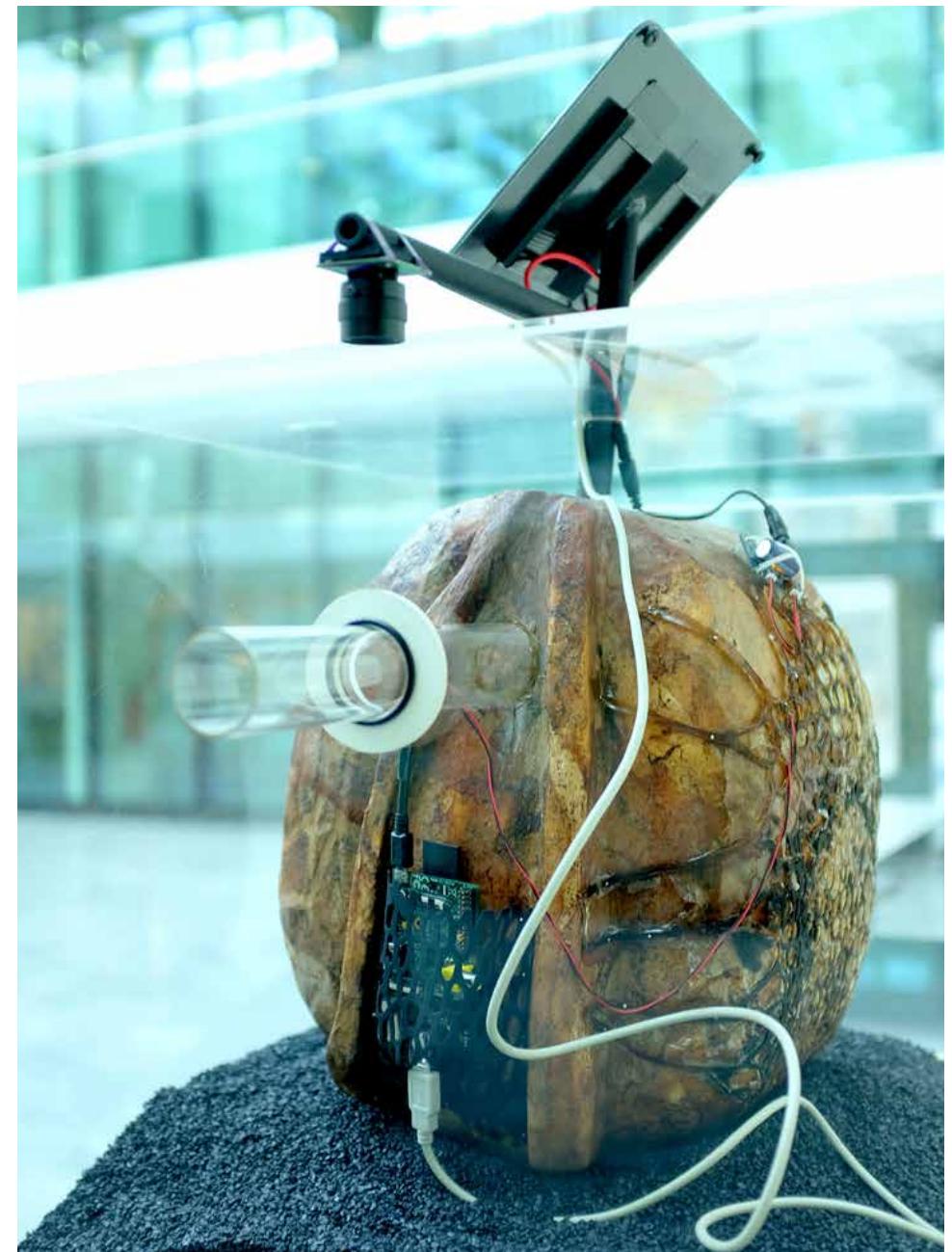
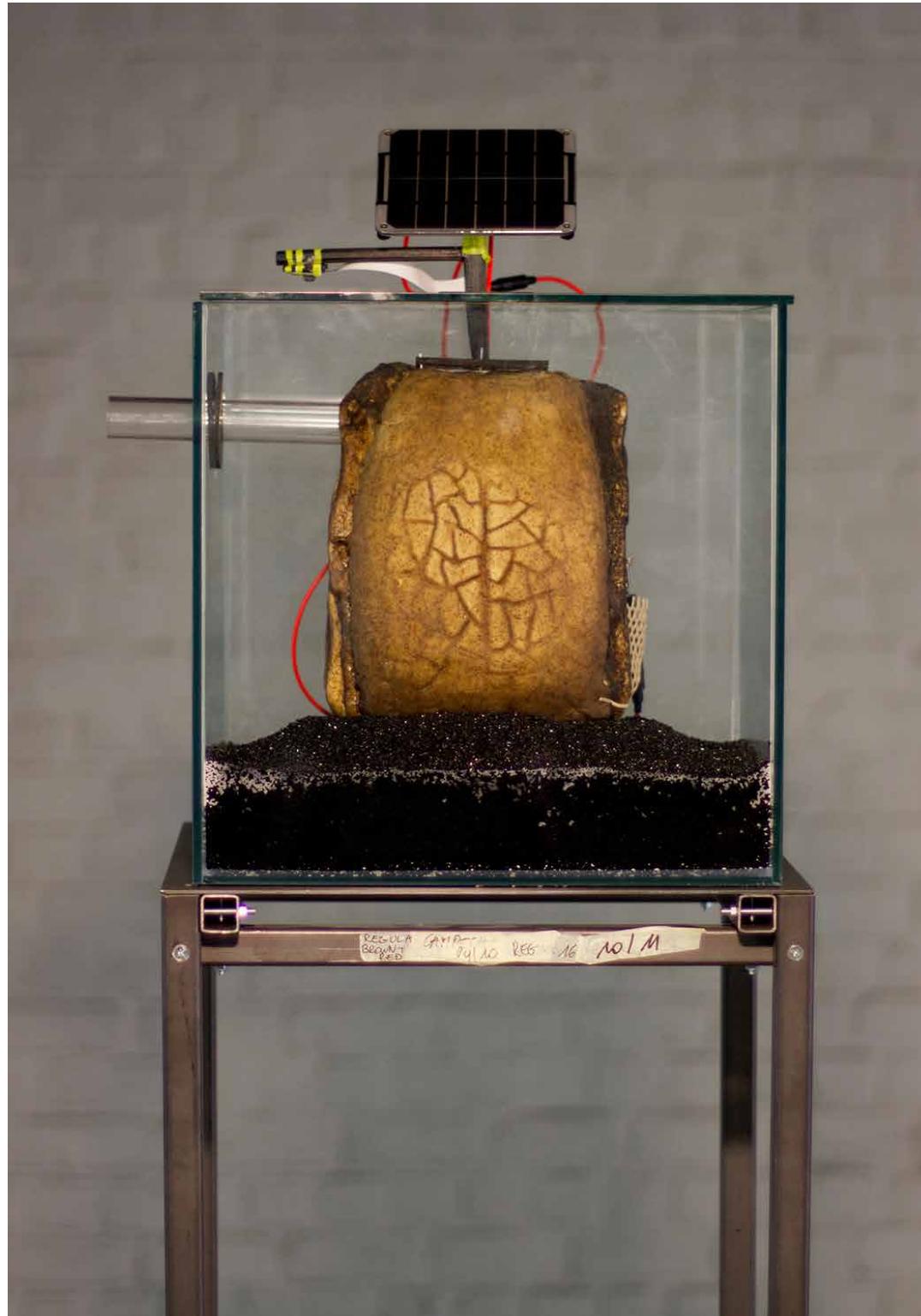


# the INTELLIGENT BEEHIVE



a bio-art project by AnneMarie Maes



(left) the *Intelligent Beehive* vs.01.

(right) Cellulose skin with a colony of *Lactobacillus plantarum* bacteria.



The Intelligent Beehive is a 'living machine', expanded by technical parts (solar panel, camera, Raspberry Pi computer) and by living technology (bacteria).

It is prototyped out of organic materials and is powered by green energy. The cellulose skin is augmented with a biofilm populated with colonies of bacteria. Their changing colors reflect the degree of environmental contamination.

For the experiment, the prototype is placed into a sealed container with condens, to keep the cellulose skin humid. The bees leave the hive via the tube.

For most of the past decade I have been growing, hacking, digitizing, building, and thinking about beehives - particularly those in urban areas. Collaborating with a team of biologists, I am reconceptualizing what a beehive is and what it can be.

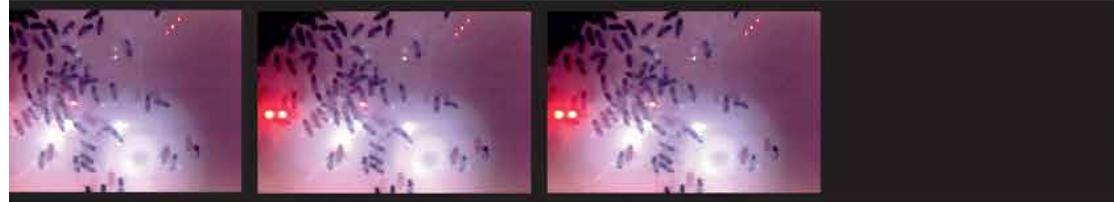
The bio-art project the *Intelligent Beehive* monitors the behaviour of urban honeybee colonies as a source of inspiration for ongoing artistic research into issues of ecological, architectural and social sustainability in urban environments. Bees are bio-indicators. They reflect the health of their surrounding ecosystem as well as the cumulative effects of different pollutants. In many industrialized regions the colonies are threatened. Air pollution, the compromised state of their foraging fields, pesticides and parasites are among the main factors.

To raise awareness about the disappearance of the honeybees, I imagined the concept of an Intelligent Beehive. It is a radically new beehive. Tailored to the needs of the bees (instead of those of the bee-keeper), and augmented with supportive bacteria, it is intended to help the bees in their survival and pollinating tasks, and thus protect the biodiversity of the environment.

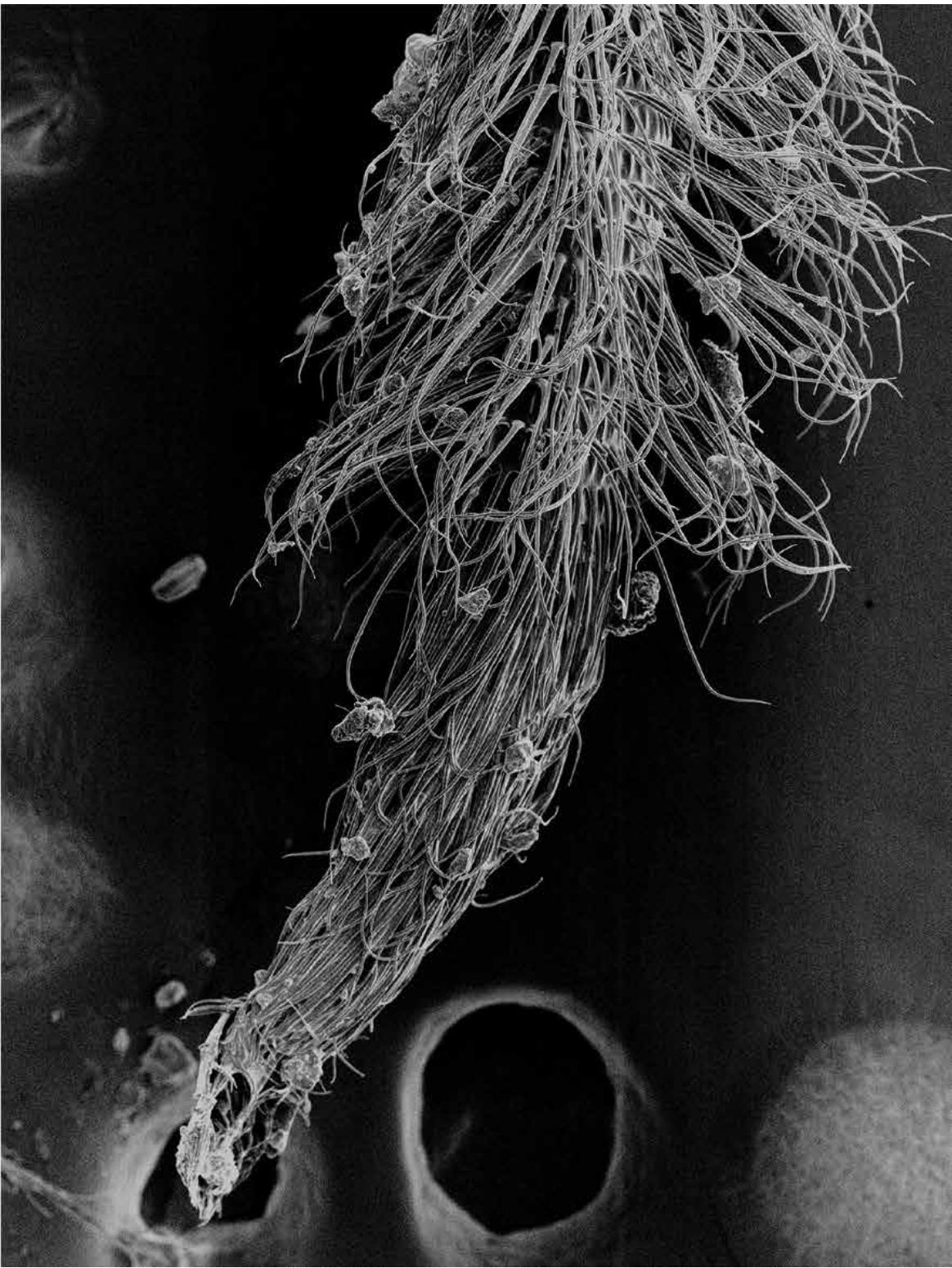
My *Intelligent Beehive* has been a starting point for exploring possible futures through artistic research on materials science and biotechnology. Navigating between a blueprint and a proof of concept, the Intelligent Beehive artistically tackles a new challenging application domain where a collaboration between human and non-human actors is necessary to maintain the resilience of our ecological system.

### Observer\_2.1

Customized computer for continuous monitoring and on-line streaming, observing the honeybees as prime citizens in the Republic of Pollination.



I carry out my fieldwork in the Bee Laboratory, my open-air lab that I installed on the rooftop of my studio in the center of Brussels. With custom-made observation beehives, augmented with monitoring technology, I have collected huge datasets on bee behavior and analyzed them using deep-learning algorithms in cooperation with researchers from the Artificial Intelligence Lab of the University of Brussels (VUB).





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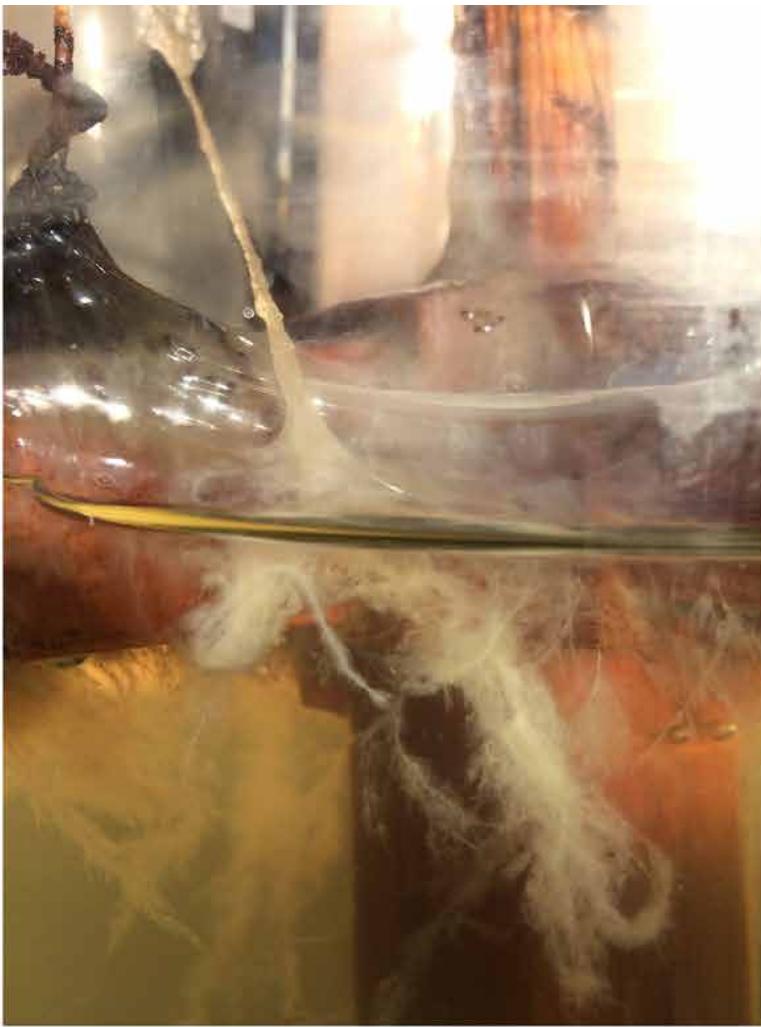
(left) Cellulose skin growth-container with medium, bacteria and yeast cells.

(right) Honeybee Proboscis (bee tongue)  
Scanning Electron Micrograph, 150x magnified.

this page:

(top) Hunting for bacteria in the apiary.  
(right) Bacteria tissue culture in petridishes.





(top and front) Rotating skin culture.

In my lab I work with a range of organic components, including propolis and chitine, and with living systems, such as fungi and bacteria, to help Nature grow fabrics. I research how these biofabrics can be supplemented through embedded electronics and how more sensorial qualities can be implemented in the membranes via living technology.

The *Intelligent Beehive* is a speculative research project that combines in a radical way smart materials, biomimetic forms and biotechnology. Through the Intelligent Beehive project I am addressing urban ecology, politics, and social systems.

The Sensorial Skin –the outer membrane of the Intelligent Guerilla Beehive - is a smart fabric that integrates a mix of organic and electronic elements for sensing and actuating, for computation and for communication. Bacteria living in the upper cellulose skin act as biosensors. When they sense a specific degree of pollution, they are changing colors and making patterns that reflect the environmental threats. The double-sided skin, waxed at one side and covered with a pattern of porous stomata at the other side, is also giving room to beneficial bacteria to attack the bees' natural enemy the Varroa destructor mite.

(right) Sensorial Skin  
Bacterial cellulose, dyed with organic material.





*The Invisible Garden* in the Green Light District (exhibition Buda/Kortrijk, November 2015 - February 2015).

The garden was a 3 month long experiment on working with closed ecosystems in wintertime. I designed and developed the 200m<sup>2</sup> factory room as a copy of my own rooftop garden in the center of Brussels, and the space became my temporary lab. There was a food forest, a mediterranean herb garden and a vegetable garden in which the temperature and humidity values were monitored, and the density of the infrared light was programmed on the circadian rhythm of the plants. The blackboard was functioning as an interface between the artist, the local communities and visitors. During my 'residency' in this temporary 'Biosphere'-lab, I conceived the concept for the bio-intelligent Beehive.



*Intelligent Beehive* - installation at Joint Research Center (JRC) Ispra

The research and development of the Beehive has been a constant exploration on the edge of art, science and biohacking. The goal is to provide a biological skin for a beehive, a skin that functions as an interface to compute and communicate the outer environmental data and the internal beehive signals.

I was experimenting with different technologies to create the skin: on a 3D printed skeleton (in chitosan), bacteria are growing and from scratch they create a cellulose fabric which is later augmented with a supplementary biofilm with pollution-sensing bacteria. As such, the beehive becomes a sensing device.

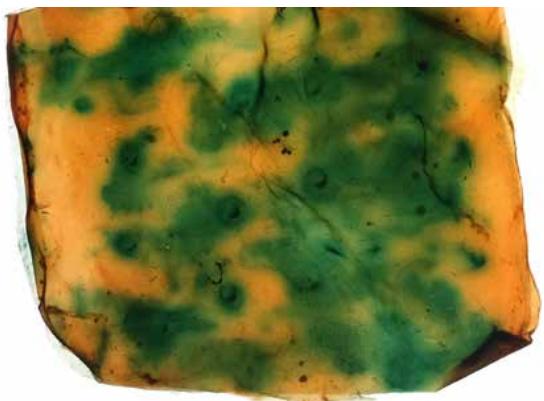
My research operates between experimental urban horticulture, scientific research, and metabolic architectures. My experiments connect living, intelligent systems and technology/biosciences with social, architectural and technological prototyping and experimentation. My toolset includes microbial life and algorithmic generations for the development of bioremedial beehives, my research trajectory is using technology and tools such as scanning electron microscopes (SEM), sensors and computation.

The artworks are the result of a complex work-methodology: first-hand observation, laboratory probes, and digital monitoring for testing in research gardens, overgrown urban lots, and rooftop apiaries. They contain a political statement, supporting the integration of nature as a social/sensory/phenomenal living matrix. This matrix is imaginable in collaboration with bees and their urban foraging. The resulting theory and practice emphasizes fairness to nature, as represented amid species.

Specifically, it draws attention to fragile affinities between humans, bees, bacteria, and the urban neighborhoods they symbiotically inhabit.

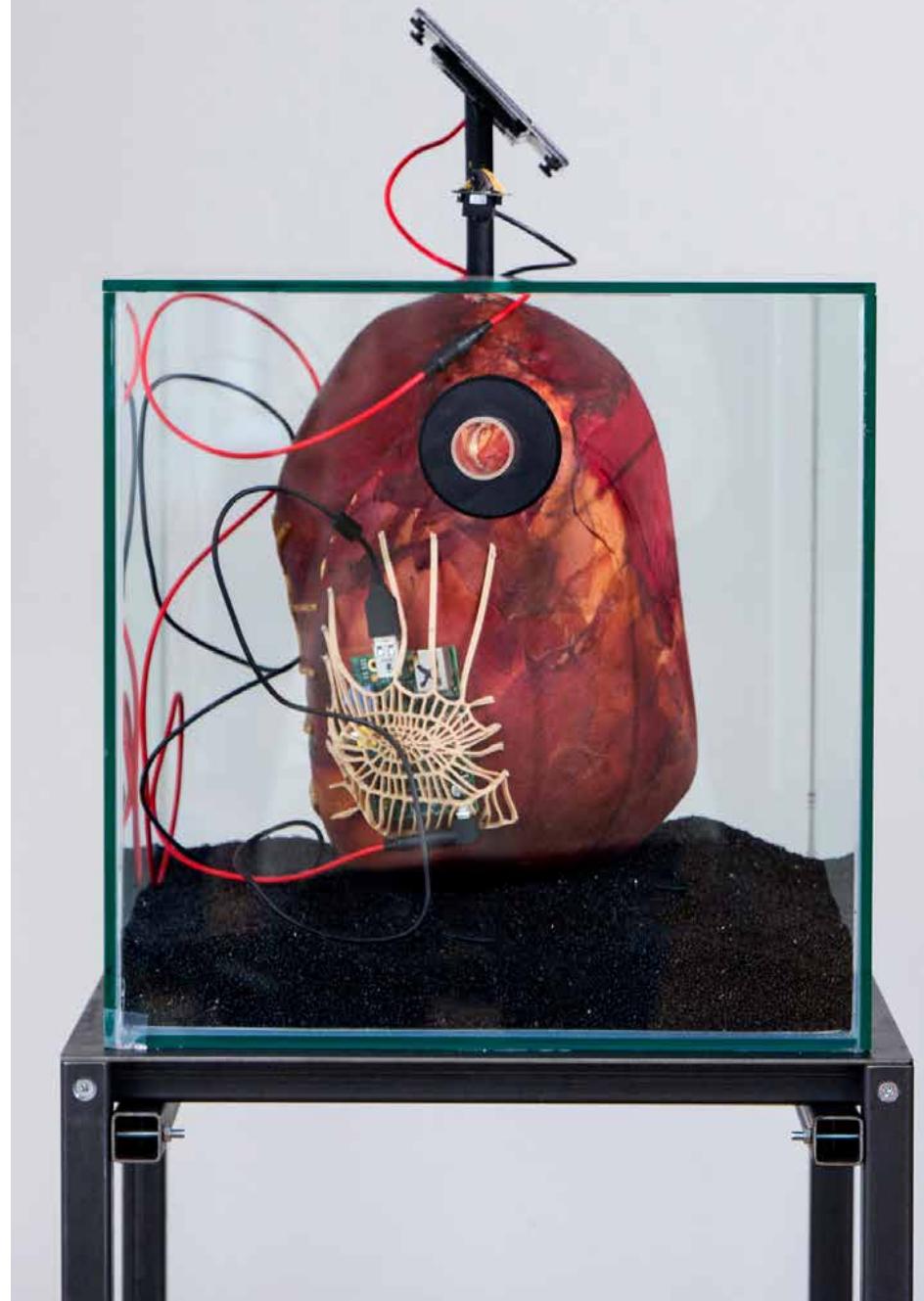
The *Intelligent Beehive* serves as a physical model for biological actions in conjunction with technological fabrication appropriate to envisioning metabolic architectures. My project vision suggests that, while recognizing and incorporating machine intelligence, the use of technology and analysis transcends machines as inanimate to arrive at complex visions. The vision incorporates bacteria as contributing agents enabling the Intelligent Beehive to autonomously interact with the bees, mites, humans and urban environment.

Between nature and technology, my investigations take on precise types of intellectual scaffold building, calling into question not only machine-to-insect intelligence, but questioning how we deal with biological performance in hybrid materials.



(top) Lactic acid bacteria *Lactobacillus plantarum* on humid cellulose skin.

(right)  
biomimetic beehive covered with cellulose skin & organic dyes. The beehive-body as a site for energy conversion - metabolism as a technology.





'Patchwork' - cellulose skin curtain, organic dyes.

Sculpture 'second skin'.  
Cellulose skin, bacterial grown  
membrane with wool - metabolic  
functions (temperature and ventila-  
tion).



The *Intelligent Beehive* project received a Honorary Mention at Ars Electronica 2017 in the category Hybrid Art.

AnneMarie Maes (be) is an artist and a researcher. Her practice combines art and science with a strong interest for DIY technologies. Many of her installations and long term projects (such as the Beehives Project, Urban Corridors or the Laboratory for Form and Matter) use biological, digital and traditional media, including live organisms, and they have been exhibited worldwide. Her art projects have taken the form of interactive installations, interventions, photography, web work, video and sculpture. She uses technological mediation to search for new forms of communication with the natural world, to make the invisible visible.

AnneMarie Maes:  
artist, concept, research, materials research, design & fabrication

Nuria Conde Pueyo:  
supervision of bacterial experiments

Support received from:  
the art laboratory OKNO (BE)  
Fablab Barcelona (IAAC, ES)  
Made@EU (EU grant via IAAC)  
JRC-Joint Research Center EU (Ispra, IT)  
Ministerie van Cultuur van de Vlaamse Gemeenschap (BE)

## SELECTION OF EXHIBITIONS

2018: BEEHAVE – Fundació Miró, Barcelona, Spain  
2017: NOVA-XX – St. Géry Brussels, Be  
2017: ARS ELECTRONICA, Cyber Art exhibition, Linz, Austria  
2017: RESONANCES II, Museum for Science and Technology Milano, Italia  
2017: RRESONANCES II, JRC/EU campus Ispra, Italia  
2017: ECOVENTURE EUROPE – Museum De Domeinen, Sittard, NL  
2017: ARS ELECTRONICA BERLIN (Drive. Volkswagen Group Forum)  
2017: solo GREY AREA/SIVA ZONA, Korcula, Croatia  
2016: solo / SONICVILLE STUDIOS Brussels  
2016: NEO NOMAD, Istanbul & New York  
2016: Made@EU, Barcelona (Es) & Plymouth (UK)  
2016: WISSENSCHAFTKOLLEG zu Berlin, (De)  
2016: solo / LEDA Gallery Brussels  
2016: solo / BRDCST festival – Brussels  
2015: AC GARDEN, Zagreb, Croatia  
2015: RENEWABLE FUTURES Festival + Conference – Riga, Latvia  
2015: 3D BIOLAB, Mons Cultural Capital  
2015: ARTES@IJCAI (A.I. and the Arts), Buenos Aires, Argentina  
2015: INSTITUTE OF EVOLUTIONARY BIOLOGY, Barcelona, Spain  
2015: POPPOSITIONS, Brussels  
2015: ALOTOF festival , Brussels / Prague / Nantes  
2014: SKOLSKA GALLERY, Prague, Czech Republic  
2014: KUNSTRADIO WIEN, Vienna, Austria  
2014: THE GREEN LIGHT DISTRICT, Buda Factory, Kortrijk, Belgium  
2014: THE OLFACtORY, Mad-Hasselt, Belgium  
2014: ART ICT CONNECT, Brussels Electronic Arts Festival, Bozar, Brussels, Belgium  
2014: INNOVATION LAB, Café Europa, Riga, Latvia  
2014: FIELDS EXHIBITION, Rixc, Riga, Latvia  
2013: SCIENTIFIC INQUIRIES, Koç University, Istanbul, Turkey  
2012: BURNING ICE, Kaaitheater, Brussels, Belgium  
2012: OPEN HOUSE – COLLECTIVE WORKSPACES, Brussels, Belgium  
2012: TIME INVENTORS KABINET, Okno, Brussels, Belgium  
2012: ART&ICT, Directorate General ICT EU, Brussels, Belgium  
2011: ON A DIFFERENT SOIL, Yo-Yo, Prague, Czech Republic  
2011: DESERT NUMERIQUE, Incident, St.Nazaire, France  
2011: BURNING ICE, Kaaitheater, Brussels, Belgium  
2010: SOFT BORDERS, upgrade, Sao Paulo, Brazil  
2010: HAPPY NEW EARS, Festival van Vlaanderen, Kortrijk, Belgium  
2010: TAKE YOUR TIME, Esc, Graz, Austria  
2009: IN BETWEEN, Gynaica, Antwerp, Belgium  
2009: PIXELACHE, Muu Art Gallery, Helsinki, Finland  
2009: THE GAME IS UP! Vooruit, Gent, Belgium  
2007: CCNOA gallery, Brussels, Belgium  
2006: HAPPY NEW EARS, Festival van Vlaanderen, Kortrijk, Belgium  
2005: RE: ACTIVISM – SONIC TAGS, Budapest, Hungary  
2004: BEURSSCHOUWBURG, Brussels, Belgium  
2002: JONCTIONS – Foton, Brussels, Belgium  
2002: ENERGY – Culture Bxl, Brussels, Belgium  
2002: VIVIER – St.Lucas, Brussels, Belgium  
2002: GROOT BESCHRIFT, Brussels, Belgium  
2001: ICI ET MAINTENANT – Espace 254 Nord, Brussels, Belgium  
2001: CORPS ET ESPACE, Brussels, Belgium  
2001: LOOKING GLASS, Brussels, Belgium  
2000: ADDICT!, Brussels, Belgium  
2000: Closed Circuits#2 (Permanent Work), Boudewijngebouw, Brussels, Belgium  
2000: MIRROR MIRROR – Matrix Art Project, New York, USA  
2000: LOOKING GLASS, Brussels, Belgium  
1999: VEEARTSENij PROJECT, Gent, Belgium

## permanent installation/artworks in public space

2000: Closed Circuits#2 (People Database), Boudewijngebouw, Brussels, Belgium

## workshops and lectures

<https://annemariemaes.net/presentations/talks-performances-workshops/>

## curatorial

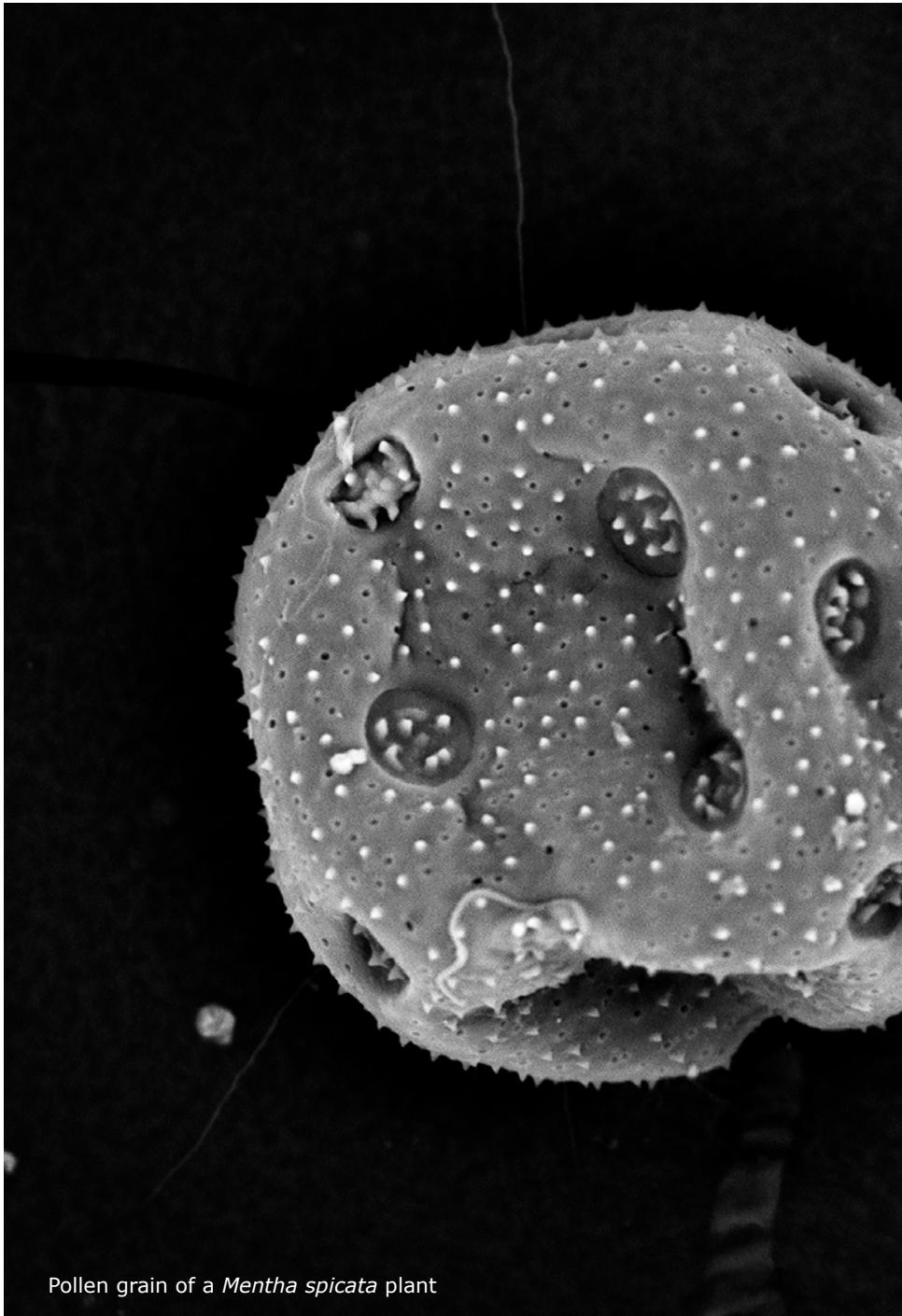
- 1999–2004: founder and curator of Looking Glass, an artist-run gallery in the center of Brussels.
- 2004–2015: co-founder and curator of the artist-collective OKNO. OKNO develops art&technology projects with a focus on ecology. OKNO is supported by the VGC, VG en het DG Culture of the EU. OKNO organized the past 10 years 100+ workshops and 100+ exhibitions.
- Curator and organizer of the mediafestivals at OKNO: OKNO Public 01, OKNO Public 02, OKNO Public 03
- Curator and organizer of the festivals TIK 2012 (Time Inventors Kabinet) en ALOTOF (2015)

## teaching

- 2005–2008: co-founder and facilitator of the workshop series xmedk/xmeda (experimental media art), a series of workshops designed for young professional artists, to enhance their art&technology skills. More than 50 artists enrolled yearly, during 4 years. Xmedk was a common project of OKNO, FoAM and Nadine, and was subsidized by the Flemish Film Fund (VAF).
- 2004–2015: multiple series of art&tech workshops at OKNO
- guest lecturer at KASK academy (2015) & LUCA School of Arts (2013)

## publications

- 2016: Alchimia Nova (monografie)  
editor: AnneMarie Maes, authors: Luc Steels, Armin Medosch, Darko Fritz, Edith Doove, AnneMarie Maes. Uitgever en distributie: MER.Paper Kunsthalle -ISBN 9789492321480  
2016: The Transparent Beehive Notebook – online publication  
auteur: AnneMarie Maes, editor: AnneMarie Maes, ISBN 9781364475666  
2015: Ignorance. Samenstelling: Giván Belá and AnneMarie Maes – ISBN 9789491775987  
2015: Open Systems Exploration for Ecosystems Leveraging  
auteurs: CS-DC e-laboratory members (Masatoshi Funabashi, Peter Hanappe, Takashi Isozaki, AnneMarie Maes, Takahiro Sasaki, Kaoru Yoshida). Artikel voor for CS-DC e-laboratory, Springer publicatie  
2015: The Sound Beehive Experiment author: AnneMarie Maes, Ignorance, ALOTOF project, ISBN 9789491775987  
2015: The Scaffolded Sound Beehive  
auteur: AnneMarie Maes, artikel voor de A.I. and Art sectie in de International Joint Conference on Artificial Intelligence, Proceedings of IJCAI-2015, Buenos Aires  
2014: Foraging Fields Catalogue  
auteur: AnneMarie Maes, titel: Foraging Fields Catalogue, bijlage bij de tentoonstelling Fields  
2013: The Transparent Beehive Notebook  
auteur: AnneMarie Maes, titel: the Transparent Beehive Notebook, published: 2013, ISBN 9789081898515  
2012: Travelling through OpenGreens  
auteur: AnneMarie Maes, titel: Travelling through OpenGreens, gepubliceerd in the TIK Publicatie – ISBN 9789081898508  
2011: Connected OpenGreens Catalog vs.1.0  
titel: Connected OpenGreens, auteur en fotoos: AnneMarie Maes  
2009: Politics of Change: on Eco-Technology and Hands-On Workshops  
auteur: AnneMarie Maes, titel: Politics of Change: on Eco-Technology and Hands-On Workshops, gepubliceerd in het magazine: Art is Politics (edition 2009)  
2006: No2Pho [from Noise to Voice]  
auteur: AnneMarie Maes , titel: No2Pho [from Noise to Voice], gepubliceerd in: x-med-a [experimental media arts] – ISBN 9081073311  
2004: Continuum Cinema : the Vision Machine  
auteur: AnneMarie Maes, titel: Continuum Cinema: the Vision Machine, gepubliceerd in: VUB Press 2004



Pollen grain of a *Mentha spicata* plant

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