

LARM² Seminar

Complex motion in monolithic soft robots: origami, metamaterials and shells

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Abstract. The development of soft robotic systems increasingly demands design strategies that integrate structure, actuation, sensing, and function into unified architectures. Traditional robotic design approaches rely on assembling separate components, which introduce interfaces that complicate fabrication and reduce robustness under large deformation. In contrast, monolithic soft systems aim to embed multiple functionalities directly within a continuous structure, providing new forms of intelligence. This approach address sustainability concerns by reducing disassembling efforts in recycling and by using sustainable bio-based materials. This talk presents recent efforts toward the development of sustainable monolithic soft mechanisms enabled by rapid prototyping and advanced fabrication techniques. By combining computational design with fabrication strategies, it becomes possible to create soft structures whose mechanical behavior is programmed directly through geometry and material distribution. These approaches allow complex motion, instability-driven actuation, and adaptive mechanical responses to be realized within single-piece structures. Recent examples will be presented of monolithic soft robotic structures that exploit origami-inspired architectures, snapping instabilities in dome-shaped shells, and compliant metamaterial designs fabricated through different rapid prototyping strategies. These systems demonstrate how co-design across materials, geometry, and fabrication enable complex motion, mechanical adaptation, and functional behaviors without relying on multi-part assemblies.



Biography. Edoardo Milana holds a BSc in Mechanical Engineering and a MSc in Nanotechnology Engineering from the University of Rome La Sapienza, and a PhD in Engineering Science from KU Leuven (2020). He had postdoctoral experiences at the Institute for the Protection of Terrestrial Infrastructure of the German Aerospace Center (DLR) and then at the Freiburg Center for Interactive Materials and Bioinspired Technologies (FIT) of the University of Freiburg thanks to the Walter Benjamin Programme of the German Research Foundation (DFG). Since 2023, he has been Assistant Professor at the Department of Microsystems Engineering (IMTEK) of the University of Freiburg, Principal Investigator of the DFG Cluster of Excellence livMatS and full member of FIT. His research interests include soft robots and microsystems, flexible mechanical metamaterials, bioinspired material systems, and embodied intelligence. His expertise lies in mechanical design and advanced manufacturing of soft and compliant structures.

Place: Room 3, Edificio Didattica; **Time:** 11.30 – 12.30; **Day:** April 1st, 2026

All interested people are invited to attend the seminar!

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