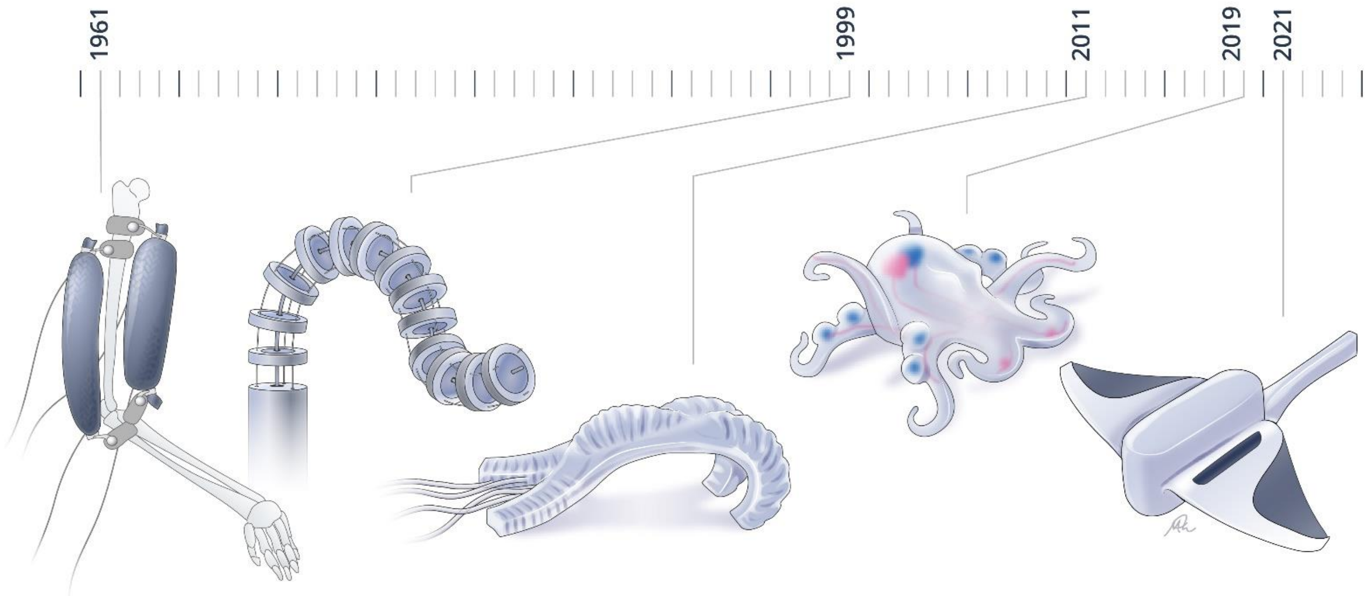
LIVING MACHINES

28th July 2021 Workshop:

Perspective for soft robotics:

The field’s past and future



Workshop program 28th July 2021

Time UTC/GMT	Session:	TALKS	SPEAKERS
13:00		Welcome	Falk Tauber & Marc Desmulliez
13:10 -13:55 UTC	The field's past	Material Innovations Enabling The Next Generation of Robotics	Robert Shepherd
14:00 UTC	How to make them move?	Will the ICs be able to move to make on-demand integrated systems?	Muhammad Hussain
14:20 UTC	How to make them sense?	Sensors inspired by Nature: an opportunity for biorobotics?	Marc Desmulliez
14:40 UTC	How to build/ produce them?	Manufacturing of soft robots with polymers and elastomers	Oliver Piccin
15:00 UTC		BREAK	
16:00 UTC	How to make them think?	Towards Soft Systems: Challenges and Opportunities in Engineering with Soft Technologies.	Adam Stokes
16:20 UTC	How to educate with them?	Getting Started in Soft Robotics	Conor Walsh
16:40 UTC		Short Break	
16:45 UTC		Plenary discussion: The field's future	All speakers of the day

Time UTC/GMT & SESSIONS	TALKS	SPEAKERS
13:00	Welcome	Falk Tauber & Marc Desmulliez

13:10 -13:55 UTC
Plenary

The field's past

Material Innovations Enabling The Next Generation of Robotics

Soft Robotics has recently become a known research discipline, but has been evolving over decades to millennia, depending on the utility of the devices in question. I will give a brief history of the evolution of Soft Robotics and then focus on the particular research question my group is asking. This question is meant to understand and address the engineering contradiction between enduring and adaptable robots—we have examples of autonomous cars that can drive for 100's of miles, or legged ones that can do backflips for a little while, but never the twain shall meet. Pushing this Pareto frontier outwards towards biological capabilities of enduring and adaptive mobility will probably require embracing complexity and multifunctionality. Meaning, hierarchical assembly of several sub-systems (i.e., organs) and packing energy into every cubic centimeter of volume. Towards this end, I will talk about our work to "innervate" robots for tactile feedback using stretchable sensing "skins" for high density shape sensing measurements to improve control authority in high degree of freedom (passive or active) continuum structures and actuators. My focus will be on the use of stretchable fiberoptic lightguides as a sensing medium for estimating deformation and temperature in the "meat" of these compliant structures and actuators. After discussing sensing, I will then describe our concept of "Robot Blood" in order to increase the overall energy density of hydraulically powered robots. This Robot Blood is an electrolyte based off of redox flow battery (RFB) chemistry that performs the additional function of force transmission and soft actuator inflation. I will close by demonstrating robots that take advantage of this electrohydraulic power.

Robert Shepherd is an associate professor at Cornell University in the Sibley School of Mechanical & Aerospace Engineering. He received his B.S. (Material Science & Engineering), Ph.D. (Material Science & Engineering), and M.B.A. from the University of Illinois in Material Science & Engineering. At Cornell, he runs the Organic Robotics Lab (ORL: http://orl.mae.cornell.edu), which focuses on using methods of invention, including bioinspired design approaches, in combination with material science to improve machine function and autonomy. We rely on new and old synthetic approaches for soft material composites that create new design opportunities in the field of robotics. Our research spans three primary areas: bioinspired robotics, advanced manufacturing, and human-robot interactions. He is the recipient of an Air Force Office of Scientific Research Young Investigator Award, an Office of Naval Research Young Investigator Award, and his lab's work has been featured in popular media outlets such as the BBC, Discovery Channel, and PBS's NOVA documentary series.

Time UTC/GMT & SESSIONS	TALKS	SPEAKERS
14:00 UTC Session 1 How to make them move?	Will the ICs be able to move to make on-demand integrated systems?	 Muhammad Hussain (PhD, ECE, UT Austin, Dec 2005) is a Professor of EECS, UC Berkeley. He was a Founding Professor of Electrical and Computer Engineering, KAUST from 2009 to 2020. He was Program Manager in SEMATECH (2008-09) and Process Integration Lead for 22 nm node FinFET CMOS in Texas Instruments (2006-2008). His research is focused on futuristic electronics which has received support from DARPA, Boeing, Lockheed Martin, GSK-Novartis, Saudi ARAMCO and SABIC. He has authored 450+ research papers and patents. He is a Fellow of IEEE, American Physical Society (APS) and Institute of Physics (UK), a distinguished lecturer of IEEE Electron Devices Society, and an Editor of IEEE T-ED. His research has been extensively highlighted by international media (CNN, Fox News, MSNBC, Washington Post, WSJ, National Geographic, Forbes, IEEE Spectrum, etc.) including being featured by Scientific American as one of the top 10 world changing ideas in 2014. He has received more than 45 international awards including Best Innovation Award in CES 2020, Edison Award 2020, UT Austin Outstanding Young Alumni Award 2015, IEEE Outstanding Individual Achievement Award 2016.

Time UTC/GMT & SESSIONS	TALKS	SPEAKERS
14:20 UTC Session 2 **How to make them sense?**	**Sensors inspired by Nature: an opportunity for biorobotics?** Mankind has always been fascinated by the multiple ways that animals and plants sense their environment. Numerous attempts, some more successful than others, have been made to translate, adapt or simply mimic sensors form the living world for human applications such as robotics. In this talk, I will review some current research studies carried out in the field of nature inspired sensing and explain the inspiration behind them. I will emphasize seeing and touching as the major modalities used today in biorobotics. I will also present unusual sensing modalities found in nature that could be of research interest for future living machines.	 **Marc Desmulliez** (Supélec, UCL, Cambridge, Heriot-Watt) is a Professor of Nature Inspired Manufacturing and Microsystems at Heriot-Watt University, Edinburgh, Scotland, UK. He created the first UK Master of Sciences in microsystems in 2001 and is now directing the Nature Inspired manufacturing Centre at Heriot-Watt. He is also the manager of the £3.2M Medical Devices Manufacturing Centre as a reaction to the COVID pandemic. He has authored around 500 peer reviewed articles and holds 9 patents. He is a Fellow of Institute of Engineering and Technology (IET), the Royal Society of Edinburgh (RSE) and the Institute of Physics (IoP). He received in 2019 the National Instrument Global Engineering Impact Award in the humanitarian category for the design, manufacturing and test of an ultrasound endoscopic capsule for the diagnosis of pathologies of the gastro-intestinal track. Marc hosted the Living Machines International Conference in 2016 in Edinburgh.

Time UTC/GMT & SESSIONS	TALKS	SPEAKERS
14:40 UTC Session 3 How to build/produce them?	**Manufacturing of soft robots with polymers and elastomers** Soft robotics has opened new avenues for the development of new devices or tools capable of completing tasks in safe interaction with human operators in complex and unstructured environments. Depending on the targeted applications, soft robots may have very different forms with varying degrees of softness or flexibility. Materials need to be carefully chosen by the designer, considering from the outset how they can be processed to get a functioning soft system. Polymers and elastomers are the main class of materials that can be used for soft robots and their resulting features also involve the parts' or robot's geometry chosen by design as well as the processes used for producing them. A range of manufacturing methods exists for elastomeric products depending on the selection of materials, the mixing of these materials with other elements to form compounds/composites. This presentation will first focus on some important design rules and guidelines for plastic and elastomer parts. Then, it will expose different ways to manufacture flexible parts and soft robots with a specific discussion on direct processes such as additive manufacturing as well as indirect processes such as molding.	 Oliver Piccin
15:00 UTC	BREAK	

Time UTC/GMT & SESSIONS	TALKS	SPEAKERS
16:00 UTC Session 4 How to make them think?	Towards Soft Systems: Challenges and Opportunities in Engineering with Soft Technologies. By Adam Stokes	 Adam Stokes is Reader in Engineering and Deputy Head of the Institute for Integrated Micro and Nano Systems at The University of Edinburgh. He is Director of the Soft Systems Group, an interdisciplinary research laboratory which focuses on robotics, fluidics, and complexity. He is Deputy Director of the Edinburgh Centre for Robotics, a £140M joint venture between the University of Edinburgh and Heriot-Watt university, and he is a member of the board for the National Robotarium. Dr Stokes is the Programme Director for MSc Electronics in The School of Engineering. He is a member of the Executive Committee of the UK-RAS Network, a member of the OGTC Academic Panel, and an Associate Editor for IEEE Robotics and Automation Letters. Before joining the faculty at Edinburgh he was a Fellow in the George M. Whitesides group at Harvard University. He holds degrees in engineering, biomedical science, and chemistry.

Time UTC/GMT & SESSIONS	TALKS	SPEAKERS
16:20 UTC Session 5 How to educate with them?	Getting Started in Soft Robotics A lack of materials, instructions, and platforms for how to start in the field of soft robotics was a market pain point that we sought to address with the development of the Soft Robotics Toolkit. It has been a great success (over three million page views and tens of thousands of engaged educators, students, and researchers). This has motivated the development of entry-level kits complete with build instructions and an educational curriculum. These provide a new opportunity to expose K-12 students to subjects typically neglected in introductory robotic design experiences such as manufacturing, material science, mechanical, design and human-robot cooperation. Alongside this, our open-ended kits seek to lower the barrier of entry for new and experienced researchers to start prototyping with soft robots. We have learned that researchers in the field of soft robotics can spend a plethora of time building control systems to test a single soft robot. This kit includes our pneumatic controller, which provides an easily programmable device to actuate soft robots, and materials to build actuators and sensors.	 Conor Walsh
16:40 UTC	Short Break	
16:45 UTC	Plenary discussion: The field’s future	All speakers of the day