vascularization

research at the intersection of design, experimental surgery, and nuclear physics

Emile De Visscher – January 15, 2025

• alchemy • bio-inspired • design for the living • electrical treeing • experimental surgery • fulgurites • new materials • particle physics • practice-based research • research through design • surgery

A recent paradigm shift in materials science and engineering has taken place. The conventional emphasis on strength, durability, and stability generates objects that are difficult to recycle and therefore directly linked to the current ecological crisis. Consequently, researchers in design, engineering, and architecture are now turning their attention to the evolutionary, self-healing, multifunctional, and active capacities of materials that behave just like living organisms. However, in living organisms, these mechanisms are often guided and orchestrated by dendritic or vascular typologies, which support metabolic functions, based on fluid circulation, and the optimization of interactions with the environment.

The resulting project stems from a collaboration between designers, biologists, and surgical researchers aimed at understanding the functioning of vascular structures in organs, and to find new techniques for manufacturing dendritic structures. In the medical field, this research focuses on extracellular matrices (ECMs), the architecture of our organs in which cells can operate. The efficient manufacture of these ECMs is a key challenge for surgical research as a means of mitigating the lack of organ donations.

Inspired by fulgurites, vitreous material formed by lightning striking sand or sediment, we have succeeded in using electrons to tunnel through materials at the micrometric scale. To accomplish this, we required an electron accelerator, which we were able to use at the École Polytechnique in Palaiseau on several occasions. The principle is simple: a block of PMMA (transparent, commonly known as plexiglass) or PLA (bioplastic, green-yellow in color) material to a beam of electrons that are captured in its structure, then given an exit path by a shock from a nail connected to the terrestrial network. Instantaneously, all the electrons are released, forming vascular networks whose pathways are optimized by the process itself. This project, both an investigation into material expression and the development of potential applications, challenges the role of the designer as a mediator between knowledge, technologies, and the discourses of disciplines traditionally considered incommensurable.

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credits

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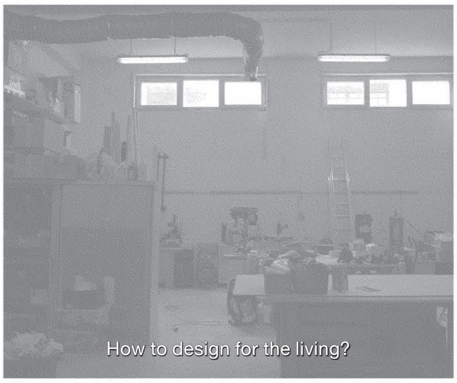
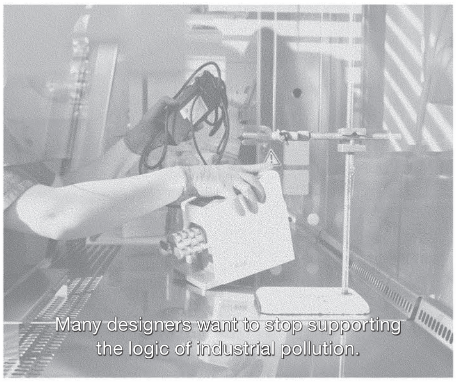
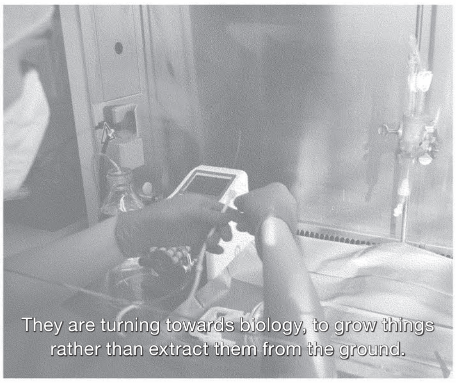
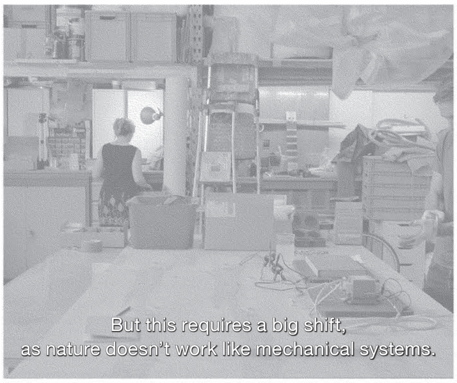
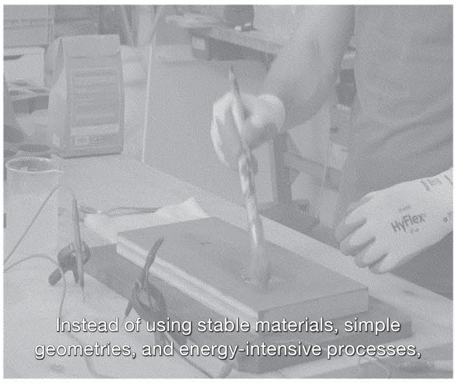
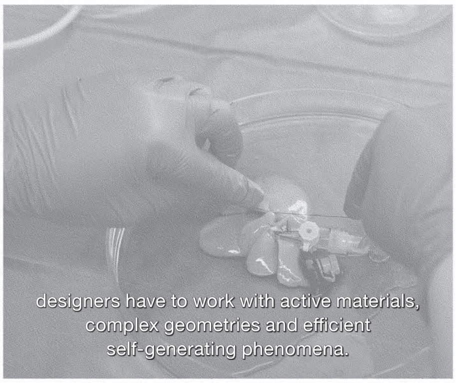
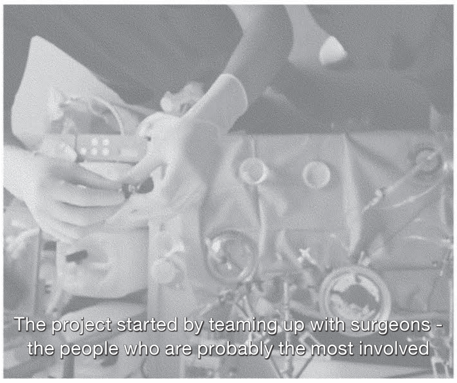
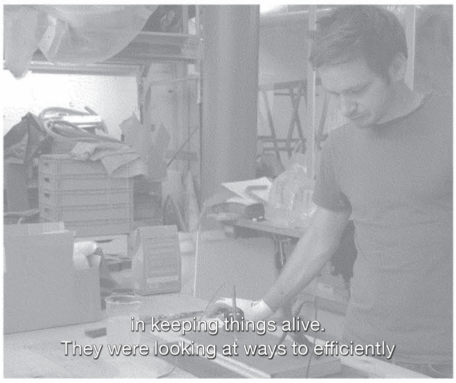
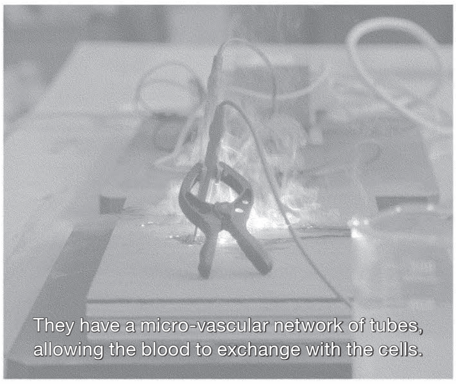
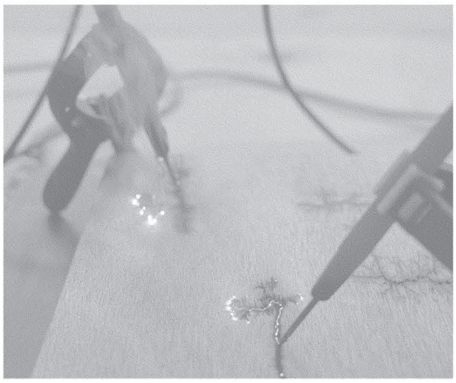
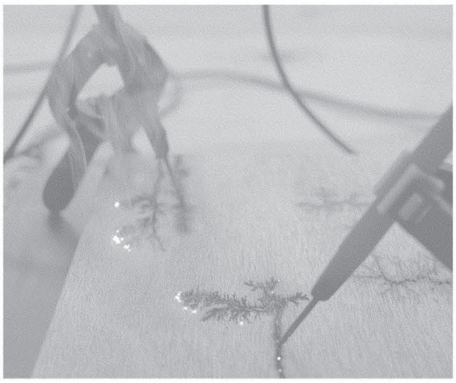
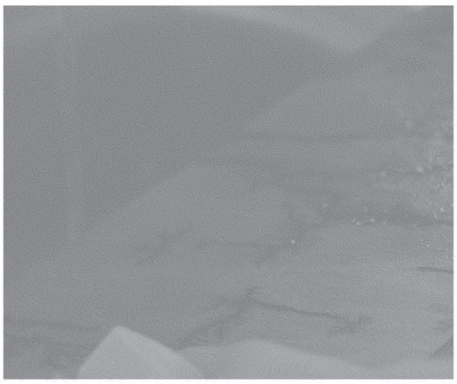
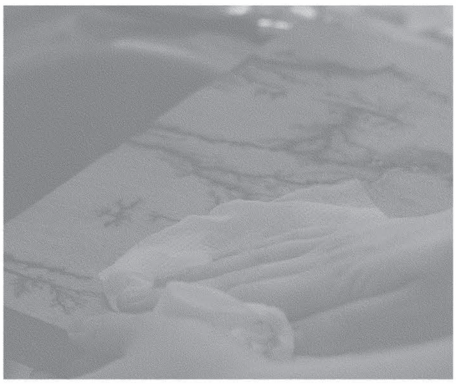
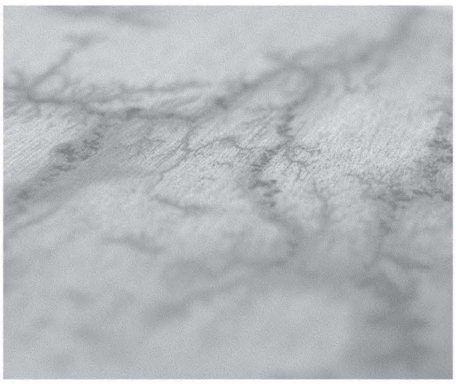
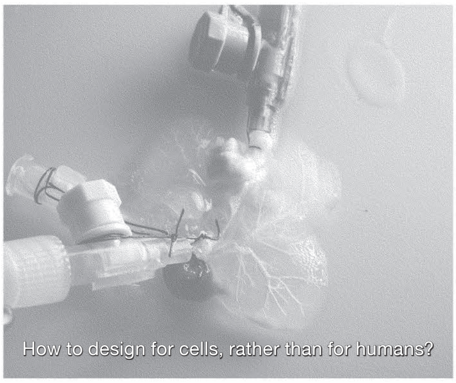
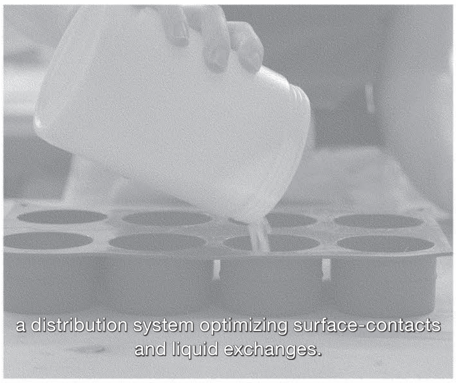
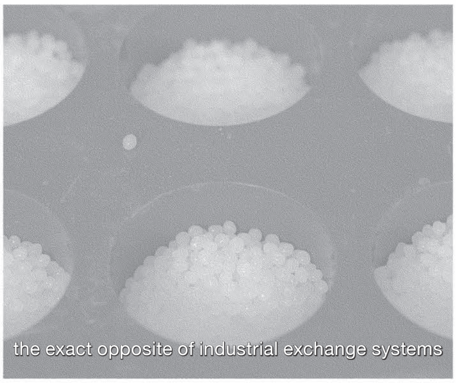
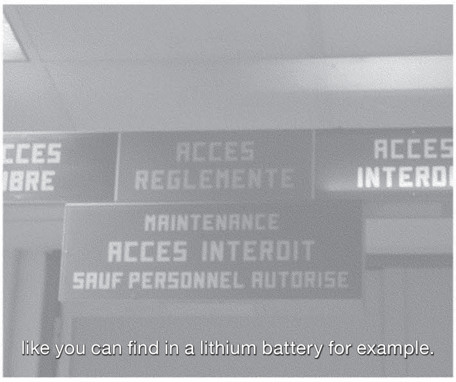

How to design for the living?

Many designers want to stop supporting
the logic of industrial pollution.

They are turning towards biology, to grow things
rather than extract them from the ground.

But this requires a big shift,
as nature doesn't work like mechanical systems.

Instead of using stable materials, simple
geometries, and energy-intensive processes,

designers have to work with active materials,
complex geometries and efficient
self-generating phenomena.

The project started by teaming up with surgeons -
the people who are probably the most involved

in keeping things alive.
They were looking at ways to efficiently

fabricate Extracellular Matrices, the architecture
of organs, to palliate donation scarcity.

They have a micro-vascular network of tubes,
allowing the blood to exchange with the cells.






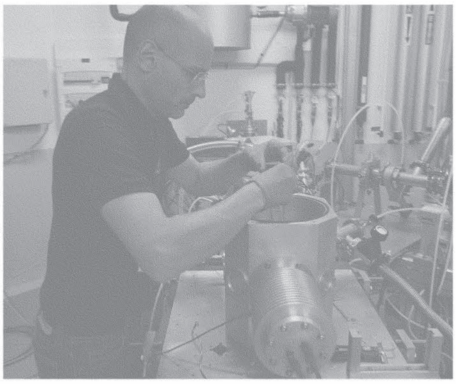

How to design for cells, rather than for humans?

Vascular structures are found all over the
biological kingdom, both macro and micro-scales.

It is one of those geometries
which belongs to nature,

a distribution system optimizing surface-contacts
and liquid exchanges.

It is a complex geometry, but with simple materials

the exact opposite of industrial exchange systems

ACCES
REGLEMENTE
MAINTENANCE
ACCES INTERDIT
SAUF PERSONNEL AUTORISE
like you can find in a lithium battery for example.





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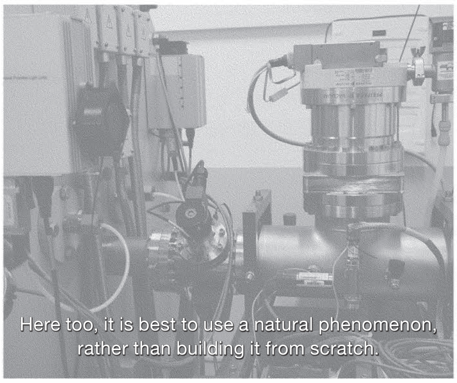
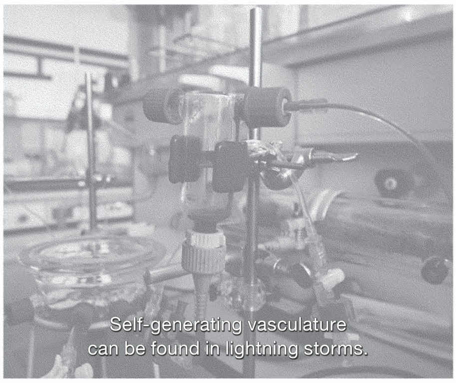
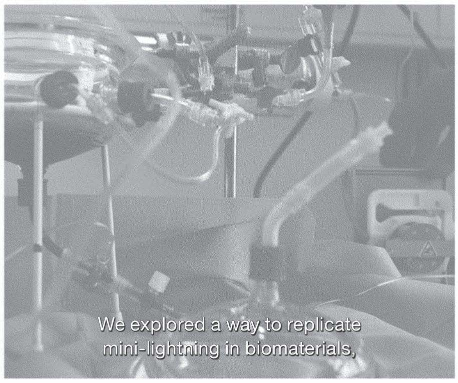
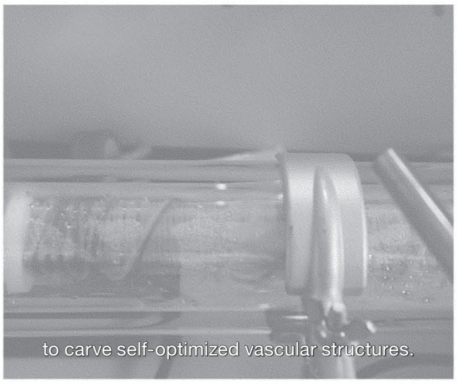
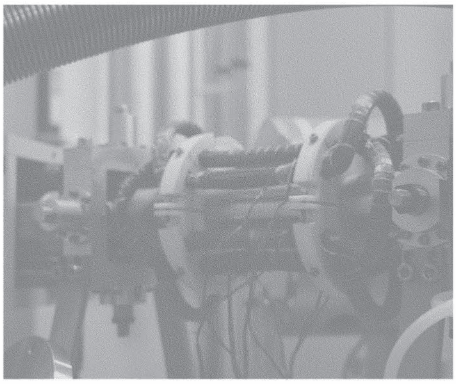
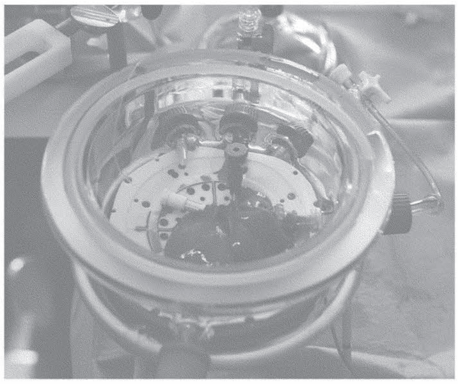
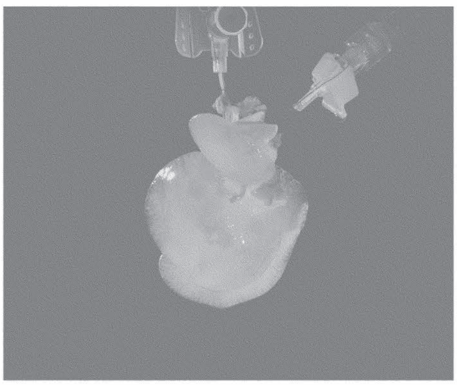
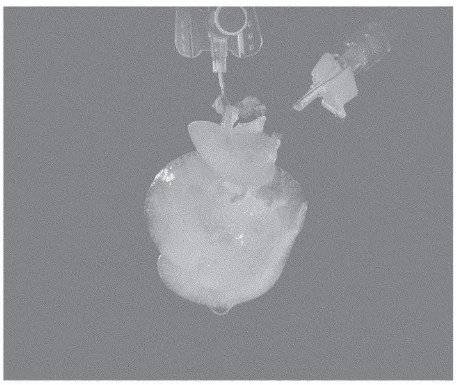
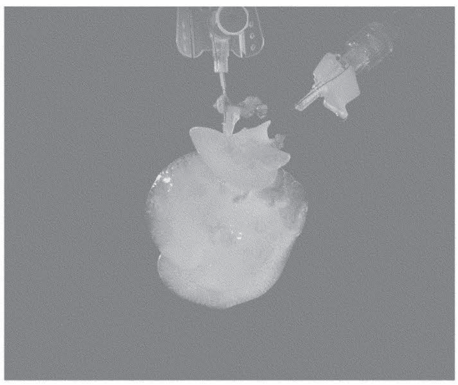
But how to generate
these micro-vascular structures?

Here too, it is best to use a natural phenomenon,
rather than building it from scratch.

Self-generating vasculature
can be found in lightning storms.

We explored a way to replicate
mini-lightning in biomaterials,

to carve self-optimized vascular structures.






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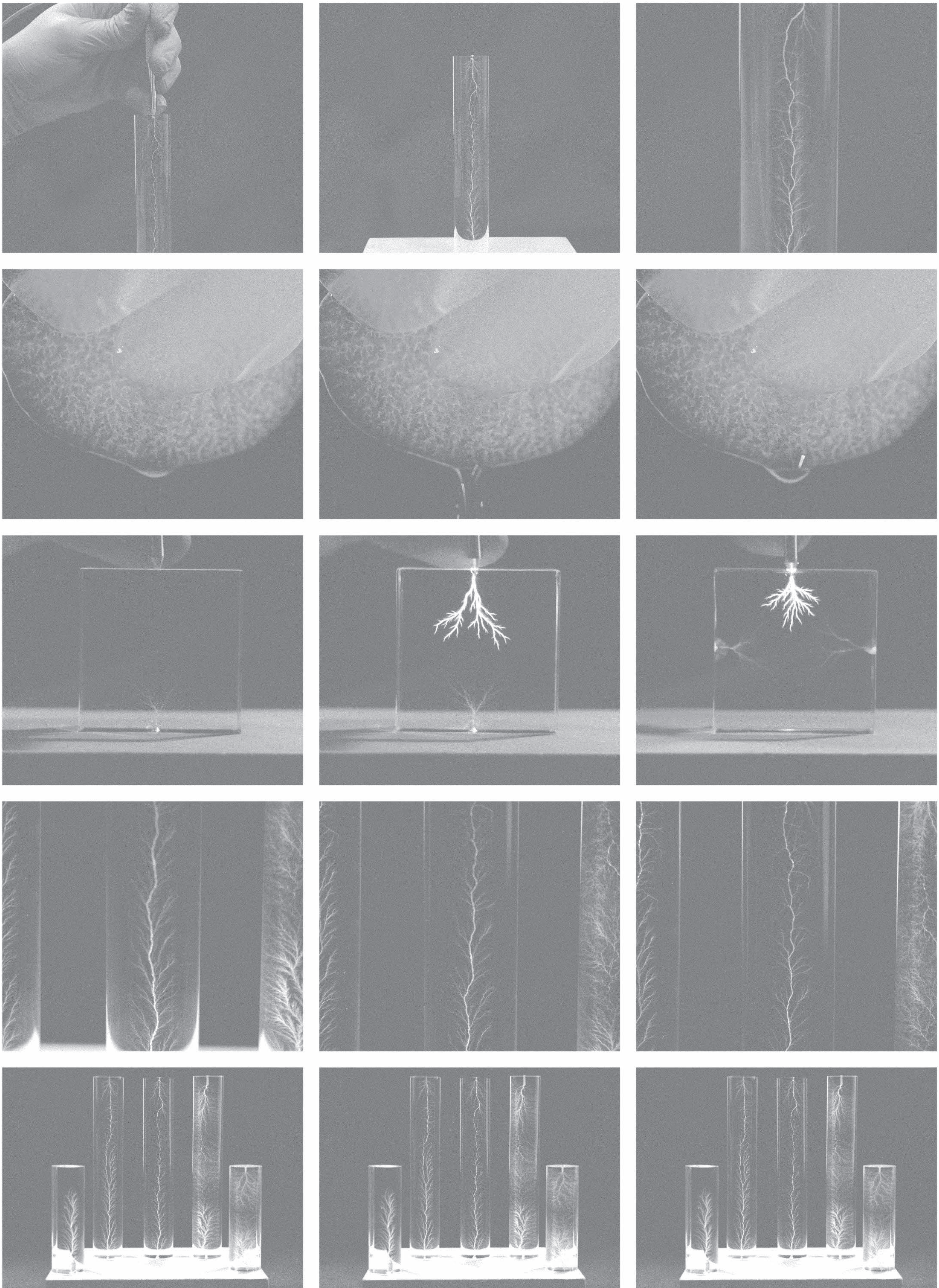
Thus, a lightning storm is used to create
conditions for the proliferation of living cells.
The biological meets the electrical.



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about the author

Emile De Visscher (PhD) is a design researcher and engineer. He completed a PhD at PSL University (ENSAD, SACRe program) and a postdoc at Matters of Activity EXC (Humboldt Universität). He now holds a Junior Professorship at ENS Paris-Saclay and the Design for Ecological Transitions Chair at CRD (Centre de Recherche en Design). His work focuses on the invention of new production tools and materials, in order to question our social, political, and ecological futures.

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SCIENTIFIC AND CONCEPTUAL CHALLENGES OF THE PROJECT

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