

Soft Robotic Matter, J.T.B. Overvelde (2017-2022)

Biography



Between 2004 and 2012, Overvelde studied applied physics and mechanical engineering at the Delft University of Technology, where he received both his BSc and MSc degrees in mechanical engineering cum laude. In April 2016, Overvelde finished his PhD in applied mathematics at Harvard University under the direction of professor Katia Bertoldi at the John A. Paulson School of Engineering and Applied Sciences. Overvelde's PhD research focussed on harnessing compliance and instabilities in engineered structural materials and devices to achieve function. In May 2016, Johannes T.B. (Bas) Overvelde became a tenure-track Group Leader at AMOLF, where he started the Soft Robotic Matter Group.

Overvelde received tenure in January 2021. In September 2020, Overvelde was appointed Associate Professor at Eindhoven University of Technology (TU/e).

Overvelde's research delves into embodied intelligence within soft robotic devices, aiming to create autonomous robots capable of effective operation in their environments. To realize this goal, his focus lies at the intersection of soft robotics and mechanical metamaterials. Leading the Soft Robotic Matter Group, he employs a combination of computational, experimental, and analytical tools to investigate how shape, non-linearities, and feedback can be strategically utilized to embody intelligent behavior in mechanical systems. The objective is to explore innovative - yet simple - avenues that extend the frontiers of knowledge, all while remaining dedicated to addressing real-world challenges that have a meaningful impact on society.

Group output

Peer reviewed Publications 2017-2022

2017

1. J.T.B. Overvelde, J. Weaver, C. Hoberman and K. Bertoldi, *Rational design of reconfigurable prismatic architected materials*. *Nature* 541, 347-352 (2017).

2018

1. Y. Mulla, G. Oliveri, J. T. B. Overvelde and G.H. Koenderink, *Crack Initiation in Viscoelastic Materials*, *Phys.Rev.Lett.* **120**, (26), 268002:1-6 (2018). **Green OA**

2019

1. Iniguez-Rabago, Y. Li and J.T.B. Overvelde, *Exploring Multistability in Prismatic Metamaterials through Local Actuation*, *Nature Commun.* **10**, 5577: 1-10 (2019). **Gold OA**
2. J.T.B. Overvelde, *How to print multi-material devices in one go*, *Nature* **575**, 289-290 (2019). **Green OA**
3. N. Vasios, A.J. Gross, S. Soifer, J.T.B. Overvelde and K. Bertoldi, *Harnessing Viscous Flow to Simplify the Actuation of Fluidic Soft Robots*, *Soft Robotics*, (2019). **Green OA**

2020

1. R. Röhrich, G. Oliveri, S. Kovaivos, T.V. Tenner, A.J. den Boef, J.T.B. Overvelde and A.F. Koenderink, *Uncertainty estimation and design optimization of 2D diffraction-based overlay metrology targets*, ACS Photonics **7**, (10), 2765-2777 (2020) **Hybrid OA**.
2. G. Oliveri and J.T.B. Overvelde, *Inverse Design of mechanical metamaterials that undergo buckling*, Adv. Funct. Mater. **30**, (12), 1909033: 1-11 (2020) **Green OA**.
3. N. Vasios, A.J. Gross, S. Soifer, J.T.B. Overvelde, and K. Bertoldi, *Harnessing Viscous Flow to Simplify the Actuation of Fluidic Soft Robots*, Soft Robotics, **7**, (1), 1–9 (2020) **Green OA**.

2021

1. H.D. McClintock, N. Doshi, A. Iniguez-Rabago, J.C. Weaver, N.T. Jafferis, K. Jayaram, R.J. Wood and J.T.B. Overvelde, *A Fabrication Strategy for Reconfigurable Millimeter-Scale Metamaterials*, Adv. Funct. Mater., 2103428: 1-12 (2021) Hybrid OA
2. G. Oliveri, L.C. Van Laake, C. Carissimo, C. Miette and J.T.B. Overvelde, *Continuous learning of emergent behavior in robotic matter*, PNAS **118**, (21), e2017015118: 1-6 (2021) Hybrid OA

2022

1. L.C. van Laake, J. de Vries, S.M. Kani and J.T.B. Overvelde, *A Fluidic Relaxation Oscillator for Reprogrammable Sequential Actuation in Soft Robots*, Matter **5**, (9), 2898-2917 (2022) Hybrid OA
2. A. Iniguez-Rabago and J.T.B. Overvelde, *From rigid to amorphous folding behavior in origami-inspired metamaterials with bistable hinges*, Extreme Mech. Lett. **56**, 101881: 1-6 (2022) Hybrid OA
3. A. Vis, A. Maziar, H. Khambati, M.S. Slaughter, J.F. Gummert, J.T.B. Overvelde and J. Kluin, *The ongoing quest for the first total artificial heart as destination therapy*, Nat. Rev. Cardiol. **19**, (2022) Green OA

Contributions to scientific books (chapters or entire book) 2017-2022

2017

1. **Overvelde, J. T. B.**, Weaver, J., Hoberman, C., Bertoldi, K., Reconfigurable Prismatic Architected Materials. *Active Matter*. Ed. Tibbits, S. Cambridge, 2017. 270-286

PhD theses 2017-2022

2021

1. A. Iniguez-Rabago, *Folding behavior of elastic origami metamaterials*, Eindhoven University of Technology, 28/09/2021, Embargo
2. G. Oliveri, *Designing optimal behaviour in mechanical and robotic metamaterials*, Eindhoven University of Technology, 19/03/2021, OA

Masters and Bachelors theses 2017-2022

2017

1. MSc thesis; Dario Mula "*Simulation and design of a soft actuated metamaterials*", Ecole Centrale Paris, Polytechnic University of Valencia
2. BSc thesis; Marc Ten Hooven "*Hybrid Heart: Soft pump design and proof of concept*". The Hague University of Applied Sciences.
3. BSc thesis; Yun Li "*Identifying meta-stable states in Origami-Inspired reconfigurable metamaterials*". Amsterdam University College.

2018

1. MSc thesis; Rick Jongerius (2018) "*Design and fabrication of a soft robotic fabric*", University of Twente
2. BSc thesis; Leah Dickhoff (2018) "*Self-learning of Crawling Gaits in Worm-inspired Robots*", Amsterdam University College.

2019

1. MSc thesis; Davide Bray: "*Designing Soft Actuators by taking advantage of structural instabilities*" University of Pisa
2. MSc thesis; Anne Pasman "*Development of a volume adaptive soft robotic innersocket for transtibial prostheses*". University of Twente.

2020

1. Cesare Carissimo, "*On a soft robot and the emergence of behaviour*", University of Amsterdam
2. Danai Galiti, "*Study of efficiency on pneumatic networks for an artificial heart*" Aristotle university of Thessaloniki
3. Mannus Schomaker, "*Towards minimal resource emergent control for dynamic locomotion tasks*". University of Amsterdam
4. Sarah Ashworth, "*Efficient simulation of soft matter using coarsefinite element analysis*". Amsterdam University College

2021

1. De Vries, J., "*Energy efficiency of soft pneumatic extension actuators*", Delft University of Technology, NL
2. Comoretto, A., "*Design of a soft buckling valve for pulsatile actuation of soft robots*", University of Trento, IT
3. Fernandez, M.V., "*Towards the fluidic control of a total soft artificial heart*", University of Groningen, NL
4. Picella, S., "*Distributed learning of emergent behavior in 2D robotic matter*", Utrecht University, NL

2022

1. M. Collaris, *Macro Sized Elastomeric Membrane Oscillator towards Fluidic Control of Soft Robots*, master's thesis, Physics Masters, University of Utrecht, The Netherlands
2. J. Tait, *Dynamic DNA Origami: Harnessing Stochasticity for Synthetic Materials*, master's thesis, The University of Edinburgh, Scotland
3. T. Bevers, *Simulating Dynamic DNA Origami using oxDNA: A Thermodynamic Analysis of Stochastic Molecular Matter*, master's thesis, Delft University of Technology, The Netherlands

Invited lectures at international conferences and meetings

2017

1. J.T.B. Overvelde, What can we learn from crumpling a piece of paper? (2017) TEDxGroningen, Groningen (NL)
2. J.T.B. Overvelde, Guest Lecturer in Robotic Building - Media Studies(2017) School of Architecture, TU Delft (NL)
3. J.T.B. Overvelde, Magic Materials make Soft Robots (2017) HMCZomeracademie, Rotterdam (NL)
4. J.T.B. Overvelde, Rational Design of Reconfigurable Architected Materials(2017) Soft and Biological Matter Seminar, Leiden (NL)
5. J.T.B. Overvelde, Magic Materials make Soft Robots (2017) PINC.18 Conference, Utrecht (NL)
6. J.T.B. Overvelde, Rational Design of Reconfigurable Architected Materials (2017) SMS Europe, Paris (FR)

7. J.T.B. Overvelde, Rational Design of Reconfigurable Devices and Architected Materials (2017) AMOLF public colloquium, Amsterdam (NL)
8. J.T.B. Overvelde, Soft Robotic Matter (2017) ICMS Complexity Science Winter School, Eindhoven (NL)
9. J.T.B. Overvelde, Rational Design of Reconfigurable Prismatic Architected Materials (2017) 4D Printing & Meta Materials Conference, Sittard-Geleen (NL)
10. J.T.B. Overvelde, Soft Robotic Matter (2017) Physics@Veldhoven, Veldhoven (NL)

2018

1. J.T.B. Overvelde, computational design of multistable prismatic architected materials (2018) ASME IMECE, Pittsburgh (US)
2. J.T.B. Overvelde, Programming the Response of Fluidic Soft Actuators by Harnessing Nonlinearities (2018) The Hamlyn Symposium on Medical Robotics, London (UK)
3. J.T.B. Overvelde, Transforming Materials (2018) ReMAR, Delft (NL)
4. J.T.B. Overvelde, Rational Design of Reconfigurable Architected Materials (2018) Physics@Veldhoven, Veldhoven (NL)
5. J.T.B. Overvelde, Finding the Mechanically Stable States of Prismatic Architected Materials (2018) Gordon Conference Multifunctional Materials and Structures, Ventura (US)

2019

1. J.T.B. Overvelde, *Soft Robots* (11 December 2019), Topics in IC, Utrecht, the Netherlands, December 11, 2019.
2. J.T.B. Overvelde, *Origami-inspired Mechanical Metamaterials*, FlexMOF, Dresden, Germany, December 3, 2019.
3. J.T.B. Overvelde, *Embedding Fluid Logic and Self-learning in Soft Robotic Matter*, livMatS, Freiburg, Germany, September 26, 2019.
4. J.T.B. Overvelde, *Transforming Materials*, Gordon Conference Crystal Growth and Assembly, Manchester, United States, June 27, 2019.
5. J.T.B. Overvelde, *Soft Robotic Matter*, Hyber, Helsinki, Finland, May 16, 2019.
6. J.T.B. Overvelde, *Sequential Actuation of Soft Robots by Harnessing Soft Fluidic Networks*, ICMS Outreach Symposium, Eindhoven, the Netherlands, March 12, 2019.

2020

1. J.T.B. Overvelde, *"Continuous learning of emergent behavior in robotic matter"* (2020), Robosoft, online (US)
2. J.T.B. Overvelde, *"Adaptive behavior through decentralized learning in soft robotic matter"*, Living Machines Conference, online (GE), (2020)
3. J.T.B. Overvelde, *"Embodied fluidic circuits to control soft robots"*, BioRob Cardio Workshop, online (US), (2020)
4. J.T.B. Overvelde, *"Embodied fluidic circuits to control soft robots"*, ETH Zurich seminar series on robotics, USA, (2021), online.

2021

1. J.T.B. Overvelde, *"From rigid to amorphous behavior in origami with bistable hinges"*, MRS, USA, 20/04/2021, online.
2. J.T.B. Overvelde, *"Embodied fluidic circuits to control soft robots"*, Princeton University/ PRISM, USA, (2021), online.

2022

1. J.T.B. Overvelde, *Soft Robotic Matter group*, 2022 Shaping the Future of Robotics through Material Innovation, Kreuth, Germany, 15/06/2022.

2. A. Comoretto, *Fluidic memory and sensing for autonomous soft robots*, Dutch Soft Robotics Symposium 2022, Delft, 01/09/2022
3. S. Zou, *A Universal Fluidic Sensing Strategy for Soft Robots*, Dutch Soft Robotics Symposium, Delft, The Netherlands, 02/09/2022.
4. S. Zou, *Can a Soft Actuator Be a Sensor?* 31st Dutch Soft Matter Meeting, Delft, The Netherlands, 01/06/2022.
5. L.C. van Laake, *Non-linear Fluidic Control Circuits Enable Autonomy in Soft Robotics*, International Workshop on Embodied Intelligence (online), 04/03/2022.

Academic teaching 2017-2022

2019

1. Weeklong hands-on workshop on Soft Robotics at the Royal Academy of Art in The Hague (NL)

2021

1. “*Device integrated responsive devices*” (Q4 2020/2021) lecturer course 6EMA62 TU/e
2. “*Soft pneumatic actuation*” (2021) guest lecturer course FTE-36303 WUR

2022

3. “*Device integrated responsive devices*” (Q4 2021/2022) lecturer course 6EMA62 TU/e

Selected awards & recognitions 2017-2022

2020

1. Techniektalent 2020, De ingenieur
2. Started as part-time associate professor with *ius promovendus* @TU/e, September, 2020.

2022

1. A. Comoretto, Best Poster Award, *Fluidic memory and sensing for autonomous soft robots*, awarded by GRC Gordon Robotics 2022, 19/08/2022.
2. L.C. van Laake, 3rd Best Presentation Award, *Reprogrammable Sequential Activation of Soft Actuators*, awarded by IEEE Robosoft 2022, 04/04/2022.

Valorization 2017-2022

1. With an EU FET open project (“Hybrid Heart”) we worked on the development of a total artificial heart. This is a collaborative project between researchers, surgeons, and also related companies. For example, we worked with EVOS GmbH for the development of a TET system, and with Xeltis BV for the development of artificial heart valves.
2. Based on output from the Hybrid Heart project, we submitted an US provisional patent application: Van Laake, L.C., Overvelde, J.T.B., (2022), Fluidic Control of Soft Robots, US provisional patent application.
3. Funded by a NOW KIEM creative industry (“project Cairo: an intelligent soft-robotic jacket”) we worked on companying artificial soft robotic muscles with fabrics, which was done together with textile innovation studio Byborre Lab BV.
4. We have worked with Felixprinters, a 3D printing company, to develop a silicone printer.