Lorenzo Tieghi

Curriculum Vitae

Education

2020 **Ph.D. in Energy and Environment (3 years course)**

Sapienza University of Rome

Final thesis on: *"Artificial Intelligence and Turbulence Modeling. Development of data-driven tools for RANS models in Turbomachinery Flows"*.

Final grade: Excellent

Supervisor: Prof. Alessandro Corsini.

Co-Supervisor: Prof. Giovanni Delibra.

2016 **MSc in Mechanical Engineering (2 years course)**

Sapienza University of Rome

Final thesis on: *"Validation of URANS model in open source CFD code – analysis of secondary flows in linear compressor cascade"*.

Final grade: 111/110

Supervisor: Prof. Alessandro Corsini.

Tutor: Dr. Giovanni Delibra.

2014 **BSc in Mechanical Engineering (3 years course)**

Sapienza University of Rome

Final thesis on: *"Build-in obsolescence in common electric equipment"*.

Final grade: 105/110

Tutor: Prof. Lorenzo Fedele.

Research Experience

2015-2016 **MSc Thesis**

Department of Mechanical and Aerospace Engineering, Sapienza University of Rome

- Development and validation of advanced turbulence models for industrial CFD and turbomachinery:
  - URANS models
  - LES models
  - LES/RANS models
- Implementation and validation of an advanced URANS model in OpenFOAM

- URANS and Hybrid LES/RANS study of turbulent flows in popular 2D test cases (periodic channel flows, periodic hills)
- URANS and Hybrid LES/RANS analysis of secondary flows in a linear compressor cascade with an accelerating endwall

2016-2019 **Ph.D. Fellow**

Department of Mechanical and Aerospace Engineering, Sapienza University of Rome

- **Turbomachinery-related activities:**
  - Development, assessment and validation of design numerical tools based on synthetic models (e.g. axisymmetric algorithms as the actuator disk), for fast performance analysis of industrial fans and turbomachinery
  - Implementation and validation of hybrid LES/RANS approach in synthetic models for fan blade design
  - Study on the effects of spinner cone modeling and polar curve sensibility in synthetic blade models for axial fans
  - Study and assessment on the application of advanced URANS and hybrid LES/RANS turbulence models to advanced solutions for noise control in industrial fans
  - Development, implementation and validation of a meta-model for lift and drag coefficient for reversible blade profiles in a cascade configuration

- **Machine-learning related activities:**
  - Development, validation and implementation of a multi-layer perceptron neural network-based wall function for steady simulations
  - Application of machine learning to near-wall modeling of TKE. A feed-forward neural network has been trained to perform run-time computation of turbulent kinetic energy in a CFD code, to enhance standard wall treatments. Presented at ASME Turboexpo 2019 and awarded with journal-quality.
  - Application of machine learning to near-wall modeling in rotating passages. Boundary layer distortion caused by the interaction with rotating in pipe flows and diffusers have been investigated through CFD simulation. An alternative wall treatment was derived and validated in the run-time computation in OpenFoam.
  - Application of machine learning to secondary flows in square ducts. Secondary flows physics near corners are incorrectly represented in RANS approach. A machine learning approach to predict Reynolds stress tensor components is currently under development.

2019-2020 **Research Scholarship on Flooding Forecasting and Alarm**

Department of Mechanical and Aerospace Engineering, Sapienza University of Rome

In collaboration with Prof. Cioffi, from DICEA department, Sapienza University of Rome and E-GEOS company. The aim was to build a system of alarm for the St. Lucia island in the East Caribbean, in presence of elevate rainfall and hurricanes. The activity was focused on two main aspects, both implemented in a run-time operative framework:

- *Development of a solver for linearized equation to describe hurricane behaviors*. The solver, implemented in Python, solve the field of motion of the hurricane returning an anisotropic rainfall field. It has been validated against past events.

- *Development of a machine-learning surrogate model for Shallow Water equations*. A multi-layer perceptron was trained on a huge database of simulations of spatially- and time-varying rainfall. Innovative techniques for images and sequences processing were applied to reduce the computational cost of the operations.

2020-2021 **Visiting researcher, Machine-learnt detection of vortex induced noise sources in turbomachinery flows**

Friedrich-Alexander University of Nurberg

This research has been conducted as a visiting researcher, under the supervision of Prof. Stefan Becker and founded by the Bavarian Reasearch Fundation. Unsupervised machine-learning techniques were applied to automatically detect the sources of noise emissions in a axial low-speed fan. The numerical database was generated through a LES approach and validated against experimental measurements. The derived models were additionally applied to have a deeper understanding of the physics underlying such phenomena.

2021-2022 **Visiting researcher, On the effect of the surge motion in wind turbine blades**

Lancaster University, UK

This research has been conducted as a visiting researcher, under the supervision of Prof. Sergio Campobasso and founded by the HPC Europa3-Programme. During this period, high fidelity numerical simulations were carried out in OpenFOAM, exploiting the computing resources of ARCHER2 UK national supercomputing senter to characterize the wake dynamic of 10 MW DTU floating wind turbine. The influence of the surge motion on the wake dynamics was characterized through a kinematic comparison with the stationary turbine.

Teaching activities

2022 Teacher of the "Turbomachinery" course, MSc in Mechanical Engineering, Sapienza University

2019-2022 Teacher of the "Computational Thermo-fluids analysis in fluid machinery" course, MSc in Mechanical Engineering, Sapienza University

2020 Tutor in the "Turbomachinery" course, MSc in Mechanical Engineering, Sapienza University

2020 Tutor in the "Computational Thermo-fluids analysis in fluid machinery" course, MSc in Mechanical Engineering, Sapienza University

2019-today Supervisor of Ph.D. fellows

2017-today Supervisor of students for master degree thesis

Conference attendence

- Presenting author at student poster session in IGTI ASME TurboExpo 2017
- Presenting author and co-chair at IGTI ASME TurboExpo 2018 and 2019
- Presenting author and session chair at IGTI ASME TurboExpo 2020 and 2021
- Participation to PhD summer school in Pisa in Sept. 2017
- Presenting author at ERCOFTAC Italian Pilot Center in May 2018 and 2019
- Invited speaker for Big Data & Turbomachinery in CMFF18
- Presenting author at Turboexpo 2021 of a live tutorial in machine-learning and turbomachinery application
- Presenting author at Turboexpo 2022 of a live tutorial in unsupervised learning methods for fan design exploration
- Presenting author at Turboexpo 2022

Prizes

- 2nd Place in the Innovation Contest for the Italian Space Agency
- Winner of the the Alfano and Caputo prize for the Italian Thermodynamic Association
- Winner of the best paper award at Turboexpo 2020 for *"A machine-learnt wall function for rotating passages."*

Relevant research skills

- Advanced knowledge of numerical methods for Computational Fluid Dynamics (CFD):
  - *Finite Elements*
  - *Finite Volumes*
  - *Discretization techniques*
  - *Steady-state and time-advancing solutions*
- Advanced knowledge of OpenFOAM and StarCCM softwares for CFD
- Advanced knowledge of advanced turbulence modelling
- Programming language experience:
  - *Advanced programmer of Python 3.x and Matlab*
  - *Advanced programmer of C++*
  - *Good knowledge of Fortran 77*
- Advanced knowledge of APIs for programming language interface: C_{API} and forpy
- Advanced knowledge of initial data exploration and the main libraries exploited for this purpose
- Advanced knowledge of Tensorflow library, currently used for ANN development
- Advanced knowledge of post-processing and analysis of CFD results and the major software used to this aims
- Advanced knowledge of both Linux and Windows environments
- Advanced knowledge of Pointwise, Tecplot, Paraview, Matlab, MS Office, LaTeX, Ansys

HPC Experience

2020-2021 Erlangen Regional Computing Center (RRZE)
2021-2022 ARCHER2 UK National Supercomputing Service

Referees

Tutor Prof. Alessandro Corsini
Address Dept. Mechanical and Aerospace Engineering
Organization Sapienza University of Rome
Phone +39 06 44 585 233
e-mail alessandro.corsini@uniroma1.it

Publications

2017 Tieghi L.

"Analysis of secondary flows in linear compressor cascade during transient operations with elliptic-relaxation-based U-RANS closure."

Student poster for IGTI ASME TurboExpo 2018

2017 Angelini G., Bonanni T., Corsini A., Delibra G., Tieghi L., Volponi D.

"Optimization of an axial fan for air cooled condensers."

ATI 2018 conference

2018 Angelini G., Bonanni T., Corsini A., Delibra G., Tieghi L., Volponi D.

"Effects of fan inflow distortions on heat exchange in air-cooled condensers. Unsteady computations with synthetic blade model."

ASME GT2018-76518

2018 Angelini G., Bonanni T., Corsini A., Delibra G., Tieghi L., Volponi D.

"A metamodel for deviation in 2D cascade with variable stagger and solidity and reversible profiles."

ASME GT2018-76363

2018 Angelini G., Bonanni T., Corsini A., Delibra G., Tieghi L., Volponi D.

"On surrogate-based optimization of truly reversible blade profiles for axial fans."

Issue to Design

2018 Angelini G., Volponi D., Wilkinson M., Spuy J., Bonanni T., Tieghi L., Delibra G., Corsini A., Backstrom T.

"Noise redution of a large axial flow fan for CSP air-cooled condenser."

Proceeding to FAN 2018

2018 Corsini A., Delibra G., Sheard J., Tieghi L.

"The use of serrated leading edge for inflow conditioning in centrifugal fan."

Proceeding to FAN 2018

2019 Angelini G., Corsini A., Delibra G., Tieghi L.

"Exploration of axial fan design space using a metamodel for aerodynamic properties of NACA 4-digit profiles."

ASME GT2019-91588

2019 Angelini G., Corsini A., Delibra G., Giovannelli M., Lucherini G., Minotti S., Rossin S., Tieghi L.

"Meta-modelling of gas-leak in gas turbine enclosures."

ASME GT2019-91198

2019 Angelini G., Corsini A., Delibra G., Giovannelli M., Lucherini G., Minotti S., Rossin S., Tieghi L.

"Identification of poorly ventilated zones in gas-turbine enclosures with machine learning."

ASME GT2019-91199

2019 Angelini G., Corsini A., Delibra G., Tieghi L.

"Exploration of Axial Fan Design Space with Data-Driven Approach."

International Journal of Turbomachinery Propulsion and Power

2020 Angelini G., Corsini A., Delibra G., Giovannelli M., Lucherini G., Minotti S., Rossin S., Tieghi L.

"Prediction of ventilation effectiveness for LM9000 package with machine learning."

ASME GT2020-14916

2020 Tieghi L., Angelini G., Corsini A., Delibra G.

"Assessment of a machine-learnt adaptive wall-function in a compressor cascade with sinusoidal leading edge."

Journal of Engineering for Gas Turbines and Power - GTP-20-1311

2020 Tieghi L., Delibra G., Corsini A., Van Der Spuy J.

"Numerical investigation of CSP air cooled condenser fan."

E3S Web of Conferences. Vol. 197. EDP Sciences, 2020.

2021 Tieghi L., Corsini A., Delibra G., Tucci F.

"A machine-learnt wall function for rotating passages."

Journal of Turbomachinery - TURBO-20-1368

2021 Van Der Spuy J., Tieghi L., Corsini A., Delibra G., Louw F., Zapke A., Els D., Meyer C. J.

"Evaluation of the 24 Ft. Diameter Fan Performance in the Minwatercsp Large Cooling Systems Test Facility."

Proceedings to ASME Turboexpo 2021

2021 Tucci F., Delibra G., Tieghi L., Corsini A.

"Cascade With Sinusoidal Leading Edges: Identification and Quantification of Losses With Unsupervised Machine Learning."

Proceedings to ASME Turboexpo 2021