

Lichen and Machine Interaction to Facilitate Human Connection

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Abstract—Natura Machina: Teenage Meadow is an interactive sculpture that brings together lichens and robotics in a harmonious relationship as part of a long-term goal of creating art that is simultaneously a new life form that can exist in nature. The work consists of silicone rubber elastomer, air pumps, sensors, and reindeer moss lichen. It inflates and deflates rhythmically like the movement of breathing and reacts to a person when it is touched.

I. BACKGROUND

The work explores the relationship between nature and machine. The 21st century will challenge pre-existing distinctions between nature and technology. How might the boundary between biology and technology begin to blur? Can we create a platform that is mutually beneficial for both robots and living things? Also, as Nils Bubandt described we are confronting visions and implementations that have led to an ‘uncanny Anthropocene’ [1] in relationships between humans, machines, and nature such as grotesquely genetically modified animals going through a largely automated abattoir. We are creating something that looks like nature just like building a robot to look like a human. We don’t yet know if machines and nature can truly exist symbiotically but at least we can show what it could look like.

Artists consistently merge art and technology to predict, explore, and shape the future. In 1995, Ken Goldberg and Joseph Santarromana created The Telegarden [2] a robotic art installation that allowed anyone on the Internet to interact with a remote garden. Users tele-operated a robot arm to plant, water, and monitor the progress of living plants. In Soichiro Mihara’s Blank Project#3 – A Corner of the Cosmos [3], a group of singing and dancing moss balls powered by microbial fuel cells (MFC) envisages a future where moss-generated electricity is used to power robots. In 2020 Mads Bering Christiansen et al. - Soft Robotics and Posthuman Entities [4] created wearable soft robotic skin that interacts with a *Monstera Deliciosa* plant placed on a pedestal. The pneumatic sleeve inflates and attains uncannily organic shapes when the plant is touched to create visions of technologically mediated interspecies communication. These machines are hybrid forms situated between living organisms and machines and they gesture toward an evolutionary vector between machines and what is considered a distinct natural

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Fig. 1. Natura Machina: Teenage Meadow is an interactive pneumatic sculpture that embraces elements of the natural world and the human form.

world. Laura Beloff and Jonas Jørgensen created The Condition [5] that featured Danish Nordmann fir trees that had been cloned to match the ideal cultural notion of a Christmas tree that is also marketed and sold according to Danish people’s expectation of what a Christmas tree should look like and move according to a Kohonen Feature Map algorithm so in this work human cultural, intellectual, and commercial concepts are merged with the biological. Finally, Ece Polen Budak’s Breathing Wall [6] utilizes a similar touch-based interaction to the authors’ work within the context of a wall composed of synthetic biomorphic surfaces that feel like flesh.

II. CONCEPT

Natura Machina: Teenage Meadow (see Figure 1) is an interactive pneumatic sculpture that embraces elements of the natural world and the human form. The sculpture appears to the viewer as a mound of green reindeer moss lichen that swells and contracts like a breathing lung through hidden, robotically turned gears. Lichens themselves are symbiotic structures typically formed by bacteria, yeast, and fungi so are not technically categorized as plants though they appear as such. This ambiguity of obvious categorization of a form of life in nature serves as an additional layer of contemplation within the sculpture. The sound of the pumps responsible for the mechanical breathing is quite noticeable when approaching the sculpture and this serves as an inversion to conventional expectations of natural breathing. When touched, the sculpture abruptly increases the speed of its breathing in a jarring motion. A previous work by Kuan-Ju Wu was Natura Machina: Newborn which was the first of its kind pneumatic sculpture that was the first of its kind to be made with soft robotics and moss. The movement

of this sculpture imitated a baby’s breathing pattern. *Natura Machina: Teenage Meadow* is derived from Newborn but nine times bigger in its area size and focused more on the interconnected relationship among bot, botany and human body. The authors also playfully titled the work *Natura Machina: Teenage Meadow* as the interaction reminded them of trying to wake up a peacefully resting and soon-to-be moody teenager for school. Thus, the concept and meadow can mature into adulthood in future sculptures. This work explores the interplay of interior versus exterior spaces relating to the body and nature. Singular and concrete meaning-distinctions—machine, lichens, people— dissolve along a single plane; triggered by the presence, and deactivated in the viewer’s absence. *Natura Machina: Teenage Meadow* highlights the context structuring compositions so that our role becomes nature’s role for the body. We can become the intimate and connected moments to nonhuman forces that ultimately can singularly exist.

III. TECHNICAL DETAIL

Natura Machina: Teenage Meadow consists of a 32 inch - diameter dome-shape pneumatic actuator, pumps, control electronics, touch sensor, and reindeer moss lichen.

A. Actuator

Natura Machina: Teenage Meadow utilizes the techniques commonly found in the DIY soft robotics field [7] to construct the pneumatic actuator that is the shape-changing “body”. By combining materials with different elastic behavior the “stretchy” material will expand more than the “rigid” material when the actuator is pressurized [8]. In our case the “rigid” material is a piece of 3mm thick 80cm wide glass, and the “stretchy” material is comprised of layers of silicone rubber elastomer wrapped around the glass. The process of making the actuator was done through a series of steps of casting and masking (Figure 2). We used a sheet of paper to separate two layers of silicone rubber to create the air chamber. To inflate and deflate the actuator we connected two electrical pumps through silicone tubes (Figure 3). One pump pushes the air in and the other draws the air out. The pumps are controlled by an Arduino and solid state relays. Additionally, a differential pressure sensor was installed to monitor and regulate the internal pressure of the actuator.

B. Lichen

We chose moss/lichen to be our co-living organism because it can live without soil. Reindeer moss lichen is particularly interesting because of its coral-like bushy growth structure. The vegetation expands and compresses along with the silicone rubber elastomer surface when the actuator inflates and deflates. Additionally, this fruticose lichen itself is also formed from a symbiotic relationship of fungi and plants (algae).

C. Touch Sensors

Underneath the moss we embedded copper wires to serve as capacitive touch sensors. When a viewer touches the moss

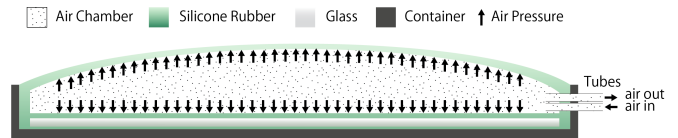


Fig. 2. The section view of the pneumatic actuator.

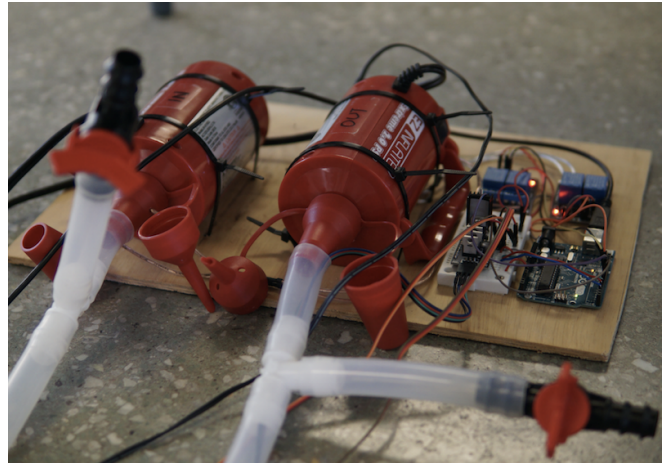


Fig. 3. Two pumps for controlling the intake and outtake of the air .

the sensor detects the electrical capacitance change due to the human body. While touched, the artwork enters a rapid breathing mode. As long as the moss remains moisturized the sensing area covers the whole surface.

IV. CONCLUSIONS

Natura Machina: Teenage Meadow poses questions about how far we can reach to merge machine and nature. Is it even possible to build a symbiotic relationship between nature and machine? If it is possible where is the human? What is the role? Is it important? We have created a vehicle for people to imagine what these things could look like. The authors believe that plants and nature are our allies and the work



Fig. 4. *Natura Machina: Teenage Meadow* showcased in the Hive Gallery, Los Angeles.

intends to help people see nature not just as an artifact but as a living organism. In *Natura Machine: Teenage Meadow* you don't see the pump but you feel nature.

REFERENCES

- [1] Bubandt, Nils. "Anthropocene uncanny: nonsecular approaches to environmental change." *A non-secular Anthropocene: spirits, specters and other nonhumans in a time of environmental change* (2018): 2-15.
- [2] Joseph Santarromana Ken Goldberg. 1995. *The Telegarden*. (1995). <https://goldberg.berkeley.edu/garden/Ars/>.
- [3] Soichiro Mihara. 2016. *blank project 3 - a corner of the cosmos*. (2016). <https://kenpoku-art.jp/en/artworks/d07/>.
- [4] Christiansen, Mads Bering, et al. "Soft robotics and posthuman entities." *Journal for Artistic Research* 22 (2020).
- [5] Beloff, Laura & Jørgensen, Jonas. (2016). *The Condition Towards Hybrid Agency*.
- [6] Ece Polen Budak, Onur Zirhli, Adam A. Stokes, Ozge Akbulut; *The Breathing Wall (BRALL)—Triggering Life (in)animate Surfaces*. *Leonardo* 2016; 49 (2): 162–163.
- [7] D. Holland, E. J. Park, P. Polygerinos, G. J. Bennett, and C. J. Walsh. 2014. *The Soft Robotics Toolkit: Shared Resources for Research and Design*. *Soft Robotics* 1, 3 (2014), 224–230.
- [8] Panagiotis Polygerinos, Bobak Mosadegh, and Alexandre Campo. 2014. *PneuNets Bending Actuators*. (2014). <https://softroboticstoolkit.com/book/pneunets-bending-actuator/>.