Modern Civil Engineering (ISSN 2470-4180)
October 2021, Volume 1, No. 5, pp. 30-40
Doi:10.15341/mce(2470-4180)/10.01.2021/005
Academic Star Publishing Company, 2021
www.academicstar.us

Hylocene: An Exploratory Pathway Among the "Today's Materials"

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Abstract: The paper presents Hylocene, the (physical and virtual) material library of the Sapienza University of Rome, based at the research infrastructure for innovation SAPeri&Co. This material library diverges from the others whose primary objective is to facilitate the access and exchange of information relating to the materials between producers and potential users and their dissemination and application in innovative products. Instead, Hylocene aims to leave space for more fluid research, which stimulates rather than informs and which specific target are designers and planners in general. Hylocene is, in fact, a material library that aims to encourage and inspire new synaesthesia of thought, activating new connections through the use of specific algorithms and a system of tags and clouds, capable of opening up to the complexity of the present in original and unique ways, with particular attention to the challenge of sustainability.

Key words: material library, sustainability, Anthropocene, experience

1. Introduction

With globalization and the ever-greater connection between different cultures and knowledge, the designer abandons its role of aesthetically appealing forms producer, at the service of seriality and profit, to become the interpreter of an extraordinarily dynamic existence. Design, in fact, acts in the artifice's project, in which phenomena, values and innovations are outsourced into reality; it embraces all sizes, applications and dimensions (from architecture to material to interfaces) and constitutes a multidisciplinary bridge between scientific and humanistic subjects. So, it can give voice to change and offer the modern complexity tactical creativity, focus and strategy [1]. In other words, designers become eclectic agents of change, understand our time and its fluidity, and translate the significant challenges of contemporary living into finite, integrated, and complex solutions that people can understand and use. Solutions that consider both environmental, ethical and social emergencies; both the significant scientific, technological and cultural advances; as much as the needs and the mood of the community.

Hylocene rises from these considerations. It is a physical and virtual material library based at the SAPeri&Co interdepartmental centre of the Sapienza University of Rome, and it focuses on promoting innovation and research in the largest university in Europe (Fig. 1). Hylocene, from the Greek *hyle:* matter and *-cene:* recent, etymologically indicates "today's materials", but more generally, it underlines the strong differentiation and characterisation of the new material library compared to the existing ones. In fact, it goes beyond the aim to give producers visibility and support potential users in the search for ideal material solutions for their projects, facilitating access to information related to materials and production processes that exist today. Instead, it aims to immerse the user in the dense networks of contemporaneity, allowing him to explore the social, economic and cultural trends that pull strings and making him aware of the most urgent contemporary emergencies. Its specific targets are designers and planners in general, offering them an overview of the central role that they are assuming in the complexity of the present and how, through the same materials and their manipulation, they can offer innovative and sustainable solutions for a better future.

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Fig. 1 ***Hylocene*** **— Physical and virtual material library based at the SAPeri&Co interdepartmental center of the Sapienza University of Rome, whose contents can be explored through a graphically presented exhibition itinerary.**

Hylocene doesn’t use “deterministic” cataloguing that divides materials into limited categories relating to technical, applicative and sometimes sensory aspects, but it is based on a general theme — from which all the contents are selected — then declined into specific topics which — in addition to the classic filters — divide all the content into fluid and flexible channels. In this way,

Hylocene can leave space for exploration rather than research, inspiration or comparison rather than an “exact” material, innovation rather than a finished object.

2. Along With the Hybrid Links Between Nature and Culture

Nowadays, we live in a complex context, especially due to large-scale processes and phenomena, such as Modernization and Globalization. In the 1980s, the biologist Eugene F. Stoermen coined the term “Anthropocene” to indicate the current geological era, which is attributed to man and his activity the significant impact on the planet’s balance. Initialized with the modern age — and therefore with the Industrial Revolution — the Anthropocene is characterized by an anthropocentric vision, which claims to determine a finalized world, to control and dominate everything that surrounds us, to enclose man and all his activities within an artificial sphere, which had walls as high as possible to shelter us from what was different or dynamic and to guarantee our survival. However, these phenomena have today reached high levels of complexity and uncontrollability, leading to a paradigmatic change in seeing things and approaching reality. This generates consequences in all disciplines and all economic, productive and social sectors, going so far as to question even the very meaning of “human being” and our position in the Universe.

First of all, the accelerated technological evolution and the pervasive anthropic occupation of our planet have led to the birth of a “Technosphere”, which is a sort of new dimension, which unites humans, the environment and artefacts in an increasingly denser technological and communicative integration. It is more and more confusing, sometimes exchanging places with the “Biosphere” in which we are born [2]. On the one hand, our artificial world has extended its borders up to real infrastructural colonization of the Earth, from its surface (with cities, roads, artefacts) to its atmosphere (with air routes, digital networks, satellites, drones). On the other hand, the boundary between a natural and artificial fade, due to new technologies that combining the physical, digital and biological spheres [3], produce structural and superstructural artefacts that look like new animated beings and, at the same, manipulate the living matter right into its deepest fibres. A simplistic vision is thus abandoned: nature, and the Universe in general, are not anymore seen as a vital opposite sphere, different from the one that the human species has progressively colonized and compromised; but as an integral part of our life and the future of humanity. Nature and culture merge and create a new single complex entity, in which man must learn to live together with his (now elusive) best creations, but also with all those “natural phenomena” incorporated within the all-encompassing culture of our species.

Secondly, the anthropocentrism that has characterized our material culture has become

particularly arrogant in recent decades. Man has progressively ignored the coexistence of other spheres outside his own, but rather has undertaken to adapt and domesticate the surrounding nature — on every scale, from the microbiota to the cosmos, including human communities and cultures — for the good of oneself and of one's specific community [4]. This behaviour (mass production, exploitation of natural and human resources, hyper-goods that becomes waste, hyper-consumption) has led to the breaking of the general equilibrium and to the emergence of environmental, ethical and social challenges that go to affect not only nature or the survival of other living species but also humanity itself, cultural diversity and endangered traditions. We are so required to rethink our role and position in the Universe and look beyond everything that is immediately visible or deducible. We realized that we are a node in a complex network of self-adapting systems, whose characteristics are not simply the sum of the individual parts, but their sharing in a single entity [5], uncontrollable and beyond our reach, so our every action — even if small and reckless — can generate unintended consequences even for us.

Understanding this universal interdependence stimulates a new collective attitude of openness towards otherness. It stimulates us to rethink our coexistence with the other as the opportunity to participate synergistically in the incessant evolution of this world [6]. Those hybrid interconnections between the natural and anthropic environment, so far blurred and severed, thus become countless alternatives to interpret the reality surrounding us and generate fascinating co-evolutionary scenarios. New synergistic relationships between living matter and artifice, man and the environment, man and man, are the substratum of a beneficial and lasting complex symbiotic ecosystem. In fact, thanks to advances in science, technology and culture, we are not only able to interact and collaborate with other protagonists of the Universe (from plants to fungi, to bacteria); but allow us to see how biological systems do not work in an "exact" way, and it is their complexity that makes them survive. From nature, we can learn a new way of thinking of systems, networks and families; new collaborative methods; mixing and circularity; long-term wisdom and the elegant ability to self-adapt under pressure.

The new material library intends to show this nascent dimension of design and the exploratory paths in the field of materials. For this reason, with its 80 (current) samples, Hylocene collects materials and products on the market and research results not yet mature and known but highly innovative, which therefore require the involvement of designers to be qualitatively improved and/or applied in new products. The aim is to show potential users how innovative and sustainable solutions emerge through creativity, aimed at recovering and repairing those old ties that allow us to be part of this interconnected Universe and re-establish a balance, dynamic but lasting, necessary in the near and distant future.

It is also the material itself that re-evaluates the centrality of its role in the contemporary scenario. This sort of "return to nature" promoted by recent scientific, technological and cultural innovations, is not given so much by our ability to imitate its shape or behaviour, or because we can control and manipulate living matter, but because we are moving further away from the rigour of manufacturing, from seriality paradigm, from the assembly of parts with distinct functions to approach concepts such as "growth" and "flexible functionalization" [7]: the new artefacts grow and form a single material system in which product-material-performance coincide.

3. Design Is Connection

By exploiting the ability to combine different knowledge, experimentation and creative thinking, reality and radical research, the contemporary practice of design interfaces with changed cultural and technical conditions and the current holistic vision of the Universe. These last stimulate design to explore and interpret increasingly articulated and specialized thematic profiles through material experimentation and process innovation. In Hylocene, we have categorized such evolutionary scenarios into three macro-areas that allow a first subdivision of the contents concerning three macro-themes: Eco-responsibility, Connectivity, Empathy. Each of them is in turn divided into three micro-areas, which explore their specific issues and developments (Table 1).

3.1 Eco-responsibility: Ethical Responsibility Towards the Environment

Ethical responsibility towards the environment or environmental sustainability is a concept that "persecutes" us for 40 years and involves the project at different levels: from the idea to the study of sustainable

Table 1 ***Hylocene*** **divides the contents into three macro-categories (Eco-responsibility; Connectivity; Empathy), further divided into three micro-categories. Each category has its own gradient scale of colours.**

Macro-categories	Eco-responsibility	Connectivity	Empathy
Micro-categories	Biocycle	Consilience	Eloquence
	Technocycle	Bio-synergies	Memoey
	Eco-active	Techno-synergies	Biophulia

materials and processes, from consumption models to product’s end of the life cycle to the communicative ability of design, to establish in the common conscience an ethical attitude and concern for the environment. However, with today’s awareness, new technologies and rediscovery of nature and its efficiency, the design goes beyond simply correct projects from a political and chemical point of view towards new, more ethical, responsible and shared innovative scenarios. Starting from the re-evaluation of edible or waste matter, up to the creation of hybrid solutions capable of assuming behaviours similar to the living, passing through the design of systems “from cradle to cradle” [8], the Biosphere that we must safeguard, becomes a model to be pursued, a source of inspiration and an immense database of potentially inexhaustible raw materials. The material library, in particular, focuses its attention on circular materials and high-performance materials, which ultimately constitute two sides of the same coin. Both are valuable solutions to many ecological problems, but while with the former, we are witnessing a return to material experimentation — often artisan and self-sufficient; with performing materials, today’s most sophisticated technologies give voice to their usefulness, endowing matter with “living qualities” of autonomy, self-organization, sensitivity and multifunctionality.

Consequently, the three micro-categories are:

Biocycle — circular materials of natural origin: this category collects circular materials deriving from upcycling processes of raw materials of natural origin, therefore renewable and biodegradable, such as coffee, chitin, bamboo and fish skin. It includes all those experiments that designers and creatives have carried out to give new life to waste (e.g., from agri-food or wine industry) or to abundant resources in nature (e.g., by addressing the surplus of algae, a negative anthropogenic consequence for natural ecosystems), and transform them in eco-innovative materials (Fig. 2).

Technocycle — circular materials of synthetic origin: this category collects circular materials deriving from upcycling processes of raw finished (or limited) materials such as plastic, metal, concrete and glass, which, unlike the previous ones, cannot be renewed. Not only: from a circular point of view, these materials cannot be consumed but used and to “return to the cradle”, they need a well-designed system to be recovered, regenerated and recycled at the end of their life, preserving their value and not polluting further. Here too, the possibilities are many, and the designers have already come up with numerous solutions (Fig. 3).

Fig. 2 In Biocycle we can find, for example, Organoid-decorative panels made with natural elements of the Tyrolean landscape that hosts their production. Their secret is a particular technique of pressing the natural material without chemical substances, keeping the structure and organoleptic properties intact, thus allowing the user to 'bring home' the alpine nature, with its colours, fragrances, and tactile experiences.

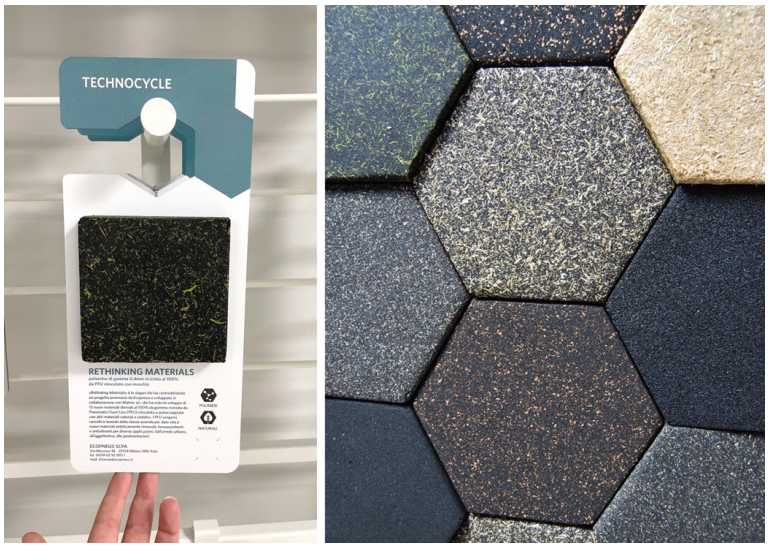

Fig. 3 In Technocycle we can find, for example, "Rethinking Materials" — a project carried on by Ecopneus and Matrec. They have developed 15 new aesthetically renewed, sound-absorbing and anti-vibration materials derived from 100% recycled rubber from discarded, mixed, and polylaminated tires, useful for different applications: from urban furniture to objects, to flooring.

Eco-active — environmentally active materials: in general, active materials, thanks to their intrinsic characteristics, can activate automatically, produce a response to certain conditions or undertake a phase change, usually reversible. The new technological possibilities, such as nanotechnologies, digital technologies, but recently also biotechnologies, have reached high levels of sophistication such as to be able to design the very characteristics of the material according to the needs and endow it with active or passive properties. This category selects materials designed to actively respond to the environment in the presence of substances or phenomena, such as radiation or pollutants. They are "living" materials that, like living organisms (from which they often take inspiration), can keep themselves clean autonomously, block UV radiation, break down pollutants, and purify the water. In this category we can find for example, "i.active BIODYNAMIC", the photocatalytic cement developed by Italcementi; or "Sunspace", a bioinspired, porous and economical material, developed by the University of Brescia and still in the definition phase, capable of capturing atmospheric particulate and regenerating itself like a leaf, constituting a valid alternative to existing filters.

3.2 Connectivity: The Ability to Connect

The new awareness that every object and subject are nodes in a complex network of complex systems and the understanding of this universal interdependence also involves and fully stimulates the design dimension, encouraging creatives to open up and confront themselves with the otherness. Thanks to the progress of science, technology and culture, designers have learned different ways of joining forces with other protagonists of the Universe — whether they belong to the Biosphere or the Technosphere, and have adopted systemic and long-term thinking, inspired by the efficiency and sensitivity of the social structures of other species. Therefore, in this macro-area, the ability to connect, identify, project and collaborate becomes the distinctive feature, while the synergies between man and man, man and biological species, man and machine materialise. The three micro-areas are:

Consilience — man-man collaboration: the American biologist Edward O. Wilson uses the term "consilience" to indicate the convergence of knowledge towards a common and shared goal [9]. An obvious concept for contemporary design, which acts as a bridge between disciplines and as an interpreter of the progressive convergence of branches of knowledge, which under the sign of creativity increasingly cancel the boundaries of their fields of action [10]. Not only that, even the geographical and cultural boundaries, between different knowledge and languages, between industrial sectors, between local and global, between innovation and tradition today are blurring. These phenomena strongly influence the design revolution and today's material experimentation and result in innovative hybrid outputs and technological transfers, many of which are included in this micro-area (Fig. 4).

Bio-synergies — man-nature interspecies collaboration: the growing pressures from an ecological point of view on the one hand; on the other hand, the development and recent accessibility of biotechnologies, have led to the birth of a fertile

interdisciplinary field: Bio-design [11]. It goes beyond the emulation of Nature, but by exploiting today's possibilities of observing, controlling and manipulating biological processes, it aims at the actual incorporation of living organisms into the project. This category collects the new organic materials, which feed and grow in a controlled or uncontrolled way and characterized by unexpected properties and aesthetics, as well as by sustainable and biological qualities, lead towards a new world in which biological processes will progressively replace industrial and mechanical systems (Fig. 5).

Techno-synergies — man-machine interspecies collaboration: with the birth of the Technosphere, we are no longer surrounded only by biological species,

Fig. 4 In Consilience we can find, for example, “I-Mesh” — panel patented by Sailmaker International for ventilated sunscreens, non-occlusive “air walls”, curtains and indoor counter ceilings. Specifically, highly resistant and durable fibres are arranged according to customized colour and effects and then heat-sealed instead of woven. Both the materials and the decorations blend in a graphic language in perfect balance between tradition and contemporaneity: they recall the Indianin Jaali, or the Middle Eastern Mashrabiya, where the geometries that symbolize cultures have always helped people to protect themselves from the sun.

Fig. 5 In Bio-synergies we can find, for example, “Mogu Acoustic” — Natural, light and sound-absorbing panels developed by the homonymous company. They are made from 80% natural fibers and 20% from mushroom mycelium, which grows on the substrate and covers it with a dense network of filaments, acting as a binder.

but also the artificial dimension has its variety, especially in an age in which machines and artefacts take on characteristics of the living and can communicate and interact with us as much as organisms. In particular, information technologies (ICT), the digitisation of information, and the ubiquity and accessibility of tools and machines have increasingly stimulated widespread creativity. Designers and planners experiment with the material and manipulate it through new, customised manufacturing techniques, free from the rigour of classical production and conditioned by human action. In this category we can find for example, “Mesh Sheets” by Wood Skin, elegant membranes in carved bamboo fibre to assume flexibility characteristics similar to those of a fabric. Thanks to digital technologies, specific textures are carved for customized solutions produced in a single step. The material, which initially looks like a flat sheet, takes on a third dimension during use thanks to “digital hinges” that allow it to fold like origami, taking on different shapes and functions without losing structural strength.

3.3 Empathy: The Values of the Universe

“Designers stand between revolutions and everyday life,” says Paola Antonelli [1]. about the renewed role of design in the complex contemporary society, which has become a fundamental tool to stimulate change and to help people face it. Compared to the Anthropocene, when a “person-centred” design was only at the service of profit, in today's fluid society, designers take on a great responsibility: to give shape, meaning and life to the degrees of freedoms opened by progress, new technologies, discoveries and awareness. Today, the values to communicate are many, and the designers immerse themselves in contemporary ethical, environmental and social problems; in the new holistic view of the Universe; as much as in the community’s state of mind, for revealing and communicating them. Also, through material experimentation, they can stimulate new languages, attitudes and behaviours, such as the respect for biodiversity or cultural diversity, the re-evaluation of memory and the importance of the quality of life. Hence, the three micro-areas are:

Eloquence — the aesthetic-communicative value: this category selects all those materials in which the aesthetic and communicative aspects are placed above the more purely technical and functional ones. In particular, they are materials capable of conveying an innovative message, both critical — encouraging speculations on the central themes of contemporaneity — or experiential and expressive — capable of stimulating the senses and going deeper, awakening memories, emotions and sensations (soft innovation). Therefore, they can stimulate and suggest new lifestyles and ways of consumption and make contemporary hybrid and complex living more intense (Fig. 6).

Fig. 6 In Eloquence we can find, for example, "Rust" — a new material for architecture created by designer Ariane Prin. She handcrafted it from a mixture of Jesmonite and metal particles, which oxidize to create aesthetically different finishes.

Memory — The value of memory: values, as we know, are arbitrary, cultural, spiritual and subjective, they live in diversity, and without it, they cease to exist. Phenomena, such as the globalization of the economy or the birth of digital technologies, have increasingly extended the space-time boundaries, absorbing uses, customs and cultural models favouring a homologated and depersonalized global aesthetic, unable to communicate value and arouse emotions. So, new material experiments are born to safeguard local specificities, which rework materials and processes inherited from specific cultures and re-propose them in projects even at a global level, safeguarding the diversity and balance between different communities, the local economy and technologies rooted in the various cultures.

Biophilia — the value of life: biophilia means "love of life" and is a concept that summarizes our innate interest in all that is living and our tendency to safeguard it, from the creatures that make up biodiversity to our own life. This category, therefore, includes all those materials, processes and experiments that deal with life, both human — related to well-being and personal care, health and quality of life and of the built environments in which we live — and of other living species — related to the conservation of biodiversity and the natural ecosystem in general, often a comfortable refuge for the same humans.

4. Telling Complexity With Experience

To make the material library more immersive and experiential, the main structure in which the contents were organised highlights the macro and micro themes before any other aspect, both physically and virtually.

Like a museum itinerary, Hylocene offers a broad and articulated vision of how current material experimentation presents itself and allows the user to venture into real exploratory paths from the general to specific themes, investigating very distant issues without losing the overall picture. On a virtual level, through specific algorithms, each material will be "tagged" with one or more themes, which, if of interest to the user, can be explored. Selected, they can lead to a webpage wholly dedicated to the topic and explain it through descriptions, articles and materials, comparing them. On the physical level, Hylocene presents an exhibition space at the Co-Working Area of the SAPeri&Co. It is a graphically presented itinerary that immediately makes the three macro-themes clear; while going in deep, you can discover the ramifications of each.

In this way, the user experience becomes experiential and interactive, allowing him to enjoy samples of the materials in person and explore their perceptual-sensory characteristics, as well as compare them with other materials, explanatory paperbacks, product prototypes, etc. Also, in this case, the user can explore and interpret the younger and more dynamic production reality that surrounds us rather than collect precise data and information like a scientist. It doesn't mean that the material library doesn't pay attention to the rest of the information: for each material will be listed physical, performative, sensorial, and sustainability properties (according to scales of gradient); category; applications and much more (Table 2); both on a virtual level — through a classic system of filters that allow you to find a specific material — both on the physical level — presenting a sheet for each material with all the necessary information (Fig. 7).

5. Conclusion

If complexity is the hallmark of the evolutionary phase we are going through, then it is time that design communication adapts to it. It shouldn’t focus on specific and discrete aspects in a deterministic way, but it should offer the interlocutor a broader and holistic vision of phenomena. And in a context in which new technical and cultural possibilities allow innovation at the quantum scale of the material, what better way to do it than through an exploratory path among the material innovations of the present.

Table 2 List of information shown for each material (physically and virtually).

Info contenute nella scheda di ogni materiale.		
Base	Name	
	Producer/Designer/ Company or Research Center	
	Contacts	
	Nationality	
Descrittive	Sample	
	Short description	
Tag	1 or more micro-themes	

Filters				
Category	Metal	Inert		
	Polymer	Process		
	Ceramic			
	Glass			
	Natural			
	Composite			
	Coating			
	Textile			
Physical Properties	General	Heavy	⟷	Light
		Stiff	⟷	Flexible
		Hard	⟷	Soft
	Structure	Solid	⟷	Porous
		Homogeneous	⟷	Heterogeneous
		Geometric	⟷	Organic
	Texture	Smooth	⟷	Coarse
		Uniform	⟷	Variable
		Dense	⟷	Sparse
Performance	Mechanics	High Resistance	⟷	Low Resistance
		Fragile	⟷	Ductile
		High Scratch R	⟷	Low Scratch R
	Physical	High Fire R	⟷	Low Fire R
		High UV R	⟷	Low UV R
Performance		High Wather R	⟷	Low Wather R
	Conductive	Thermal conduction	⟷	Thermal insulation
		Electrical conduction	⟷	Electrical insulation
		Chemical conduction	⟷	Chemical insulation
		High UV R	⟷	Low UV R
Sensoriality	Sight	Glossy	⟷	Matte
		Opaque	⟷	Translucent
		Reflective	⟷	Non-reflective
	Touch	Waxy	⟷	Rough
		Cold	⟷	Warm
		Hard	⟷	Soft
	Smell	Slight	⟷	Intense
		Sweet	⟷	Acid
		Pleasant	⟷	Unpleasant
	Hear	Bright	⟷	Dull
		Silent	⟷	Noisy
		Sound-absorbent	⟷	Sound-reflective
	Taste	Inedible	⟷	Edible
		Slight	⟷	Intense
		Sweet	⟷	Salty
	Color & Texture	Palette con colori e texture principali		
Sustainability	Origin	Renewable		
		Recycled		
		Bioplastic		
	End-of-life	Recyclable		
		Biodegradable		
		Compostable		

Additional Information	
Colour & Texture	
Application fields	

Fig. 7 ***Material sheets*** **– Each material has a dedicated sheet in which are listed all the principal informations. The properties are communicated through scales of gradient.**

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Feb.2010, Volume 4, No.1 (Serial No.26)
Journal of Agricultural Science and Technology, ISSN1939-125, USA