Ludovico Musenich

University of Genoa
Mechanical, Energy, Management and Transportation Engineering Department
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Education

University of Genoa — Genoa, IT
Ph.D. in Mechanical Engineering — *Expected, May 2024*

Provisional thesis title: Design of multifunctional bioinspired structures. Supervisor: Flavia Libonati

University of Genoa — Genoa, IT
M.S. in Mechanical Engineering. 110 cum laude/110 — *October 2020*

Thesis title: FEM modeling for structural verification of the supporting frame of the DarkSide-20k dark matter detector. Supervisors: Alessandro Rebora, Stefania Farinon, Alessio Caminata

University of Genoa — Genoa, IT
B.S. in Mechanical Engineering. 106/110 — *February 2018*

Thesis title: Analysis of the boundary layer transition on axial compressor blades. Supervisors: Pietro Zunino, Daniele Simoni

Research Experience

Laboratory of Atomistic and Molecular Mechanics — Cambridge, MA
Massachusetts Institute of Technology — *June 2023 to*
Supervisor: Markus J. Buehler — *Present*

3-month research activity as a Visiting Scholar. Topics covered: generation of a dataset to train Machine Learning algorithms to identify novel combinations of mechanical and non-mechanical properties for the design of new multifunctional diatom-inspired architected materials. Mechanical characterization of biodegradable honeycombs produced by 3D printing

Multiscale Mechanics of Multifunctional Materials Lab — Genoa, IT
University of Genoa — *September2022 to*
Supervisor: Flavia Libonati — *Present*

Multifunctional structural materials development through a biomimetic and data-driven approach. Main activities: study of structural materials found in Nature (main reference: diatoms); CAD modeling of biomimetic materials (software used: PTC Creo Parametric, Grasshopper, nTopology, Space Claim); parametric linear and nonlinear finite element analysis (mainly through ANSYS Mechanical APDL); multiscale modeling for the study of the mechanical properties of hierarchical materials and innovative products designed with such materials (e.g., protective helmets for sports activities); rapid prototyping by additive manufacturing of samples for experimental tests (main technologies used: FFF, SLA, SLS); dual-channel measurements for mechanical and electrical characterization of 3D-printed self-sensing materials; regression model development using machine-learning

algorithms to characterize the property-structure relationship of designed materials. Collaboration with designers on aesthetics and product renderings

Laboratorio di Caratterizzazione Meccanica Genoa, IT
University of Genoa *September2021 to*
Supervisor: Massimiliano Avalle *Present*

Usage and maintenance of Prusa FFF 3D printers for additive manufacturing of samples. Execution of experimental tests for the mechanical characterization of polymers, elastomers and composites using a Zwick Roell ProLine universal testing machine according to ASTM and UNI EN ISO standards (tensile, compression and bending tests). Writing technical manuals for the use of the aforementioned machines. Design of custom tooling for the testing machine. Post processing of data from mechanical characterization tests

DarkSide-20k Collaboration Genoa, IT
National Institute of Nuclear Physics (INFN) *March to*
Supervisors: Stefania Farinon, Alessio Caminata *October 2020*

Structural analysis of DarkSide-20k dark matter detector supporting frame: finite element model development for static verification; coworking with mechanical design unit; attending international meetings for project management

Laboratory of Aerodynamics and Turbomachinery Genoa, IT
University of Genoa *September 2017 to*
Supervisors: Pietro Zunino, Daniele Simoni *February 2018*

Wind tunnel data acquisition to study the evolving boundary layer transition on axial turbocompressor blades as three main fluid dynamic parameters change: Reynolds number, free-stream turbulence intensity, and flow-averse pressure gradient. To characterize the flow-blade interaction, pressure measurements using static intakes (wall taps) and Kiel probes, and velocity measurements using Particle Imagine Velocimetry (PIV) were performed

Research Interest

My broad research interests concern: Biomimicry; Multifunctional architected materials design and characterization; FEM modeling; Additive Manufacturing; Data-driven material design using Machine Learning techniques

Awards

Best project *July 2022*

Best project in the final competition of the summer school “Deep Learning: a hands-on introduction” offered by the Machine Learning Genoa Center. Project title: Optimal Deep Generated Bioinspired Materials

Best Master Thesis *July 2022*

Best Master Thesis by the Verein Deutscher Ingenieure (VDI) - the Association of German Engineers. Role: co-tutor. Thesis title: Design and Manufacturing of Bone-like Composites

Fellowships

International mobility scholarship *May 2023*

Scholarship provided by the University of Genoa to conduct a 3-month research period at the Massachusetts Institute of Technology

Ph.D. Scholarship *October 2020*

Scholarship provided by the University of Genoa for the XXXVI cycle of PhD degrees

ERASMUS scholarship *June 2017*

Scholarship provided by the University of Genoa to conduct a period of study abroad at the University of Málaga

Cultural exchange with France *April 2013*

School program of the bilingual curriculum of the G.D. Cassini High School

Teaching Experience

Structural FEM Design Genoa, IT
Master's degree program in Mechanical Engineering *Spring 2023*
University of Genoa

20 hours of frontal classroom lectures. Topics covered: introduction to ANSYS Mechanical APDL. Fundamentals of FEM modeling using ANSYS MAPDL. Main finite-element types for structural analysis and their application. Linear finite element analysis. Hints on nonlinear analysis. Guided exercises on trusses, frames, plates, shells, pressure vessels and other machine components. Preparation of teaching materials: slides and exercises

Machine Design Genoa, IT
Master's degree program in Mechanical Engineering *Spring 2023 &*
University of Genoa *Spring 2022*

6 hours of frontal classroom lectures. Topics covered: solution methods for structural problems related to machine design. Implementation of numerical methods in computer programs: examples with ANSYS Mechanical APDL. Preparation of teaching materials: slides and exercises

Mentoring Experience

Mechanical Engineering Genoa, IT
University of Genoa *September2021 to Present*

Tutoring of 4 master's degree students. Topic covered: Design and structural analysis of osteon-inspired composite tubes produced by pull-winding. Design of a 3D Printed Adaptable Shape Structure with Self-Locking Joints Activated Through a Magnetic Force. Design of a 3D printable diatom-inspired elastomeric sports helmet. Collaboration with Fraunhofer IGCV and TU Delft

Tutoring of 1 bachelor's degree student. Topic covered: Coupled mechanical and electrical characterization of PLA specimens loaded with nanotubes and carbon nanoparticles for the development of self-sensing materials

Tutoring of 1 international internship student. Topic covered: Study of the role of functional gradients in natural materials. Home university: Polytech Paris-UPMC

Organization of Scientific Meetings

52° Convegno AIAS — Genoa, IT
Associazione Italiana per l'Analisi delle Sollecitazioni — *October 2022 to September 2023*
Organizing committee member

Industrial Research Projects

Promat S.p.A. — Filago, IT
Mechanical Designer — *November2020 to March 2022*

Development of a new formwork prototype aimed at minimizing production waste associated with the company's current production system. Concept design. Study of surface condition and possible technical solutions to improve the surface quality of the artifacts. Writing of technical reports.

Membership of Scientific Societies

Materials Research Society (MRS) — *November 2022 to Present*

Modification, Degradation and Stabilisation of Polymers Society (MoDeSt) — *September 2022 to Present*

Associazione Italiana per l'Analisi delle Sollecitazioni (AIAS) — *September 2022 to Present*

Publications (Accepted)

Musenich, L., Stagni, A., & Libonati, F. (2023). Hierarchical bioinspired architected materials and structures. *Extreme Mechanics Letters*, *58*, 101945. https://doi.org/10.1016/j.eml.2022.101945

Musenich, L., Stagni, A., & Libonati, F. (2023). Design of hierarchical lattice structures attainable by additive manufacturing techniques. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1275, No. 1, p. 012003). IOP Publishing. https://doi.org/10.1088/1757-899X/1275/1/012003

Musenich, L., Libonati, F. (2023). Damage and Failure Mechanisms of Biological Materials. *Comprehensive Structural Integrity (Second Edition), vol 2, pp 2-40.* Elsevier. https://doi.org/10.1016/B978-0-12-822944-6.00015-3

Cuneo, A., Timossi, F., **Musenich, L.**, Stagni, A., Wilhelm, F., & Libonati, F. (2022). Design and Manufacturing of Bone-like Composites. *Procedia CIRP*, *110*, 287-292. https://doi.org/10.1016/j.procir.2022.06.052

The DarkSide-20k collaboration et al (2021). Sensitivity of future liquid argon dark matter search experiments to core-collapse supernova neutrinos. *Journal of Cosmology and Astroparticle Physics*, 2021(03), 043. https://doi.org/10.1088/1475-7516/2021/03/043

The DarkSide-20k collaboration et al. (2021). Separating 39 Ar from 40 Ar by cryogenic distillation with Aria for dark-matter searches. *The European Physical Journal C*, *81*(4). https://doi.org/10.1140/epjc/s10052-021-09121-9

(In Submission)

Musenich, L., Derin, L., Stagni, A., & Libonati, F. Tunable Energy Absorption in Diatom-inspired Architected Materials Designed for Additive Manufacturing. https://doi.org/10.31224/3056

Musenich, L., Origo, D., Gallina, F., Buehler, M.J., & Libonati, F. Unravelling the property-structure relationship of diatom-inspired materials from a multidisciplinary perspective

Musenich, L., Strozzi, L., & Libonati, F. The D-HAT: Diatom-inspired Helmet Against Trauma

Musenich, L., Berardengo, M., & Libonati, F. Dual-channel anisotropy characterization of carbon-doped thermoplastic composites for the additive manufacturing of self-sensing piezoresistive materials

Conferences

(International)

Musenich, L., Stagni, A., Derin, L., Strozzi, L. & Libonati, F. (November 2022). Tunable Energy Absorption In Bioinspired Materials Designed For Additive Manufacturing. *2022 MRS Fall Meeting & Exhibit*. Boston, Massachusetts, USA

Musenich, L., Stagni, A., & Libonati, F. (September 2022). Hierarchical Bio-based Architected Structures. *Polymers, Health and Sustainability*. Salina, Italy

Libonati, F., **Musenich, L.**, Stagni, A. (August 2022). Hierarchical bioinspired architected materials and structures. *15th WCCM Congress on Computational Mechanics*. Yokohama, Japan

Cuneo, A., Timossi, F., **Musenich, L.**, Stagni, A., Wilhelm, F., Libonati, F. (June 2022). Design and Manufacturing of Bone-like Composites. *5th CIRP Biomanufacturing Conference*. Maierato, Italy

Libonati, F. & **Musenich, L.** (May 2022). From Diatom Frustule to the Design of Novel Bioinspired Lightweight Materials. *2022 MRS Spring Meeting & Exhibit*. Honolulu, Hawaii, USA

Musenich, L. & Libonati, F. (September 2021). Diatom Nanostructured Frustule: new insights for the design of novel biomimetic materials. *NanoInnovation2021 – Conference & Exhibition*. Rome, Italy

(National)

Musenich, L., Stagni, A., & Libonati, F. (September 2022). Progettazione di strutture reticolari gerarchiche realizzabili mediante tecniche di produzione additiva. *51° Convegno Nazionale della Società Scientifica Italiana di Progettazione Meccanica e Costruzione di Macchine (AIAS)*. Padova, Italy

Reviewing Activities

(Journals)

2 peer reviews for "**ACS Omega**". (2023). ISSN: 2470-1343

1 peer review for "**IEEE/ASME Transactions on Mechatronics**". (2021). ISSN: 1941-014X

(Conferences)

1 peer review for "**20th International Conference on Advanced Robotics (ICAR)**". (2021)

Summer Schools

Deep Learning: a hands-on introduction — Genoa, IT
Machine Learning Genoa Center (MaLGa) — *July 2022*

Advances In Biomechanics — Virtual Course
AIAS Academy — *June 2021*

Licenses

Professional Engineering License - Industrial Engineering — *November 2020*
Issued by Ordine degli Ingegneri di Genova

Prevention and Protection Service Manager (Module C) — *May 2018*
Issued by University of Genoa

Certifications

Deep Learning: a hands-on introduction 2022 — *July 2022*
Issued by Machine Learning Genoa Center (MaLGa)

Machine Learning — *February 2022*
Issued by Coursera, Stanford University

Languages

Italian
Native or bilingual proficiency

English
Full professional proficiency

French
Limited professional proficiency