real configurations and validated with experimental data of in-cylinder flows. He has also recently proposed a new method to automatically generate hexahedral high-quality grids to reduce the pre-processing user time and, at the same time, increase the accuracy of the simulations. The mesh management approaches he developed are widely used in the context of different collaborations and research projects.

2. **Fuel-air mixing in direct-injection engines**: he developed a comprehensive methodology to predict mixture formation, with particular attention to liquid jets emerging from multi-hole atomizers which are widely employed in modern engines. Spray was modeled using the Lagrangian approach, so he implemented suitable sub-models (atomization, injection, breakup, evaporation) accounting for the effects of nozzle geometry, flow and jet turbulence. The proposed methodology was extensively validated at different operating conditions, by comparing computed and experimental data of spray penetration, Sauter Mean Diameter and mixture fraction distribution. Fuel-air mixing models developed by Tommaso Lucchini are applied in research works and industrial collaborations to simulate the evolution of Diesel, Biodiesel and Gasoline sprays. He has also developed a liquid film model where conservation equations for its mass, momentum and energy are solved on the mesh boundary, taking into account interactions between spray, film and gas phase (impingement, secondary atomization due to sharp edges, evaporation). The liquid film contributes to the air-fuel mixture formation process mainly in spark-ignition engines and can be a possible source of emissions (soot, unburned hydrocarbons).

3. **Spark-ignition combustion**: he implemented a model to predict flame kernel growth and turbulent combustion in SI engines. The approach he proposed incorporates the most promising features available in the related literature: Lagrangian particles representing the spark-channel together with suitable sub-models take into account flame kernel expansion after breakdown, effects of energy transfer from electrical circuit, re-strike (flame-holder effect), transition from laminar to turbulent flame. Distribution of flame surface density is computed from Lagrangian particle position and size and used to compute the consumption rate of the air/fuel mixture. The model was validated with literature data, showing its capability to predict the effects of local flow, equivalence ratio and turbulence on initial combustion stage and transition to turbulent flame propagation. The model developed was also successfully applied in the context of an industrial collaboration where fundamental investigations about flame kernel growth in SI engines were carried out.

4. **Diesel combustion**: development of a comprehensive library of combustion models to predict

ignition, turbulent combustion and pollutant formation in Diesel engines. To this end, he has implemented different models based on reduced and detailed chemistry:

- Reduced chemistry: Characteristic Time-Scale Model (reduced chemistry) to be applied for practical simulations;
- Detailed chemistry: Well-Stirred Reactor Model (no turbulence-chemistry interaction); Multiple Representative Interactive Flamelets Model (with turbulence chemistry interaction and assuming diffusion flame structure); Eulerian-Field Transported Probability Density Function Model (based on stochastic differential equations). This set of models is suitable for detailed numerical investigations and to study operating conditions where multiple injections, high EGR rates and low temperature combustion are employed.

Experimental validation of the proposed approaches was performed by simulation of constant-volume and engine combustion experiments, via a detailed comparison between computed and experimental data of mean quantities (in-cylinder pressure, heat release rate, emissions of soot and NO) and flame structure data (flame lift-off, distribution of OH, formaldehyde and PAH). To identify the most suitable approach for the specific combustion mode to be simulated, attention was also focused on the differences between the implemented models. This was done by comparing them consistently with the same numerical spray and mesh setup, performing validation with a well-documented set of experimental data.

5. **Acceleration techniques to handle detailed chemistry**: to reduce computational time when a large number of chemical species and reactions are used for the prediction of ignition delay, flame structure and pollutant formation. Together with Dr. Contino, he developed the TDAC method (Tabulation of Dynamic Adaptive Chemistry) which combines the In-Situ Adaptive Tabulation algorithm (ISAT) and techniques to reduce the mechanism in each computational cell. In this way, chemistry is integrated in a limited number of cells considering only a reduced set of species and reactions. This method was proven to be very effective when simulating advanced combustion modes (HCCI, PCCI), where the air-fuel mixture is nearly homogeneous at ignition time. Under such conditions, the speed-up factor compared to the case where direct-integration is used is above 300 making possible to employ very large schemes (more than 100 species) and predict effects of ozone and nitrogen oxides on HCCI combustion. For non-premixed combustion, he has contributed to the development of the CCM (Chemistry Coordinate Mapping) algorithm, solving chemistry equations in the phase space (mixture fraction, temperature and scalar dissipation rate): in this way the number of points in which such equations are solved is significantly lower than the grid size. Compared to the standard multi-zone chemistry approaches, CCM is more oriented to the simulated combustion mode, since the third spatial coordinate (scalar dissipation rate) includes additional information about local mixing. Achieved speed-up factors by CCM are of the order of 10-20 compared to direct integration. Both CCM and TDAC were shown to be accurate and consistent with direct integration when reducing the allowed tolerance.

The main result achieved by Tommaso Lucchini in his entire career is represented by the development of an open-source code for the simulation of gas-exchange, fuel-air mixing and combustion in IC engines. Such code includes the state of the art of numerical models and for this reason it can be used as a possible alternative to commercial codes. Furthermore, availability of advanced spray and combustion models make that code also an ideal tool for detailed investigations in the context of research and industrial projects.

# Supervision of M.Sc. and Ph.D. theses

Tommaso Lucchini supervises and co-supervises M.Sc. theses in the field of internal combustion engine modeling since 2003, when he has started his Ph.D. He usually follows 3/5 master students per year.

He has supervising the research work of three Ph.D. students at Energy Department of Politecnico di Milano:

- Luca Cornolti, *CFD modeling of turbulent premixed combustion for spark ignition engines*. Ph.D. project duration: September 2011 - December 2014.
- Amin Maghbouli, *Development of an advanced multi-dimensional CFD framework for modeling low temperature combustion in DI CI engines*. Ph.D. project duration: September 2013 - December 2016.
- Ehsanallah Tahmasebi, *CFD modeling of flow and cavitation in multi-hole injectors*. Ph.D. project duration: September 2013 - December 2016.
- Lorenzo Sforza, *Development of a comprehensive CFD model for spark-ignition engine combustion*. Ph.D. project duration: September 2015 - September 2018.

He is currently supervisor of three Ph.D. students at the Energy Department of Politecnico di Milano:

- Davide Paredi (project duration 2016-2019): Ph.D. project related to full-cycle simulation of low-emissions and low-fuel consumption SI Engines;
- Giovanni Gianetti (project duration 2017-2020): modeling of light-duty natural gas engines;
- Qiyan Zhou (PhD activity in collaboration with SJTU): modeling of conventional and avanced combustion mode for compression ignition engines;
- Co-supervisor of Gilles Decan (Ghent University): modeling of dual-fuel combustion in heavy duty engines.

He was also member of the evaluation committee of the following PhD candidates:

- Francesco Contino ("Homogeneous Charge Compression Ignition engines: experimental analysis of ethyl esters and development of a method to include detailed fuel chemistry in numerical simulations"), University of Louvain (Belgium), May 2011.
- Pedro Marti ("Development of a Computational Model for a Simultaneous Simulation of Internal Flow and Spray Break-Up of the Diesel Injection Process"), Universidad Politecnica de Valencia (Spain), October 2014.
- Chen Huang ("Numerical Modelling of Fuel Injection and Stratified Turbulent Combustion in a Direct-Injection Spark-Ignition Engine Using an Open Source Code"), Chalmers University of Technology, December 2014.
- Alberto Hernandez Lopez("Optimization and analysis by CFD of mixing-controlled combustion concepts in compression ignition engines"), Chalmers University of Technology, December 2017.
- Jiajie Xu ("Numerical and Experimental Analysis of Fuel Injection and Mixture Formation in High-Performance Natural Gas Engines"), Politecnico di Torino, September 2019

# Participation to public research projects

- Task-participant in the FIRB Project 2006, entitled: "Expansion and development of automotive industry (including two-wheels vehicles) with internal combustion engines with reduced fuel consumption and low environmental impact". Such project involved four different departments of Politecnico di Milano (Energy, Aerospace, Mechanics and Electronics) and one industrial partner (MV-Agusta SPA) working in collaboration. The project was mainly devoted to identify innovative solutions for next generation of high-performance motorcycles. Tommaso Lucchini was involved in the engine development part and worked three years full time on this project. His main tasks were related to CFD modeling of innovative motorcycle engines with direct-injection. To this end, he has developed suitable models for mesh management, spray evolution (including liquid film formation) and combustion in SI engines. Simulations allowed to define a preliminary layout for two possible engine configurations: two-stroke, direct-injection engine with multi-hole injectors and stratified charge combustion; four-stroke, port-fuel injection engine with multi-hole injectors and homogeneous combustion. The activity carried out in the context of this project is presented in references.

- In 2014, he submitted a research project proposal for the third LISA Call promoted by Consortium CINECA and Regione Lombardia to support and strengthen the talent to produce technological innovation and to make research by using super-computing resources. His proposal about "Modeling of fuel-air mixing, heat transfer and combustion in engine-like geometries using a Eulerian Probability Density Function Method" was accepted and granted with 60000 hours of CPU time on a modern Linux cluster (EURORA). He is currently working on this project as principal investigator.

- Task participant in the HDGas Eu Project (2015-2018). The overall objective of the HDGAS project was to develop, demonstrate and optimize advanced powertrain concepts for dual-fuel and for pure natural gas operation engines, perform integration thereof into heavy duty vehicles and confirm achievement of Euro VI emissions standards, in-use compliance under real-world driving conditions and CO2 or greenhouse gas targets currently under definition. In particular, Tommaso Lucchini is working as task participant in a workpackage involving Politecnico di Milano, Borg Warner, FPT Industrial, Ricardo and AVL. Objective of the workpackage is the development of a natural gas, direct-injection engine for heavy duty applications. His main tasks are related to the application of OpenFOAM and Lib-ICE codes for the design of cylinder head, injection and combustion systems.

- Task participant in the Hercules-2 EU project (2015-2018). Objective of the project is the design of high-efficient, multi-fuel internal combustion engines for heavy duty marine applications. The workpackage where Tommaso Lucchini partecipated involved different institutions including MAN B&W, Lund University of Technology, Denmark University of Technology. The research activities carried out involved:

  - Validation of flamelet models for modeling conventional Diesel combustion
  - Validation of combustion models for single and dual fuel operation (Diesel + methane) based on tabulated kinetics.

- Task participant in the Upgrade Eu Project (2016-2019). Objective of the project is the design of a low-emission, high-efficiency direct-injection gasoline engine. The workpackages where Tommaso Lucchini partecipates involves different institutions including Politecnico di Milano, Centro Ricerche Fiat (CRF), University of Genova, IFPen and Shafflerer. Two different research activities were carried out:

  - Full cycle simulation of a GDI engine design by CRF using OpenFOAM and Lib-ICE in order to study gas exchange process, fuel-air mixing, combustion and formation of pollutants;
  - Development of numerical models to predict formation of soot emissions during the combustion process in GDI engines.

- Task participant in the Imperium Eu Project (2016-2019). Objective of the project was the reduction of fuel consumption in Heavy Duty Diesel Engines by means of advanced control strategies. The project involves also FPT-Industrial, AVL, Politecnico di Torino and Bosch. Within the project, CFD simulations of the combustion process in a FPT-Industrial Diesel engine will be carried out in order to:
  - Increase combustion efficiency of an HD Diesel Engine;
  - Use results of CFD simulations for the development of real-time, control-oriented models.

# Collaborations with industries

The CFD tools implemented by Tommaso Lucchini are used by different companies in the field of internal combustion engines. The main objective of each industrial collaboration is the development of a CFD methodology for engine design based on advanced numerical models and open-source codes. The companies involved in such collaborations support financially the Department of Energy through research contracts

- Fiat Powertrain Industrial (2013-ongoing): development of a CFD methodology to model combustion in Heavy Duty engines operating with Diesel, natural gas and alternative fuels. Within this collaboration, he has developed spray and combustion models which are currently used as design and development tools by engineers working at Fiat Industrial.

- Magneti Marelli Powetrain (2010-2014): development of a CFD methodology for injection system design (spray targeting and injection strategy) for direct-injection engines (Diesel and spark-ignition). This collaboration is mainly focused on the simulation of the fuel-air mixing process. To this end, he has developed suitable CFD approaches to model gas exchange and spray evolution for liquid jets emerging from multi-hole atomizers. The numerical tools he has developed in the context of this collaboration are currently used by engineers working at Magneti Marelli for design purposes.

- Nissan (2011-ongoing): development of advanced numerical models to study the flame kernel growth in spark-ignition engines operating with lean mixtures and high turbulence. Results of the simulations carried out by Tommaso Lucchini were used by Nissan engineers to understand fundamental aspects related to flame kernel growth process and how it is affected by turbulence, flow field near the spark-plug, air/fuel ratio and properties of the ignition system.

- BMW (2011-2012): simulation of gas exchange process in a spark-ignition, direct-injection engine using an open-source CFD code.

- Liebherr (2009-2012): development of a CFD methodology to design Diesel engines for industrial applications. Development of CFD models for gas exchange and combustion simulations.

- Continental (2009-2010): simulation of combustion in Euro V Diesel engines with advanced injection strategies. A joint paper presented the main results of the activity carried out in this research project.

- Seatek (2006-2011): development of a CFD methodology for cylinder head and combustion system design in a Common-Rail, Diesel engine for marine applications.

## Collaborations with universities and research institutes

Tommaso Lucchini collaborates with different institutes in the context of the Lib-ICE development, application and validation. The choice of using an open-source code promotes the exchange of knowledge among the different involved institutions and the possibility for joint development of numerical models of common interest. The most important collaborations are:

- University of Louvain (Belgium): development of the TDAC algorithm for CFD simulation of combustion in IC engines with detailed chemistry. People involved in the collaboration: Prof. H. Jeanmart, Dr. Francesco Contino. Within the context of this collaboration, Francesco Contino spent six month working at Politecnico di Milano on CFD modeling of HCCI combustion using OpenFOAM under Tommaso Lucchini's supervision.

- Lund University of Technology (Sweden): development of the CCM algorithm to predict non-premixed combustion in IC engines; combustion modeling using transported PDF models. People involved in the collaboration: Prof. X. Bai and Dr. M. Jangi. Since 2010, Tommaso Lucchini and Dr. Jangi have yearly meetings (2/3 days) in Milan or Lund working on common aspects of their research activities.

- Chalmers University of Technology (Sweden): development of combustion models for Diesel engines based on detailed chemistry and turbulence-chemistry interaction. People involved in the collaboration: Prof. A. Karlsson, Dr. A. Kosters, Dr. Chen Huang. Both Chen Huang (2009) and Anne Kosters (2012) spent two months in Milan working on CFD modeling of combustion using OpenFOAM under Tommaso Lucchini's supervision.

- Freiberg University (Germany): development of spray models for multi-component fuels. People involved in the collaboration: Prof. C. Hasse, Ph.D. student P. Keller. Tommaso Lucchini supervised Peter Keller's work on Lagrangian spray modeling using OpenFOAM during his visit to Milan (two months in 2012).

- Malaysian Campus of Nottingham University (Malaysia): CFD simulation of combustion in engines fueled with biodiesel using detailed chemistry. People involved in the collaboration: Prof. H.K. Ng, Dr. H.M. Ismail. Within the context of this collaboration, Dr. Ismail spent two months in Milan working on Diesel spray combustion modeling using OpenFOAM under the supervision of Tommaso Lucchini.

- CNR - Istituto Motori (Naples, Italy): application and validation of spray and combustion models for direct-injection engines. Researchers involved in the collaboration: Dr. L. Allocca, Dr. A. Montanaro, Dr. M. Migliaccio, Dr. V. Fraioli. Several researchers at CNR applies the libraries and solvers developed by Tommaso Lucchini for CFD simulations of Diesel, HCCI and dual fuel engines.

## Research visits and seminars

During his Ph.D. studies, Tommaso Lucchini spent 9 months (August 2004 to June 2005) as a visiting PhD student at the Department of Thermal and Fluid Dynamics at Chalmers University of Technology (Goteborg, Sweden). During that period, he learned how to use the OpenFOAM technology for

spray and combustion simulations. His activity at Chalmers University of Technology was supervised by Prof. N. Nordin and Prof. I. Denbratt.

In 2010, Tommaso Lucchini was invited for one week at Argonne National Labs (Illinois, USA) to held seminars and a training course about CFD simulation of IC engines using the OpenFOAM technology. Seminars were organized by Dr. Riccardo Scarcelli and Dr. Sibendu Som, from 15-18 November in the context of the "Bridge the Gap" project.

He was also invited to held seminars on CFD simulations of IC engines using OpenFOAM technology at CMT Motores Termicos (Valencia, Spain, October 2009), Chalmers University of Technology (Goteborg, Sweden, December 2009 and May 2013), Lund University of Technology (Lund, Sweden, June 2010), University of Freiberg (Germany, December 2011), University of Duisburg-Essen (Duisburg, January 2013), ETH Zurich (Switzerland, February 2013).

In 2014, he was invited to give a plenary lecture at the $23^{rd}$ Journées d'Etude of the Belgian Section of the Combustion Institute. Presentation title was "Combustion modeling in IC engines: current state, role of detailed chemistry and future developments".

# OpenFOAM training

Tommaso Lucchini gave specific OpenFOAM training sessions within the following events:

- OpenFOAM workshop 2008 (Milan): two lectures (1 hour each) about how to program in C++ and customize the OpenFOAM code;
- OpenFOAM workshop 2009 (Montreal): three lectures (1 hour each) about OpenFOAM post-processing, programming and customization;
- OpenFOAM workshop 2010 (Goteborg): four lectures (1 hour each) about OpenFOAM structure, tutorials, parallel run and post-processing;
- OpenFOAM training at the "About Flow workshop", organized at the Queen Mary University (London) in 2013 in the context of the About Flow European Project concerning Adjoint-based Optimisation of Industrial and Unsteady Flows: two lectures (2 hours each) about C++ programming and customization of the OpenFOAM code.

# Awards

In 2017, Tommaso Lucchini received the "SAE John Johnson Award for Outstanding Research in Diesel Engines" at the SAE World Congress in Detroit. The awarded paper was *Experimental and Numerical Analyses of Liquid and Spray Penetration under Heavy-Duty Diesel Engine Conditions*.

# Publications

Tommaso Lucchini is author of more than 100 publications. Scopus statistics are: 105 documents; H-Index: 21; number of citations: 1319.

1. Lucchini, T., Pontoni, D., D'Errico, G., Somers, B., *Modeling diesel combustion with tabulated kinetics and different flame structure assumptions based on flamelet approach*(2020) International Journal of Engine Research, 21 (1), pp. 89-100.

2. Paredi, D., Lucchini, T., D'Errico, G., Onorati, A., Pickett, L., Lacey, J., *Validation of a comprehensive computational fluid dynamics methodology to predict the direct injection process of gasoline sprays using Spray G experimental data*(2020) International Journal of Engine Research, 21 (1), pp. 199-216.
3. Decan, G., Lucchini, T., D'Errico, G., Verhelst, S., *A Coupled Tabulated Kinetics and Flame Propagation Model for the Simulation of Fumigated Medium Speed Dual-Fuel Engines*(2019) SAE Technical Papers, 2019-September (September), .
4. Sforza, L., Lucchini, T., Gianetti, G., D'Errico, G., *Development and Validation of SI Combustion Models for Natural-Gas Heavy-Duty Engines*(2019) SAE Technical Papers, 2019-September (September), .
5. Lucchini, T., D'Errico, G., Paredi, D., Sforza, L., Onorati, A., *CFD Modeling of Gas Exchange, Fuel-Air Mixing and Combustion in Gasoline Direct-Injection Engines*(2019) SAE Technical Papers, 2019-September (September), .
6. Fatehi, H., Persson, H., Lucchini, T., Ljungqvist, M., Andersson, O., *Effects of In-Cylinder Flow Structures on Soot Formation and Oxidation in a Swirl-Supported Light-Duty Diesel Engine*(2019) SAE Technical Papers, 2019-September (September), .
7. Migliaccio, M., Montanaro, A., Paredi, D., Lucchini, T., Allocca, L., D'Errico, G., *CFD Modeling and Validation of the ECN Spray G Experiment under a Wide Range of Operating Conditions*(2019) SAE Technical Papers, 2019-September (September), .
8. Lucchini, T., Della Torre, A., D'Errico, G., Onorati, A., *Modeling advanced combustion modes in compression ignition engines with tabulated kinetics*(2019) Applied Energy, 247, pp. 537-548.
9. Maghbouli, A., Akkurt, B., Lucchini, T., D'Errico, G., Deen, N.G., Somers, B., *Modelling compression ignition engines by incorporation of the flamelet generated manifolds combustion closure*(2019) Combustion Theory and Modelling, 23 (3), pp. 414-438.
10. Tahmasebi, E., Albertelli, P., Lucchini, T., Monno, M., Mussi, V., *CFD and experimental analysis of the coolant flow in cryogenic milling*(2019) International Journal of Machine Tools and Manufacture, 140, pp. 20-33.
11. Fatehi, H., Lucchini, T., D'Errico, G., Karlsson, A., Bai, X.-S., Andersson, Ö., *Effect of In-cylinder Flow Structures on Late Cycle Soot Oxidation in a Quiescent Heavy-duty Diesel Engine*(2019) Combustion Science and Technology, .
12. Varna, A., Wehrfritz, A., Hawkes, E., Cleary, M., Lucchini, T., D'Errico, G., Kook, S., Chan, Q., *Application of a multiple mapping conditioning mixing model to ECN Spray A*(2019) Proceedings of the Combustion Institute, 37 (3), pp. 3263-3270.
13. Decan, G., Broekaert, S., Lucchini, T., D'Errico, G., Vierendeels, J., Verhelst, S., *Evaluation of wall heat flux calculation methods for CFD simulations of an internal combustion engine under both motored and HCCI operation*(2018) Applied Energy, 232, pp. 451-461.
14. Maes, N., Dam, N., Somers, B., Lucchini, T., D'Errico, G., Hardy, G., *Heavy-Duty Diesel Engine Spray Combustion Processes: Experiments and Numerical Simulations*(2018) SAE Technical Papers, 2018-September, .
15. Gianetti, G., Sforza, L., Lucchini, T., D'Errico, G., Soltic, P., Rojewski, J., Hardy, G., *CFD modeling of combustion of a natural gas Light-Duty Engine*(2018) Energy Procedia, 148, pp. 954-961.
16. Fatehi, H., Wingren, E., Lucchini, T., D'Errico, G., Karlsson, A., Andersson, O., Bai, X.-S., *A Numerical Study on the Sensitivity of Soot and NOx Formation to the Operating Conditions in Heavy Duty Engines*(2018) SAE Technical Papers, 2018-April, .

17. Paredi, D., Lucchini, T., D'Errico, G., Onorati, A., Montanaro, A., Allocca, L., Ianniello, R., *Combined Experimental and Numerical Investigation of the ECN Spray G under Different Engine-Like Conditions*(2018) SAE Technical Papers, 2018-April, .
18. Behzadi, J.J., Talei, M., Bolla, M., Hawkes, E.R., Lucchini, T., D'Errico, G., Kook, S., *A Conditional Moment Closure Study of Chemical Reaction Source Terms in SCCI Combustion*(2018) Flow, Turbulence and Combustion, 100 (1), pp. 93-118.
19. Tahmasebi, E., Lucchini, T., D'Errico, G., Onorati, A., Hardy, G., *An investigation of the validity of a homogeneous equilibrium model for different diesel injector nozzles and flow conditions*(2017) Energy Conversion and Management, 154, pp. 46-55.
20. Sforza, L., Lucchini, T., Onorati, A., Zhu, X., Lee, S.-Y., *Modeling Ignition and Premixed Combustion Including Flame Stretch Effects*(2017) SAE Technical Papers, 2017-March (March), .
21. Maghbouli, A., Lucchini, T., D'Errico, G., Izadi Najafabadi, M., Somers, B., *Numerical Investigation of PPCI Combustion at Low and High Charge Stratification Levels*(2017) SAE Technical Papers, 2017-March (March), .
22. Lackmann, T., Lucchini, T., D'Errico, G., Kerstein, A., Oevermann, M., *Modeling n-dodecane Spray Combustion with a Representative Interactive Linear Eddy Model*(2017) SAE Technical Papers, 2017-March (March), .
23. Lucchini, T., Della Torre, A., D'Errico, G., Onorati, A., Maes, N., Somers, L.M.T., Hardy, G., *A comprehensive methodology for computational fluid dynamics combustion modeling of industrial diesel engines*(2017) International Journal of Engine Research, 18 (1-2), pp. 26-38.
24. Ibron, C., Jangi, M., Lucchini, T., Bai, X.-S., *Numerical Estimation of Asymmetry of In-Cylinder Flow in a Light Duty Direct Injection Engine with Re-Entrant Piston Bowl*(2017) SAE Technical Papers, 2017-October, .
25. Lucchini, T., D'Errico, G., Cerri, T., Onorati, A., Hardy, G., *Experimental Validation of Combustion Models for Diesel Engines Based on Tabulated Kinetics in a Wide Range of Operating Conditions*(2017) SAE Technical Papers, 2017-September, .
26. Varna, A., Wehrfritz, A., Hawkes, E.R., Cleary, M.J., Lucchini, T., D'Errico, G., *Application of multiple mapping conditioning mixing model to non-reacting spray a*(2017) 11th Asia-Pacific Conference on Combustion, ASPACC 2017, 2017-December, .
27. Paredi, D., Lucchini, T., D'Errico, G., Onorati, A., Golini, S., Rapetto, N., *Gas Exchange and Injection Modeling of an Advanced Natural Gas Engine for Heavy Duty Applications*(2017) SAE Technical Papers, 2017-September, .
28. Decan, G., Broekaert, S., Lucchini, T., D'Errico, G., Vierendeels, J., Verhelst, S., *Evaluation of Wall Heat Flux Models for Full Cycle CFD Simulation of Internal Combustion Engines under Motoring Operation*(2017) SAE Technical Papers, 2017-September, .
29. Lucchini, T., D'errico, G., Onorati, A., Frassoldati, A., Stagni, A., Hardy, G., *Modeling non-premixed combustion using tabulated kinetics and different fame structure assumptions*(2017) SAE International Journal of Engines, 10 (2), pp. 593-607.
30. Maes, N., Dam, N., Somers, B., Lucchini, T., D'Errico, G., Hardy, G., *Experimental and Numerical Analyses of Liquid and Spray Penetration under Heavy-Duty Diesel Engine Conditions*(2016) SAE International Journal of Fuels and Lubricants, 9 (1), pp. 108-124.
31. Maghbouli, A., Lucchini, T., D'Errico, G., Onorati, A., Malbec, L.-M., Musculus, M.P., Eagle, W.E., *Parametric Comparison of Well-Mixed and Flamelet n-dodecane Spray Combustion with Engine Experiments at Well Controlled Boundary Conditions*(2016) SAE Technical Papers, 2016-April (April), .
32. Zhu, X., Sforza, L., Ranadive, T., Zhang, A., Lee, S.-Y., Naber, J., Lucchini, T., Onorati, A., Anbarasu, M., Zeng, Y., *Experimental and Numerical Study of Flame Kernel Formation Processes of Propane-Air Mixture in a Pressurized Combustion Vessel*(2016) SAE International Journal of Engines, 9 (3), .

33. Skeen, S.A., Manin, J., Pickett, L.M., Cenker, E., Bruneaux, G., Kondo, K., Aizawa, T., Westlye, F., Dalen, K., Ivarsson, A., Xuan, T., Garcia-Oliver, J.M., Pei, Y., Som, S., Hu, W., Reitz, R.D., Lucchini, T., D'Errico, G., Farrace, D., Pandurangi, S.S., Wright, Y.M., Chishty, M.A., Bolla, M., Hawkes, E., *A Progress Review on Soot Experiments and Modeling in the Engine Combustion Network (ECN)*(2016) SAE International Journal of Engines, 9 (2), .
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# Referee activity

Tommaso Lucchini is associated editor of the SAE International Journal of Engines.
He performs reviews for the following journals: SAE Journals, International Journal of Vehicle Design, Applied Energy, Energy and Fuels, Journal of Power and Energy, Computer and Fluids, Combustion and Flame, Fuel, International Journal of Engine Research, Atomization and Sprays, Journal of Computational Physics.

He was selected by MIUR (Italian Ministry of Instruction, University and Research) as a referee for research project proposals.

# Teaching activity

Tommaso Lucchini has been teaching at Politecnico di Milano since 2003 when he started his Ph.D. studies, in the context of Fluid Machines, Internal Combustion Engines and Computational Fluid Dynamics courses.

## PhD courses

- Teacher of the course "Computational Fluid Dynamics with open-source software", 5 credits. Inter-doctoral course for Ph.D. students of Politecnico di Milano. Course taught in English. Academic years 2013/2014, 2015/2016, 2016/2017, 2019/2020.

- Lessons for the course "Combustion: theory and applications", 5 credits for doctoral program in Energy and Nuclear Science and Technology. Academic years 2009/2010, 2012/2013.

## MSc courses

- Teacher of the course "Fluid Machines for Low-Carbon Technology", 8 credits, MSc course in Energy Engineering, I year, Politecnico di Milano (Piacenza Campus). Course taught in English. Academic years 2016/2017-now.

- Teacher of the course "Turbomachinery and Internal Combustion Engines", 8 credits, MSc course in Energy Engineering, I year, Politecnico di Milano (Piacenza Campus). Course taught in English. Academic years 2011/2012-2015/2016.

- Teacher of the course "Propulsion Technologies with Reduced Environmental Impact", 5 credits, MSc course in Mechanical Engineering, I year, Politecnico di Milano (Piacenza Campus). Course taught in Italian, original name is "Tecnologie di Propulsione a Basso Impatto Ambientale". Academic year 2009/2010.

- Lessons for the course "Bio-energy and waste-to-energy technologies", 8 credits, MSc course in Energy Engineering, II year, Politecnico di Milano (Piacenza Campus). Official course teachers: Ing. Federico Viganò, Ing. Mario Grosso. Course taught in English. Academic years 2011/2012-2013/2014.

- Teaching assistant of the course "CFD for engineering", 8 credits, MSc course in Energy Engineering, II year, Politecnico di Milano (Bovisa Campus). Official course teacher: Prof. Fabio Inzoli. Course taught in Italian, original name is "Termofluidodinamica Computazionale per l'Ingegneria". Academic years 2011/2012, 2012/2013.

## BSc courses

- Teacher of the course "Fluid Machines and Energy Systems", 7 credits, BSc course in Mechanical Engineering, III year, Politecnico di Milano (Bovisa Campus). Course taught in Italian, original name is "Macchine e Sistemi Energetici". Academic years 2015/2016-now.

- Teacher of the course "Fluid Machines", 5 credits, BSc course in Transportation Engineering, II year, Politecnico di Milano (Piacenza Campus). Course taught in Italian, original name is "Macchine". Academic years 2006/2007-2008/2009.

- Teaching assistant of the course "Fluid Machines and Energy Systems", 7 credits, BSc course in Mechanical Engineering, III year, Politecnico di Milano (Bovisa Campus). Official course teacher: Ing. Gianluca Montenegro. Course taught in Italian, original name is "Macchine e Sistemi Energetici". Academic years 2009/2010, 2010/2011-2014/2015.

- Teaching assistant of the course "Fluid Machines", 10 credits, BSc course in Energy Engineering, II year, Politecnico di Milano (Bovisa Campus). Official course teacher: Prof. Angelo Onorati. Course taught in Italian, original name is "Macchine". Academic years 2008/2009-2010/2011.

- Teaching assistant of the course "Fluid Machines", 5 credits, BSc course in Transportation Engineering, II year, Politecnico di Milano (Piacenza Campus). Official course teachers: Ing. Gianluca Montenegro and Prof. Giancarlo Ferrari. Course taught in Italian, original name is "Macchine". Academic years 2003/2004, 2005/2006.

- Teaching assistant of the course ”Fluid Machines and Energy Systems”, 5 credits, BSc courses in Management and Environment Engineering, II year, Politecnico di Milano (Cremona Campus). Official course teacher: Prof. Giancarlo Ferrari. Course taught in Italian, original name is ”Macchine e Sistemi Energetici”. Academic year 2003/2004.

- Teaching assistant of the course ”Environmental Impact of Transportation Systems”, 5 credits, BSc course in Transportation Engineering, III year, Politecnico di Milano (Piacenza Campus). Official course teacher: Prof. Giancarlo Ferrari. Course taught in Italian, original name is ”Impatto ambientale dei sistemi di Trasporto”. Academic year 2002/2003.

Milan, 19 January 2020

The declarant