

LIVING MACHINES

Proposal for a Living Machines 2020 Satellite Event

Title: “Growing structures: bioinspired innovation insights for architecture and robotics”

Organisers:



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Duration: Full-day

Abstract:

During the last decades, the fields of architecture, materials, and robotics have been increasingly enriched by the use of biomimetics and bio-inspired design. The fundamental paradigm is that key features of a large variety of organisms, such as hierarchical structure, growth and adaptation, can be exploited for inspiring the design of innovative sustainable materials, structures and robots. In the era of digitalization, artificial intelligence and automation, robotics, biomimetic design, and architecture are getting closer. In robotics for example, plants and animals have inspired the design of soft, multi-functional, adaptable, self-growing robotic structures, and the coordination of collective robots for autonomous building or repair. At the same time, architects are more and more interested in integrating robotic fabrication methods, additive manufacturing technologies, dynamic energy-efficient mechanisms, and robotically-augmented architecture, where constructions can adapt and evolve with the surrounding environment, and last but not least can be built in an energy and material efficient way.

At the interface of biomimetics, biorobotics, and architecture, this satellite event will bring together material scientists, biologists, bioroboticists, civil engineers, and architects to present the latest innovations and trends for future sustainable building construction and maintenance.

Cross-disciplinary talks will show: the form-structure-function-relationship on various hierarchical levels of biological materials and structural systems; growing and building strategies in plants and animals; plant-inspired technologies for adaptable and growing robots; biomimetic and biorobotics architectural installations and buildings; and the social implications of innovative technologies for creative arts, cultural heritage, and digital humanities. Moderated by the organizers, speakers and participants will discuss major

perspectives and roadmaps, current international initiatives and projects relevant to the future urban sustainable innovation.

Why do you consider LM2020 to be a good venue to host this event?

The integration of science-based and application-driven features of *biomimetics and bioinspiration* and of the new field of *growing robotics* is an opportunity to organise a new cross-disciplinary networking initiative that perfectly suits with the Living Machines conference vision.

The proposed event reflects both the importance of understanding the key features of living systems and the crucial process that traduces scientific knowledge into technology and its application, specifically for robotics and architecture. This approach allows shedding light on unknown scientific issues and on the development of associated future real-world technologies and structures.

The organization of a satellite event at Living Machines will be the chance to promote the establishment of many collaborations and initiatives across a variety of disciplines: integrating art and architecture with science and technology is timely and relevant to guide the evolution of our urban environment in a sustainable and effective way.

How will you solicit and evaluate contributions to the event?

The event will include contributions by invited speakers, selected by the organizers considering their expertise in the different topics addressed in the workshop context.

The first part of the event will be a “face-to-face” from biology to robotics – and vice versa – with two kinds of talks: i) talks dealing with strategies of growth and building showed by animals (spiders and termites specifically) and plants; and (ii) talks demonstrating the implementation of biology-like strategies for robotic collective construction and for adaptable growing robots.

During the second part of the event, speakers will illustrate a series of examples of the use of biomimetic materials, robotic systems, and other innovative technologies for building construction, autonomous manufacturing, arts, and cultural heritage.

Each talk will have duration of 25 minutes, including 5 minutes for questions and answers. Speakers will involve participants using an interactive modality of presentation to animate the discussion, by briefly presenting key issues that deserve further analysis and interdisciplinary debate. A conclusive session of 30 minutes, moderated by the organizers and involving all the speakers and participants, will be dedicated to discuss perspectives and roadmaps for growing robotics, collective robotic construction and sustainable technologies. A draft program, with speakers’ name, affiliation, an indicative topic of their talk and a URL, is provided in the following table.

9:15 – 9:30	Welcome and overview of the event: Barbara Mazzolai, Thomas Speck, Mirko Kovac
	Animals and plants: a face-to-face of growing structures from biology to robotics
9:30 – 10:00	Fritz Vollrath , Oxford Silk Group, Department of Zoology, Oxford University Topic: Spider web engineering and behavior URL: https://www.zoo.ox.ac.uk/oxford-silk-group
10:00 – 10:30	Mirko Kovac , Aerial Robotics Lab, Imperial College London Topic: Tensile web construction and perching with aerial vehicles URL: http://www.imperial.ac.uk/infrastructure-robotics
10:30 – 11:00	<i>Coffee break</i>
11:00 – 11:30	Justin Werfel , Wyss Institute for Biologically Inspired Engineering, Harvard Topic: Collective construction in insects’ colonies URL: https://projects.ig.harvard.edu/del
11:30 – 12:00	Kirstin Petersen , Collective Embodied Intelligence Lab, Cornell University Topic: Collective embodied intelligence approach to construction URL: https://cei.ece.cornell.edu/
12:00 – 12:30	Nicholas Rowe , Botany and Modelling of Plant Architecture and Vegetation, CNRS Topic: Architecture, functioning and evolution of plants URL: http://amap.cirad.fr/en/index.php
12:30 – 13:00	Barbara Mazzolai , Center for Micro-BioRobotics, Istituto Italiano di Tecnologia Topic: Plant-inspired growing artefacts URL: https://www.iit.it/it/people/barbara-mazzolai

<i>Biomimetic materials and technologies for architecture, robots and cultural heritage</i>	
14:00 – 14:30	Andreas Lendlein , Institute of Biomaterial Science, Helmholtz-Zentrum Geesthacht at Teltow Topic: Active biomaterials for growing robots URL: https://www.hzg.de/institutes_platforms/biomaterial_science/director/index.php.en
14:30 – 15:00	Cecilia Laschi , The BioRobotics Institute, Scuola Superiore Sant'Anna Topic: Sensory-motor architecture for growing robots URL: https://www.santannapisa.it/it/cecilia-laschi
15:00 – 15:30	Thomas Speck , Plant Biomechanics Group, University of Freiburg Topic: Biomimetic architecture materials and structures inspired by plants URL: https://www.botanischer-garten.uni-freiburg.de/mitarbeiter/pbg
15:30 – 16:00	Achim Menges , Institute for Computational Design and Construction, University of Stuttgart Topic: Bioinspired architecture URL: https://www.icd.uni-stuttgart.de/team/Menges-00002/
16:00 – 16:30	<i>Coffee Break</i>
16:30 – 17:00	Barbara Imhof , Liquifer Systems Group and University of Applied Design, Vienna Topic: Space architecture URL: http://spacearchitect.org/
17:00 – 17:30	Robert Stuart Smith , Computer Science Autonomous Manufacturing Lab, Univ. College London Topic: Design, robotics and computation URL: https://www.aml-ucl.co.uk/team
17:30 – 18:00	Arianna Traviglia , Center for Cultural Heritage Technology, Istituto Italiano di Tecnologia Topic: Innovative technologies for cultural heritage URL: https://www.iit.it/research/lines/cultural-heritage-technologies
18:00 – 18:30	<i>Discussion session on perspectives and roadmaps for growing robotics, collective robotic construction and sustainable architecture</i>

The novelty of the area and the multidisciplinary approach will stimulate creativity and interactions among participants, with the potentiality of a strong impact for different topics in engineering, ICT solutions, and basic science.

The scientific and technical background of the organizers reflects the cross-disciplinary character of the proposed event. The expertise of speakers spans knowledge on plant biology and biomechanics, materials science, additive manufacturing, bioinspired technology, soft-continuum robotics design and control, and architecture. The speakers are internationally recognized and the panel shows a well-balanced framework of scientific and technological know-how, country of origin, and gender.

Most of the speakers are part of international joint projects and/or have already collaborated together in joint research activities and other initiatives focusing on the addressed research fields, demonstrating a strong coherence with the vision and spirit of the event.

To solicit participation, the event will be pre-announced using different communication channels (e.g. social media channels, mailing lists, advertisement on projects and institutional websites, etc.) and the network of partnerships of the organizers and the speakers.

Participants:

This event is intended to be open to all.

Additional facilities/equipment:

Suggestions and/or support for the online hosting platform would be helpful to hold the event virtually and in line with the whole conference format.

Additional costs:

No additional costs.

Biographical information about the organizers:

Barbara Mazzolai is an expert of the fields of plant-inspired robotics and bioinspired growing robots. She was coordinator of the EU-funded FET Open Plantoid project (2012-2015) and is currently the Coordinator of the EU FET Proactive GrowBot project (<https://www.growbot.eu/>), which aims at developing a new generation of growing robots inspired by climbing plants to scale a variety of surfaces

using different anchoring strategies and to explore unstructured environments. Her research activities are in the field soft robotics, biomimetics and bioinspired robotics. She is member of the Scientific Advisory Board of the Max Planck Institute for Intelligent Systems (Tübingen and Stuttgart, Germany, since 2016) and member of the Advisory Committee of the Cluster on Living Adaptive and Energy-autonomous Materials Systems - livMatS (Freiburg, Germany, since 2019). She is author and co-author of more than 270 papers appeared in international journals, books, and conference proceedings.

Thomas Speck is an expert in the field of bio-inspired materials research, biomechanics und functional anatomy of plants. In recent years he became especially interested in biomimetic architecture and bio-inspired soft machines. He is full professor for 'Botany: Functional Morphology and Biomimetics' and Director of the Botanic Garden of the University of Freiburg.

He is spokesperson of the Competence Network Biomimetics, vice-president of BIONIKON international, and vice-chair of the Society for Technical Biology and Bionics. Thomas Speck is a member of the directorate of the Freiburg Center for Interactive Materials and Bio-Inspired Technologies (FIT), scientific member of the Materials Research Centre Freiburg (FMF) and member of the spokesperson-team of the Cluster of Excellence livMatS "Living, Adaptive, and Energy-autonomous Materials Systems". He received several scientific awards, is (co-)editor of several scientific books and journals and has published more than 280 scientific articles in peer reviewed Journals & Books in the fields of functional morphology, biomechanics, biomimetics, evolutionary biology and palaeobotany. With his research on bio-inspired soft machines (biomimetic soft peristaltic pumps and artificial Venus flytraps), he and his group has previously contributed to Living Machines with scientific papers and posters.

Mirko Kovac is an expert in the field of bioinspired aerial robotics and in the development of flying and soft robotic solutions for digital infrastructure systems. At Imperial College, he has started the Centre of Excellence on Infrastructure Robotics Ecosystems (CEIRE, <http://www.imperial.ac.uk/infrastructure-robotics>), where research activities move across robotics, sensor networks, AI, data science, business innovation and environmental policy, to study more sustainable and safer solutions for the management of infrastructures in cities, undergrounds and offshore environments.

Dr. Kovac is also Head of the Materials and Technology Centre of Robotics, an institutional partnership between Imperial College London and the Swiss Federal Laboratories for Materials Science and Technology (Empa), in which research activities integrate advanced materials with machine-learning based controllers and multi-sensor perception to develop novel soft robotic systems for infrastructure maintenance and environmental monitoring. Member of international boards of conferences and journals, and regularly acting as advisor to government, investment funds and industry on robotics, he and his group has previously contributed to Living Machines with robot demonstrations and exhibits.