

ecoLogicStudio,
BIO.Tech Hut pavilion,
Expo 2017,
Astana,
Kazakhstan,
2017

Within the 'Living' space of the BIO.Tech Hut pavilion at Expo 2017 in Astana, ecoLogicStudio installed a photosynthetic sculpture, hosting living cultures of cyanobacteria, that would symbiotically breathe with the visitors of the Hut. The project forms part of the studio's HORTUS (Hydro Organism Responsive To Urban Stimuli) series.

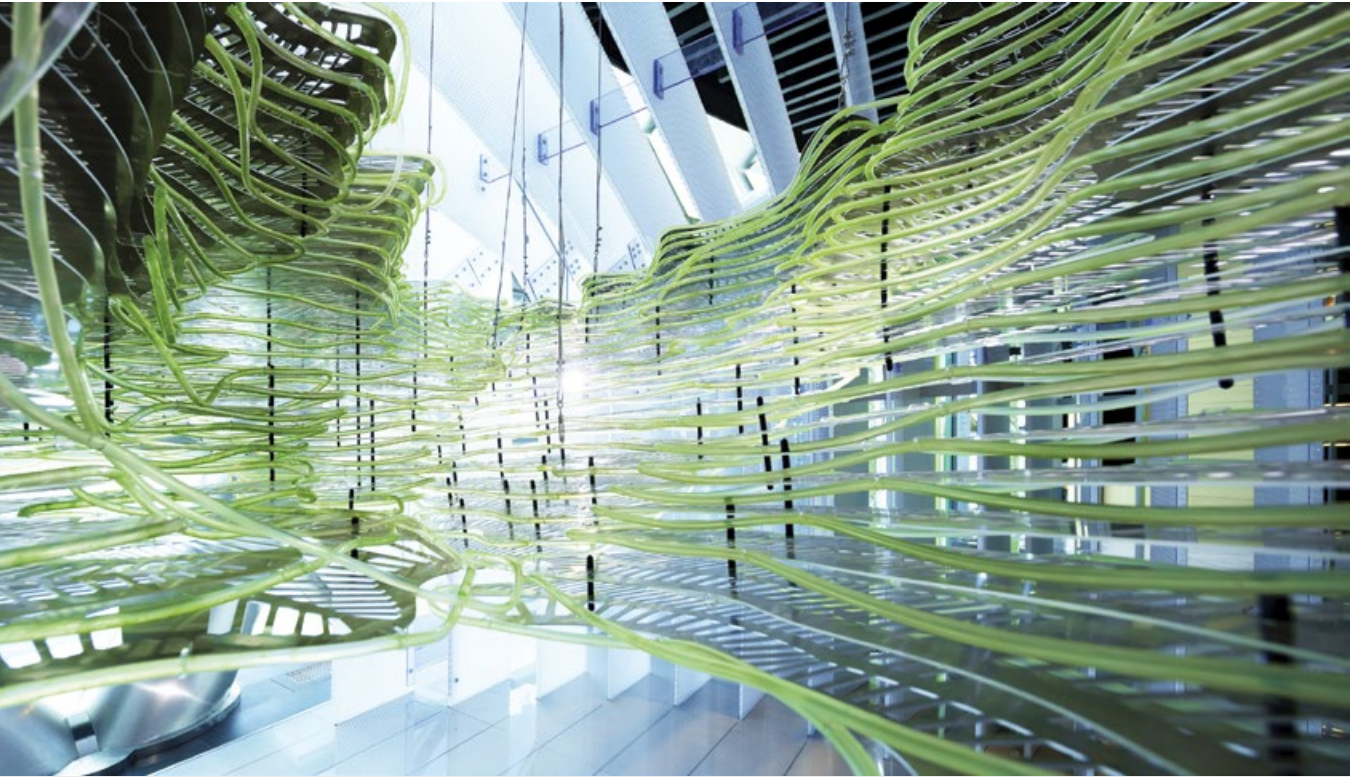


BEAUTY AS ECOLOGICAL INTELLIGENCE

BIO-DIGITAL AESTHETICS
AS A VALUE SYSTEM
OF POST-ANTHROPOCENE
ARCHITECTURE

Internal view of the photosynthetic sculpture. As visitors exhaled carbon dioxide they could manually pump it into the sculpture, feeding the living cultures and releasing fresh oxygen. The coral-inspired morphology with its convolutedness increases the irradiated surface and the lengths of molecular exchange.

Claudia Pasquero and Marco Poletto



By incorporating living micro-organisms within architecture, London-based ecoLogicStudio have found ways to read their evolving appearance as a measure of environmental value. Practice partners **Claudia Pasquero** and **Marco Poletto** combine this approach with digital techniques to create arresting architectural assimilations of the organic and the inorganic that celebrate the beauty of non-human intelligence.

It is timely in the Anthropocene, more than ever before, to search for a non-anthropocentric mode of reasoning, and consequently also of designing. The new Photosynthetic Consortium, established in 2018 and including London-based ecoLogicStudio, the Urban Morphogenesis Lab (Bartlett School of Architecture, University College London (UCL)) and the Synthetic Landscape Lab (University of Innsbruck, Austria), has therefore been pursuing architecture as a research-based practice, exploring the interdependence of digital and biological intelligence in design by working directly with non-human living organisms.

The research focuses on the diagrammatic capacity of these organisms in the process of growing and becoming part of complex bio-digital architectures. A key remit is training architects' sensibility at recognising patterns of reasoning across disciplines, materialities and technological regimes, thus expanding the practice's repertoire of aesthetic qualities.

Recent developments in evolutionary psychology demonstrate that the human sense of beauty and pleasure is part of a co-evolutionary system of mind and surrounding environment. In these terms human senses of beauty and pleasure have evolved as selection mechanisms. Cultivating and enhancing them compensate and integrate the functions of logical thinking to gain a more systemic view on planet Earth and the dramatic changes it is currently undergoing.

This article seeks to illustrate how a renewed appreciation of beauty in architecture has evolved into an operational tool to design and measure its actual ecological intelligence.

Dark Ecology¹

The current rush of many cities to develop blue-green plans dealing with future threats of climate change is a testament to the obsession of searching for 'true' answers within a problem-solving framework. The experience in practice illustrated in this article highlights the urgent need for a new design method capable of engaging the systemic nature of urban landscapes and their architecture. This could be termed an aesthetic approach to socio-ecological issues.

Aesthetics is often absent from urban planning discussions. However, it should be noted that today architects and planners rely on a 'sanitised' vision of the world's ecosystems exemplified by the very notion of blue-green planning and its focus on re-greening cities. This notion may be one of the most enduring aspects we have inherited from modernity. And if bacteriological control was at the origin of its sanitation efforts, modern architecture and urban design turned it into a style; in other words, modernity did embed sanitation into an aesthetic value system. The contemporary paradigms of green cities and smart cities are the direct consequence of the evolution of that value system.

But most urban systems today are non-linear and composed of billions of interlocking feedback loops. Waste, decay, digestion and dissolution are some of their most intense processes and a critical part of their

circularity; these processes often constitute the dark side of urban ecology, a side confined to restricted zones and erased from the consciousness of most urban dwellers. It therefore becomes apparent how critical it is to address the necessary drive to a sustainable urban future by challenging its underpinning aesthetic value system.

Non-human Architecture

Reassessing the dark side of urban ecology means opening up to a new aesthetic of nature and, as a consequence, of architecture. This new aesthetic of nature projects the architectural discourse into the realm of micro-organisms such as bacteria and fungi, creatures endowed with exceptional properties that make them capable of turning waste and pollution into nutrients and raw material. These scalar and material domains unveil the missing links to redefine the contemporary urban metabolism. From this perspective ecoLogicStudio's bio-digital architectures promote a new urban aesthetic centred around a novel appreciation for the micro-scale of bacteria as well as other forms of non-human intelligence. Within ecoLogicStudio's body of work these are 'culturalised', thus entering the realm of architecture and, alongside humans, of bio-citizenship. Notable examples are ecoLogicStudio's 'HORTUS' series (begun in 2012) and XenoDerma (2018), a research project initiated by the Urban Morphogenesis Lab at the Bartlett, UCL.

ecoLogicStudio,
HORTUS XL Astaxanthin.g,
Centre Pompidou,
Paris,
2019

opposite: Front view of the installation and cyber-gardeners. A digital algorithm simulates the growth of a substratum inspired by coral morphology, which is digitally deposited by 3D-printing machines. The photosynthetic bacteria are inoculated on a bio gel medium in triangular units (or 'bio-pixels'), arranged to form hexagonal blocks of 18.5 centimetres (7.28 inches).

below: Interior view. The metabolisms hosted by the structure are powered by photosynthesis, converting radiation to oxygen and biomass. The density of bacteria on each bio-pixel has been digitally computed to ensure the organisms are positioned in areas of increasing incoming radiation.



Bio-digital architectures promote a new urban aesthetic centred around a novel appreciation for the micro-scale of bacteria as well as other forms of non-human intelligence





ecoLogicStudio,
photo.Synt.Etica,
Dublin,
2018

The prototype is composed of 16 modules measuring 2 by 7 metres (6 by 23 feet), covering the first and second floors of the Printworks Building. Each module functions as a photobioreactor, a digitally designed and custom-made bioplastic container that utilises daylight to feed the living micro-algal cultures.

Noticeably there are multiple interactions in buildings that can be activated by the intelligence of microalgae colonies. The microorganisms grow faster in the bio-digital environments designed by ecoLogicStudio than in the wild

HORTUS – Hydro Organism Responsive To Urban Stimuli – is a series of photosynthetic sculptures and urban structures that create artificial habitats for cyanobacteria integrated in the built environment. Within HORTUS, cyanobacteria are deployed not only as photosynthetic machines but also to absorb emissions from building systems. They constitute a new active layer part of both urban and natural metabolic cycles, thus reconnecting the so-called green and dark sides of ecology.

Noticeably there are multiple interactions in buildings that can be activated by the intelligence of microalgae colonies. The micro-organisms grow faster in the bio-digital environments designed by ecoLogicStudio than in the wild because they are very closely connected with human life. Manmade emissions, like heat and carbon dioxide for instance, stimulate biomass growth. The biomass in turn can be used as source of energy or food. It is a new kind of architectural symbiosis.

In XenoDerma this symbiotic relationship mobilises multiple forms of intelligence including animal intelligence. Spiders' minds – in this case Asian fawn tarantulas – do not completely reside in their bodies, as their webs constitute a form of spatial thinking. Information from the web becomes an integral part of their cognitive system. The behaviour of the spiders and the production of silk are thus reprogrammed in XenoDerma through the design of the 3D-printed architectural substructure and of its geometrical features. The result consciously seeks for a productive ambiguity, revealing in the alien beauty of its silky morphologies an intelligence that resides somewhere at the intersection of the biological, technological and digital realms. It is a new aesthetic of nature that is deployed here to question the conventional meaning of sustainability in the contemporary architectural discourse.

The Polycephalum Machine

Even if ecoLogicStudio's first experiments of this kind date back more than ten years, their earliest conceptualisation as a bio-computational design method is found in a design apparatus, named Polycephalum Machine, that was conceived with a research team at the Urban Morphogenesis Lab in 2013. At its core is a living biological organism called *Physarum polycephalum* (PP). PP is a single-cell organism which contains hundreds of thousands of tiny nuclei. Through their life cycle there is a phase when the nuclei become afloat and are able to interact with each other by means of biochemical secretions, creating what computer scientist Andrew Adamatzky has defined as an 'unconventional general-purpose computer'.² PP accumulates traces in the environment that form a distributed spatial memory, its outsourced brain. It is through multiple local interactions among nuclei and environment that PP's overall morphology emerges; these low-level interactions are critical for higher-level collective intelligence to evolve in the absence of a nervous system.

In one recent experiment presented originally at the 2017 Tallinn Architecture Biennale, curated by Claudia Pasquero and titled Bio.Tallinn, ecoLogicStudio developed a 3D-printed substratum based on the urban morphology

of Tallinn, Estonia's capital, which was inoculated with PP. Remarkably PP's networked body grew to resemble urban minimised detour networks,³ the ones that typically evolve in hundreds of years of urban growth and that connect all relevant resources with the minimum overall expenditure of energy. However, working with artist and professor Heather Barnett to capture these behavioural morphologies in a series of time-lapse videos⁴ revealed something altogether different: the true alien qualities of PP's collective intelligence.

This realisation suggests that the true value of these design experiments has to be observed at the commensurable scale of the living organism, while carefully avoiding any form of human abstraction of its behaviour as a kind of biomimetic model. This would in fact imply extracting a special-case solution for a human-oriented problem.

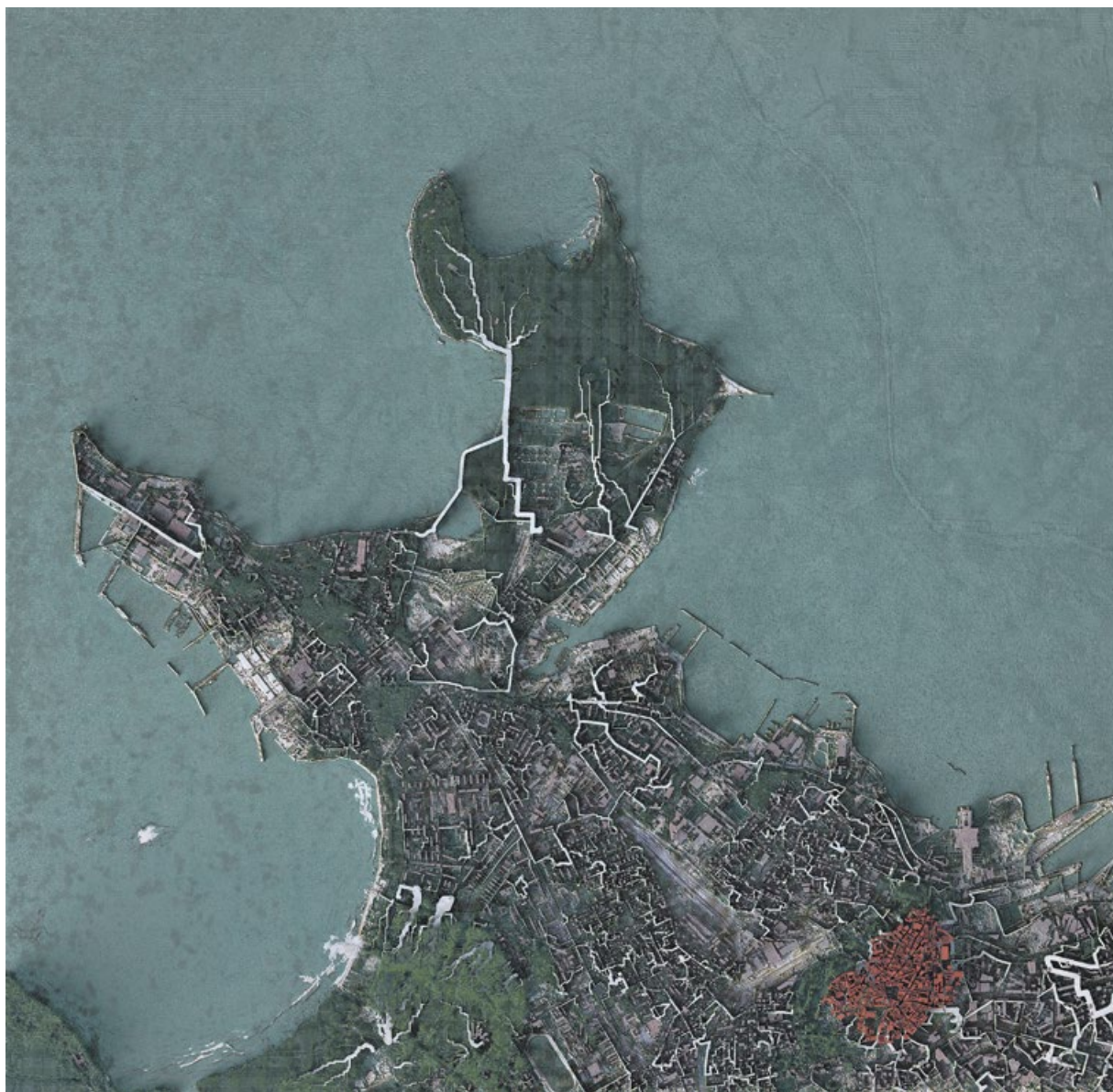
EcoLogicStudio are now therefore focusing on the observation of the diagrammatic capacity of the living system PP in the process of growing and slowly becoming part of an architectural apparatus – that is, of computing and solving architectural and urban problems. In the

apparatus documented by Heather Barnett's video, for instance, this means the process by which PP internalises the morphological and metabolic features of Tallinn within its distributed spatial memory, its actual non-human brain. This is achieved through a large number of low-level integrations among the PP's nuclei and the 3D-printed substratum in the apparatus.

These aspects of the Polycephalum Machine experiments become a critical tool to focus and train a new design sensibility, apt at recognising patterns of reasoning across scalar, temporal and technological domains well beyond the classical ranges set by modern masterplanning.

ecoLogicStudio,
Tallinn Wet City,
2018

Morphological studies and proposal for new blue-green infrastructure for Tallinn connecting the existing wastewater system with a new urban terrain for rainwater capturing, wastewater processing and protection from Baltic sea surges and contamination. Bird's-eye view of the main urban structures.



Urban Morphogenesis Lab,
XenoDerma, Bartlett School of Architecture,
University College London (UCL),
2018

Prototype of an architectural skin morphology developed through direct manipulation of the Asian fawn tarantula's web-building behaviour. The hacking process involves an algorithmically simulated and 3D-printed space frame substratum that becomes part of the tarantula's expanded perception of space.

Bio.Tallinn

Critically, and without many of us noticing, today we all inhabit the Urbansphere, the global apparatus of contemporary urbanity, a dense network of informational, material and energy infrastructures that sustain our increasingly demanding metabolism. Endo-symbiotic relationships unexpectedly emerge among the Urbansphere's heterogeneous components, especially when biological evolution negotiates contaminated habitats and ubiquitous forms of artificial intelligence. EcoLogicStudio have found a significant example of this condition in the city of Tallinn and brought it to international attention as the core topic of the 2017 Tallinn Architecture Biennale.



The emerging aesthetic qualities of the videos and drawings produced with the Polycephalum Machine have become in the context of the Bio.Tallinn project manifestoes for a drive towards progressively higher degrees of synthesis among the heterogeneous systems of the Urbansphere. PP's alien beauty promotes the emergence of a novel aesthetic value system in architecture that, in this project, projects the image of Tallinn's future ecological infrastructure.

Diving into the microscopic world of PP's distributed intelligence challenges the logics of traditional planning processes, laying the ground for a co-evolutionary architecture that can be grown by an extended cohort of bio-citizens. Strategic planning is thus interfaced directly with the material processes and related molecular transactions that underpin a new urban morphogenesis.

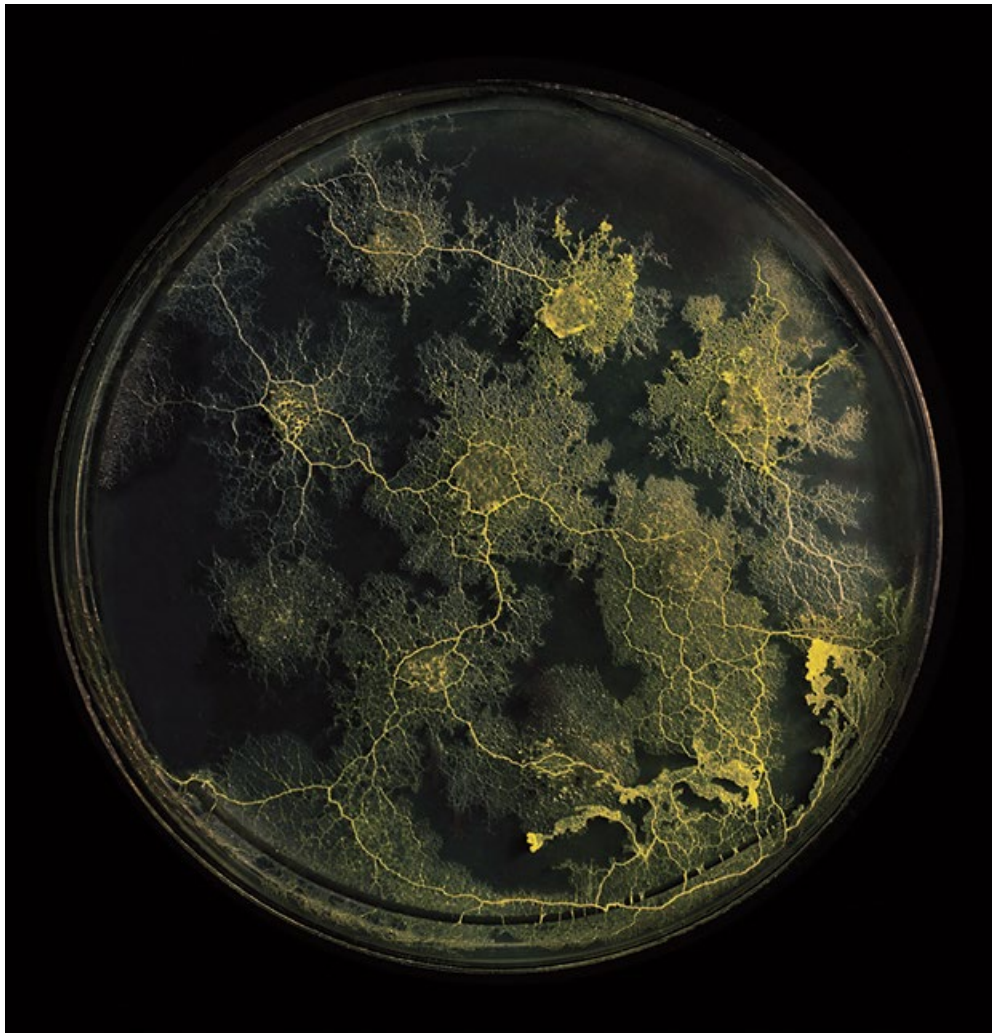
In 2018 the Bio.Tallinn project was further developed by ecoLogicStudio as part of research aimed at developing the first comprehensive blue-green plan for the Estonian capital. Just like in PP, the emerging urban forms of future Bio.Tallinn manifest into the pulsating rhythms of the city's blue-green infrastructures, with their daily, weekly and seasonal fluctuation, or into the morphological convolutedness of the city's future blue-green networks or even in the ungraspable fuzziness of its physical boundaries, all of which defy both the classical canons of beauty and the rational logics of efficient engineering.

So while typical blue-green urban planning still promotes a typologically driven design methodology that has not evolved much since the time of the Garden City movement in the late 19th and early 20th centuries, ecoLogicStudio's new bio-digital plan for Tallinn shows the dawn of a new paradigm that recognises the opportunities offered by the inevitable merging of digital and biological intelligence in the Urbansphere. It is from this perspective that the studio sees in PP's aesthetic an instrument to define a novel value system for architecture in order to evolve cities' actual ecological intelligence.

Perhaps the beauty of PP rests precisely in its ability to solve the liminal condition between infrastructure and landscape, that fuzzy zone where its networked body becomes distributed intelligence. In doing so it provides a new aesthetic canon for post-Anthropocene urban design. ▴

Notes

1. See Timothy Morton, *Dark Ecology: For a Logic of Future Coexistence*, Columbia University Press (New York), 2016, and *Ecology Without Nature: Rethinking Environmental Aesthetics*, Harvard University Press (Boston, MA), 2007.
2. Andrew Adamatzky, *Physarum Machines: Computers from Slime Mould*, World Scientific (Singapore and Hackensack, NJ), 2010, p.35.
3. Frei Otto, *Occupying and Connecting: Thoughts on Territories and Spheres of Influence with Particular Reference to Human Settlement*, Axel Menges (Stuttgart), 2008, p.68.
4. See for example *Resilient Topographies #1: The Peninsula of Paljassaare*, 2017, <https://youtu.be/qRzRXUTkgP0>.



Urban Morphogenesis Lab,
Polycephalum,
Bartlett School of Architecture,
University College London (UCL),
2018

Bio-digital drawing developed through direct manipulation of *Physarum polycephalum*'s (PP's) growth behaviour during the plasmodium phase, displaying distributed intelligence morphology.

PP's alien beauty promotes the emergence of a novel aesthetic value system in architecture

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