2023.02.23 Lecture Notes
Lecture 4 – Neri Oxman

PowerPoint/ScreenShare: 10am
check box for video audio on

Arthur Drexler, Director of **MoMA Dept. of Architecture and Design** (replaced **Philip Johnson**), published volume of work by **Five Architects** (**1972**), the Whites **Peter Eisenman** (Venice Biennale with **Frank Gehry**, **1991**), **Michael Graves**, **Charles Gwathmey**, **John Hejduk**, and **Richard Meier**. The New York Five (**PJ**).


Ink on velum

+1

Richard Meier's Douglas House (Harbor Springs, Michigan, **1973**, 3200sq.ft.)
All (painted) white, porous, 4 story, forested hillside on Lake Michigan.


Le Corbusier's Villa Savoy: modern white, horizontal window, roof garden, free façade (pilotis/curtain wall), free plan. "copy" **Robert Stern**, the Grays (1973).


"...the problem with crisp, white, pristine houses is that their impact depends on remaining crisp, white and pristine. **Meier**'s buildings age like any other, subject to time, weather and gravity. Aging, however, doesn't suit them as it might, say, a **Richardsonian** masonry structure enhanced by the patina of time. (Changing home ownerships can also take its toll. After the Douglas family sold the Harbor Springs house, new owners wallpapered the interiors, and under a third owner, it suffered years of delayed maintenance.) **Meier**'s buildings may be born as perfect Platonic ideals, but the perfection requires regular care, even upgrades."
[Architectural Record, Feb.21, 2023]

Original painted (organic) redwood exterior beams in bridge and staircase had sagged (replaced); condensation inside walls rotted wood-framing; HVAC system was inadequate for solar gain from west wall of single-glazed windows, causing it to rain inside. = 15 year renovation. **Meier** advised replacing redwood with steel, "so long as outward appearance remained as originally intended."
[Reassembled the original furniture **Le Corbusier**'s LC-2 Grand Confort chair, **Mies van der Rohe**'s Cantilever dining chair, **Marcel Breuer**'s Wassily chair.]

"For all its dazzling complexity and apparent liberties, the geometric control underlying the design was highly disciplined, elaborate to a point of aesthetic saturation." For **Meier**, "surfaces mattered" most. [#MeToo March 13, 2018-2021]

With little understanding of material science, assembly, durability, the average lifespan of an American house is 34 years, requiring continuous maintenance, repairs, eventual replacement. If not for physical deterioration, then psychological, by human propensity for change, fashion, competition (keeping up with the **Jones**).

Even if we could transform all of our new buildings and the renovation of existing buildings to carbon neutral, renewable energy efficient buildings before 2030 [**Edward Mazria**'s **Architecture 2030 Challenge** (**2002**) to be carbon neutral], the increases in energy use, mining and manufacturing of materials to do so, will **accelerate us past the warming planet tipping point**, not slow or reverse pace.

The Null Stern Hotel ("Zero Star", **Daniel Charbonnier**, **Frank & Patrik Riklin**, Artists, Teufen, Appenzellerland, Switzerland, June 5, **2009**) former nuclear bunker in the Swiss Alps converted into a hotel. Adaptive Reuse.

What is needed is a full stop in the building industry, as was seen during the Covid lockdown when businesses, transportation, construction nearly stopped, resulted in a drop in daily global carbon emissions of 17% (**April, 2020**).

Zero Real Estate project introduced bedrooms without roof, **walls**, or washroom (https://nullsternhotel.ch/, **2022**). End of Architecture

Covid pandemic accelerate the trends toward remote working and less consumption, however **to reverse the momentum**, a wholly symbiotic way of life will be needed: from consuming Nature to augmenting her, learning to **live within the wilderness** we inhabit, **rather than extracting and domesticating** her as a resource.

This calls for a different approach to buildings, that account for 40% of energy use, the dominant source of greenhouse gas emissions.

Continuing from last week's lecture on **Philippe Block**'s experiments in building material science, exploring new methods of building fabrication, today's lecture on the work of **Neri Oxman**, Associate Professor of Media Arts and Sciences at the **MIT Media Lab**, where she founded **Mediated Matter** research group in **2010**.

Degree from the same school as **Zaha Hadid**, the **Architectural Association** in London, as well as training in Medical Sciences at Hebrew University in Jerusalem.

150+ scientific publications and inventions, in collections at MoMA, Smithsonian, San Francisco Museum of Modern Art, Centre Pompidou, Cooper Hewitt, ...

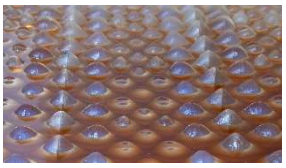
Her team conducts research at the intersection of computational design, digital fabrication, materials science and synthetic biology.

Oxman coined the term, and pioneered the field of, **Material Ecology**, which considers computation, fabrication, and the material itself as inseparable dimensions of design. In this approach, products and buildings are biologically informed and digitally engineered **by, with and for, Nature,** that explores, informs, and expresses interrelationships between the built, the grown, and the augmented.

Generating new ways of production, with structures whose physical properties are designed to seamlessly match the environment which they inhabit.
Rigidity, elasticity, color, transparency, conductivity—even smell and taste—can be individually tuned for each 3D pixel of a physical object.

The construction of buildings is therefore no longer limited to collections of discrete parts with homogeneous properties. Rather, objects, like organs, can be computationally 'grown', additively manufactured and biologically augmented to create heterogeneous and multifunctional constructs.

Cartesian Wax (MoMA, NYC, 2007 MIT PhD):



Experiment with light and heat-sensitive construction techniques, specific to a given environment. Inspired by the Cartesian Wax thesis by **Descartes** in the 1640's: the essence of wax is whatever survives various changes in the wax's physical form.

Cartesian Wax is an architectural skin-like surface made of tiles. Generated out of a single 3D–milled, semi-adjustable mold, each cast and cured at high temperatures, process that increasingly deforms the original mold with each cast.

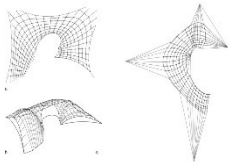
Geometrical and physical property variation in tiles by modulating temperature across entire wall, each resulting tile, similar in shape, differs in stiffness and opacity; reflecting and responding to the conditions which "formed" it. Variation in material properties used to correct and augment, structural performance.

Gaudi's Casa Batlló chair

For example, in regions that were made thinner due to the deformation of the mold, stiffer composites were cast to ensure structural support under self-load. A continuous surface responding to array of conditions: light transmission, heat flux, stored energy modulation, and structural support.

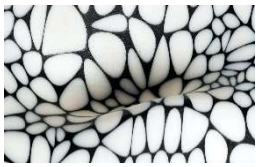
Monocoque (MoMA, NYC, 2007 MIT PhD): 

Technologies are applied to physical properties and behaviors. Texture inherits geometrical features as defined by analyzing where pressure is concentrated,



(**Block**'s **Thrust Network Analysis**, 2007) based on **Voronoi pattern** (Nature's tendency to favor efficiency: the nearest neighbor, shortest path, and tightest fit. Each cell has a seed point. Everything inside is closer to it than to any other seed. The lines between cells are always halfway between neighboring seeds.) Global and local mean curvature values inform its density, denser, smaller cells are organized in areas of steep curvature, and larger cells in areas of shallow curvature.

Hollow skeletal framework, allowing light to pass through voided low stress cells, creates shadow pattern on surface, leads to multi-material smooth surface.



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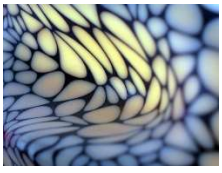
The surface patches are 3D printed in a new multi-jet matrix, simultaneously deposits materials of different properties and materials within a single build. Loads are supported by the object's external skin, similar to an egg shell.



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Vein-like elements that are built into the skin distribute shear stress and pressure over their surfaces, becomes softer and more flexible where tension needs to be relieved, and stiffer where more support is required. Volume of each cellular cushion is locally informed by pressure data averaged with values that represent structural support and flexibility.

November 19, 2021, Oxman debuted her manifesto, **NATURE X HUMANITY** at a critical juncture when the an-t(h)ro-po-mass (the mass produced by humans) has exceeded that of all living biomass on Earth. Although human beings are part of the natural world, human activity and the "goods" we design and build — from our clothes to our cities — have increasingly set us apart from nature, negatively impacting ourselves and our planet.

"Concrete, metals, bricks and glass will exceed plants, animals, bacteria, fungi. Current building technologies and material practices are main culprits, propelling us to an inevitable future, where we are called upon to build shelter against ourselves."

"What are the values, principles, knowledge, skills, that we must cultivate, as we architect a future of synergy, between the natural and the built environment?"

We call for a radical realignment between grown and built environments, with the hope and conviction that humanity has the power not only to restore, recover, and replenish the natural world but to empower it. Embracing complexity and diversity across systems and scales in design, we open ourselves to advancing beyond mere maintenance (conservation) towards the betterment (augmentation) of nature.

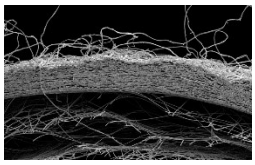
By the time Neri's daughter Raika is 80 years old, 6th mass extinction under way, "As master builders and authors of the an-t(h)ro-po-mass, architects, the gardeners of tomorrow, will either make or break our bond with nature."

"Fuse hardware, software, wetware, to create new types of structures that can respond, adapt and evolve. ...the only way home."

"Why hurry to Mars, while we can architect a synergy between humans and nature? Rather than being forced to abandon this precious planet, let us design our way back into it? Make nature your client."

A call to architects, to architecture, to save the human species. Manifesto proposes **5 new material systems tenets**: fibers, glass, polymers, pigments, cellular solids.

Multi-Species over Mono-Species (Fiber)



Silk Pavilion I (Media Lab, Cambridge, 2013): Relationships between digital and biological construction, proposing methods that unite the biologically spun and the robotically woven. Inspired by the silkworm's ability to generate a three-dimensional cocoon out of a single silk thread.

Silk Pavilion I took form as a three-meter wide dome, constructed over three weeks with a flock of 6,500 live silkworms assisted by a robotic arm. Each spun a single silk thread filament about 1km long. Combined, as long as the Silk Road. Studying how the silkworm's spinning behavior is informed by spatial and environmental conditions, able to guide the silkworm's movement to spin two-dimensional sheets rather than three-dimensional cocoons.

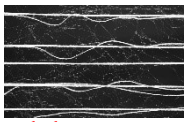
The base structure of the pavilion was created of 26 polygonal panels made of silk threads laid down by a Computer-Numerically Controlled (CNC) machine. Once established, a swarm of 6,500 silkworms positioned at bottom rim of the scaffold, spinning flat non-woven silk patches, locally reinforcing the gaps. An algorithm that places a single continuous thread providing various degrees of density, variations informed by the silkworm itself, deployed as a biological "printer".

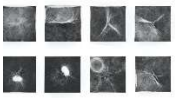
Tiny magnets to the heads of silkworms to motion-track their movements. This data to program the robotic arm to deposit silk on the metal frames. "Our aim was to translate the motion-capture data into a 3D printer connected to a robotic arm in order to study the biological structure in larger scales."

Their sensitivity to environmental conditions: found to migrate to darker and denser areas. Therefore, able to calibrate variations in the thickness of the silk sheets to desired specifications. Sun-path diagram used to modulate distribution of light and heat on the surface, influencing position of silkworms and density of silk structure.

Silk Pavilion II (MoMA, NYC, 2020): 

Can humankind and other species collaborate in the construction of buildings? Extract silk without boiling cocoons? Average 1000 cocoons boiled = 1 silk shirt. Pavilion II stands six meters tall and five meters wide, tackles challenges associated with scale and sericulture. Integrated kinetic mandrel designed to guide the natural spinning motion of the silkworms through clockwise rotation, facilitates the silkworms' upward spinning motion, fusing technology and nature.

Primary structure a braided steel-wire cable system (1D), the intermediate soluble knit yarn scaffold layer (2D) acts as support for the silkworms biologically spun (3D), Similar **Zaha & Gehry** layered structural skin.  +3 

Fiber density across the surface area of the structure varies as a function of local environmental factors such as the direction, duration and intensity of heat and light, affect the silkworms' movement and spinning, resulting thickness of silk layer. The holes, which release some of the tensile stress in the structure, result from chemical reactions between the silkworms' excretions and the underlying yarn. These structural forces are influenced biochemically, expressing a 'metabolic footprint' of the silkworms' fluxes and flows.  

17,532 silkworms sourced from Teolo, Italy. In this region of Veneto, sericulture and silk manufacturing blossomed during the 12th century Renaissance. Sericulture has been criticized by animal welfare and animal rights activists, process of harvesting silk from the cocoon kills the larva. In textile and silk industry today, silkworms are exterminated while in their cocoons, dissolving the adhesive that glues strand of silk to the layers below, allows a single silk filament to be unrolled. Silk Pavilion demonstrates can influence silkworms to spin sheets instead cocoons, thereby producing the same quantity of silk without boiling cocoons. The project illustrates how these compact and unique insects can act not only as living looms but as co-designers collaborating with humans to design and construct architectural-scale structures embodying co-fabrication for cohabitation; our hope is that the research underlying this work will inspire many to question 7,000 years of sericulture policy at large.

10:45

Synthetic Apiary I (Media Lab, Cambridge, 2016):  

Rather than locating the apiary outside, Synthetic Apiary takes up an entire room and offers precise control of light, humidity and temperature to replicate the ideal environment for bees to survive and produce honey, tricks into thinking it's spring throughout the year. The colony is provided with synthetic pollen and sugar water, and its health is constantly monitored. The first demonstration of sustainable life in a completely synthetic environment. Control queen's biological clock to lay eggs.

Synthetic Apiary II (2021): 

As agents of pollination, bees are integral to roughly 70 per cent of our edible flowering crops; without them, we would not have the fruits and vegetables. May be key to support regenerative food systems for long-term space missions.
Integration of biology into a new kind of architectural environment, integrated city, for the benefit of humans and non-human organisms alike. Wax hives that house tens of thousands of individuals, all working together in eusocial behavior, such as swarm intelligence, emergent behaviors and social organization.
Create functional structures from comb without the use of any top-down blueprints. Learn how to incorporate them into our own construction practices – not only to cohabitate but also to co-fabricate with bees.  +2 

Designed environments to convey information to the colony. The comb that the bees construct their response to the input information, enabling a form of communication between humans and bees. Chemical cues created through a novel pheromone 3D-printing process; magnetic fields of varying strength and direction; and geometries of varying complexity or designs that alter their form over time.

Offered wax augmented with synthetic biomarkers, bees readily incorporate it into their construction process, likely due to high energy cost of producing fresh wax. Wax structures built by the colonies are analyzed by high-throughput X-ray computed tomography (CT) scans for a holistic digital reconstruction of structure.

Essential to our mutual survival to not protect, but moreover to empower these critical pollinators. In order to design our way out of the environmental crisis that we ourselves created, we must first learn to speak nature's language.

10:50

If **grown organics** have a lower carbon footprint than traditional **mined materials** for constructing buildings, should plants, animals, bacteria be **enslaved** to produce?

If organics can be made in a **lab**, yet still a **biological living material**, is it better?

Line **blurred between living material shelter and living inhabitant sheltered**...
Is a **synergetic co-habitant lifeform** that shelters **merely a wall or roof**?

[FIVE MINUTE BREAK]

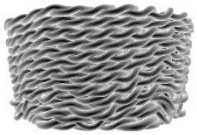
10:55

Technology over Typology (Glass)

+1

Glass I (Media Lab, Cambridge, 2015):
Ancient yet modern, enclosing yet invisible, created Mesopotamia 4,500 years ago. Discovery of core-forming process for bead-making in ancient Egypt, through the invention of the metal blow pipe during Roman times, to the modern industrial Pilkington process for making large-scale flat glass.

G3DP additive manufacturing platform to print optically transparent glass.
The platform is upper chamber as a Kiln Cartridge (1900°F), lower chamber to anneal the structures, molten material through alumina-zirconia-silica nozzle.



+6

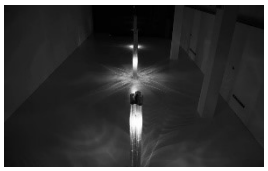
The tunability enabled by geometrical and optical variation driven by form, transparency and color variation can drive, limit or control light transmission, reflection and refraction. (Is glass organic? living?)

+1

Glass II (Cooper Hewitt Smithsonian Design Museum, NYC, 2016):

Glass II installation for Milan Design Week at Milan Triennale on April 4th, 2017. Series of 3m-tall glass columns manufactured with the Glass 3D Printing platform.

Demonstrating ability to 3D print range of shapes determined by desired mechanical and optical properties. Higher the physical load, the greater the surface area in plan, greater number of lobes desired, tighter turning radius for 3D printing, and contributing to geometric expression of the caustics.



Dynamic internal lighting system (una stellina) programed to travel up and down, generating a varied caustic footprint with kaleidoscope-like patterns, resulting in changes to the surface area, sharpness, and intensity. Architecturally scaled lenses that can concentrate or disperse light from within and/or outside the glass surface.

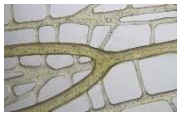
Decay over Disposal (Polymers: chitin & cellulose)

Aguahoja I (Media Lab, Cambridge, 2018):

(agua-hocha)

United Nations Environmental Program (UNEP): over 300 million tons of plastic are produced globally each year. Less than 10% of this material is recycled, becomes waste, dumped into landfills and oceans; raw ingredients extracted faster than can be replenished, processed through environmentally destructive means. Organic structures embody more efficient and adaptable material properties, and leave no environmental marks. From a limited palette of molecular components, including **cellulose**, **chitin**, and **pectin** (in trees, crustaceans and apple skins) natural systems construct functional materials with no synthetic parallels.

Chitin, manifests in thin, transparent dragonfly wings, and soft tissue of fungi. **Cellulose** makes up more than half of plant matter planet-wide. Living materials, outperform human engineering in diversity of functions, resilience, sustainability, and adaptability.




11:05

Aguahoja a biopolymer composite material alternative to plastic, tunable properties with varied mechanical, optical, olfactory and gustatory properties.
This project points towards a future where we subvert the industrial cycle of overproduction and obsolescence through the use of abundant natural materials.
Ability to temporarily divert materials from healthy ecosystems, to integrate them in human designs, and to enable natural decomposition back into the environment.
By enabling digital design and fabrication with biopolymers, incentivize the protection and strengthening of ecosystems, providing new frontier of production.


React to their environment over their lifespan, adapting their geometry, mechanical behavior and color in response to fluctuations in heat, humidity, and sunlight. Time-based 'temporal' behavior as a design feature, able to sense, inform the user of, and adapt to changing environmental conditions. Over time, with the evaporation of water, the pavilion's skin-and-shell composite transitions from a flexible and relatively weak system to a rigid one that can respond to heat and humidity. Upon exposure to rain water, pectin-based elements rapidly dissolve, allow cellulose- and chitosan-based elements to deform, degrade in controlled 'programmed' fashion. Through life and programmed decomposition, shelter-becomes-organism as it holds the potential to promote the health of natural resource cycles, promoting soil microorganisms and providing nutrients for 'growing' buildings, Material Ecology.


+6


Robotic platform for 3D printing hydrogels biomaterials, additively manufactured with varied mechanical, optical, olfactory and gustatory properties. Shape and material composition informed by physical properties (stiffness and opacity), environmental conditions (load, temperature, and relative humidity), and fabrication constraints (degrees-of-freedom, arm speed, and nozzle pressure). Organic material allocation, texture, distribution computational driven, additively manufactured high resolution. This enables control over specific physical properties and environmental adaptation to changing weather conditions.


+3


Aguahoja I is a 5 meter architectural pavilion, combining shell-like and skin-like elements, derived from shrimp shells and fallen leaves, the pavilion's overall stiffness and strength are designed to withstand changing environmental conditions.


+1

Monograph show at SFMOMA (February 2022), exposed the Aguahoja I pavilion to the elements, measuring the transference of calories as it decomposes (estimated at 40,000 calories), indicating how much energy has been transferred to the direct natural environment (the garden) surrounding the built structure (the pavilion), displaying real-time weather data such as wind, humidity, temperature, and precipitation, inform structural decomposition and degradation of the pavilion over space (shape deformation) and over time (rate of decay). An appreciation for the cycle of decay, expressing how the loss of built matter is recovered through and in the environment, a tree becomes a building, a building becomes a tree.

Heterogeneity over Homogeneity (Pigment: melanin)

Totems (MoMA, NYC, 2019):

Biodiversity on planet Earth is under momentous threat, **Melanin**, a naturally occurring chemical chain that gives all living things their pigmentation, can sustain and enhance biodiversity at the genetic, species and ecosystem levels. A biomarker of evolution, melanin is the color of life. One of the most resistant, heterogeneous, and pervasive pigments found across the kingdoms of life, substance that defines the color of skin, hair and eyes. Critical role in providing protection from ultraviolet radiation, variety of functions: mechanical protection, energy harvesting, cell growth, metal binding, thermal regulation, and protection from oxidative stress. Melanin represents unity in the diversity of life on earth and is clearly linked to biological survival throughout the ages. It is considered by some to be more valuable than gold, and its impact—in the age of climate change—is key to human survival on Earth.



11:15

Melanin can be synthesized through a reaction between an enzyme from a mushroom, called tyrosinase, and the protein building block L-tyrosine. The pigment can be extracted from bird feathers and cuttlefish ink amongst other sources, then purified and filtered in a series of steps. The genes for melanin production can also be engineered into bacterial species, such as Escherichia coli, and thereby controlled over space and time in response to changes in the environment. For instance, its coloration could deepen as the sun reaches its peak, providing protection from solar radiation.


+1

Totems, a series of spherical objects featuring a single connected channel filled with liquid melanin. These spheres display a wide range of colors and absorption spectra, from light yellow to dark brown. The channels within these spheres have been computationally 'grown,' 3D printed and biologically augmented to create pockets for the liquid melanin to reside, with channel diameters ranging from millimeters to centimeters.

Installation for exhibition, **Broken Nature: Design Takes on Human Survival** as part of the **XXII Triennale di Milano exhibition** (2019), features a column-based demonstration of melanin production on an architectural scale for deployment in specific environmental contexts. It is comprised of a totem—a spirit being, sacred object, or symbol that serves as an emblem of the Tree of Life. The research at the core of this work fuses digital fabrication, design computation and chemical reaction dynamics, resulting in 'a biological totem' with introduction of tyrosinase, an enzyme that is light-sensitive, leading to color formation over the span of a day, deepening as the sun reaches its zenith and easing into lighter hues as the sun sets.


Melanin-infused glass structure. It is designed to contain multiple types of melanin, naturally obtained on site and biologically synthesized at the Lab.
It provides UV protection during the day while enabling stargazing at sunset.

+2

System over Object (Cellular Structures)

Digital Construction Platform (NASA, 2021): large scale digital manufacturing. Mobile, self-driving system, 5-axis hydraulic arm (macro, gross movements) with 6-axis robotic arm (micro, fine movements) mounted on end point, for 11 degrees of freedom, 10 meter reach, similar to human shoulder and hand. Robotic arms offer greater task flexibility, excavate and build with local materials.

+5

Demonstration 50ft. diameter dome, with open top, made of expansive geothermal foam (8,000 pounds of material), fabricated in 13.5 hours over two work days. Largest continuous print, on site, by a mobile printer. Double layered form could be filled with concrete and reinforcing elements for structural strength, insulated for thermal efficiency. Completed, platform returned with push of button on iPhone.

+1

Application for on-site data gathering for real-time design and fabrication, as autonomous system used in disaster relief, hazardous environments, and extraterrestrial terrain. Acquired by NASA's Marshall Space Flight Center for remote construction on Lunar and Martian missions.

Ecologies without division, blur line between human-made & Nature-grown,
without **wall**, blur line between enclosed & exposed,
End of Architecture, without differentiation between architecture & landscape,
between augmentation & body.

Wanderers (**EuroMold**, Frankfurt, Germany, Nov.25-28, **2014**)
An Astrobiological Exploration
Traveling beyond planet Earth involves voyages to hostile landscapes and deadly environments. Crushing gravity, amonious air, prolonged darkness, and temperatures that would boil glass or freeze carbon dioxide.

How can we design relationships between the most primitive and the most sophisticated life forms?
Can we design wearables embedded with synthetic microorganisms that can enhance and augment biological functionality?

3D printed wearable capillaries designed for interplanetary pilgrims are infused with synthetically engineered microorganisms to make hostile habitable and the deadly alive.

Each wearable is designed for a specific extreme environment where it transforms elements that are found in the atmosphere to one of the classical elements supporting life: oxygen for breathing, photons for seeing, biomass for eating, biofuels for moving, and calcium for building.

Mushtari (a wearable for Jupiter), **Zuhal** (a wearable for Saturn),
Otaared (a wearable for Mercury); and **Qumar** (a wearable for the Moon)


Mushtari (**2015-2017**) 3D printed wearable (**Objet Connex3**, color multi-material 3D Printer developed by **Stratasys**) 58 meters of internal fluid channels, as a microbial factory that uses synthetic biology to convert sunlight into useful products for the wearer.

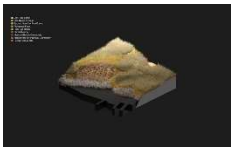

With a symbiotic relationship between two organisms: a **photosynthetic microbe** – such as microalgae or cyanobacteria - and **compatible microbes** – such as baker's yeast and E. coli - that make useful materials. The photosynthetic microbe converts sunlight to sucrose – table sugar – which is then consumed by compatible microbes and converted into materials such as pigments, drugs, food, fuel and scents.

This is a form of microbial symbiosis, a phenomenon commonly found in nature. The wearer would be able to trigger the microbes to produce a particular substance, for example fungi created melanin for protection from radiation in outer space.

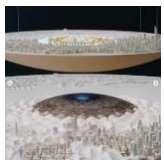
If an augmented body, symbiotic with the environment, provides for shelter, safety, comfort, warmth, water, and also the metaphysical, metaphor, identity,
What is the need for structures to enclose space, when we can live exposed?
What is the need for architecture, when the body becomes landscape?

Man-Nahāta (SFMOMA, 2022)
Study for **Francis Ford Coppola**'s MGLPLS (forthcoming film, **Megalopolis**)

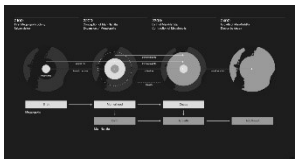

Taking the long view of habitat loss and species extinction, Oxman revisits Manhattan's pre-1600s island, home to the **Lenape** people and known as

Mannahatta ('land of many hills'). Before the Dutch arrived, the center of Manhattan was once a diverse, natural landscape of hills, valleys, forests, fields, wetlands, salt marshes, and streams. Mannahatta had over 55 different ecological communities on a territory of 20 square miles.

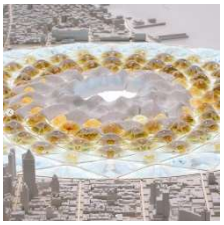


An architect and scientist who seeks to rebuild New York City as a utopia with a magical material, the **megalon**, a multi-scalar genetically modulated physical intelligence, with computational growth algorithms that can be applied across material, architectural as well as urban scales…



2100, climate intensifies, conditioning a re-balancing of landscape and inhabitants. **Four essential seeds**—shelter, nutrients, energy, society—self-organize into a layered circular system. Sunlight and airflow shape its morphology, the water line defines its boundaries, and the hilly landscape underlies its grid.

2300, global temperatures and sea levels rise, the city undergoes time-based decomposition, its organic substances breaking down into **megalithic architectural elements**: carbon dioxide, water, sugars, and mineral salts.



The buildings of the urban landscape are transformed through repeated morphological closing operations, simulated erosion and soil deposition are applied, from the center to the outskirts of a circular region. This results in a topography where hills are remains of skyscrapers and valleys follow the streets of the city grid.

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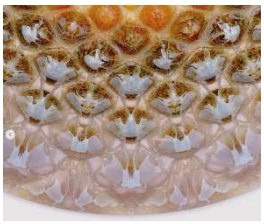

2400, the urban cityscape of Manhattan persists as a memory captured in the hills and valleys of the landscape. The wetlands, salt marshes, and biodiversity of ancient Mannahatta are almost completely reborn in a new form, the old city becomes a **fossil**, on top of which a new cycle of humanity is built.