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Science and Design intermediate language
Linguaggio intermedio Scienza e Design

The thought of Ashby and Beylerian in "Circular" Methodology
of Science to Design and vice versa.
Il pensiero di Ashby e Beylerian nella Metodologia "circolare"
della scienza al design e viceversa.

Dottorando | PhD Candidate Orkide MOSSAFFA
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Introduzione

Today, beyond the "basic" materials such as wood, metal and plastic, the world of materials includes a universe made up of many sub-categories that are constantly and rapidly updated, which develops new and hybrid materials which, however, does not always correspond to a consolidated product or production technology (Manzini, E. 1987. La materia dell'invenzione. Arcadia Milano).
Knowing the new materials, knowing how to use and work them and even knowing how to choose them, thus becomes one of the key points of design.
Choosing a material means "selecting" its technical-functional qualities and choosing, for example, the hardness of ceramics rather than that of metals, the formability of plastics rather than that of wood.
Choosing a material, however, also means evaluating its aesthetic perceptive and therefore experiential qualities (Lucibello, S. 2009. Design follows materials. Alinea Editor. Florence). The surface of a texture, its color and translucency, rather than the feeling of lightness or softness, are all characteristics that have a major effect on the way a product is perceived and used.
Choosing a material also means considering its economic "repercussions", that is, seeking the right ratio between manufacturing costs and number of pieces to be produced, between performance, durability and cost of the final product.
Choosing a material then means considering its economic-social aspects and therefore also its "sustainability" (Thackara, J., 2005. In the Bubble. MIT Press).
The growing need to think about a sustainable future, in fact, intervenes right from the choice of the material and, given that we cannot stop consuming, we must at least try to make the application of materials and their use more intelligent, exploring the different ways in which these can be used to allow products to be easily broken up into components and recycled.

In fact, despite the large number of innovative materials developed by scientific laboratories, their application in new serial productions presents many complications. In addition to the long time for industrial development, there is also the difficulty of entering the market for a new material that must find suitable applications. In this context, design acquires a significant role, because it "closes the cycle of innovation", defining project scenarios and concepts for future creations for the material, capable of giving value and meaning to the use of technology.
The designers, with the ability to manage technical and conceptual activities, are able to mediate between scientists / users and between producers / users. They are able to improve communication in the different stages of the innovation path, reducing the risk that the research developed within scientific laboratories is not properly exploited and setting in motion a virtuous circle "from Science to Design".
Starting from these considerations, the idea of this research is a reasoned reading that intends to address the theme of material design, in the light of the reflection of important authors of the last century.
analyze and study to find a synthesis point in the language used by designers and scientists. starting from the comparison between the writings of authoritative authors in the field of materials engineering and a scheme that includes the designer's point of view in this field.

The texts published by a professor of the Engineering department of Cambridge University, Mike Ashby, as a source of material science, which recognizes the competence of the designer in the selection of materials for the product characterization and essential for the success of a project as well as the study of functional characteristics. The book "Materials and Design" of Ashby also emphasizes how it is necessary to find a common language between engineers and designers, categories so different that they also imply a different complementary approach to each other.
As a technical-engineering vision, believing that this point of view is useful to activate an open reasoning on the part of the design world.

And in front of scientific engineer, investigate and deepen the thoughts of a designer and founder Materials library ConneXion, George Beylerian, through his books and material library company. Where offers its members a gallery space, database and archive for these new materials. With this premise: Design thrives on interdisciplinary collaborations in which a working knowledge of science, technology and ecology invariably stimulates innovation, creating a service for Architects, designers, environmentalists, contractors, industrial designers, educators, students and just about anyone else interested in new materials can join.

flanked by Beylerian, we analyze the published work of Enzo Manzini, design professor and critic on the field of material and product. how he examines the new option and suggests what they might portend for the future with visuals of new materials that have radically altered the options available to industrial designers. Categorized a different sort of design history, it focuses almost exclusively on the materials that form the basis of innovative design.
Since designers may not seem like great writers, especially in the field of materials, for deepening the thought of the designer and creator, there will be their product and projects in the study path, so chosen the designer Neri Oxman as a designer for the future with interdisciplinary and approach of material ecology.

The designer who emphasis the new scenario of design. Whether regarded as indulgent, edgy, challenging or just downright funny, the material-centric products created by today's designers are not design as we once knew it. These days, a new generation is fighting against the backlash of bent shapes, rectilinear forms and mundane materials in order to explore strident sources of innovation. As they investigate the shifting relationship between object and user, designers challenge the premise that a fixed structure should constitute the basis of formation. As a result, interactive designs, retractable surfaces, technological interfaces and labile textile components are transforming everyday functional objects into dynamic tools for contemporary life. (Ultra Materials: How Materials Innovation is Changing the

World)

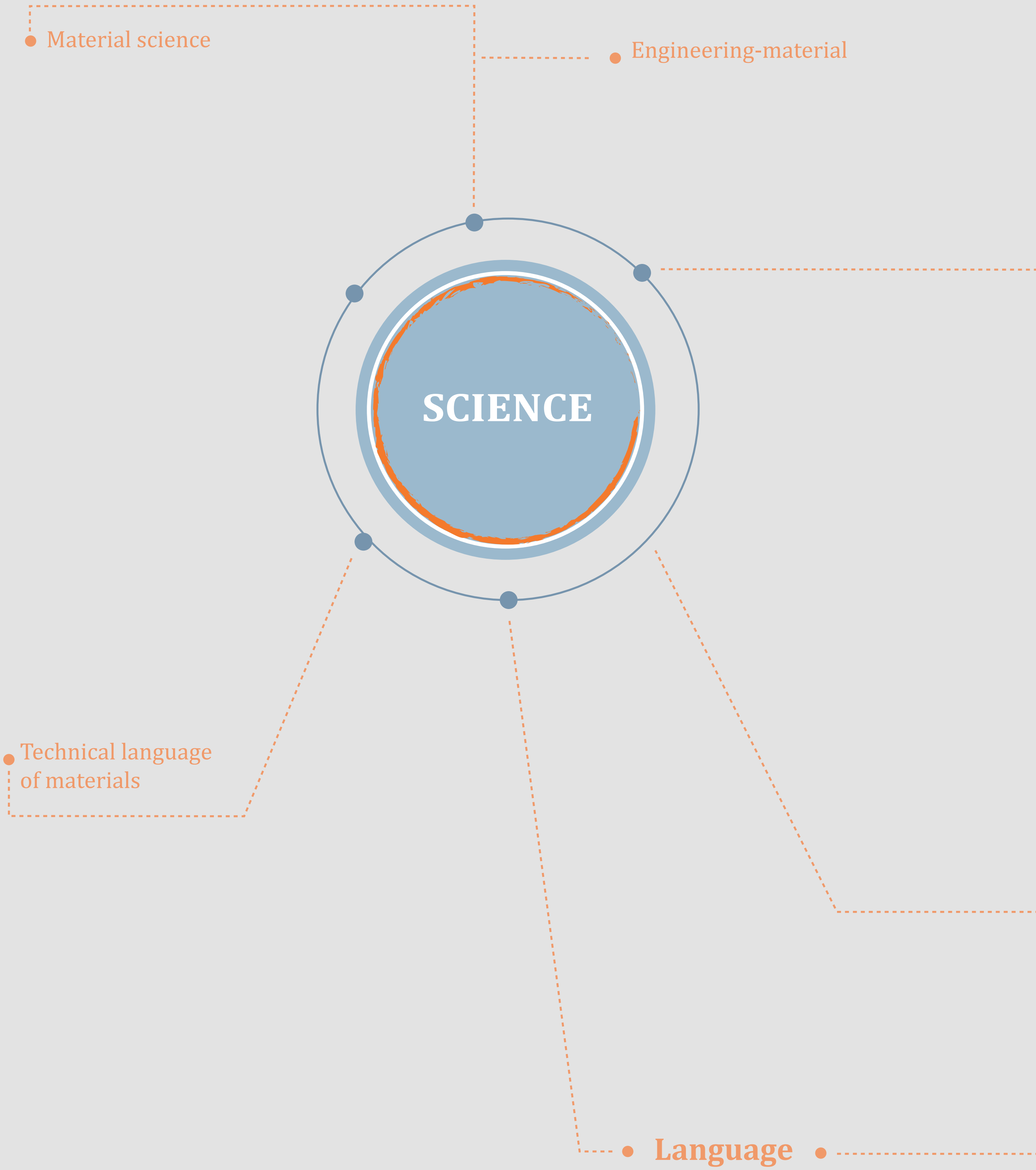
This research focused on authors and their thought, their methodology, their theory of material characteristics, how to divide the material categories, selection of materials with their perspective of materials engineering or design, how to obtain information and how to express this information in their notes.

Studying the method of Ashby in materials science, examining the engineering properties of the materials from the scientific point of view, staying on the border of design and designer language.
Talk about Ashby's diagrams, created for the characteristics of materials, and how he made a numerical calculation become a more tangible diagram for a designer, A figure that when selecting a material, a precise number of hardness does not illustrate his ideas , but a cloud of color can give an idea of how to choose the next step. He had a thorough understanding of the importance of materials in design. "The main steps that bring a material from laboratory studies to the production of a successful product are: Data collection, Statistical analysis, Selection of materials, Concept and product phase investigation"(Ashby,M. 2002. Materials and design, Oxford, Cambridge press). So with his method, he had a say in showing the need for collaboration and data exchange with the right language between the two disciplines.
But to fill this huge gap, was his methods sufficient to recognize the need for the perceptual properties of the material in the language of design so that it can be used to fruitfully stimulate the consumer's senses for the final product?
Through their books let's examine the developing an approach with the sensorial and perceptive characteristics of the material in design.
How the Manzini speaks clearly on these subjects, like the important point of reference for planning: “The design features” and “The characteristics of the materials with light or surface”
Focus on Beylerian, his theory of materials selection and the material characteristi-

cs, how explain the material rules in product, in our worlds, and the reason and how his company of material library came into being.

The language of design is a scheme or a general style that guides the design of a complement of products or architectural environments. Designers who wish to give their product suite a unique yet consistent look, define a design language that can describe choices for design aspects such as materials, color combinations, shapes, patterns, textures or layouts. Then they follow the pattern in the design of each object in the suite.
In general, it comes from the inner world of each of us (senses and expressions) in dealing with the external world. With the knowledge of the cultures, habits and needs of each society.

Identify the methodology used by designers and scientists, and because they use completely different approaches and methodology, but both starting from the experimental / deductive approach.
The comparison of the authors' thinking with the identified keywords, in the debates around the project and products and the program for the future in the field of materials. A comparison carried out through the selection, analysis and synthesis of citations of the authors and projects of the designers.


Material science
Engineering-material
SCIENCE
Technical language
of materials
Language

Extend of the role of materials

Expressive langua-
ge of material

Histor

PART I

Thought of Science or Design

Thought of science or
design in material
history

DESIGN

CHAPTER 1:

Thought of Science or Design

ABSTRACT

Today, beyond the "basic" materials such as wood, metal and plastic, the world of materials includes a universe made up of many sub-categories that are constantly and rapidly updated, which develops new and hybrid materials which, however, does not always correspond to a consolidated product or production technology (Manzini, E. 1987. La materia dell'invenzione. Arcadia Milano).

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broken up into components and recycled.
In fact, despite the large number of innovative materials developed by scientific laboratories, their application in new serial productions presents many complications. In addition to the long time for industrial development, there is also the difficulty of entering the market for a new material that must find suitable applications. In this context, design acquires a significant role, because it "closes the cycle of innovation", defining project scenarios and concepts for future creations for the material, capable of giving value and meaning to the use of technology.
The designers, with the ability to manage technical and conceptual activities, are able to mediate between scientists / users and between producers / users. They are able to improve communication in the different stages of the innovation path, reducing the risk that the research developed within scientific laboratories is not properly exploited and setting in motion a virtuous circle "from Science to Design".

1.1 Thought of science or design in material and history

We live in a world of objects that are part of our daily experience, made from the materials that surround us. The materials in the pattern of forms that we touch, see, hear, smell and even taste. they are the common objects that over the years build a mental catalog in each one of us, in every relationship between us and the material we try to extract a name from this catalog for any material.
The memory, experience, intuition and culture are the pillars of this catalog, called the Collective Memory, that is for any society can be different from another for a different culture or raw material available.

This was possible for each user to know and extract a name for the material until a few decades ago when It was a meager list of the basic materials, like wood, metal, polymer, ceramics, that built the whole world of objects.
But today knowing all the materials surrounded by them is an impossible job, it must be said that it is difficult even for professionals such as material engineers or designers.
Because the world of materials includes a universe made up of many sub-categories that are constantly and rapidly updated, which develops new and hybrid material. And thus the work of selecting the material entrusted to the role of designer o engineer.
However, with this dynamic that the world of materials is growing, it is obvious that many designs have never reached the marketplace, like so many materials that do not become a product. They must be tried, worked, known by the market and experienced and recognized by users. That's why translating a design or a material into a successful product requires investment, and investment depends on confidence, on establishing economic viability.
The investment required to commercialize a technically viable product will be forthcoming only if the technical, market, and business case assessments are all attractive. And finally there is the question of attitude to risk.
Some consumer products eagerly seize upon new materials and

processes and enthusiastically promote products made from them, accepting the risk that, being new and imperfectly characterized, they may fail prematurely. This partly depends on the design and his choices.

It has been argued in the past, and the argument is still sometimes used today, that a product designed to function properly will automatically have aesthetic appeal; that “form follows function”. But today this sentence can not be said because on the one hand the products are now technically mature; distinctions in technical performance are slight, and the prices of products with nearly the same performance are almost the same. As the market for a product saturates, sales can be stimulated by differentiation. This means creating product lines that are distinctive and have a personality that resonates with the tastes and aspirations of a particular user-group.
On the other hand the user does not choose a product with just one look, functionality or beauty.
This was a topic that in the past rationed the designer's work and separated him from the other disciplines, but instead mixing and amalgamating the fruit of their work he created the impeccable projects and works in the world of design. like the chair by Mies van der Rohe or the objects by Philippe Starck.

The work of the designer is, arouse interest, stimulate, and appeal to the senses, particularly the sense of beauty, along with running form.
Synesthesia is the combination of senses: for some people this is a physical disorder, for designers it is inspiration. Aesthetic elements when surprisingly isolated or unexpected combined create new opportunities for design and the experiences that those designs enable.
Aesthetics seems to be no other that quite captures the sensory attributes of materials and products. Designers manipulate these senses, and the reactions to each sense, to create a product’s personality.

A designer needs the physical and even expressive information of a material to draw. How important is the functionality of a product, its appearance, visual and tactile characteristics are also important. On this aspect Mike Ashby, after many years of study and work in the production field, introduces in his evaluation of the visual /

tactile aspect of the material.
"With respect to materials and design, it is the combination of elements of art and science that make it work. Materials are not simply numbers on a datasheet. And design is not a meaningless exercise in styling and it is not an isolated exploration of technology. What matters is the process of finding solutions that are meaningful to people, that enable new experiences and inspire and create positive impact in society and in our own daily lives. Today, people are looking for products that are sustainable and lovable, and it is the job of a designer to create those products. We need to evolve from an industrial society that is driven by consumerism to one that respects and admires materiality and efficiency. To explore materiality, we need to get inside the factory and meet the crafts- men and -women that make our products. To make decisions about efficient use of materials, a basic foundation of technical knowledge of materials and manufacturing is required. In combination, materiality and efficiency allow the designer to create products that are creative and yet fully optimized tangible expressions of an idea. It is this idea that will go-to-market. People - consumers - buy things because they like them – love them, even. To succeed, a product must, of course, function properly, but that is not enough: it must be easy and convenient to use, and it must have a personality that satisfies, inspires, gives delight. This last - personality - depends strongly on the industrial design of a product. When many technically equivalent products compete, market share is won (or lost) through its visual and tactile appeal, an exploration of other senses or emotional connection, the associations it carries, the way it is perceived, and the experiences it enables. Consumers now expect delight as well as function in everything they purchase. Creating it is a central part of design."
(Ashby, Material and Design)

Human capacity & Disciplines are collection

Designers actually cultivate and make use of the human ability of mental capacity, the capacity that distinguishes humans from other living beings.
Humans have a very structured and developed brain, very large in proportion to the size of the individual, with remarkable qualities of neuroplasticity, capable of thinking developed in the form of creativity, abstract reasoning, language and introspection. Along with

other features, binocular vision is necessary for the perception of depth and the consequent precision in the manipulation of objects, allowing the humans to create a great variety of artifacts and tools to improve their adaptation to the environment, survival and creative expression.

That's what allows *"Our species – homo sapiens – differs from others most significantly, perhaps, through the ability to design - to make things out of materials - and in the ability to see more in an object than merely its external form. Objects can have meaning, carry associations, or be symbols of more abstract ideas. Designed objects, symbolic as well as utilitarian, predate any recorded language – they provide the earliest evidence of a cultural society and of symbolic reasoning."* (Ashby, Material and Design)

This is in fact the result of progress and performance in the two fields of applied science, Visual Arts and Engineering, that advance these abilities of humans to give more comfort, enjoyment and pleasure to artifacts and tools, over to beyond survival and adaptation to the environment.
However, most of this thesis focuses on materials, the physical appearance and character of the materials, their behavior and how to apply it in visual arts disciplines. The engineering and science discipline represent the main tool for the study and development of production processes of visual arts.
But as these abilities of man are not separable, and their growth is in harmony with one another, so are the sciences created by man all connected. It is precisely the capacity of human language that connects the disciplines, even if perhaps each discipline has its own special language but these connections are what build the inter disciplinarians or multi disciplinarians.

Through science and design are separate

Even if these disciplines are connected and only work with each other, it is seen in division between each discipline and also the critical thinking in some way that distances the two fields.
From the point of view of computational science, what is considered a normal and necessary trend in the world of design is a bit out of the question. Throughout the research process, little attention has been paid to it and it is called the sensory properties of the

laboratory material. In this regard, Ashby explains to his audience that: *"There are many books on the subject of Industrial Design. You will find, it may surprise you, that they hardly mention the issues of functionality and efficiency that have concerned us so far. They focus instead on qualities that cannot be measured: form, texture, proportion and style; and on subtler things: creative vi*sion, historic perspective, honesty to the qualities of materials." (Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)

History of science materials discipline

If we look more closely at the path of birth and growth of the discipline of material science and/or material engineering, they show us a path from pure science results, and developed with material engineering and technology. but we find that it does not end there, as long as the aim is to arrive at a product or service, the path leads to the design field.

Materials science is one of the oldest forms of engineering and applied science, it evolved, starting from the 1950s, because it was recognized that to create, discover and design new materials, one had to approach it in a unified manner. Thus, materials science and engineering emerged in many ways: renaming and/or combining existing metallurgy and ceramics engineering departments; splitting from existing solid state physics research (itself growing into condensed matter physics); pulling in relatively new polymer engineering and polymer science; recombining from the previous, as well as chemistry, chemical engineering, mechanical engineering, and electrical engineering; and more.

The field of materials science and engineering is important both from a scientific perspective, as well as for applications field. A discipline based on chemistry, physics and partly on engineering, which deals with the design, production and use of all existing classes of materials and the interaction of materials with the environment, health, economy and industry.
That it works on the design or engineering of the structure of a material, based on the aforementioned structure-property correlations, to produce a certain set of properties.

Materials are of the utmost importance for engineers or designers or other applied fields, because usage of the appropriate materials is crucial when designing systems. As a result, materials science is an increasingly important part of an engineer's education.

The field is inherently interdisciplinary, and the materials scientists or engineers must be aware and make use of the methods of the physicist, chemist and engineer. Thus, there remain close relationships with these fields. Conversely, many physicists, chemists and engineers find themselves working in materials science due to the significant overlaps between the fields.

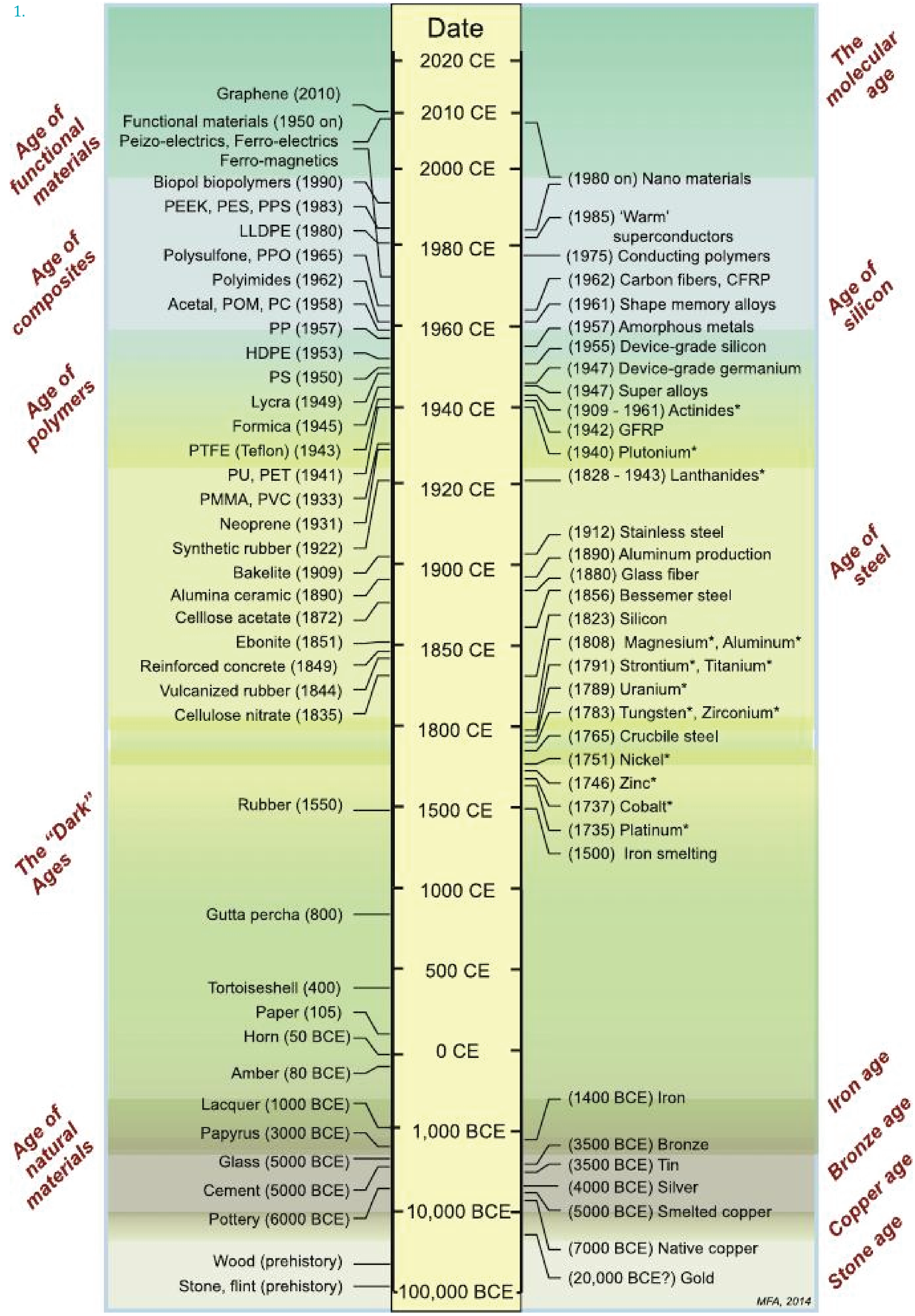
Difference between material science and material engineering

It is sometimes useful to divide the discipline of materials science and engineering into the sub disciplines 'materials science' and 'materials engineering'. The first refers to the discipline that studies the relationships between structures and properties of materials. Instead, materials engineering means the design or engineering of the structure of a material, based on the aforementioned structure-property correlations, to produce a certain set of properties. From a functional point of view, the role of a materials scientist is to develop or synthesize new materials, while a materials engineer is required to create new products or new systems using existing materials and / or develop techniques for the processing of materials. Most materials graduates are trained to become both materials scientists and engineers. (William D. Callister)

Image 1.1
A materials time-line. The timescale is nonlinear with big steps at the bottom and small at the top. The figure brings out the accelerating rate of material development and, with it, our dependence on an ever larger number of them.

"Materials have a long history. The earliest "engineering" materials were those of nature: stone, wood, fibers, bark, skin, hide and bone. Their applications were largely mechanical (housing and tools) or thermal (clothing and protection). Subsequent advances in technology and science-stimulated bursts of material development: thermochemistry in the seventeenth century, then of electrochemistry in the eighteenth and nineteenth centuries, so that by the mid twentieth century almost the entire periodic table was accessible for engineering purposes.
The growth of polymer and ceramic sciences in the first half of the

1.



Date
2020 CE
2010 CE
2000 CE
1980 CE
1960 CE
1940 CE
1920 CE
1900 CE
1850 CE
1800 CE
1500 CE
1000 CE
500 CE
0 CE
1,000 BCE
10,000 BCE
100,000 BCE
Age of functional materials
Age of composites
Age of polymers
The "Dark" Ages
Age of natural materials
The molecular age
Age of silicon
Age of steel
Iron age
Bronze age
Copper age
Stone age
Graphene (2010)
Functional materials (1950 on)
Peizo-electrics, Ferro-electrics
Ferro-magnetics
Biopol biopolymers (1990)
PEEK, PES, PPS (1983)
LLDPE (1980)
Polysulfone, PPO (1965)
Polyimides (1962)
Acetal, POM, PC (1958)
PP (1957)
HDPE (1953)
PS (1950)
Lycra (1949)
Formica (1945)
PTFE (Teflon) (1943)
PU, PET (1941)
PMMA, PVC (1933)
Neoprene (1931)
Synthetic rubber (1922)
Bakelite (1909)
Alumina ceramic (1890)
Celllose acetate (1872)
Ebonite (1851)
Reinforced concrete (1849)
Vulcanized rubber (1844)
Cellulose nitrate (1835)
Rubber (1550)
Gutta percha (800)
Tortoiseshell (400)
Paper (105)
Horn (50 BCE)
Amber (80 BCE)
Lacquer (1000 BCE)
Papyrus (3000 BCE)
Glass (5000 BCE)
Cement (5000 BCE)
Pottery (6000 BCE)
Wood (prehistory)
Stone, flint (prehistory)
(1980 on) Nano materials
(1985) 'Warm' superconductors
(1975) Conducting polymers
(1962) Carbon fibers, CFRP
(1961) Shape memory alloys
(1957) Amorphous metals
(1955) Device-grade silicon
(1947) Device-grade germanium
(1947) Super alloys
(1909 - 1961) Actinides*
(1942) GFRP
(1940) Plutonium*
(1828 - 1943) Lanthanides*
(1912) Stainless steel
(1890) Aluminum production
(1880) Glass fiber
(1856) Bessemer steel
(1823) Silicon
(1808) Magnesium*, Aluminum*
(1791) Strontium*, Titanium*
(1789) Uranium*
(1783) Tungsten*, Zirconium*
(1765) Crucbile steel
(1751) Nickel*
(1746) Zinc*
(1737) Cobalt*
(1735) Platinum*
(1500) Iron smelting
(1400 BCE) Iron
(3500 BCE) Bronze
(3500 BCE) Tin
(4000 BCE) Silver
(5000 BCE) Smelted copper
(7000 BCE) Native copper
(20,000 BCE?) Gold
MFA, 2014

twentieth century delivered new structural materials. They were followed, in the second half of the century, by the development of materials with greater functionality: piezoelectric, thermoelectric, magnetic, and above all semiconducting and optoelectronic materials.
The time steps of Figure 1.1 are nonlinear, with big time steps at the bottom, small at the top, reflecting the accelerating rate of materials innovation. It shows no sign of slowing. Since 1971, when the last of the actinides was isolated, material developers have had access to all 92 of the stable elements of the Periodic Table.In a surprisingly short space of time, we have become dependent on this treasure chest of elements and the materials made from them.
Even half a century ago, engineering relied on relatively few, widely available elements (Figure 1.1). Many products, today, draw on a much wider spectrum, some of which occur only as lean, highly localized ores, or are extracted only as a by-product of another element, making their supply uncertain. Our dependence on some of these is now so extreme that Governments classify them as "critical" and regard access to them as a strategic necessity.
And we use them in enormous quantities. Speaking globally, we consume roughly 10 billion (1010) tones of engineering materials per year, an average of 1.4 tones per person." (Ashby, Materials and Sustainable Development)

Connection between the discipline of design-material and engineering-material and Histor

Now with this definition, it is interesting to know the opinion from someone who had an important role in the field of design-materials from the 70s to today.
Beylerian recounts the progress of materials science and the history of design in a short story.
"Most of the materials we consider to be modern today were born in the early part of the 20th century, mainly created by engineers, metallurgists and scientists. The study of polymers advanced rapidly after the Second World War, gradually leading scientists to conceive of a new interdisciplinary field that became known as material science. The study of materials developed in parallel with industry, and many of the materials-based professions were reinvented. The impact of technology and the burgeoning aerospace industry generated a new

awareness of materials, and those with a capacity to function as media created new possibilities for architecture and design. The 1980s are remembered for metals research, culminating in the development of 'superalloys' that combined upwards of thirteen different metal additions. The 1990s addressed ecological issues and introduced a wide range of sustainable materials, and subsequently generated a renewed appreciation for craft traditions. Today, textile design, metalwork, ceramics and glass are advancing dramatically as material science identifies new techniques and uncovers cross-disciplinary potentials, yet the touch of the human hand still remains as important as ever. As material science continues to broker even more interdisciplinary exchanges, the boundaries between science, technology, craft and design blurs even more. Right now, materials are regarded as one of the richest sources of innovation. No longer intended for practical use alone, materials are playing an important role in taking aesthetics forward. As they imbue design with extravagance, imagination and symbolism, they also make space for brilliant colors, rich textures, unexpected finishes and lavish motifs. Whereas 20th-century materials evolved as high-tech solutions, the materials of the 21st century have emerged as a style-oriented phenomenon. As these materials build the world around us they also fashion the face we show to the world. They are what separate us from the street - and perhaps what make us human." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

Beylerian also analyzed design in its parallel way, "*Historically, the materials chosen by designers have been essential determinants of the forms of designed objects. Steel tubing was mass-produced and used in architectural railings (one of its first applications was in the Bauhaus school, where it was undoubtedly seen by Marcel Breuer and Mies van der Rohe), and the steam-bending of wood led to the design of wine barrels and, later, bent- wood furniture. These developments were part of a design continuum in which formal and material invention built upon one another. The Modernist Movement was based on faith in that continuum. At its heart were the axioms that new materials led to new forms; that evolution was the essential work of design; and that structure and surface formed an integral whole. Modernism believed in functional efficiency, fitness for purpose, and truth to materials. It espoused volume rather than mass, regularity rather than symmetry, and dependence upon materials rather than upon applied ornament. We no longer hold these truths to be self-evident. In 1966, Robert Venturi astounded the design world with the proposi-*

*tion that less is not more and that man could look to history for confirmation that diversity and variety, even complexity and contradiction, were signs of cultural and architectural richness. Venturi's Complexity and Contradiction in Architecture (1966) provided a manifesto for a new approach to materials and decoration. It offered a philosophic umbrella for the design community that espoused richness and ambiguity over unity and clarity, contradiction and redundancy over harmony and simplicity. In the 1980s, developments in materials technology created new vehicles for the expression of new cultural and material values. In the early part of the 20th century, stamped steel revolutionized the automotive industry, providing elegant and resilient car bodies. But the introduction of strong. Lightweight plastics that can replace steel allows today's manufacturers to build lighter, more fuel-efficient cars without sacrificing safety. Likewise, when the International Style came into our vocabulary, characterizing a form of early 20th- century European avant-garde architecture which eliminated all arbitrary decoration inside and out, materials other than concrete, glass or steel took a secondary place in architecture. This scenario, which created 'default' materials, allowed two completely separate paths to emerge between those architects who embraced the new visual style and who chose to bring novel materials to it, and those who explored the amazing range and versatility of the limited set of mate*rial options promoted by it." (Beylerian, Mondo Materialis: Materials and Ideas for the Future)

Beylerian talks about Manzini opinion in the role of material and its development in the history of art and design and technology and an important aspect of the material that today is inspired and appreciated by many designers, " *Ezio Manzini, an Italian theorist of architectural engineering, analyzed the change in the impact of materials technology on our architecture and design in his book, The Material of Invention (1986): After the Modern Movement culture rediscovered the value of surfaces and the sensory variables which surfaces can bear. By opposing the concrete and physical idea of sensory quality to the abstract idea of formal quality, culture rehabilitated decoration, which modernism had branded immoral, and is now emphasizing the designer's control over the soft qualities of objects-not only visual qualities but also qualities of touch, warmth, smell... This many-faceted approach could not be understood overall if one were to ignore the simultaneous technical transformations that form its background, more or less unconsciously. The development of mate-*

rials toward composites in which each layer has a specialized function sets the design and manufacturing problem of what qualities to give the outermost layer (the skin)." (Beylerian, Mondo Materials)

Design Discipline explain

The discipline of design, based on mathematics and technology, chemistry, physics and engineering, builds the beauty, and enjoyment of a project or service, through material and technology to produce artifacts that awaken the expression of the senses.
As the path of a project always passes through the science of materials, every designer is aware of the importance of the material and its characteristics.
but this does not always fall in the field of material engineering, there is still the thought of being two independent disciplines, design and material engineering.

Over the years we see when it was a collaboration between the roles of designer, artist, material engineer or craftsman the results were a complete project. But with the industrial revolution, the growth of new materials and the development of scientific methods, a success that for design and engineer has defined a scientific discipline with the scientific method, instead they have been separated, craftsman, defined as the creator of artifact created by hand or by means only of tools, and for artist, creator of an aesthetic expression of feelings in material. And the belief in the power of collaboration is discolored, until today they return and reconstruct the material science laboratories, inside the designer or artist workshops. And all thanks to the new thinking of the designers and engineers.

Thought of designer and engineering

"... The first argument is the one most likely to appeal to the engineer: that a functionally efficient machine is, of itself, aesthetically satisfying; it is the basis of what is called a 'machine aesthetic'. But something is obviously missing. It is part of the purpose of the machine to be opened, and the design is incomplete if the satisfaction of the operator is ignored. The missing elements include the ergonomics - the man-machine interface - and they include the idea of visual enjoy-

ment and aesthetic pleasure for its own sake. It is as if eating had been reduced to the intake of measured quantities of carbohydrate and protein, depriving it of all gastronomic pleasure." (Ashby, Materials Selection In Mechanical Design)

"On a smaller scale, product designers seek to blend the technical with the aesthetic, combining practical utility with emotional delight. Think of Wedgewood china, Tiffany glass, Chippendale furniture these were first made and bought to fulfill a functional purpose, but survive and are treasured today as much for their appeal as objects of beauty." (Ashby, Material and Design)

The *"materials are the ingredients designers use to imagine, create, and modify an idea so that when it is made it becomes more than an object or a product, part of a bigger system of storytelling and experiences. We want to inspire and guide designers to build something that is extraordinary and iconic, something that has its own voice, its own story."*(Ashby, Material and Design)

Both observation and perception contribute to creativity in design. Ashby divides in four the attributes of products, particularly those relating to industrial design and the personality of a product which are very closely related to material characteristics.
• Aesthetic attributes are those that relate directly to the senses: sight, touch, taste, smell, hearing; those of sight include the form, color, and texture of a material or product.
• Attributes of association are those that make a connection to a time, place, event, person, or culture, thus a jeep has military associations, gold has associations of wealth, the color black of death, the color red of weddings.
• Perceived attributes describe a reaction to a material or product, that it is sophisticated, or modern, or humorous, for instance; these reactions are a sum of what you initially perceive and are heavily influenced by context and experience.
• Emotional attributes describe how material or product makes you feel, happy, sad, threatened perhaps – "emotional ergonomics," in the words of Richard Seymour of SeymourPowell, London. To these we add the idea of style, based on design history. Styles have names: Art Nouveau, Art Deco, Modernist, Post-Modern, etc. Each is shorthand, so to speak, for a particular grouping of aesthetic, perceived, and emotional attributes and associations, one about which there is general agreement. Design styles, sometimes, are

linked to certain materials, but it cannot be said that a material has a style, only that it acquires one when it becomes part of a product.

"Until recently, specialized knowledge of materials was an area normally left to experts or scientists, but today materials have become a source of interest and inspiration for us all. High-tech techniques, smart substances, intelligent interfaces and sensory surfaces are radically redefining the world live in. As today's generation of materials breaks new ground, many are able to anticipate and respond to changes in the environment. Now dynamic and interactive, materials have the power to change how the human body is experienced and how the urban environment is built. Combined with the new potentials they create for industrial design and medical science, they have the capacity to transform our way of life more radically now than ever before." (Beylerian, Ultra Materials)

The Importance of the language of materials in design and engineering

The material as an important part of design has a lot of properties, how these properties are categorized is a complete debate in itself, but a designer needs complete information about the material or group of materials that are candidates for the design in order to select the appropriate material in their design.
whoever has perfectly understood this importance of choice agrees on the relationship between the roles of designer and scientist.

"The role of materials in the design process stepped forward to include the idea of experimentation. It became evident that in a highly constrained world of materials, manufacturing, and design – where cost constraints, technical limitations, or sustainability concerns sometimes drive the final selection of materials – we needed to force ourselves to jump ahead of the curve. We needed to experiment early in the design process in order to break the rules, to see what's possible and to find new constraints." (Kara Johanson, Ashby, Material and Design)
"In this era of seemingly endless programes of building development, materials serve a critical purpose in helping to differentiate one product from another. By simply changing the material of virtually any product, without altering any other aspect of its design, one can change it from a commodity product into luxury goods (or vice

versa). Choose the right material and a designer can make this transformation without altering the unit cost of the product. That kind of knowledge is obviously extremely powerful. Materials can transform design, and design therefore has the power to transform our lives."(Beylerian, Ultra Materials)

Therefore the importance of the characteristics of the materials and their properties is a tool, a language, of communication from the laboratory to the design laboratory, for every aspect of a material, to give the complete panorama of a 360 degree knowledge.

1. 2 Technical language of materials

Mathematical and artistic thinking

The brain system is complex and very interesting. We've already talked about the development of the human brain and how it differs from other creatures, but the intricacies of the brain aren't limited to this growth and development. The human brain is divided into two hemispheres, which at the same time work and analyze the received data and respond to the codes, each hemisphere has a different way of functioning for these analyzes and examining data.

The first, the domain of the left hemisphere of the brain, utilizes verbal reasoning and mathematical procedures. It moves from the known to the unknown by analysis, an essentially linear, sequential path. The second, the domain of the right hemisphere, utilizes images, both remembered and imagined. It creates the unknown from the known by synthesis, by dissecting, recombining, permuting, and morphing ideas and images. The first way of thinking, the verbal mathematical, is based on learned rules of grammar and logic. The second way of thinking, the visual, makes greater use of the imagination; it is less structured but allows greater conceptual jumps through free association.

Visual thinking, also called visual-spatial learning or picture thinking, is the phenomenon of thinking through visual processing. It is common in approximately 60–65% of the general population. "Real picture thinkers", those who use visual thinking almost to the exclusion of other kinds of thinking, make up a smaller percentage of the population. Research by child development theorist Linda Kreger Silverman suggests that less than 30% of the population strongly uses visual-spatial thinking, another 45% uses both visual-spatial thinking and Verbal-Mathematical thinking, and 25% thinks exclusively in words. According to Kreger Silverman, of the 30% of the general population who use visual-spatial thinking, only a small percentage would use this style over and above all other forms of thinking, and can be said to be true "picture thinkers". (Linda Kreger Silverman, Upside-Down Brilliance: The Visual-Spatial Learner)

This is precisely the difference between the scientific method and that of the designer's way of thinking.
Mathematics and most of the sciences are registered on the basis of the mode of thought, even if the method of scientist and designer are the same, experimental-deductive, but for their language of registration, they create the scientific language, designer language and engineer language.

*"The power of the visual image lies in the ease with which it can be manipulated by the mind and its ability to trigger creative thought. A picture of a car tail light made of acrylic, taken to show its transparency and ability to be colored, reveals much more: that it can be molded to a complex shape, which can resist water and oil, and which is robust enough to cope with unprotected use on the road. Diagrams showing relationships, in particular, have the power to trigger new ideas. Without the visual image, these ideas are not so easily suggested, Visual communication and reasoning, therefore, have a long-standing place in th*e world of materials science. But how are they used in design? To answer this question, we need to look at the design process itself..."(Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)

Ashby; Graphic method to be less mathematical

A scientist who starts from the chemical formulations of the material must translate all the numbers of his research to the expressive information of the material. Thus it creates tables with numbers and schemes for the different materials and divides them into classes and subclasses based on their characteristics and properties.

Ashby in his years of work feels the need to find a way to show the numbers in a way that is more memorable and easy to understand for the designer and engineer and also for the scientists themselves. So he creates his famous diagrams and explains that, *"Information can be more densely packed in diagrams and images that show relationships. Phase diagrams relate the regimes of stability of competing alloys. Micrographs reveal structural similarities between differing materials, suggesting, perhaps, that a heat treatment used for one might be effective for another. Deformation mechanism maps relate the regimes of dominance of competing deformation mechani-*

sms. Material property chart relates a population of materials in material property space, a space with many dimensions. Each of these captures a vast amount of information and compresses it into a single image, revealing patterns in the data that words and equations do not." (Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)

It is here that they become a tool not only for communication, but also for reasoning.
*"To create a tool for material selection we need to structure the information that has been presented so far. This tool should capture and store material, process, and product information, organizing it in a way that allows rapid retrieval, presents the same information in a creative format, and allows browsing, retrieval, and combination of "bits" of information about materials, processes, an*d the products they create. The first step is that of classification." (Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)
He has revolutionized the approach to the selection of materials to take into account four aspects: feature, material, geometry, and processes.

"Most new materials for design emerge through the commercialization of research, that is through science driven development. The developer communicates information about the material through advertising, press releases, profiles, and datasheets.
The communication, if successful, stimulates designers to use the material in creative ways. But for this to work two things are necessary. The first: that the information includes that required for product design and as we know, that means much more than just technical attributes. And second: that the language in which it is expressed has meaning both for the supplier and the designer, requiring a vocabulary to express design requirements and material behavior that both parties can understand.
If information is flowing in the forward direction, it can also flow back:
The designer influences the development of materials by suggesting or requesting specific technical, processing or aesthetic behavior." (Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)

In fact, Ashby's progress in this field reflects the fact that the language of science, or the mathematical language, needs to become a visual language when it becomes a practice and visual tool. With the advancement and expansion in the number and variety of materials and their data, in today's world, the need for a more visual language or language close to the thinking of designers is felt.

Ashby in his material sheets, presents each material in five steps it includes:

What is it
Notes for the project
Applications and sectors of use
Alternative materials
Types and classification

And after a sheet of the characteristics of the material

Material characteristics:
Price and Density,

Technical Attributes:
El. modulus, GPa
Elongation, %
Fr. toughness,
Vickers hardness, HV
Yld. strength, mpa
Service temp. ^C
Specific heat, j/kg•k
Th. conduct. W/m•k
Th. expansion

Eco-Attributes has only some generic information:
Energy content, mg/kg
Carbon footprint, CO2 (kg/kg)
Recycle potential

Characteristics in relation to the other materials of the same family:
Durable and tough
Easily molded
Readily colored
Optically clear
Easily foamed

Strong
Tough
Durable
Low cost
...

Aesthetic Attributes (Expressive-Sensory):
Low (0), High Pitch (10)
Muffled (0), Ringing (10)
Soft (0), Hard (10)
Warm (0), Cool (10)
Gloss, %
Transparent to matt
From optical quality transparent to opaque

After summarizing this division and classifications of Ashby sheet, realize that according to the needs of today's world, the needs of designers have been upgraded and only the technical information of the materials does not meet the needs of the design.
In the traditional method how a designer selects his material and what information he has available is more a scientific path with language and scientific reasoning. A search on the databases of information on scientific sites and engineering books shows the results that Ashby has a step further in communication with designers and knowledge of the need for intermediate language.

Selection of material

Usually the most common path to select a material, in the conceptual design stage, the designer requests generic information, for the widest possible range of materials. In the next phase of development he requests information for a subset of these materials, but at a higher level of precision and detail, more specialized dealing with a single class of materials and properties.

The materials are known by dividing the class of material and their property that lays down on the characteristics. Features are developed and organized by the scientist with a scientific reason to know material from the scientist's point of view. Over the years, collaborating designers with scientists developed another division of characteristics that approached the designer's need to know the

material and design.
The characteristics of the materials can be divided into chemical or physical properties, mechanical, technological properties.

The scientist punt view

All scientists have the same method to divide the material properties.
Here are some chemical-physical properties:

Acoustical properties
  Acoustical absorption
  Speed of sound
  Sound reflection
  Sound transfer
  Third order elasticity (Acoustoelastic effect)
Atomic properties
  Atomic mass:applies to all elements
  Atomic number: applies to pure elements only
  Atomic weight: applies to individual isotopes or specific mixtures of
  isotopes of a given element
Chemical properties
  Main article: Chemical property
  Corrosion resistance
  Hygroscopy
  pH
  Reactivity
  Specific internal surface area
  Surface energy
  Surface tension
Electrical properties
  Capacitance
  Dielectric constant
  Dielectric strength
  Electrical resistivity and conductivity
  Electric susceptibility
  Electrocaloric coefficient
  Electrostriction
  Magnetoelectric Polarizability
  Nernst coefficient (thermoelectric effect)

- Permittivity
- Piezoelectric constants
- Pyroelectricity
- Seebeck coefficient

Magnetic properties

- Curie temperature
- Diamagnetism
- Hall coefficient
- Hysteresis
- Magnetostriction
- Magnetocaloric coefficient
- Magnetothermoelectric power (magneto-Seebeck effect coeffi cient)
- Magnetoresistance
- Permeability
- Piezomagnetism
- Pyromagnetic coefficient
- Spin Hall effect

Manufacturing properties

- Castability: How easily a quality casting can be obtained from the material
- Machinability rating
- Machining speeds and feeds

Mechanical properties

- Optical properties
- Absorbance - How strongly a chemical attenuates light
- Birefringence
- Color
- Electro-optic effect
- Luminosity
- Optical activity
- Photoelasticity
- Photosensitivity
- Reflectivity
- Refractive index
- Scattering
- Transmittance

Radiological properties

- Neutron cross-section
- Specific activity
- Half life

Thermal properties
- Binary phase diagram
- Boiling point
- Coefficient of thermal expansion
- Critical temperature
- Curie point
- Ductile_Brittle Transition Temperature
- Emissivity
- Eutectic point
- Flammability
- Flash point
- Glass transition temperature
- Heat of vaporization
- Inversion temperature
- Melting point
- Specific heat
- Thermal conductivity
- Thermal diffusivity
- Thermal expansion
- Triple point
- Vapor pressure
- Specific heat capacity.

They are useful information for designers, but when designers want to use it most to know how to translate the data of this information in expressive language.

"The characteristics of the materials are those found in the intimate structure of the same (for example the color, shape, chemical structure, deformation, elasticity, conductivity and propagation) as well as their resistance to stress. external (mechanical properties), or to the behavior in the various stages of their processing (technological properties) or the expressive features." (Ashby, Material selection in mechanical design)

Physical properties are one of these properties that change during the process of study, recognition and production of materials. It is often referred to as observables. They are not modal properties.
For designers Physical properties are an important part of design, it's not physical-chemical properties it's only physically as shape,

color, transparency etc, The expressive characteristic.

Ashby shows the mind of a designer well. looking for and finding and selecting a material for designers, in a world of new and varied materials, is not that simple. first he must at least know or see these developments and discoveries, every day, study and store them all and then be able to remember the basic information to have a better selection in the world of materials.

“The picture that emerges is that of the designer’s mind as a sort of melting pot. There is no systematic path to good design, rather, the designer seeks to capture and hold a sea of ideas and reactions to materials, shapes, textures, and colors, rearranging and recombining these to find a solution that satisfies the design brief and a particular vision for filling it. Magazines and yearbooks, material collections, museum exhibitions, trade shows, and the designer’s own experience provide the raw ingredients; the designer permutes, modifies, and combines these, stimulated by brainstorming or free discussions and astute observation of what other designers are doing. This involves drawing freely on memories or images, combining aspects of each, imagining and critically examining new solutions, a sort of self-induced virtual reality. The brain is good at storing an enormous number of images, but is poor at recalling them in detail without prompts or specific triggers.

These prompts can be created by using stored images and visual infor- mation about materials and products, provided these are indexed in ways that allow rapid recall. Indexing, then, is key to ordering material and process information to provide a design tool. To do this effectively, indexing must be sufficiently abstract to capture relationships, yet be sufficiently concrete to be easily understood by a novice user. If this can be achieved, a framework for organizing and manipulating the attributes of materials and their role in technical and industrial design becomes possible. The ultimate aims of this creative framework might be:

- *To capture and store material and process information of the sort found in magazines, yearbooks, and exhibition-based publications.*
- *To present information about materials and processes in a creative format that is relevant to product design.*
- *To allow browsing of potential materials or processes via hypertext links or free-text searching.*

• *To allow retrieval of "bits" of information about the technical and perceived attributes of materials, processes, and the products they create.*
These all lie within the scope of present day software engineering, but they require more thought about the best way to organize information for designers." (Ashby, Materials and Design)

The need, then, is one of communication. The usual information sources for new materials, press releases, supplier datasheets, producer catalogs, report what is good about them but seldom what is bad, and they generally focus on technical attributes. The attributes that bear on industrial design are far harder to find, with the consequence that materials that are technically familiar are often unknown to the industrial designer. Here the need is for visual and tactile attributes, those that help create the associations and perceptions of a product.
The desire to fill this need motivates occasional exhibitions, books, and services (1) But for example an information for a material can describes the technical or perceived attributes of a new material (a metal foam) hinting at the possibilities of energy absorption and lightweight design. And this is the truth that Ashby had found and tried in the next steps to recover this gap and get closer to the designer's language.

1. Antonelli (1995) catalog of the MOMA exhibition "Mutant Materials," Juracek (1996) book of images and textures and Manzani's (1989) book "Material of Invention" are examples. The New York-based consultancy Material Connation provides a material information service for industrial designers. The consultancies listed in Chapter 2 provide material collections and material information services for industrial designers.

1.3 expressive language of material

Vocabulary from the designer's gaze (expression)

Why are features important from a designer point of view?

After the industrial revolution, a need has grown for a role between craftsman-artist and engineer, a role that uses science and technology to create comfort and pleasure to eliminate a need through innovation and harmonies, it was designer.
The role of designer over the years has been defined, between a craftsman, artist, engineer and scientist. One who knows how to amalgamate wisdom well to arrive at a complete goal from all points of view. The designer to reach his goal, to design a product, uses many tools and a lot of knowledge, from pure science to the daily life of people.

Movement of designers between art and engineering

In the history of design, the designer always moves between art and science, being more artist or engineer has not lowered the importance of the designer's product. What An interesting Art Deco that is also the Bauhaus furniture. Even now a new and interesting world of products and projects is created which show the attention of their creators to arrive at the project through all kinds of means between the fields of art and science, to use and create innovations with the aim environment and sustainability or comfort and beauty etc. It is precisely for this reason that the world of design is a collective world between expression and reason.
In history the product characteristics include the usage, consumption, creation, and trade of objects as well as the behaviors, norms, and rituals that the objects create or take part in. Some scholars also include other intangible phenomena that include sound, smell and events, while some even consider language and media as part of it. That is the responsibility of the designer.

The designer creates his idea with every means available. His secret weapon is his mind free from any social or cultural beliefs. technology, science, materials are all his tools.

The designer creates his idea with every means available. His secret weapon is his mind free from any social or cultural beliefs. technology, science, materials are all his tools.
"Aesthetics is a difficult word, having too many shades of meaning to convey a sharp message, yet there seems to be no other that quite captures the sensory attributes of materials and products. Designers manipulate these senses, and the reactions to each sense, to create a product's personality." (Ashby, Materials and Design)

Knowledge of materials

The material is the appearance, function and sometimes also the purpose of a project that is communicated with the characteristics of the material chosen by the designer. In the past knowledge of materials was created with practical experience of the use of the material and practical studies on the design, *"the metis could exercise itself, in the practical knowledge of the craftsman as well as in the practical component of that of the engineer, on the direct experience of a limited and present knowable with all its physicality."* (Manzini, The Material of Invention)
But *"today, faced with a material that dematerializes itself as a set of codes, languages, technical specifications, metis must find new paths and new forms. The new ground on which astute reason must know how to move"*. (Manzini, The Material of Invention)

"Many individual designers and design houses assemble collections of materials and suppliers, but not much more. There is a need for an accessible sample collection with links from the image and supplier to a larger file of aesthetic and technical data. The physical nature of the samples is the key point: new ideas, inspiration, can come more readily from handling (not just visualizing) a material. Familiar materials carry associations that derive from their traditional uses: polished wood, the sense of warmth, civilization, discrete luxury; brushed aluminum, the sense of clean mechanical precision, and so forth. But the use of familiar materials in an unfamiliar way is also a creative step. New materials, particularly, act as a trigger to inventive thinking, offering the potential for novel design. This is where maintaining a material collection becomes challenging. Most material development is driven by technical need, not by motives of industrial design, with the result that information does not readily reach the designer. Material information services exist that carry

large sample collections and offer web-based access to images and suppliers, but not much more. There is a need for an accessible sample collection with links from the image and supplier to a larger file of aesthetic and technical data." (Ashby, Materials and Design)

Today the growth of materials is much faster and spread over different disciplines, at this point the ancient methods for designers do not work for a broad knowledge when selecting the material.
In fact, today, knowing the material is not limited to a few technical or physical characters, having different options in different groupings has forced the designer to know more and more in different disciplines.

Material selection

As the designer has looked at the material not as a choice at the end but as a part of the idea, the importance of the characteristics of the material and what it conveys through its shape, color or history is felt more and more. The features that bring the limits or an advantage in the design.

"New developments in materials and processes are sources of inspiration for product designers, suggesting novel visual, tactile, sculptural, and spatial solutions to product design." (Ashby, Materials and Design)

Inspiration, the ability to stimulate creative thinking.
Beylerian interprets the aesthetic approaches to materials and makes statements about what, and in what ways, materials may be used to produce calculated visual and tactile effects in the built environment. Some of them are based on nostalgia and romance, some on what we call a traditional modernist perspective, and others focus on the properties of surface and texture.
The approach that refers to nostalgia and romance tend to assume a decorative attitude. They are concerned with evocation, the summoning of comfort, tranquility, whimsy, and with imitation, the mimicry and restoration of materials of the past. Traditional materials and techniques, such as mosaics, evoke specific historical periods and styles. Found materials romanticize personal, serendipitous environments. The colleges that express a traditional

modernist perspective investigate "classic" materials, such as bronze, steel, brass, glass, and natural fibers. They refer to the elegance of materials and the integration of the aesthetic of the material with architecture. They seek to express the purity and clarity of materials. They exalt perfection, singularity, strength, and simplicity.
Several architects and designers refer, in their written statements, the physical properties of surfaces and textures, as the determinants of design in our decade, taking over the role played by color and form in decades prior to our own. They posit surface phenomena as new building materials with the power to activate the senses. They celebrate a tactile, sensory approach to environments and welcome new technologies that make the selection and mixing of finishes an important art in the creation of built environments.(Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

Difference between languages

Although the material for engineers is a scientific result, with numbers to show his information, for a designer it looks different.
interpretation of Manzini for scientists' language is very interesting, *"The languages in which technical knowledge speaks are the synthetic way to overcome what is known and quickly arrive on the front of the new. The delimitation of the field is the only way not to waste the intellectual energy of the researchers."* (Manzini, The Material of Invention)

The discovery of the complexity to which the new material leads us must not mean surrender in the face of the unmanageable tangle of relationships that characterize the system. Instead it means moving within the entire range of technical possibilities, referring to a system of values that includes *"social intentions, linguistic expressions, poetic values".* (Manzini, The Material of Invention)

An engineer uses a direct and coded language for scientific results for communication and how we see numbers in the field of design, or what is called scientific-mathematical language, are not clear and effective to show the characteristics of a material that does not only play in the technical role that also the physical and expressive aspect.

Expressive language of material

"Sensuous, exuberant, sexy and sublime: the colours, textures and shapes found in the material world have a unique presence. Whether crafted into furniture, everyday objects, high-tech hardware or tactile textiles, the beauty and versatility of the materials used today can help to showcase the mysteries of nature and the magic of science. From the warmth of harvested wood to the unsurpassed strength of solid stone, materials and their capabilities have moulded the built environment for many millennia. Just as alchemists once endeavoured to synthesize gold, modern scientists are now in pursuit of miracle materials. Perhaps because they stimulate our senses and fashion our existence, materials will always fabricate our world and continue to transform it for the better." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

Materials are the core of the built environment: everything we touch and smell, and most of what we see and hear, is based on a material of some kind. Design is the practice of making those materials into products and environments that, hopefully, meet the needs and desires of the consumer.
The feelings that we find in contact with objects are the characteristics of their materials in the front row. The characteristics come from properties of scientists, but with another angle.
Tactile, Visual, Acoustic, Noise, Heat, Light are senses of humans in mutual relationship with the material characteristics. The five senses that humans have are the way to contact the outside world. lack of a sense, creates a higher development for the person. This is fortunate for the designer to understand and study these senses through the properties of materials, and vice versa, it studies and creates materials based on the user's sensory perception.
These characteristics come from the Superface, the Color, the Texture, the Sound, the Temperature, etc. The difference in how the designer viewpoint is in device and communication is the properties and characteristics.

For example
Tactile
In the tactile sense we have a texture, the texture for a designer device in Visual Texture and Tactile Texture, Tactile with the hands or Tactile with the tongue.
In the tactile contact the user can perceive the Heat, the Weight, the

Emotion, etc.

"Color and surface motifs: Textiles can contribute to our well being in a number of ways: colourways and surface motifs are believed to stimulate the body's innate healing ability, while textiles constructed from encapsulated fibrs medicate the wearer through the skin." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

Sound:
"Sound is an invisible and intangible material that can completely transform energy, mood and perception.
... unlike visual materials that closed eyes can shut out, its presence is almost unavoidable. Sound works at a sensorial level and its vibrations can be powerful and evocative.
... The sound creates a point of orientation that the public engages with, manipulating them physically as it draws them closer, or drives them away. Paris-based sound artist Valerie Vivancos uses what she describes as the most basic materials known to man': resonance, vibrations and the audible word." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

The idea of Beylerian in his project of material library is about contrasting, about putting opposites side by side, and about examining the relationships between materials. His group is concerned with the variability and diversity in materials and, by extension, the variability and diversity of the environments in which they are used. "We believe that the popularity of juxtaposition as a theme, both in the exhibition and in the work of design professionals, is based on the continuing interest of designers and architects in exploring complexity and contradiction, ambiguity, and even perversity, in the built environment. These collages juxtapose natural and man-made, hard and soft, light and dark, the abstract and the concrete, the simple and the complex, common and precious, rough and smooth, old and new, fragile and tough, the transparent and the massive, the prosaic and the poetic. They make a place for a diversity of materials and meanings. They declare that through materials the built environment can reflect the full range of history, values, and aspirations of the culture it serves." (Beylerial, Mondo Materials) they mix the language of scientists and expression together.

New Materials libraries, such as Beylerian, which present the reality of differences between languages and the importance of material properties from the designer's point of view, present information in a different format. But this method is not yet complete and is growing, to complete it requires the cooperation of the designer and the needs of the users.

Skin material introduction next part

“The concept of a sincere image of materials thus becomes useless, in the way that the Modern Movement understood it. To the degree that materials have a skin their image is sincerely that of the skin, with the entire range of variations that the skin permits. Today the increasing spread of the artificial implies that the variety of surfaces has become a design topic, and that the surface quality is now determined for the most part independently of other formal and functional aspects. We are encountering, in short, the design of the relationship of closeness with objects.” (Beylerian, Mondo Materials)

We will talk about the different points of view in characteristics of material in detail in later chapters.How different perspectives generate the new field for another discipline.

As Beylerian says in “Mondo Materials” book, aesthetic approaches to materials make statements about what, and in what ways, materials may be used to produce calculated visual and tactile effects in the built environment. Some of them are based on nostalgia and romance, some on what we call a traditional modernist perspective, and others focus on the properties of surface and texture.
The approach that refers to nostalgia and romance tend to assume a decorative attitude. They are concerned with evocation- the summoning of comfort, tranquility, whimsy, and with imitation-the mimicry and restoration of materials of the past. Traditional materials and techniques, such as mosaics, evoke specific historical periods and styles. Found materials romanticize personal, serendipitous environments. The colleges that express a traditional modernist perspective investigate "classic" materials, such as bronze, steel, brass, glass, and natural fibers. They refer to the elegance of materials and the integration of the aesthetic of the material with architecture. They seek to express the purity and clarity of mate-

rials. They exalt perfection, singularity, strength, and simplicity. Several architects and designers refer, in their written statements, to the physical properties of surfaces and textures, as the determinants of design in our decade, taking over the role played by color and form in decades prior to our own. They posit surface phenomena as new building materials with the power to activate the senses. They celebrate a tactile, sensory approach to environments and welcome new technologies that make the selection and mixing of finishes an important art in the creation of built environments.

According to the rationalist philosophy, design is informed by research and knowledge in a predictable and controlled manner. (Fred Brooks, IEEE Virtual Reality Career Award)

Although we use rationalism design more often, we are growing in the world of information. If we want to have rational control, it can lose pace. The projects of successful designers show that we have to throw ourselves into the sea and create novelty, try the impossible and go for innovations.
"specialism never ends: every specialist knowledge opens up a range of new problems to which new specialisms correspond. Until recently this was not foreseen, the current model in the technical-scientific environment considered the knowable a finite quantity of information" in reality "specialist knowledge thus appears, a point where a bundle of straight lines is encountered, which fan out above and below the limited area under consideration." (Manzini, The Material of Invention)

1.4 extend of the role of materials

Art in Design

A work of the designer is continually judged, with a fine line between an artist's work of art and a designer's product. Hence, if a designer gives more importance to appearance and sensory expressions, he risks evaluating his product as a work of art. but perhaps there is no borderline for each discipline but a nuance between them. In which he moves from engineer to design and enters art or other disciplines, or starts from biology, plant biology and moves into many other disciplines, which today are mixed to create new fields, projects and materials.

“In The Elements of Design by Loan Oei and Cecile De Kegel, a richly illustrated world of patterns, textures and colors is revealed, including dots, crossing lines, planes and circles, all of which have supplied us with much visual excitement over the years. Our world is full of symbolism, and, looking at the myriad examples that demonstrate art imitating nature or one hemisphere taking inspiration from another, it is evident that the evolution of creative design is infinite.” (Beylerian,Ultra Materials: How Materials Innovation is Changing the World)

At the same time that Beylerian refers to the book Mondo Materials, which is a collection of materials in the form of works by artists, he makes a very intelligent reference to the influence of the process of the art movement in design.

“As we look at the 125 colleges here that express our world of materials, we should recognize and place in perspective the roles that engineering, design, art, and fashion have played in the evolution of materials and in the education of those who use them to create the built environment.
“The artist, like the architect and designer, uses materials to explore ideas. The difference is in the artist's intention. He or she uses materials for purely subjective purposes while the designer works to fulfill a function and satisfy demands of the marketplace. (There are those who would argue that this distinction is no longer relevant given the

1.2, 1.3
Fitch RS
London
The theme of our panel is contradiction and prediction. Contradiction arises from the William Morris chintz design, "Tulips and Willow" Morris (1834– 1896), medievalist, Romantic, and perhaps Britain's greatest designer, loathed the modernity of his con- temporary world and mistrusted modern materials and values. He argued for a society that would turn away from mass production and return to the days of craftsmanship. Prediction is demonstrated by the inclusion of materials which suggest a return to Morris's values. The environmental crisis, growing consumer awareness and unrest, perhaps suggests return to more natural materials and a more transparent design ethic.

1.4. Franklin D. Israel Design Associates Inc.
Beverly Hils, California
Surreal Materiality The materials of the future come from the imagination. They represent raw reality, yet demand that we as designers pay homage to what we ourselves have to give. Seeing the immediate world in different ways will help us select materials that best represent things as they are, and force us to understand better how precious are those things that protect us from that rawness and give us beauty, scale, and harmony. For it is that understanding which provides inspiration for the new, however shocking it might be.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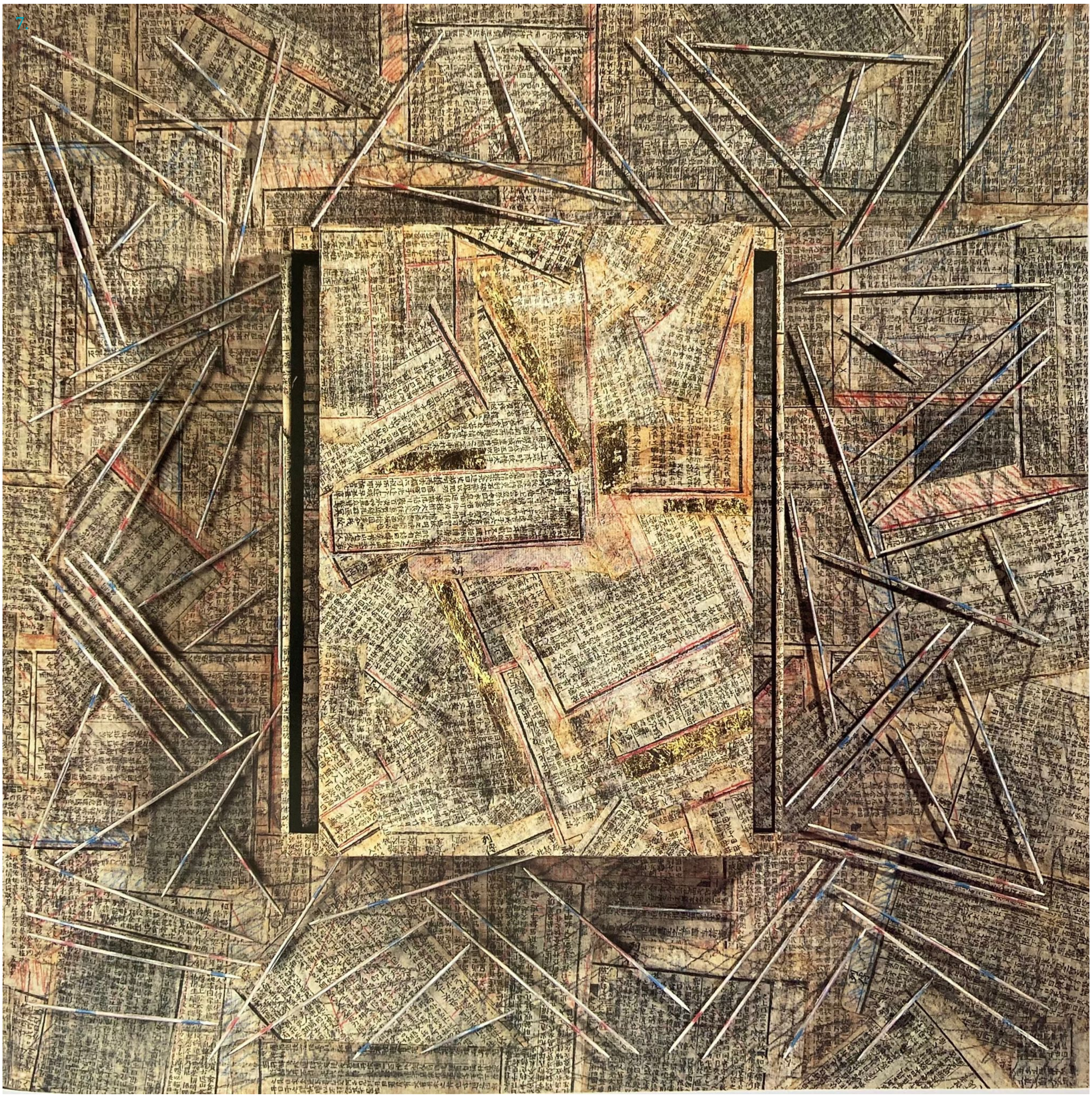
6.
THE NINETIES : TWO KINDS OF MATERIALS
WILL CREATE OUR ENVIRONMENT
1. SHADOWS AND LIGHT
LIGHT IS A REAL ARCHITECTURAL ELEMENT WHICH STRUCTURE SPACE, SHAPE UP VOLUMES AND BOOST ENVIRONMENT
1. MIRROR AND REFLECTION
DREAMING YOUR SPACE WITH NEW PERSPECTIVES "MIROLLEGE", HIGH TEMPERATURE STRECHED FILM SURFACE UPON ALUMINIUM FRAME
2.TRADITION AND ACTUALITY: STONE, WOOD, LEATHER, WOOL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1.5. Ivy Ross
Santa Monica, California
The next five years in the built environment will involve a process of un-building, chaos, instability, and asymmetry as a reflection of nature. It will be an exploration of the proper balance between nature and the built environment, an establishment of new relationships between man and nature and man and man. Time is a construction and nature one of the building blocks. Nothing is truly new anymore, we just see things differently. That must change. There is no longer one society, but many societies. Ways to express that individuality must be incorporated into the built environment. It must be able to grow and change just as individuals do over time. Those responsible must reach beyond short-term results for both the world within and the world around them. There is no longer one solution, but many questions. Why not?

1.6. Berthet Pochy
Paris
The Materials of the 1990s in the coming decade, two distinct kinds of forces will occupy front stage. 1. Shadows and light On the one hand, light will be used as a material structuring space, molding volumes, giving life to a setting, creating new perspectives, different spaces, and dreams. 2. Tradition and actuality On the other, there will be a definite return to natural (stone, wood, leather, wool) and traditional materials. It is not a question of a step backward, but rather of a harmony between a perfect

advent of aggressive and carefully cultivated "markets" for fine art. But the artist has played an important role in experimenting with new materials and devising forms, patterns, and juxtapositions of materials that are later appropriated by designers of the built environment. In this sense, artists are often the forerunners of design. Minimalist paintings predated minimalist interiors. In our time, artists possess the power to create fashion and it cannot be denied that fashionable elements, colors, and materials appear and reappear in the objects, façades, and interiors of the environments we build." (Beylerian, Mondo Materialis: Materials and Ideas for the Future)

"Material experimentation today can blur the lines between art and function. Yet this transition between the two applications is proof that materials can often provoke the design possibilities of 'either/or and a piece might easily become a functional/non functional art object. In these cases. The work is not quite finite: the artist is sometimes more anxious to play with the material than to create an object for commercial reasons. Cross-utilization is an area that is of great interest to designers all over the world, and especially to Material ConneXion, mainly because it supports the benefits of cross-fertilization between the fields of design, architecture and art, encourages the economies of usage, and ultimately makes pure economic sense. For artists, who often have no interest in the physical properties of a material, they are free to use those materials that appeal to them on a purely visual level. Tensile strength? Not a problem, but look at the way it catches the light! In other disciplines of design, this can also be effective." (Beylerian,Ultra Materials: How Materials Innovation is Changing the World)

One topic Beylerian deals with in detail is the role of material in other disciplines. Technology and material is not a tool only for engineers and designers or architects, how much to create a material is not the job that only the engineer or the material scientist does.

"Within the realm of innovation, creative artists are almost always fascinating. Admittedly they are freer to express themselves generally in whichever form or materials they want. unless of course, it's a specific project they have been commissioned to deliver. Pulling materials and ideas from thin air with such impact is usually a thrilling experience for viewers. The artist sees, thinks and transforms - what the artist sees is a material. followed by the thought process 'I can do

this' or what is seen here is an opportunity to convey...' and lastly comes the process of transforming the material into the ultimate phase of its existence: the finished art piece. Artists are also able to explore and utilize materials for purely aesthetic reasons, especially where performance is of no particular concern to the consumer. Finishes and surface treatments form part of the materials universe, and many artists have become leaders in understanding and applying this field to their work. Moreover, they are leaders because they are eager to experiment and are able to immerse themselves in a single material to 'see where it takes them' rather than concerning themselves with the outcome and seeking only the routes that will lead them there. Going back almost half a decade, the design world experienced the real "handling'' potential of materials when they were mutilated, bonded and burnt - a sadomasochistic trip that explored materials as art. Such widespread experimentation around the world has provided a significant source of newly constituted materials that play a leading role not only in design and architecture, but also in the world of art." (Beylerian,Ultra Materials: How Materials Innovation is Changing the World)

Examples

Fashion design

In fashion design the Radical changes are taken with new technology and new materials. we witness a new dynamic between the body and non-fashion materials. where the possibilities of new materials and high-tech processes are enhancing the performance of clothing. The new technology gave the opportunity to allow fashion designers to focus more on the creative aspects that translate ideas into material form, instead of many of the physical demands of production. like the technology of three-dimensional garments that can be produced by a printer, sprayed from aerosol cans or fabricated in cyberspace with different materials.
"When designing, Mizrahi surveys a wide array of materials, and spends time imagining the things that could be made from particular textiles and polymer films But materials are never his first inspiration. "Usually start with an idea. But materials and ideas are so closely interlinked that you can hardly think a thought without needing some kind of reference or visual picture. As well as designing fashion and homeware, I also design for the theatre, and I work in

knowledge of yesterday's materials and today's creativity. To the interior designer and architect, the actuality of his conceptions is doubtless more important than the pseudo-modernism of "new materials." Why make a desk out of carbon fiber [fibre de carbone] when, except for its fashionable aspect, it will have nothing but drawbacks: high cost, and excessive lightness that will make it necessary to "ballast" the whole thing order to make it serviceable. Quality and permanence Any contemporary setting requires the achievement of high quality: as in great cooking, the "basic ingredients" are decisive. The demand for quality and durability plays an integral role in the choice of materials, which also explains the return to natural and traditional materials.

1.7. Robert W. Ebendorf
Santa Monica, California
I feel that in the next five years the artist, architect, and designer will be creating and designing more personal statements. The environment has become a social theater. The objects that we once took for granted are becoming a means for communication. These products and interior spaces display a sense of individualism and risk-taking. Colors, patterns, forms, textures, and most importantly, choice of materials can effectively counterbalance the plethora of micro- chip technology and standardized parts. In my way of thinking, there is little in terms of a unifying style or set philosophy of design. The main factor that brings these elements together-and sets them apart is

8.

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different mediums." Those media show up in fashion, linens, furniture, appliances and footwear." (Beylerian,Ultra Materials: How Materials Innovation is Changing the World)

For many artists and few designers, the material should not always come out of a laboratory process, it may have simply come from a different point of view than usual.

"Mizrahi also seems adept at pulling material inspiration from nowhere. On a cab ride home one night, he saw a billboard for a recycling programme called 'We Can' and it led him on an interesting adventure that took aluminum cans- and his idea-around the world, and put a signature Mizrahi-twist on the idea of sustainability. We collected Coke cans, 7-Up cans and Budweiser cans, for however long we collected, with the homeless people from the programme: we split them open, washed them, and sent them to Paris, where they were cut into palettes. And then we sent the palettes to India to be sewn onto dresses just like sequins. Of course the dresses were mostly aluminum, which meant that they were practically weightless. That was so exciting to me because in fashion, most things weigh certain amounts, and I'm always thinking, "Oh, that's too heavy, too heavy - lighter, lighter, lighter, lighter." So without expecting it, I discovered that the material had produced the lightweight dress I wanted." (Beylerian,Ultra Materials: How Materials Innovation is Changing the World)

It is the expressive and sensory properties of the materials that accompany the designer or artist to connect to his expectations.
Although the beginning of the idea does not always begin with a material, for an artist it is a fundamental element that communicates his goal through the work with an aspect of the material that uses it. An aspect that is not only visual and tactile, but also through taste or sound brings the viewer into the world of the artist. it is the sensorial perception of the viewer who perceives the artist's message through the characteristics of the material.

Test and Sound

The artists first started working on some senses which for designers is still a mental obstacle to understanding how they can

what they are made of or what they have or do not JO have in common. As we move into the future, we will see an approach having more of a human touch (feeling, warmth, emotions, and risk-taking) by many creative designers, architects, and artists.

Image 1.8, 1.9, 1.10
Fabrican by Manel Torres makes fashion choices easy and fun. Tiny fibres suspended in an aerosol solution can be sprayed directly onto the skin to create instant garments. A similar material was first introduced in pharmaceuticals as a bandage preparation, which Torres appropriated for fashion.

exploit it, taste and sound.
The sound works at a sensorial level and its vibrations can be powerful and evocative. Even when devoid of musical or communicative associations, sound carries an abstract language that we respond to at a primal level.

"Valerie Vivancos the sound artist regards sound as an uncharted territory within the arts, underpinned by many of the same theoretical constructs applied to visual arts, performance or writing. During the last decade, Vivancos has exhibited sound installations in museums, galleries and off-site spaces, and published her work in the French sound art journal, Vibrö. Her artwork has contributed to the field of vibro-acoustics, and she has conducted interactive programmes with the hearing impaired, Her 'Towards Silence' project at the Parque Das Ruínas Art Centre in Rio de Janeiro resulted from one of her sound sound workshops, including a participatory performance that explored the absence of sound." (Beylerian,Ultra Materials: How Materials Innovation is Changing the World)

Sensory experiences in art are merely stimulation for the senses.

Korean designer Jin Hyun Jeon studies emotions starting from cutlery, manipulating sensations and the experience of taste intensifies with a series of spoons and utensils made of ceramic, plastic and silver that play with color , shape, weight, consistency and temperature. The designer wants to foment the "Sensory Cutlery", thinking of the act of eating not as the simple fact of swallowing or sinking, but rather it would constitute a tasting, a fruit with all the senses. Taste, smell, vision... that they mix, they merge and they complement each other.

Jin Hyun Jeon
In Project Synesthetic Design, Jinhyun Jeon aims to influence the Innate Human Sensory capacity and challenge the Social Thought Patterns. She completed her master's program in Social Design and granted the Young Creative Talents sponsored by Creative Industries Fund Netherlands (2013-2014), which enables her artistic career with a base in the Netherlands.
By training the subconscious in the daily routine, he researches and develops a synesthetic design that induce new sensory experiences and intuitive behavioral patterns.

Sensory Cutlery Collection, 2012
Cutlery design focuses on getting food in bite-sized morsels from the plate to the mouth, but it could do so much more. The project aims to reveal just how much more, stretching the limits of what tableware can do. Focusing on ways of making eating a much richer experience, a series of dozens of different designs has been created, inspired by the phenomenon of synesthesia. This is a neurological condition where stimulus to one sense can affect one or more of the other senses.
An everyday event, 'taste' is created as a combination of more than five senses. Tasty formulas with the 5 elements – temperature,

color, texture, volume/weight, and form – are applied to design proposal. Via exploring 'synesthesia' if we can stretch the borders of what tableware can do, the eating experience can be enriched in multi-cross-wiring ways. The tableware we use for eating should not just be a tool for placing food in our mouth, but it should become extensions of our body, challenging our senses even in the moment when the food is still on its way to being consumed. Each of designs have been created to stimulate or train different senses – allowing more than just our taste buds to be engaged in the act and enjoyment of eating as sensorial stimuli, therefore it would lead the way of mindful eating which guides to rediscovering a healthy and joyful relationship with food.

The materials in the design currently compose of metal, plastic and ceramics. Each material possesses its natural temperature, which works in harmony with the intent of the design. From the thickness of the handle to the volume mass of the spoon, it evokes a different effect. Weight distribution changes according to the thickness and the volume affects the sound vibration. Each of these features is subtle but in combination, they harmonize into enhanced tasty effects. As for the specific workings of the features of the design, it could be understood through the elaboration of the five elements – temperature, color, texture, volume/weight and form.

Enhanced Tasty Formulas

Temperature
SWEET × 36.5°C = SWEET × +++
SALTY × < 36.5°C < SALTY × < 0°C
SOUR × 36.5°C = SOUR × 100°C
BITTER × 36.5°C > BITTER × 100°C

Tactility
+++ × (SWEET + SALT) = X
SWEET + (0.5% × SALT) = SWEET ++
SALT ÷ SOUR = SALTY/SOUR –
SALTY × SOUR = SWEET +

Colour
10% × (5R 4/14 + 5YR 4/14 + 5Y 4/14) = 2.0
90% × (5R 4/14 + 5YR 4/14 + 5Y 4/14) = 0.1
20% × R > 20% × Y

11.

12.

Image 1.11, 1.12 ,1.13
Sensory Cutlery Collection, 2012

13.

Volume/ Weight
5cm3 × SOUND/ SIGHT = 10g × TOUCH

Form
1mm × TOUCH > 10mm × TOUCH
(y=f(x)) × TOUCH = Y

As we also see in this project, a scientific language is used to measure. This time they measure the senses perceived through the tools for eating.
This can be an example of future design where materials along with their class, metal, plastic or composite, are exploited for their sensorial features which are the goals of the project.

Interface art

Such kinaesthetic experiences can be triggered today by interactive artworks, created through the application of technological processes and sophisticated materials. Information technology, ephemeral devices, lasers, intangible acoustics, and even explosive materials, transform energy and vibrations into tangible forms. It's all a way to trap or stimulate the senses for a senorial experience, thanks to the creativity and courage of the artist and technology and material.

"London-based, Usman Haque creates responsive environments, interactive installations, digital interface devices and choreographed performances. Since his tenure as artist-in-residence at the International Academy of Media Arts and Sciences in Japan, Haque has used a wide range of unexpected materials in his art. Haque creates architectural environments, then deploys sensory stimuli to bring them to life. Haque has used a range of analogue and digital equipment to produce electromagnetic waves, subsonic frequencies, anechoic and acoustic cancellation systems, and ephemeral forms are his materials of choice. By using intangible responses among his audience, Haque triggers reactions by using materials that the individuals were not immediately conscious of.
These ingredients came together spectacularly in Haque's Haunt' installation, a project that recreated some of the sensations that parapsychologists have recorded in haunted spaces. Inside a special-

ly-built chamber, Haque used coils and audio equipment to create an environment where electromagnetic fields, temperature fluctuations and infrasonic frequencies combined to induce the perception of invisible forces, like movement, taste and sound, and the sensation of the presence of others. The installation elicited responses described as a 'sense of presence', 'chills on the spine', 'uneasiness' in some parts of the chamber, 'dizziness' and visual and auditory hallucinations, including seeing flies in the chamber and hearing the sound of someone coughing. As expected, it showed how ephemeral materials and conditions could elicit spooky sensations." (Beylerian,Ultra Materials: How Materials Innovation is Changing the World)

Imagine 1.14, 1.15, 1.16, 1.17
Chamber for three-dimensional positioning of fragrances without dispersion

Funded by a Wellcome Trust Sciart Award, Scents of Space was an interactive smell system created in collaboration with Josephine Pletts and Dr Luca Turin.

The study of the human olfactory system has progressed rapidly in recent years. This project demonstrates how smell can be used spatially to create fragrance collages that form soft zones and boundaries that are configurable on-the-fly.

Inexperienced laboratories of the material

Some designers and artists with a different thought towards materials, its laboratory and the role of the material scientists have started for a decade, creating materials or looking for new funds outside their laboratory.

Perhaps more than any other contemporary designer, Neri Oxman embodies the futuristic momentum and holistic vision of a 21st century demiurge. The strength of the impact with which, with her Mediated Matter research group at MIT's Media Lab in Boston, she initiated a real revolution suspended between architecture and microorganisms, is based on a double premise.

On the one hand, Oxman uses the vanguard tools made available by technological innovation to inaugurate a new production season based on the engineering of nature. On the other hand, he combines these new opportunities in the means of production with a radical methodological rethinking, which makes the interdisciplinary nature of science, biology, design and art a combination capable of accelerating a more sustainable physiognomy of the world. These are characteristics that literally make her one of the most significant innovators of the last ten years and that make her research a milestone on which many applications to come will be developed.

"The world of design has been dominated since the Industrial Revolution by the rigors of manufacturing and mass production. Assembly lines have dictated a world made of standard parts framing the imagination of designers and builders who have been taught to think

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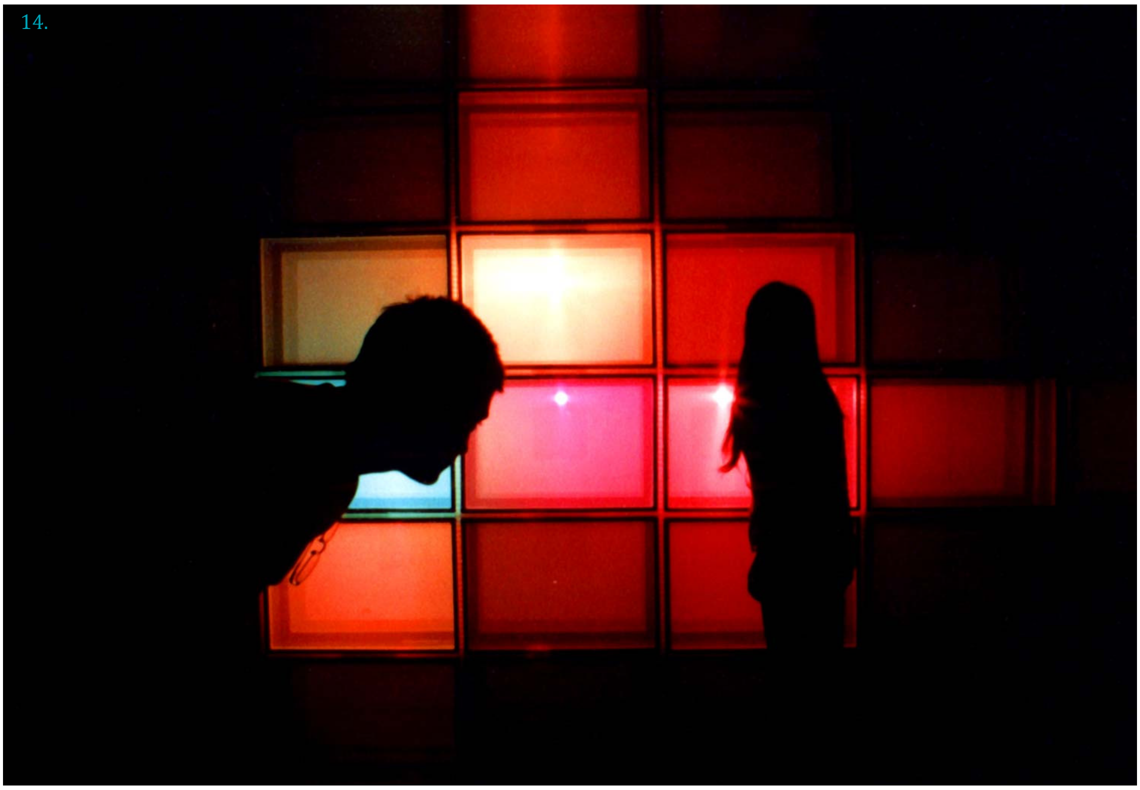

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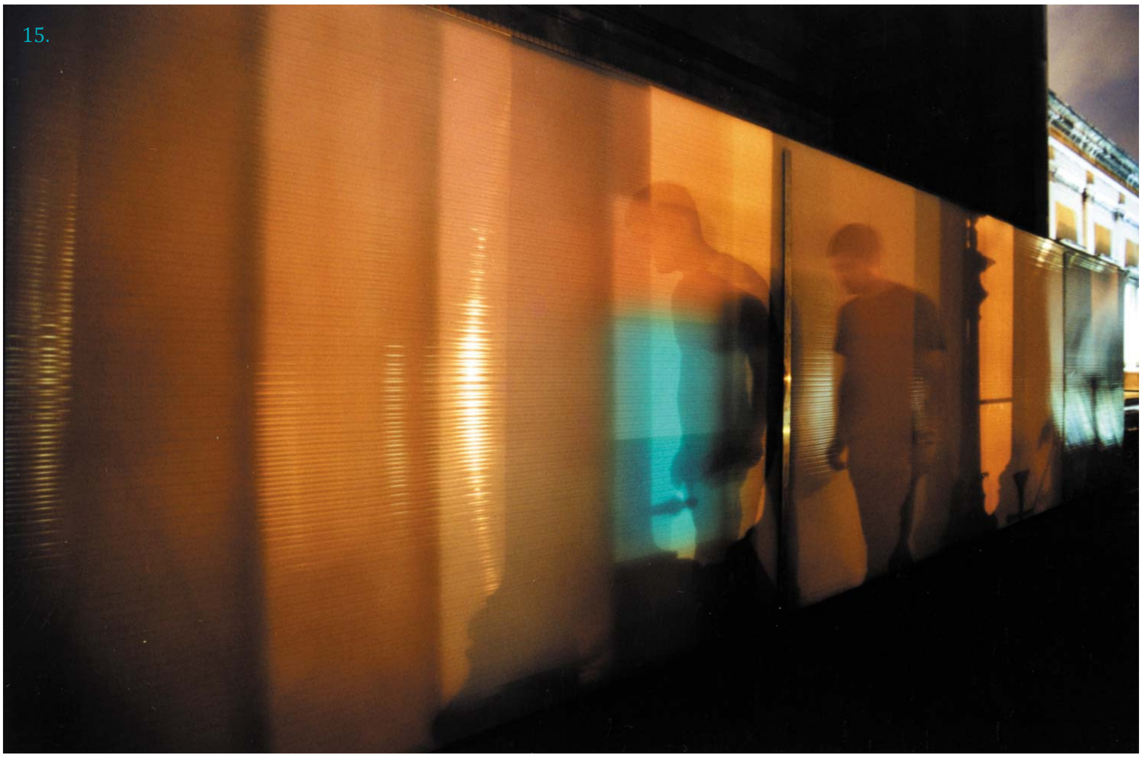

Image 1.2,1.3,1.4
Scents of Space (2002)

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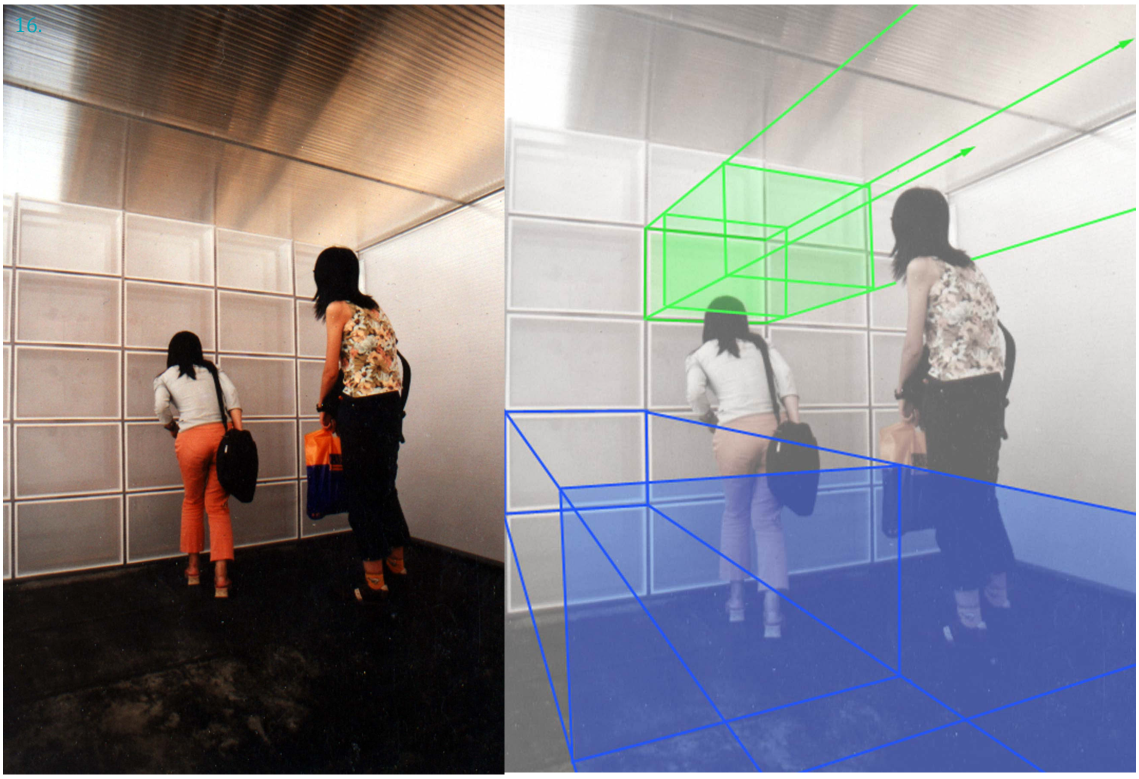

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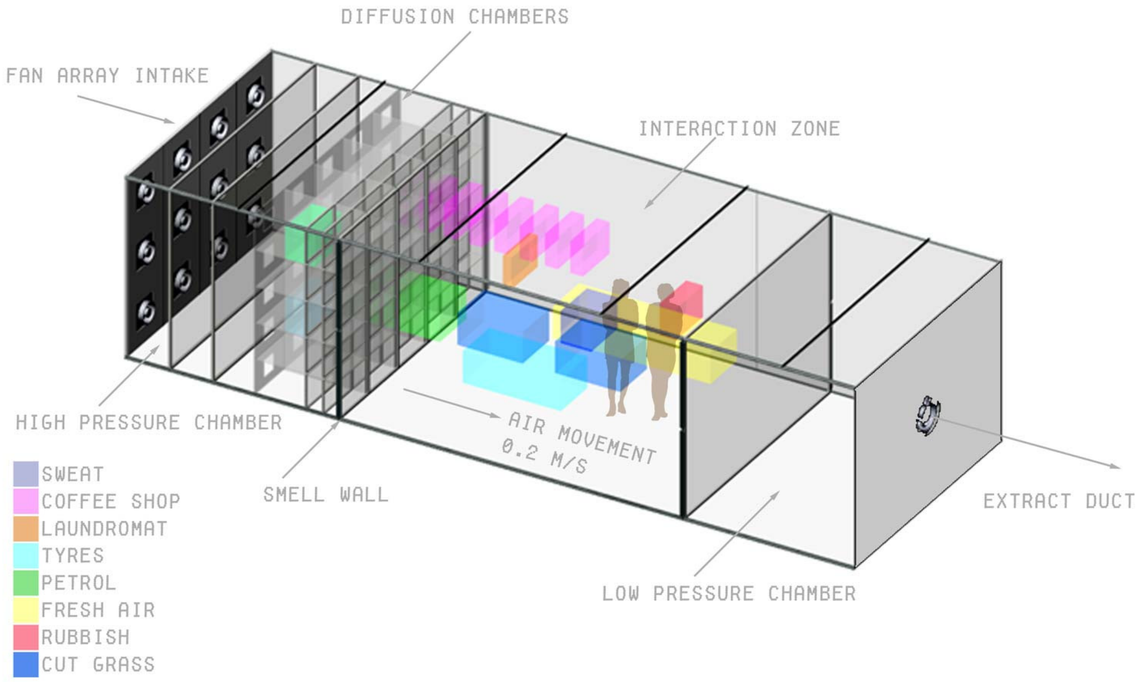


about their design objects and systems in terms of assemblies of parts with distinct functions. The assumption that parts are made of single material and fulfill predetermined specific functions is deeply rooted in design and usually goes unquestioned; it is also enforced by the way that industrial supply chains work. These age-old design paradigms have been reincarnated in Computer-aided Design (CAD) tools as well as Computer-aided Manufacturing (CAM) technologies where homogeneous materials are formed into predefined shapes at the service of predetermined functions." (Neri Oxman, Material ecology)

"*The complex relationship between biology and technology has for centuries constructed our view of Nature. It has also limited our ability as designers to integrate external environmental forces with the inherent material behavior of buildings and products. However, while the biological world expresses functionality from the bottom up - through self-organization, cell differentiation, growth, remodeling and regeneration - the practice of design traditionally operates from the top down, establishing constraints that inform or guide form generation and construction. Neri Oxman, Associate Professor and head of the Mediated Matter Group at the MIT Media Lab, introduces how new advances in additive manufacturing coupled with emerging capabilities in materials science and synthetic biology are today empowering designers to combine top-down design procedures with bottom-up digital or physical growth across spatial and temporal scales."* (Neri Oxman, Material ecology)

But we always remember Beylerian's words on the innovation that *"With so much richness in non-advanced materials and old-fashioned techniques, it is important to remember that we do not always need to look for answers in technology. Putting up skyscrapers of 100 storeys and higher is no longer the zeitgeist of innovation, whereas buildings that use material innovation make a truly artistic and individual impact compared to the backdrop of other less interesting buildings. Likewise, reducing the size of electronic components in products can only encourage technological advances so far…*
We often seem attracted to those who can create new ideas, new applications, new installations, new fashion or new buildings. Yet in the context of material innovation, the term 'new' is most obviously applicable to those who can think laterally and apply their imagination to developing new vistas where materials, blended with creativity, can produce new 'products'., If this can also be extended to

creating new solutions to an existing model, or a completely new invention, that is even better." (Beylerian,Ultra Materials: How Materials Innovation is Changing the World)

If we look closely Oxman's ideology regarding industry and mass production goes back to the period before the Industrial Revolution that an artifact and craftsmanship were the products of design. There is a huge difference between his work and that of the period, which today with development in the field of materials and technology, innovations and collaborations between disciplines, a product is not necessarily a craftsmanship, it can also be an industrial production based on the criteria of consumer demand.
It can be an answer to the problem of the environment with the material of zero kilometers, use and intervention of different disciplines for respect for nature and sustainability, with an awareness of how much and when it is important to use innovation and novelty or methods and ancient material and traditional in a different and creative way, for a product suited to the needs of users in the environmental standards.

Michael Farries Ashby

Graphic Diagrams

The engineering approach

Modern meadow

George M. Beylerian

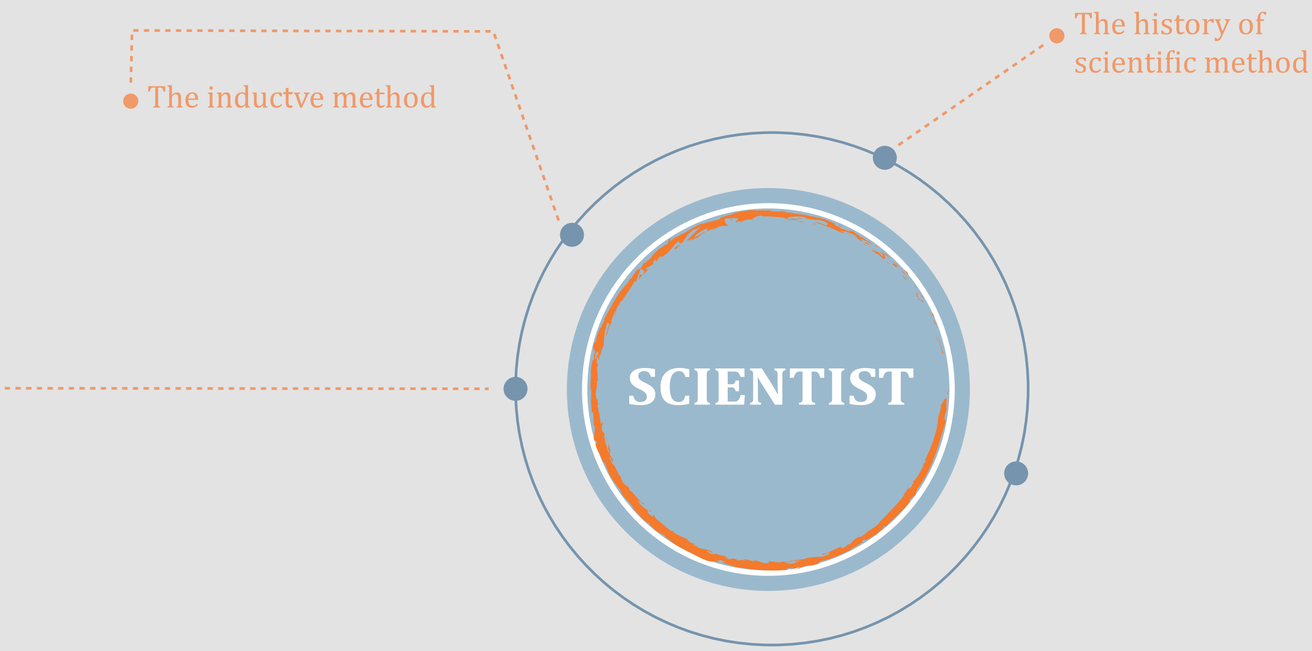
Neri Oxman

Ezio Manzini

The design approach

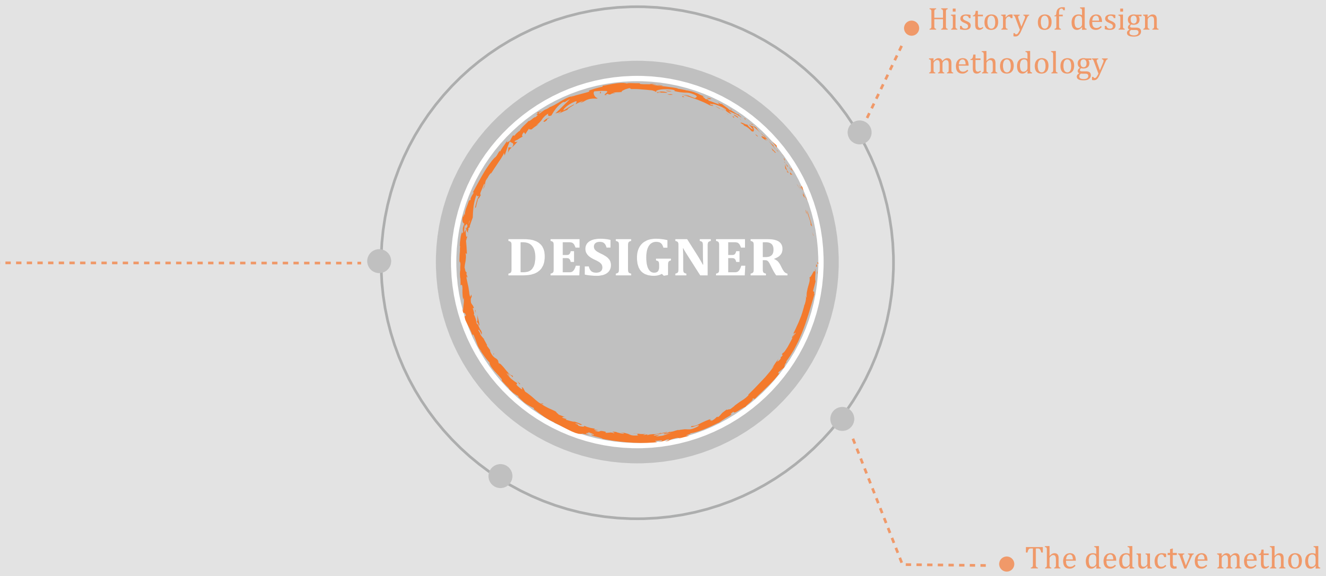
Jen kean

Hella Jongerius



PART II

Approach of Scientist and Designer



CHAPTER 2:

Approach of Scientist and Designer

ABSTRACT
Once I discuss the history of materials, the point of view of the designer, engineer and scientist. The source of their method of recording and communicating for each discipline. The next step is to know the most important figures for design on the subject of language between disciplines. Divided into two groups; scientist, who means figures outside the design discipline, in the role of the scientist like Ashby or an intermediary figure like Beylerian.
Also a choice between designers. As this research is done by the designer's field, the choice includes a theorist and critic of design, Manzini. And a group of designers who have put a step forward in the discourse of materials and collaboration between disciplines.
Investigate the history of the methodology of science. How created and arrived at these results and from where and how the difference of the scientific method begins. design methodology and path of the design discipline. And his approach to Ashby.

ABSTRACT (italiao)
Una volta discuto la storia dei materiali, il punto di vista del designer, dell'ingegnere e dello scienziato. La fonte del loro metodo di registrazione e comunicazione per ogni disciplina. Il passo successivo è conoscere le figure più importanti per il design sul tema del linguaggio tra le discipline. Diviso in due gruppi; scienziato, che significa figure al di fuori della disciplina del design, nel ruolo dello scienziato come Ashby o di una figura intermediaria come Beylerian.
Anche una scelta tra designer. Poiché questa ricerca è svolta dal campo del designer, la scelta include un teorico e critico del design, Manzini. E un gruppo di designer che hanno fatto un passo avanti nel discorso dei materiali e della collaborazione tra le discipline.
Indagare la storia della metodologia della scienza. Come si è creato e si è arrivati a questi risultati e da dove e come inizia la differenza del metodo scientifico. metodologia progettuale e percorso della disciplina progettuale. E il suo approccio ad Ashby.

2.1 Actors of the engineering approach: the scientists

With the industrial revolution the Arts and Crafts movement was born. where he develops the thought that the artistic-creative process is not an end in itself, but begins to be adapted to the creation of objects of common use, are the possibilities offered by new production systems and the progress in the use of materials, in artisan form or a serial production.
According to many critics and historians of design, the birth of design was with the activity of the AEG company, in the early twentieth century. AEG was founded with the production of electricity, with the purchase of some patents from Thomas Edison.
but it was the first manufacturing company in everything: it designed from factories, to products, to communication.
Throughout history, the discipline of design has always been accompanied by engineering and science, as the input for design, with their technology, material and any innovation.
The role of the scientist or engineer has always been accompanied by designers in the history of industrial design.
Among the scientists and engineers who have collaborated with designers, in the last decade we can nominate Ashby and Beylerian as two important figures in the field of materials, who are the initiators to develop and create a comprehensive view for the material field in design and project.

The background of Ashby and Beylerian

Michael Farries Ashby

Ashby born in 1935, He is the son of the leading botanist and educator Lord Ashby.
He was educated at Campbell College in Belfast and the University of Cambridge where he studied the Natural Sciences Tripos as a student of Queens' College, Cambridge. He received his Bachelor of Arts degree in Metallurgy in 1957 (First Class Honours); his Master of Arts degree in 1959 and his PhD in 1961.
During his studies he won medals and scholarships, CBE (Fellow of the Royal Academy of Engineering), FRS (Fellow of the Royal

Society), FREng (Order of the British Empire), for his services and study in different years of his research.

Michael Ashby's early work illuminated problems in materials science. He does very useful work in the field to engineers, metallurgists, ceramists and geologists, including dispersion hardening, the migration of particles through solids, dislocation nucleation, diffusional creep, grain boundary sliding, the deformation of cellular structures using physical insight to guide experiments and mathematical modelling. He has pioneered the important and fruitful concepts of deformation and fracture maps, which display in a single field the area of dominance of specific flow and fracture mechanisms.

In the last decade, his focus has been on systematic methods for materials selection to meet criteria of engineering design, environmental stewardship and sustainable development.
He served as Royal Society Research Professor, and a Principal Investigator at the Engineering Design Centre at the University of Cambridge. He is known for his contributions in Materials Science in the field of material selection.

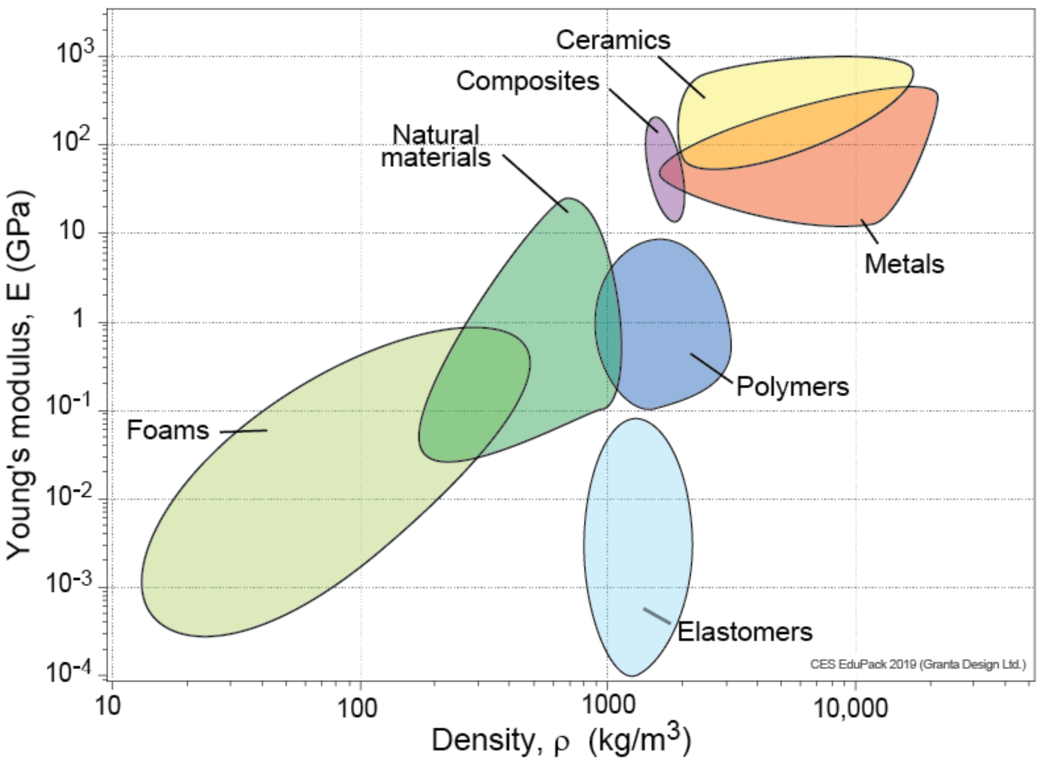
By conducting numerous studies on the active deformation mechanisms under different temperature conditions, M.F. Ashby developed a graphical approach for determining these mechanisms. He generalizes this approach to the broader field of material selection by developing the software CMS(Cambridge Materials Selector)in collaboration with David Cebon, with whom he co-founded Granta Design Limited. He also collaborated extensively with Yves Bréchet (CNRS Silver Medal). He continued to work on the software to improve its pedagogical value across Materials Education (CES EduPack - used at more than 1000 universities worldwide and value to industry (CES Selector). This software is currently available from the company Granta Design, of which he is the chairman.

Here Ashby explains in his graphic diagrams, one of his achievements in the field; "Information can be more densely packed in diagrams and images that show relationships. Phase diagrams relate the regimes of stability of competing alloys. Micrographs reveal structural similarities between differing materials, suggesting, perhaps, that a heat treatment used for one might be effective

for another. Deformation mechanism maps relate the regimes of dominance of competing deformation mechanisms. Material property relates to a population of materials in material property space, a space with many dimensions. Each of these captures a vast amount of information and compresses it into a single image, revealing patterns in the data that words and equations do not.
It is here that they become a tool not only for communication, but also for reasoning.
“ The power of the visual image lies in the ease with which it can be manipulated by the mind and its ability to trigger creative thought.” (Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design')

image 2.1:
Young's Modulus vs Density

1.



Ashby has revolutionized the approach to the selection of materials to take into account four aspects: feature, material, geometry, and processes; moreover, he worked with the division in classes and subclasses. In doing so he has developed a comprehensive approach that associates to the expected mechanical functions of an object a performance index that has to be optimized. These indices allow us to better take into account all the properties required of a material, such as specific stiffness (ratio between the elastic modulus and density) instead of a single elastic module. His approach allows one to rationally choose the most suitable materials for each application.

In practice, this approach firstly asks to identify the performance index starting from the expected function and geometry. Then it is possible to select thresholds for certain properties in order to select the most useful materials from those present in a database that has some 80,000 materials. The division into classes allows pre-selecting representative materials and therefore working only with certain classes of materials. Finally, the selected materials are shown in a 2-dimensional chart, called the Ashby diagram, in order to view those with the highest performance index. These diagrams often also contain nanostructured materials and composites.
In more recent years he has concentrated on materials and the environment and sustainability, writing award-winning textbooks and pioneering teaching methods to get this complex topic across to engineering students. He has been honored by the American Society of Engineering Education by having a teaching prize named after him.
Ashby has achieved remarkably innovative work in the areas of materials, design, and sustainability as well as in that of pedagogy.

George M. Beylerian

He was born in Egypt in 1935. He grew up in a merchant family and finished his study in commerce at New York university. He married a designer student, Luisa, thanks to her and her colleagues, Beylerian has set up her new business.

In1964 Beylerian opened Scarabaeus, an innovative retail gallery in Manhattan offering new ideas in home furnishings and decorative accessories,with an emphasis on modern, cutting-edge products.

But as he confesses *"My first thing was to open a store, but I had already engaged myself towards design people and artists. They came with their creations and things. I managed them and their career. I guided them towards making products. I didn't have an experience either, except I had the shop, which was a testing ground."*(Arkitektur Assembly,...) Although he was in contact with designers and artists, the business was his target, in his path he found his passion.

Later he was in the Italian design show at MOMA, where He got a lot of good connections, then he traveled in Italy and eventually including Kartell, which is the plastic furnisher language. He took the license and started manufacturing in America, under both names, Kartell by Beylerian.
His next enterprise, The Beylerian Collection, was a wholesale line of colorful, luxurious, and exotic accessories designed by architects, industrial designers, craftsmen and artists. These products are now widely recognized as having awakened the American market to Italian design, including stylish, plastic home furnishings.
Beylerian turned his attention to contract furniture, specifically focusing on high-end imports from Italy. Steelcase bought his company in 1987, beginning a long and fruitful collaboration between the two. When Steelcase established the Steelcase Design Partnership, Beylerian was named Creative Director and became responsible for creating the image of its boutique furniture, textile, and accessory companies. Among Beylerian's noteworthy efforts were the highly acclaimed exhibits: Industrial Elegance, Women of Design, Communicating Ideas Artfully, Chairmania, Mondo Materialis, Edible Architecture: Delicious, Designs, and Work, Life, Tools.

In 1994, Beylerian founded Culture & Commerce, a design consultancy widely recognized as today's leading design management agency in the U.S. From product design to boutique hotels, Culture & Commerce connects its designers (including Yves Behar, Dror Benshetrit, Milton Glaser, Sami Hayek, Piero Lissoni, MIO, Paola Navone, Philippe Starck, Marcel Wanders and Lenny Kravitz) to a diverse array of projects. From limited collections for TARGET by Starck, MIO, and Hayek, and Rosenthal's best-selling Vase of Phases to the first designer mouse for Microsoft, Culture & Commerce continues to orchestrate some of today's most exciting design partnerships. In 1997, Michele Caniato was appointed President of the Company.

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It was in these years that Beylerian began to think of another type of business, certainly it was a next step from Culture & Commerce. Beylerian had been given a space in that building to launch Material Connexion. *"The company liked the idea enough and they knew it would bring people, architects, because in the olden days, the central focus of where architects came was in the '40s and '50, like Madison Avenue and ... Again, all those companies that were there, whether it was AI, Cassina, and all, were there because that was the place to shop* *for high end furniture."* (interview Arkitektur Assembly, DESIGN IN MIND: GEORGE BEYLERIAN)

In 1997-2011 one of Beylerian's most outstanding contributions was as Founder and CEO of Material ConneXion, which he established in 1997. This unique Materials Library and Consultancy is today the world's leading global material consultancy and materials library, with locations in New York, Cologne, Milan, Daegu ans Seoul in South Korea, Bangkok, Beijing, and Shanghai. Established for use by architects, designers, engineers, artists, manufacturers and entrepreneurs, the library features samples of more than 6,500 materials, with 45-60 new materials added monthly. The consulting team advises clients in every area of design, from BMW and Target to Proctor Gamble and Steven Holl Architects, on materials strategy, sustainability, performance and aesthetics. Committed to educating the next generation of designers, Material ConneXion's academic programs provide over 150,000 students worldwide with access to materials knowledge via Material ConneXion's online database and libraries. Of equal importance is the necessity to create vibrant dialogue on materials and design. As such, Material ConneXion presents exhibitions, workshops and conferences on a diverse array of material-related topics, and publishes MATTER, a quarterly magazine on materials and design.

The new materials are selected each month by an international and interdisciplinary jury, among the many contents directly from companies or researched by complete technicians.
The materials, once chosen, are entered in the on-line database and physically both in the New York headquarters and in those in Milan and Cologne and become the most interesting product innovations from the point of view of innovation, technical characteristics and application possibility.
The Material ConneXion Libraries host materials divided into eight categories: polymers, metals, glasses, ceramics, carbon-based materials, cement-based materials, natural materials and those derived from natural materials.

In 2011 he sold two beloved companies, Material ConneXion and Culture + Commerce, he has developed a new company with Design Ideas called DESIGN MEMORABILIA where he celebrates industrial designers from the 20th and 21st centuries worldwide.
Timely yet commemorative, Design Memorabilia's inaugural

collection, aptly named de Gustibus, is at once forward-thinking in its mission and preservationist in spirit. Coinciding, both thematically and timing-wise, with the 2015 Expo Milano, the collection presents new and old tabletop design,some reissued, others slightly reimagined, from thirtytwo notable designers (living and dead), most of whom are Italian, or have worked and lived in Italy. The line first debuted in July at the MoMA SoHo Design Store, reviving several past pieces while introducing new ones, from designers such as Tobia Scarpa, Paola Navone, Frederica Marangoni, Aldo Cibic, and Roberto Sambonet.

Over the years, Beylerian worked in differents activity , entrepreneur, curator, collector, among others, in this new project has given him the opportunity to resume that of merchant, a title of which he is particularly fond, by teaming up with old colleagues to develop beautiful products at a reasonable price point, while paying homage to Italian design. For him italian designer and design was the beginning of his activity, how he said “My early years in business took me to Italy, and that really forced things because Italy is full of design and creativity.”
In this project Beylerian relives Italian design, doing his trade as a merchant enjoying the companion of his friends, present it to young generation, who maybe don't know the old italian design, making a revival of design from Beylerian's point of view, as he himself explains his project “I Revisited things I was doing fifty years ago as a young man. First, was one of the pieces in the collection by Ettore Sottsass,those are the square bowls with the round cup, I used to sell them in my store in 1967, and for the same price as now after all these years,” Beylerian explains. “There was a lot of symbolism and emotional implications in many of these pieces.”
Or In the case of Anna Castelli Ferrieri’s Cirri Cookie and Cake Stand, Beylerian decided to bring the piece, first produced in 1991 for Sambonet Italy, back to life. This time, it is made of ABS plastic instead of silver, yet still retains its delicate, lace-like form. Only now the stand is being sold at “one tenth of the price” Beylerian says. “Like I say sometimes, there is a time and place for everything. It was probably designed too early or it was designed too precious and the market wasn’t there for the precious category.”(modern magazine, By NICOLE ANDERSON | February 4, 2016)

Awareness of collaboration

The discipline of design has always been a collaborative work between scientists, engineering, artist, designer, biologist, etc.
Lately the disciplines that always work together in the field of design have had a conscience of the need for a close collaboration in order to have the best results.

At the time this collaboration was more between engineering and materials science. But with advancement of science in different fields, innovations in disciplines, this collaboration on disciplines such as biology, medicine, biomechanics and many others. Speech is that the definition of the sciences is no longer an area with borders with precise lines. With the acquisition of sciences and innovations, the disciplines look like branches of plants that as they grow, meddle and create a wonderful and fascinating wood for users.

Only revealing this type of cooperation is something a little new in the communication of the product registration, perhaps also because this collaboration is circular, it is not linear as it once started from a scientific, material or technology project, and applied in the design to a bilateral contribution with a common final goal.

Modern meadow

Modern Meadow was born from the belief that "the multidisciplinary collaboration between design, biology and materials science can lead to smarter methods of producing evolved materials, inspired by nature and based on the essential elements of life on our planet: cells, DNA and proteins. modified“.
From this design and applied research studio, based in Brooklyn, the Zoa brand was born, which represents a family of innovative materials based on a collagen protein studied ad hoc in the laboratory of the US company.

The son of a theoretical physicist turned bioengineer, Andras Forgacs, the founder of Modern Meadow. Andras’ passion for science came from his father, Gabor Forgacs, who was a pioneer and innovator. A lifelong physicist, Gabor was one of the first to apply the frameworks of physics to understand biological phenomena such as how embryos develop and organs form. Around 2006, Gabor was pursuing some of the most interesting work of his career: developing a form of biofabrication called bioprinting. This innovation in 3D printing of human tissue led Andras and his father Gabor to partner with Keith Murphy and Eric David,other co-founders, to create the company Organovo (meaning “new organ”).

Driven by the lack of sustainable material alternatives, in 2011 Andras and Gabor pulled a small scientific team together to form Modern Meadow. The company’s goal was to look at the starting point for the creation of bio fabricated materials, which is proteins. Since its inception, Modern Meadow has experimented with several different biofabrication processes and has evolved its approach to creating materials which support sustainability while also prioritizing performance, aesthetics and accessibility.

Modern Meadow’s co-founder and chief executive Andras Forgacs was named to Crain’s New York Business 40 Under 40 list in 2016, and the company was recognized by the World Economic Forum as a 2018 Technology Pioneer. In 2017, it was announced that Modern Meadow had plans to develop the “world’s first biofabrication leather;” the company displayed a prototype T-shirt made from the material at the Museum of Modern Art in an exhibit, “Items: Is Fashion Modern,” until 2018.

In 2017, Modern Meadow relocated its headquarters to a 72,900 sq ft state-of-the-art laboratory in Nutley, New Jersey, having outgrown their previous location in Sunset Park, New York. The company also established a design and applied research studio at New Lab in the Brooklyn Navy Yard.

2.2. Actors of the design approach: the designers

For architects and designers, the challenge of using a new material is both exciting and terrifying. With a new material comes risks and uncertainties; it could fail to perform, discolour, create a chemical reaction or even disintegrate over time. Introducing a new material means evaluating its impact on the environment and the likelihood of developing an alternative construction process. Even though new materials require investment and experimentation, the possibilities that they present make it well worth the effort.

There are two ways that new materials are created in a scientific laboratory, for a request with the precise properties and characteristics, while trying to make a material with these characteristics, a group of materials that are not their target are created, a different color, resistance, texture, shape, duration in time, but due to the diversity in the characteristics they can be useful in different fields of design, architecture, art or others. So this is where the role of designer on the journey of creating a material can be a step towards a bilateral collaboration

And so the designers began to study and work precisely with material in the field of scientists and collect information and documents of the relationship between material and design not as a component and tool but as an important axis between the world of materials science and design.

Ezio Manzini

Manzini is a critical and theoretical designer on the subject, one who more than designing products, dedicated his life to study and criticize the discipline and the world of design, the role of material and innovation in this field and create environments to grow a new generation of designers connected to the world of design in the future.

Ezio Manzini was born in 1945. He studied at the Politecnico di

Milano where he later joined the faculty. During his time at the school, Manzini worked on several international research projects including co-ordinating the Unit of Research DIS (Design and Innovation for Sustainability), the Doctorate in Design and, later, DES: (Design dei Servizi) the Centre for Service Design in the Indaco (Industrial Design, Arts, Communication Department).

Manzini is an author on sustainable design. Throughout the 1980s and 1990s his research focused on the design of materials and strategic design. He wrote on topics such as scenario building toward solutions that encompass environmental and social quality; innovative processes in the system of production and consumption; and the relationship between product strategies and environmental policies from the perspective of sustainable development. Though he is perhaps most well known for his work on design for social innovation. In the 2015 book, Design, When Everybody Designs, Manzini provides an overview of the way design has been deployed in the social innovation space to guide transition to more sustainable practices. The book explores the role of diffuse and expert design, it describes the concept of cosmopolitan localism, and Manzini's Small, Open, Local, and Connected (SLOC) scenario.

In addition to his time at Politecnico, Manzini was the Director of Design and Vice-president of the Domus Academy in the 1990s, and Chair Professor of Design under the Distinguished Scholars Scheme at Hong Kong Polytechnic University in 2000. at the same time starting specific courses in Service Design in thePolitecnico in Milan.

He has received honorary titles at several universities including Honorary Doctor of Fine Arts at The New School of New York; Honorary Doctoral of Arts at Aalto University, Honorary Doctor and Chair Professor of Fine Arts at The New School and Goldsmiths, University of London; Honorary Professor at the Glasgow School of Art; and Fellow at the Australian Centre for Science, Innovation and Society at the University of Melbourne, Guest professor at Tongji University and Jiangnan University and presently Distinguished Professor on Design for Social Innovation at ELISAVA.

In 2009 Manzini founded DESIS, an international network of schools of design and other design-related organizations specifically active in the field of design for social innovation and sustainability, which he founded and coordinated.

Here we would see a small crop of designers, who work and study the field of materials as a ground for cultivating the results sown with the designer's purpose. The materials known and experienced with their designers.

Example

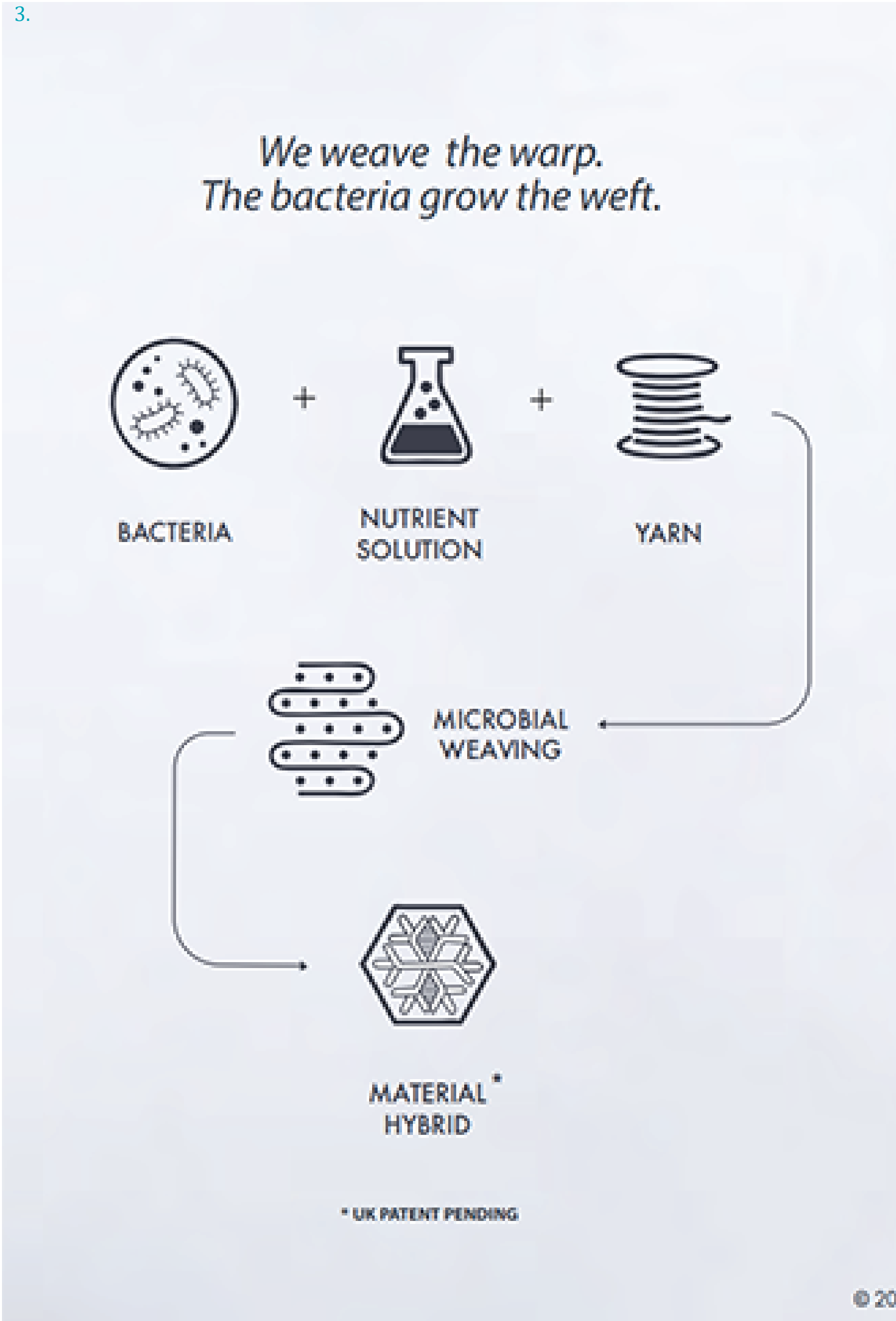
Jen kean

Jen Keane examines how microbes such as bacteria and yeast can be used to develop a new generation of hybrid materials. Her project, This is Grown, manipulates the growing process of k.rhaeticus bacteria to form a new type of microbial weaving. The resulting material is strong, lightweight and potentially customizable, with Keane developing a trainer prototype from the material. As humankind's impact on the environment intensifies, eco-conscious fashion brands are exploring bio and synthetic materials as more

2.

image 2.3:
Jen kean project

3.




19 Jen Keane All Rights Reserved

sustainable alternatives. However, as innovation in the field continues, Jen Keane questions whether we are collaborating with nature or controlling it.
She is a designer and creative researcher working in between the disciplines of design and science, technology and craft. Inspired by notions of sustainability, and fascinated with new digital and biological tools, she is exploring how these technologies could be employed to design a new generation of hybrid materials, and perhaps change our approach to making them altogether.
The Netherlands Designer Hella Jongerius, born in 1963, combines the traditional with the contemporary, the newest technologies with age-old craft techniques. She aims to create products with individual character by including craft elements in the industrial production process.

Hella Jongerius

In 1993, after graduating at the Academy of Industrial Design in Eindhoven, she founded the Jongeriuslab studio, where independent projects are developed as well as work for major clients, including the upholstery fabric company Maharam, the interior design of the Delegates' Lounge of the United Nations Headquarters in New York, cabin interiors for the airline KLM and the installation 'Colour Recipe Research' at the invitation of curator Hans Ulrich Obrist for the MAK (Vienna). Since 2012, Jongerius has served as Art Director for the rug company Danskina and since 2007 as Art Director of colours and materials for Vitra.
Recent projects include the publication of the book 'I don't have a favourite colour' for Vitra (2016), the exhibition 'Breathing Colour' on her colour research for the Design Museum London (2017) as well as an exhibition and an accompanying publication 'Beyond the New. On the Agency of Things' with Louise Schouwenberg for the Pinakothek der Moderne, Die Neue Sammlung Munich (2017).
Many of Jongerius' products can be found in the permanent collections of important museums (such as MoMA, New York, and Victoria and Albert Museum, London, and Boijmans van Beuningen Museum, Rotterdam).

Finding expressions that describe her approach is sometimes difficult, because many of her works straddle the divide between

tradition and innovation, or move between playful irony and heavyweight ideas. Jongerius' designs have been made from a vast repertoire of materials, ranging from polyurethane, latex, foam and plastics, to steel, felt, porcelain, glass, bronze and gold. But irrespective of her choices of media and sources of inspiration, the stylized objects that result from Jongerius' designs are beautiful tools for modern life, crafted in forward-thinking designs that help to bridge the gulf between everyday functionality and ideals of comfort, efficiency and beauty.
For almost fifteen years, Jongerius' work has been strongly rooted in concepts, ranging from subtle poetic statements to self-assured declarations that boldly outline a new rationale for design. I'm certainly not unique in making designs that realize ideas, Jongerius says. 'In fact, one of the things I noticed when I first became a designer was how everything seemed to rotate around the concepts already underpinning design. That made me want to pare every product down to the bone, so I did, asking myself what they were for, what history clung to them, and what ideas lurked beneath our understanding of them. As a result, I completely undressed the products. It may not have led me to discover any real meanings in them, but it meant that I could see what the materials were really about.

Neri Oxman

Oxman was born in 1976, in Israel. Her parents are both architects. Her younger sister, Keren Oxman, is an artist. She grew up between nature and culture, spending time in her grandmother's garden and her parent's architectural studio.

She entered Hebrew University's Hadassah Medical School. After two years, she switched to studying architecture at the Technion – Israel Institute of Technology, and then at the London Architectural Association School of Architecture, graduating in 2004.

In 2005, she moved to Boston to join the architecture PhD program at MIT, under adviser William J. Mitchell. Her thesis was on material-aware design.
In 2010, she became an associate professor at MIT in the MIT Media Lab as the Sony Corporation Career Development Professor (so named as the position is funded with a grant from Sony).

Oxman's work has been displayed around the world, with pieces in the permanent collections of the Museum of Modern Art, the Cooper Hewitt Design Museum, the Centre Georges Pompidou, Vienna's Museum of Applied Arts, SFMOMA, and Boston's Museum of Fine Arts and Museum of Science.
Exhibits have also been shown at the Smithsonian, and the Beijing International Art Biennale and in 2020 a major retrospective of Oxman's work opened at the Museum of Modern Art.

She published papers on parametric and contextual design, and developed specific engineering techniques to realize those designs in various materials. In 2006, she launched an interdisciplinary research project at MIT called material ecology, to experiment with generative design.
Material Ecology is a design philosophy, research area, and scientific approach that explores, informs, and expresses interrelationships between the built, the grown, and the augmented. With Material Ecology, Oxman has pioneered a field that promotes previously impossible opportunities for design; informing how buildings and products are made and how their shape and material composition may perform in harmony with the ecosystems they inhabit.
This project and related collaborations informed her early art. She has promoted the idea of finding new ways to communicate about and collaborate on design. In 2016, she helped launch the open multidisciplinary Journal of Design Science.

She has appeared on the covers of Fast Company, Wired UK, ICON, and Surface magazine.Her work is mentioned as an inspiration for changing how materials and structures are designed, and her artistic works were described by Andrew Bolton as "otherworldly, defined by neither time nor place".

On becoming a professor in 2010, Oxman founded the Mediated Matter research group at the MIT Media Lab. There she expanded her collaborations into biology, medicine and wearables.
The Mediated Matter group focuses on Nature-inspired design and design-inspired Nature. They conduct research at the intersection of computational design, digital fabrication, materials science, and synthetic biology, and apply that knowledge to design across scales, from the micro scale to the building scale. They create biologically inspired and engineered design fabrication tools and technologies

and structures aiming to enhance the relation between natural and man-made environments. Their research area, entitled Material Ecology, integrates computational form-finding strategies with biologically inspired fabrication. This design approach enables the mediation between objects and environment; between humans and objects; and between humans and environment.

These designers are not the first to collaborate and design their material for the project. But the difference between this generation and that of art deco or Bauhaus is precisely the source of the material, it is the discipline that is working and the way of collaboration. The collaboration between the figure of presenting the new material and the figure of the designer has always brought a period and a permanent masterpiece. But today it is the difference in the role of the designer to create a new material or use of a technology that changes the way of collaboration between disciplines.
It is the method of working, following the project from creating a material to creating a project, which changed the collaboration, the language, and the path of design in the world of design with other disciplines.

4. Neri Oxman, and her team, Mediated Matter, utilise unique multi-material 3D printing technology to create a customized 3D printed mask for Björk's Tokyo performance.
Inspired by Björk's most recent album, "Vulnicura", Oxman and his team used 3D scans of Björk's face to create digital interpretations of his bone and tissue structure, with the custom design brought to life with the unique multi- Stratasys color material 3D printing technology.

5.6. The Wanderers collection, An Astrobiological Exploration:
No field remains excluded from the research field of the team that arrives on the catwalk with the Wanderers, An Astrobiological Exploration collection. Garments made to allow humans to obtain nutrients from their clothes and live in hostile planets or environments. Like a second skin, the works are inspired by the human body and contain cyanobacteria, which transform light into sugar and Escherichia which make sugar a useful biofuel for humans. Bioluminescent organisms, bees, plant and animal structures become accomplices of human productions. In the Neri team, organic design reaches an advanced level, which goes beyond the imitation of nature to collaborate alongside it, in view of a tomorrow - which is increasingly today - which requires sustainable perspectives and a collective effort.
To the new opportunities in the means of production, it is essential


5.

to combine a methodological rethinking - says the designer - which sees in the encounter between science, biology, design and art the formula to accelerate the change that our planet is asking for.

7. Aguahoja:
Ia matter-organism made of biopolymeric compounds that captures carbon dioxide, improves pollination, increases soil microorganisms and provides nutrients. The additional characteristics - the patterns, the shapes, the colors of the surface, the various mechanical, optical, olfactory and gustatory properties - can be achieved through organic waste streams and therefore without interfacing with ecological niches.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2.3 Two peculiar approaches: Beylerian and Ashby

The scientific method

The term "scientific method" can be used to refer to significantly different concepts.
On the one hand, the scientific method can be understood in an abstract sense, as the set of criteria on the basis of which a result, theoretical or experimental, can be considered effectively scientific and must be accepted as such by other scientists and the state in general.
On the other hand, the scientific method can refer not to the characteristics on the basis of which a certain result is considered scientific but to the path concretely followed to achieve the result itself and therefore refer more exquisitely to the daily and concrete practice of the scientist, or at least to the practice adopted by the scientific community as a whole, in its research activity.

There are different shades of meaning related to the concept of scientific method, there has been much discussion and there is still no generally shared agreement on a possible definition of the method applicable to all "scientific" disciplines.

The scientific method involves formulating hypotheses, via induction, based on such observations; experimental and measurement-based testing of deductions drawn from the hypotheses; and refinement (or elimination) of the hypotheses based on the experimental findings. These are principles of the scientific method, as distinguished from a definitive series of steps applicable to all scientific enterprises.

The scientific method also defines an experimental-deductive method. Though , it could be said that scientists of each discipline are interested in defining the methodologies applicable to their field, indispensable for a contribution to be called "scientific" and used by the community of peers.

The history of scientific method

The history of scientific method considers changes in the methodology of scientific inquiry,
as distinct from the history of science itself. The development of rules for scientific reasoning has not been straightforward; the scientific method has been the subject of intense and recurring debate throughout the history of science, and eminent natural philosophers and scientists have argued for the primacy of one or another approach to establishing scientific knowledge. Despite the disagreements about approaches, scientific method has advanced
in definite steps. Rationalist explanations of nature, including atomism, appeared both in ancient Greece in the thought of Leucippus and Democritus, and in ancient India, in the Nyaya, Vaisesika and Buddhist schools, while Charvaka materialism rejected inference as a source of knowledge in favor of an empiricism that was always subject to doubt. Aristotle pioneered the scientific method in ancient Greece alongside his empirical biology and his work on logic, rejecting a purely deductive framework in favor of generalizations made from observations of nature.
Some of the most important debates in the history of scientific method center on: rationalism, especially as advocated by René Descartes; inductivism, which rose to particular
prominence with Isaac Newton and his followers; and hypothetico-deductivist, which came to the fore in the early 19th century. In the late 19th and early 20th centuries, a debate over realism vs. antirealism was central to discussions of scientific method as powerful scientific theories extended beyond the realm of the observable, while in the mid-20th century some prominent philosophers argued against any universal rules of science at all.

There are few explicit discussions of scientific methodologies in surviving records from early cultures. The most that can be inferred about the approaches to undertaking science in this period stems from descriptions of early investigations into nature, in the surviving records. The early Babylonians and Egyptians developed much technical knowledge, crafts, and mathematics used in practical tasks of divination, as well as a knowledge of medicine, and made lists of various kinds. While the Babylonians in particular had engaged in the earliest forms of an empirical mathematical science, with their early attempts at mathematically describing natural phenomena, they generally lacked underlying rational theories of nature.

Greek-speaking ancient philosophers engaged in the earliest known forms of what is today recognized as a rational theoretical science, with the move towards a more rational understanding of nature.

In ancient Indian philosophers of the Nyaya, Vaisesika and Buddhist schools, the Cārvāka epistemology was materialist, and skeptical enough to admit perception as the basis for unconditionally true knowledge, while cautioning that if one could only infer a truth, then one must also harbor a doubt about that truth; an inferred truth could not be unconditional.

Towards the middle of the 5th century BCE, some of the components of a scientific tradition were already heavily established, even before Plato, who was an important contributor to
this emerging tradition, thanks to the development of deductive reasoning, as propounded by his student, Aristotle. In Protagoras (318d-f), Plato mentioned the teaching of arithmetic, astronomy and geometry in schools. The philosophical ideas of this time were mostly freed from the constraints of everyday phenomena and common sense. This denial of reality as
we experience it reached an extreme in Parmenides who argued that the world is one and that change and subdivision do not exist.

In the 3rd and 4th centuries BCE, the Greek physicians Herophilos (335–280 BCE) and Erasistratus of Chios employed experiments to further their medical research; Erasistratus at one time repeatedly weighing a caged bird, and noting its weight loss between feeding times.

Aristotle's inductive-deductive method used inductions from observations to infer general principles, deductions from those principles to check against further observations, and more cycles of induction and deduction to continue the advance of knowledge.
Aristotle introduced what may be called a scientific method. His demonstration method is found in Posterior Analytics. He provided another of the ingredients of scientific tradition: empiricism. For Aristotle, universal truths can be known from particular things via

induction. He largely ignored inductive reasoning in his treatment of scientific enquiry.
Towards the end of the Posterior Analytics, Aristotle discusses knowledge imparted by induction.
Thus it is clear that we must get to know the primary premises by induction; for the method by which even sense-perception implan-ts the universal is inductive.
Induction is not afforded the status of scientific reasoning, and so it is left to intuition to provide a solid foundation for Aristotle's scien-ce. With that said, Aristotle brings us somewhat closer to empirical science than his predecessors.

During the Middle Ages issues of what is now termed science began to be addressed. There was greater emphasis on combining theory with practice in the Islamic world than there had been in Classical times, and it was common for those studying the sciences to be artisans as well, something that had been "considered an aberra-tion in the ancient world." Islamic
experts in the sciences were often expert instrument makers who enhanced their powers of observation and calculation with them. Starting in the early ninth century, early Muslim Persian and Arabic scientists started to put a greater emphasis on the use of experi-ment as a source of knowledge. Several scientific methods thus emerged from the medieval Muslim world by the early 11th century, all of which emphasized experimentation as well as quan-tification to varying degrees.

Arab physicist Ibn al-Haytham (Alhazen) used experimentation to obtain the results in his
Book of Optics.
Ibn al-Haytham also employed scientific skepticism and emphasi-zed the role of empiricism. He also explained the role of induction in syllogism, and criticized Aristotle for his lack of contribution to the method of induction.
Al-Haytham was regarded as superior to syllogism, and he conside-red induction to be the basic requirement for true scientific resear-ch.

The Persian scientist Abu Rayhan Biruni introduced early scientific methods for several different fields of inquiry during the 1020s and 1030s. For example, in his treatise on mineralogy, Kitab al-Jawahir (Book of Precious Stones), al-Biruni is "the most exact of experiimental scientists", while in the introduction to his study of India, he declares that "to execute our project, it has not been possible to follow the geometric method" and thus became one of the pioneers of comparative sociology in insisting on field experience and information. He also developed an early experimental method for mechanics.

The inductive and deductive method

The knowledge cycle defines the (recursive) path to reach or consolidate knowledge of a given topic. There is no universal agreement on what this path is, because its definition also depends on what is generally understood by knowledge, and this constitutes a topic for discussion of philosophy. In this regard, the debate between deductivists and inductivists is particularly heated. We now try to review the two methods, the inductive and the deductive.

The Deductive method

Deductive reasoning ("top-down logic") contrasts with inductive reasoning ("bottom-up logic"): in deductive reasoning, a conclusion is reached reductively by applying general rules which hold over the entirety of a closed domain of discourse, narrowing the range under consideration until only the conclusions remains. In deductive reasoning there is no epistemic uncertainty. In inductive reasoning, the conclusion is reached by generalizing or extrapolating from specific cases to general rules resulting in a conclusion that has epistemic uncertainty. (Jan Zi, Models of 6-valued measures: 6-kinds of information)

The inductive method

Limiting itself to the field of natural, physical and mathematical sciences, the inductive or induction cognitive cycle describes the path followed to arrive at the drafting of a scientific law starting from the observation of a phenomenon. It consists of the following steps, repeated cyclically:

Observation
It is the starting point of the knowledge acquisition cycle in the sense that it constitutes the stimulus for the search for a law that governs the observed phenomenon and also the verification that the law found is actually always respected. It is a question of identifying the characteristics of the phenomenon observed, carrying out adequate measurements, with exactly reproducible methods.

Experiments
Once predictions are made, they can be sought by experiments. If the test results contradict the predictions, the hypotheses which entailed them are called into question and become less tenable. Sometimes the experiments are conducted incorrectly or are not very well designed when compared to a crucial experiment. If the experimental results confirm the predictions, then the hypotheses are considered more likely to be correct, but might still be wrong and continue to be subject to further testing. The experimental control is a technique for dealing with observational error.
The experiment, where possible, is programmed by the observer who perturbs the system and measures the responses to the perturbations. There are experimental programming techniques, which allow you to be in the best conditions to perturb in a minimal, but significant way, in order to observe the answers in the best way.

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Correlation between the measures
The analysis of the correlation between the measures, which is placed in the cycle immediately after the observation phase, constitutes the initial part of the technical-scientific heritage that can be

Sir Karl Raimund Popper:
One of the 20th century's most influential philosophers of science,Popper is known for his rejection of the classical inductivist views on the scientific method in favour of empirical falsification.

used for the construction of the model. The raw data, which generally consists of tables of measures, can be manipulated in various ways, from the construction of a graph to the logarithmic transformation, from the calculation of the average to the interpolation between the experimental points, using the methods of descriptive statistics.

Definition of a physical model
To facilitate the task of writing the law that expresses the trend of a certain phenomenon, a physical model is mentally constructed, with elements whose functioning is known, and which is supposed to represent the overall behavior of the phenomenon studied.

Development of a mathematical model;
The mathematical model is placed at the highest level of abstraction in the cognitive cycle: the part of the cycle that deals with models is the domain of the theoretical sciences.
In general, a mathematical model is made up of several linked elements, each of which is described by an equation and characterized by the parameters that enter that equation.

The problem is according to this methodology, science would be based on the collection of observations regarding a certain phenomenon X, from which to draw a general law that allows us to predict a future manifestation of X. Put briefly, induction has no logical consistency because a universal law cannot be formulated on the basis of individual cases.

Observation problem

A similar problem is that in science it is not enough to "observe": one must also know what to observe. Observation is never neutral but is always imbued with theory, with that theory that, in fact, one would like to test. According to Popper, theory always precedes observation: even in any alleged "empirical" approach, the human mind unconsciously tends to superimpose its own mental schemes, with its own categorizations, on the observed reality.
Popper then elaborated a definition of a deductive scientific method based on the falsifiability criterion, rather than on the inductive one of verifiability. Empirical experiments can never, for Popper, "verify" a theory, they can instead disprove it. The fact that

a prediction made by a hypothesis has actually occurred does not mean that it will always happen. That is, for the induction to be valid, infinite empirical cases would need to confirm it; since this is objectively impossible, any scientific theory can only remain in the status of conjecture.

What is important here for us and Popper also points out in his proposal in the inductive argument that there are several observations.
Already at this point there is a very clear branch in the scientific method and the reason for the difference between the inductive-scientific and inductive-design method.
The way of observing the phenomenon from a scientist and a designer is very different, for many reasons, such as a scientific or artistic point of view, for the purpose of observation, and interest.

Originated from a diversity of mathematical and artistic thought. As we talked about in the first chapter, the mathematical thought that is the result of years of study in the field of science radically changes the mentality of each person with a scientific approach.
On the other hand, the study and the need for attention to sensory expression in the design discipline brings a mentality and subsequently a more careful and precise observation on the subject of user experience and perception and its culture. (we speak in the field of materials)

However, having two different mentalities of observing, with the same method of research and work, the designer and the scientist have different results and reasoning.
Moreover, the different method of recording data and results from the same field of experimentation results in two similar but different languages for each discipline.

Ashby and others approach

It is Ashby's own mathematical and engineering approach that involves reasoning other than Beylerian andand even more with another designer like Manzini and Oxman. Even though he has worked for years in this field and is so close to the methodology of designers but still reasoned like a material scientist.

Logical positivism, also known as neo-positivism, neo-empiricism or logical empiricism, it is a philosophical current that arose in the first half of the twentieth century with the Vienna Circle, based on the principle that philosophy should aspire to the methodological rigor of science.
As can be deduced from the name, at its base are the typical concepts of the scientific method of "empirical", that is related to experience, and "logical", since its supporters believe that knowledge must be analyzed according to its own logical criteria analysis of language which ensure to the propositions a precise meaning endowed with meaning

Empiricism is a theory that states that knowledge comes only or primarily from sensory experience. It is one of several views of epistemology, along with rationalism and skepticism. Empiricism emphasizes the role of empirical evidence in the formation of ideas, rather than innate ideas or traditions. However, empiricists may argue that traditions (or customs) arise due to relations of previous sense experiences..

“Technical design relies on deductive reasoning – thinking based on logic and analysis. Deductive reasoning, applied to the selection of materials, It lends itself to formulation as a set of steps, often involving mathematical analysis. Industrial design, by contrast, relies on inductive reasoning – synthesis, drawing on previous experience. Inductive methods for selecting materials use perception and visualization.” (Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)

These we need to explore more fully since they are central to the discussions that follow.

“Techniques for creative thinking work by breaking down barriers and forcing new angles of view. Some help the designer to escape from the view of the “product” as it is now, seeking to see it in new ways. Others are ways of extrapolating ideas from the past and present to envisage new solutions for the future. Still others rely on the accumulation of information that relates to design challenges, slowly building a “scaffold” of ideas that becomes, when the last pieces are in place, the framework of the new design. All require work. Creativity, it is rightly said, is 1% inspiration and 99% perspiration.” (Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)

And also how Ashby explains the designer's observation and his definition for creativity and role of material in design.
“… Conversations with designers reveal a similar syndrome: they are always alert to the possibilities offered by a shape, a texture, a material, a surface, an image that might be adapted in an innovative design. It is a characteristic not confined to product designers: fashion designers and architects also use what they have observed and their ability to manipulate it as a creative tool.
Industrial designers and engineers, like fashion designers and architects, describe their work as “creative,” implying that their best ideas are self generated, the result of a sort of inspiration. But even inspiration has its sources and methods. Discussions with designers suggest several and emphasize the central role of materials and processes in each.”(Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)

However, Ashby also underlines the diversity of method and language for the field of materials that creates a discomfort for collaboration between designer and scientist.

“ The teaching of the science and technical application of materials is highly developed and systematized, supported by numerous texts, software, journals, and conferences; there is no similar abundance of support for the teaching of materials in industrial design. Bridging this gap in information and methods is not simple. The technical terms used by engineers are not the normal language of industrial designers indeed they may find them meaningless. Industrial designers, on the other hand, express their ideas and describe materials in ways that, to the engineer, sometimes seem bewilderingly vague and qualitative. The first step in bridging the gap is to explore how each group “uses'' materials and the nature of the information about materials that each requires.” (Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)

His approach in Physics, Materials science, Engineering colored, allows one to rationally choose the most suitable materials for each application, which demonstrates his approach turns out to be the material as a final goal in a process carried out in just one perfect way.

History of design methodology

Design experience, design strategy in creative design processes and idea generation are examples of only a few aspects of knowledge necessary to understand the design process and the designers’ behaviour.
This kind of knowledge delivers the foundation for hypotheses on how designers should work efficiently and effectively. The hypotheses are the source for developing prescriptive methods that should support the designer. If we assume that designing is not an innate or purely artistic ability but is a procedure that can be taught and learned, knowledge is needed about the thoughts and actions of designers throughout the process of designing in various contexts to create methods that are aligned with their needs.

Accordingly, there are two aspects to design methodology:

descriptive and prescriptive. (Cross, A History Of Design Methodology)

In order not to face everything under discussion in the history of design methodology, let us be content with naming the past methods to arrive at the present and future methods.
"The first prescriptive methodologies were developed in the area of mechanical engineering (Hansen,1956, Kesselring, 1942) and, like the more general design methodology in design research, were developed based on abstraction and generalization of observations and experienced design activities in industry (Rodenacker 1970, VDI Guideline 2222 1973, Hubka 1973, Pahl and Beitz 1977)." (Cross, A History Of Design Methodology)

In the 1970s and 80s, the gap between the design prescription in the design methodology and the way it is perceived and experienced, the machine language, the behaviorism, the constant attempt to fix the whole life in a logical frame, has identified a participatory process in which designers partnered with problem owners (customers, clients, users, the community) and the need for psychological aspects to be included in the creation of a field of engineering design that is close to practice.

Perhaps a third generation of the 1990s might be based on a combination of the previous two; or, as in the model proposed by Cross (1989), on understanding the commutative nature of problem and solution in design. The last decade has been notable for the development of product quality assurance methods.

There has been significant new work on problem 'types', for example by Schon and by Oxman.

A new approach to cognitive design theory. Schön formulated his view on design in terms of "reflective activity" and related notions, especially "reflective practice", "reflection-in-action", and "knowing-in-action". We interpret the activities underlying these notions as forms of what situativity authors have qualified as "situated action" and "situated cognition". In "reflection-in-action", "doing and thinking are complementary.
Doing extends thinking in the tests, moves, and probes of experimental action, and reflection feeds on doing and its results. Each feeds the other, and each sets boundaries for the other" (Schön,

design as a reflective practice)

For Schön, design was one of a series of activities in domains that involve reflective practice: City planning, engineering, management, and law, but also education, psychotherapy, and medicine. As he says it, “the designer constructs the design world within which he/she sets the dimensions of his/her problem space, and invents the moves by which he/she attempts to find solutions.” (Visser, SCHÖN: design as a reflective practice)
or
Neri oxman with design intersection of technology and biology.
Oxman has developed new ways of thinking about materials, objects, buildings, and construction methods, also created a new frameworks for interdisciplinary and even interspecies collaborations for brings together materials science, digital fabrication technologies, and organic design, to create new possibilities for the future, what she calls “material ecology".While individually these works are beautiful and revolutionary, together they put forward a new philosophy of designing, making, and even unmaking, the world around us.

. Materials Selection and Process in Mechanical Design

. Materials and Design

. Materials and the Environment

. Materials and Sustainable Development

Michael Farries Ashby

intermediate language words

Innovation

George M. Beylerian

. Mondo Materialis

. Ultra Materials

. Material ConneXion

The Material of Invention

Neri Oxman

Environment

Nature as Inspiration

PART III

Anthological Selection

Material ecology,
Computer-Aided Design

Ezio Manzini

CHAPTER 3:

Anthological Selection

ABSTRACT

Following the names of authors chosen for this research, there will be a list of the books and articles of their research to clarify the reason and results of the studies on these notes.

Their path and growth over time and goals they have followed or changed and perhaps find the reason for their new point of view.

The aim of this thesis is language. Structure of the languages of science are the keywords that communicate the work and results of each discipline. Then choosing the fundamental keywords in the design discipline and other sciences, explaining their origin and meaning, the role they have had and the meaning they have to date. Their vocabulary and division in science.

ABSTRACT (italiao)
A seguito dei nomi di autori scelti per questa ricerca, ci sarà un elenco dei libri e articoli di loro ricerche per chiarire il motivo e risultate gli studi su questi appunti.
Il loro percorso e crescita nel passo del tempo e obiettivi che hanno seguito o cambiato e magari trovare il motivo del loro nuovo punto di vista.
Obiettivo di questa tesi è il linguaggio. Struttura dei linguaggi delle scienze sono le parole chiave che comunicano i lavori e risultati di ogni disciplina. Quindi scegliendo le parole chiave fondamentali nella disciplina design e altre scienze, spiegando il loro origine e significato, il ruolo che hanno avuto e il significato che hanno fino ad oggi. Il loro vocabolario e divisione nella scienza.

3.1 A possible critical approach: the anthological selection

This century is very eventful for the field of materials. The technologies and the knowledge and curiosity of the scientist and designer is leading the field of materials to have another gap in the discipline of materials science. An imaginable development and growth that is taking root in many other disciplines far from material science. Bringing a wonderful world for designers, artists, architects and many more.

Michael Farries Ashby

The first author chosen in this research was a material engineer with a lot of experience and work in the field of materials selection in design and planning to design. He is a scientist interested in the role of the material from the point of view of a designer. Micheal Ashby is a scientist that all designers know or have used his methods and diagrams to select materials or to know the most suitable material for their project.

Ashby, at the beginning of this century, in his research path and in his publications, after years of study and work on the science of materials and the behavior of materials and their chemical-physical characteristics, begins to have a special attention on the subject of design, materials and the product in design.

In these years, he already publishes the clearest ideas on the subject of materials and the relationship between the selection of materials with aesthetic attributes as well as technical attributes of materials, making products delightful as well as functional.

Ashby as an engineering figure has worked extensively in the design field, explaining and emphasizing another aspect and purpose of design to engineers. By analyzing the design process differently, he approaches the design discipline to the point that his studies and diagrams are known and appreciated by the designers. And his

books have become a source of information for these disciplines to get to know the point of view of the designer and engineer in the design process. His books illustrate the model followed by designers to design and their methodology, which for this research creates a perfect figure to be able to talk about design and material in the design discipline with the language of designers from the engineering point of view and the scientist's thinking.
He walks on a line between the discipline of design and that of materials science to prepare the design engineer. A path that is not exactly interdisciplinary but that created a generation with an interdisciplinary mentality.

Materials Selection in Mechanical Design, 1999

In his book "Materials Selection in Mechanical Design", he expresses his opinion moving to perfect the design method and his gaze towards the physical sensory or aesthetic characteristics of the material, in a somewhat vague way, which perhaps is hidden, for to explain even more progressively the path of an engineer with the mathematical-scientific language and culture up to the language of design.
"*Materials, one might say, are the food of design.*" (Ashby,Materials Selection in Mechanical Design)
For each chapter or topic he clearly explains what the designer's thinking is, even if immediately after he enters the role of scientist with a mathematical language.
"Each material can be thought of as having a set of attributes: its properties. It is not a material, per se, that the designer seeks; it is a specific combination of these attributes: a property-profile. The material name is the identifier for a particular property-profile."(Ashby, Materials Selection in Mechanical Design)
He explains on the topic "The microscopic or microstructural shape factor" the functionality of the shape of the microstructure, how the characteristics of the material change.

His point of view on material and material structure shows his attention to the discourse of mimicry and changes in the characteristics of materials through microstructures, but as we also see in the next book we do not arrive at a free mint for natural materials or functional changes of the macrostructure or called Texture, a very broad topic towards a different future in the field of materials. his point of view is a scientist who with so much attention and important discoveries on the language of design and an intermediate language, fails to free the mind for a step closer to sensory expression and "skin materials".

"*... Efficiency can be achieved in another way: through shape on a small scale; microscopic or 'microstructural' shape…*
Many natural materials have microscopic shapes. Wood is just one example. Bone, stalk and cattle all have structures which give high stiffness at low weight. It is harder to think of manmade examples, although it would appear possible to make them." (Ashby,Materials Selection in Mechanical Design)

In this book his diagram is expressed starting from the mathematical language to facilitate understanding all the data on a kind of character in properties of materials in the same class or different class for engineers.
"The engineering properties of materials are usefully displayed as material selection charts. The charts summarize the information in a compact, easily accessible way; and they show the range of any given property accessible to the designer and identify the material class associated with segments of that range..."(Ashby,Materials Selection in Mechanical Design)
That is the same diagram that will be explained in the "Material and design" book in another way for designers.

Although Ashby in this book still speaks with the scientific and mathematical language, his path leads to writing the book "materials and design" which teaches and uses the language of design.

'Materials and Design: The Art and Science of Materials Selection in Product Design. 2002

The book "Materials and Design: The Art and Science of Materials Selection in Product Design", is his first interesting book focused in this study and analysis on the subject of materials, is all about material and design. Divided into two parts, the first part opens the topic of product design and design by working and thinking less about engineering and more about the aesthetic and pleasant aspect than

the technical and functional.
Comparing the engineering design method in history, up to those years.
Showing the strengths and weaknesses of this design process to confront it with the designer's method for functional products. With case studies that make the concept understandable.
In the second part, it summarizes and classifies the materials for their family, class, subclass and type, developing the properties of the materials. Creating the columns with a series of characteristics of the materials, that quantify their physical, mechanical, electrical etc behavior, what he names "the technical sheet".

Materials and the Environment: Eco-informed Material Choice, 2009
Materials and Sustainable Development, 2015

The second group of books that select in this thesis from Ashby are, “Materials and Sustainable Development” and” Materials and the Environment: Eco-informed Material Choice”, which he looks to a future, the future that after a few years later still, is the option and the salvation of the world from the point of view of many critics.
Where he explains the meaning of the fundamental words in this research, that are basic for the design field for the future and the path of science.

“Materials and the Environment” book is about materials and the environment: the eco-aspects of their production, their use, and their disposal at the end of life. It is also about ways to choose and design with them in ways that minimize the impact they have on the environment.

He deals with the topics that are missing in his books from the 2000s, topics such as natural materials and their role in the world of the material and the product. topics with sustainability, circular economy, biodegradable materials that we talk to each other more broadly later.

George M. Beylerian

On the other hand, George Beylerian, (how analize and take price in art and design), work deeply in the materials field.
studying design works with knowledge of user demand and the American market, evaluating design products as a functional work of art, arrives at an understanding of the importance of the role of material that follows the design process.
For a new and thirsty market for design accompanied with aesthetics and sensuality and at the same time being functional up to the right point, he discovered the importance of the position of the material on the sensory aspect of the product.

Mondo Materials: Materials and Ideas for the Future 1990

As in his book "Mondo Materials: Materials and Ideas for the Future" he tries to show the material not as a tool to objectively realize the idea, but as a fundamental ingredient to build and structure the shape of the idea and/or product.

As Beylerian explains "Mondo Materials is an exploration of materials in the built environment." the collage panel of materials created by an international group of architects, interior designers, and product designers for inclusion in an exhibition sponsored by The Steelcase Design Partnership.
it is an overall look at the next generation of design through the prism of materials.
The horoscope of the exhibition was *"think of materials you find vital and fresh, whether they are traditional or new. These may include finishes, processes or textures which inspire you. We want to present a palette which no. believe will be important in your work for the next five years. The panel you create should be in the most communicative from. What is desired is an artful collage of materials."*(Beylerian, Mondo Materials: Materials and Ideas for the Future)
This book shows us the choice of designer and architect on what materials are readily available for use by designers in the built environment and what materials are currently in vogue.

This book is therefore important in this research, it would be an analysis and a critic of the 90s on the opinion and strategy

underway by designers and their methodology of design. These presentations make Us aware of the influence of fine art in the work of architects and designers and the importance of style and fashion in determining what materials are chosen for use in buildings and products.
"*Mondo Materialis is a beautiful celebration of materials and time capsule that reflects the cultural and creative concerns of design professionals in the final decade of the twentieth century.*" (Beylerian, Mondo Materials: Materials and Ideas for the Future)
But the interesting point that even though this exhibition was a good opportunity to discolor and illustrate the innovation and all the novelty but few attendees let go, is this shows how traditional or afraid of novelty we are!

Ultra Materials: How Materials Innovation is Changing the World, 2007

Then there is the book "Ultra Materials: How Materials Innovation is Changing the World 2007" very similar to the structure of the book "material and design" of Ashby, the first part is theoretical and critical on the designer, the discipline and methodology of design. With examples of the works of designers, architects and artists who tell and illustrate their works. Their opinion of material as a primary choice, with the idea to get to the product. Proving how relevant is the appearance and sensoriality of the product that has a direct relationship with the material and its characteristics and properties.

Material ConneXion: The Global Resource of New and Innovative Materials for Architects, Artists and Designers 2005

The second part of book and the "Material ConneXion: The Global Resource of New and Innovative Materials for Architects, Artists and Designers 2005" book are the sources of materials and information about his method in individualize the materials and their properties, which use in this research to explain the key-words and his opinion on them.

As Beylerian himself relates to this need for a language and knowledge between disciplines, a database, or "a family vocabulary", we understand the urgency of knowledge and the relationship of all disciplines in correlation to the material.

“Industrial designers have the challenge to meet clients' rigorous needs. It's about performance, originality, price and quality all integrated into one hard-core assignment.
Who would believe that someone with a phobia for science, technology and chemistry would delve into a venture based on those very skills and knowledge? In 1997 I was 'driven' to create a company that would connect the world of science with the diverse audiences that seem to have a need for scientific information. Most of those people would fall into the category in which I myself belonged. I am using the past tense not because my knowledge has increased, but because I have conquered part of the anxiety caused by the vast amount of knowledge out there that is still totally foreign to me. The truth is that I can now tackle the world of technology because I am able to recognize materials through the lens of a more familiar vocabulary. This lens - and my inspiration in creating Material ConneXion - is a precious tool that uses simple vocabulary to explain the phenomena of the world of science.” (Beylerian, Material ConneXion)

Manzini, Ezio
The Material of Invention,1986

Manzini as a critical designer with the “innovative material in design” ha aperto un dialogo per i designer sul discorso dei materiali, non come un argomento didattico, come un metodo e il linguaggio, What the designer knows and uses but is not written and discussed by the designers precisely because of the method in design which is not a theoretical method but an illustrated method which in the language of communication which results in the final product. He is a voice from the discipline of design and history in the period of the growth of material in the laboratories of science.

Oxman, Neri
Material ecology, 2015

Ed dopo abbiamo il voce dei designer di futuro ad oggi, Neri Oxman, che viaggia con i suoi progetti per lanciare un design a un futuro molto più innovativo e completo with her book “Material Ecology, 2015”. working on a different ground from materials science, with an interdisciplinary hypothesis realized with success, showing to the many the new possibilities experienced by her in the discourse of new materials and interdisciplinary work.

3.2 Keywords of research

At this point the research takes the direction to show some things about the language and the method of communication between the disciplines.
The first step is to show and explain the role of the key words in the path of study and collection of the subjects and the origin of this theme. The choice of the topic; intermediate language, circular design and interdisciplinarity in the field of material, has brought the results of important fields and descriptions that have a fundamental role and guide an important part of this path.
Or they showed the problems or topics to be addressed in the path of a circular design and selection of materials in the interdisciplinary field and the communicating language between these disciplines.

"*Materials have become hip at last. Until recently, specialized knowledge of materials was an area normally left to experts or scientists, but today materials have become a source of interest and inspiration for us all. High-tech techniques, smart substances. intelligent interfaces and sensory surfaces are radically redefining the world we live in. As today's generation of materials breaks new ground, many are able to anticipate and respond to changes in the environment. Now dynamic and interactive, materials have the power to change how the human body is experienced and how the urban environment is built. Combined with the new potentials they create for industrial design and medical science, they have the capacity to transform our way of life more radically now than ever before."* (Beylerian,Ultra Materials: How Materials Innovation is Changing the World)

As we also see in Beylerian's text there are the words like technology, interface, sensory surface, Environment, are born or take life in the environment of materials. The words that open a new world in the future or have a story but continue to buy their path in the field of design and material as a novelty. These are the words that arise thanks to the knowledge and development of science and technology or for the change on the point of view.

These words are divided by the field they are entered and criticized.
The first group are those related to innovation, the words that enter the topic of the future, programs for science and the direction of research;
Technology,
Nanotechnology,
Innovation,
Intimate Environment,
Interface,
Material intelligence,
etc.

Our world is becoming stronger, faster, lighter and smarter, the words that are categorized in groups of Technology and Innovation, where it shows the definitions and explanations in different ways for the disciplines because of different thinking or different methods of design or the scientist.

As Beylerian tells the materials and the path of technology and its relationship with the human body;
"Super strong materials are engineering immersive webs and structural networks, and their ability to interface with the built environment has resulted in a fresh wave of product design as well as a novel paradigm of interwoven architecture. As materials assimilate technology, many of them also integrate software, communication devices and information exchanges. High-performance substrates are synthesized to make these materials flexible and even wearable, and imbue them with eye-catching optical effects and textures that appeal to our tactile senses."

These words are either created with new knowledge or entered into disciplines related to the material. We also have words that expand their meaning in the path of awareness in the method of its use.

Nature as Inspiration

The inspiration for the product design comes from many sources, as of course from other products and materials and processes, especially new ones. but surely nature is the richest source that has

always had its place. The mechanisms of plants or animals, the things they can do and the way they do them continue to mystify, enlighten, and inspire technical design. They are the technology that have their origins in the observation of nature. From this argument the words stand out
Mimicry,
Biomimicry,
Biomaterial,
Material ecology,
etc.

Materials and Environment

The change now is that some aspects of industrialization have begun to influence the environment on a global scale. Materials are implicated in this. As responsible materials designers, engineers and scientists, we should try to understand the nature of the problem, it is not simple, and to explore what, constructively, can be done about it. It is precisely this theme that creates an action and influence on projects and research that opens up a world with words:
Sustainability,
Environment,
Biodegradable,
Biomaterial,
Be Derived materials,
Animal-Free,
Animal origin,
Plastic-Free,
Material ecology,
etc.

Intermediate languag words

The second category is appreciated in the field of intermediate language between science and design, diversity or similarity of words in the discipline of design comparison of other disciplines.

words in the discipline of design comparison of other disciplines. Where the meaning of the word and the perception of the communicating language are important.
This group of words is inspired by the experience of designers in the scientific environment or the definition of critics and writers on the argument.
Texture,
Light,
Heavy,
Transparency,
Lighty,
Elasticity,
Resistance,
Elegant or Stylish,
Luxury,
Soft,
Surface of the material or Surface material,
etc.

3.3 Meaning of the Kwords of research

The basic definitions of this section are from the Oxford Dictionary.

Technology

Equipment, machines and processes that are developed using knowledge of engineering and science; the knowledge used in developing them. (Oxford Advanced Learner's Dictionary)

1610s, "a discourse or treatise on an art or the arts," from Greek tekhnologia "systematic treatment of an art, craft, or technique," originally referring to grammar, from tekhno-, combining form of tekhnē "art, skill, craft in work; method, system, an art, a system or method of making or doing," from PIE *teks-na- "craft" (of weaving or fabricating), from suffixed form of root *teks- "to weave," also "to fabricate." For ending, see -logy.
The meaning "study of mechanical and industrial arts" (Century Dictionary, 1895, gives as example "spinning, metal-working, or brewing") is recorded by 1859. High technology attested from 1964; short form high-tech is from 1972. (Etymology Dictionary)

Technology is the sum of techniques, skills, methods, and processes used in the production of goods or services or in the accomplishment of objectives, such as scientific investigation. Technology can be the knowledge of techniques, processes, and the like, or it can be embedded in machines to allow for operation without detailed knowledge of their workings. Systems (e.g. machines) applying technology by taking an input, changing it according to the system's use, and then producing an outcome are referred to as technology systems or technological systems. The simplest form of technology is the development and use of basic tools.

The use of the term "technology" has changed significantly over the last 200 years. Before the 20th century, the term was uncommon in English, and it was used either to refer to the description or study of the useful arts or to allude to technical education, as in the Massachusetts Institute of Technology. (G., Crabb,Universal Technological Dictionary)

The term "technology" rose to prominence in the 20th century in connection with the Second Industrial Revolution. The term's meanings changed in the early 20th century when American social scientists, beginning with Thorstein Veblen, translated ideas from the German concept of Technik into "technology." In German and other European languages, a distinction exists between technik and technologie that is absent in English, which usually translates both terms as "technology." By the 1930s, "technology" referred not only to the study of the industrial arts but to the industrial arts themselves. (Schatzberg, "Technik" Comes to America)

Technology can be most broadly defined as the entities, both material and immaterial, created by the application of mental and physical effort in order to achieve some value. In this usage, technology refers to tools and machines that may be used to solve real-world problems. It is a far-reaching term that may include simple tools, such as a crowbar or wooden spoon, or more complex machines, such as a space station or particle accelerator. Tools and machines need not be material; virtual technology, such as computer software and business methods, fall under this definition of technology. (National Science Foundation, 2002)
W. Brian Arthur defines technology in a similarly broad way as "a means to fulfill a human purpose."
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The distinction between science, engineering, and technology is not always clear. Science is systematic knowledge of the physical or material world gained through observation and experimentation. Technologies are not usually exclusively products of science, because they have to satisfy requirements such as utility, usability, and safety. (M.Sharma, A Treatise on Science Technology and Society)

Innovation

The introduction of new things, ideas, or ways of doing something.

(Oxford Advanced Learner's Dictionary)

mid-15c., innovacion, "restoration, renewal," from Late Latin innovationem (nominative innovatio), noun of action from past-participle stem of innovare "to change; to renew," from in- "into" (from PIE root *en "in") + novus "new" (see new). Meaning "a novel change, experimental variation, new thing introduced in an established arrangement" is from the 1540s. (Etymology Dictionary)

Innovation is the practical implementation of ideas that result in the introduction of new goods or services or improvement in offering goods or services. (Schumpeter, The theory of economic development)
ISO TC 279 on innovation management proposes in the standards, ISO 56000:2020 to define innovation as "a new or changed entity creating or redistributing value".
However, many scholars and governmental organizations have given their own definition of the concept. Some common elements in the different definitions is a focus on newness, improvement and spread. It is also often viewed as taking place through the provision of more-effective products, processes, services, technologies, art works or business models that innovators make available to markets, governments and society.
Innovation is related to, but not the same as, invention: innovation is more apt to involve the practical implementation of an invention to make a meaningful impact in a market or society, and not all innovations require a new invention. (Schumpeter, 1983)
Technical Innovation often, manifests itself via the engineering process when the problem being solved is of a technical or scientific nature.

Material intelligence

material (adj.)
mid-14c., "real, ordinary; earthly, drawn from the material world" (contrasted with spiritual, mental, supernatural), a term in scholastic philosophy and theology, from Old French material, materiel (14c.) and directly from Late Latin materialis (adj.) "of or belonging to matter," from Latin materia "matter, stuff, wood, timber".
From late 14c. as "made of matter, having material existence; mate-

rial, physical, substantial." From late 15c. as "important, relevant, necessary, pertaining to the matter or subject;" in the law of evidence, "of legal significance to the cause" (1580s).

intelligence (n.)
late 14c., "the highest faculty of the mind, capacity for comprehending general truths;" c. 1400, "faculty of understanding, comprehension," from Old French intelligence (12c.) and directly from Latin intelligentia, intellegentia "understanding, knowledge, power of discerning; art, skill, taste," from intelligence (nominative intelligens) "discerning, appreciative," present participle of intelligere "to understand, comprehend, come to know," from assimilated form of inter "between" (see inter-) + legere "choose, pick out, read," from PIE root *leg- (1) "to collect, gather," with derivatives meaning "to speak (to 'pick out words')."

Meaning "superior understanding, sagacity, quality of being intelligent" is from early 15c. Sense of "information received or imparted, news" first recorded mid-15c., especially "secret information from spies" (1580s). Meaning "a being endowed with understanding or intelligence" is late 14c. Intelligence quotient first recorded 1921. (Etymology Dictionary

Intelligence: the ability to learn, understand and think in a logical way about things; the ability to do this well. (Oxford Advanced Learner's Dictionary)

Engineering materials are used either for their inherent structural strength or for their functional properties. Often a feedback control loop is designed so that the mechanical response of the material is monitored and the environment that is causing such a response can be controlled. "Intelligent'', "Smart", or "Adaptive" by various researchers, e.g., Rogers (1988) and Ahmad (1988), witnesses a significant development in materials science whereby the referred-to smart material adapts itself to suit the environment rather than necessitating to control the same. In this context, development in the area of materials research aims at incorporating intelligence into engineering materials, enabling them to sense the external stimuli and alter their own properties to adapt to the changes in the environment. (Y. M. Hadad, Mechanical Behaviour of Engineering Materials)

They are designed materials that have one or more properties that can be significantly changed in a controlled fashion by external stimuli, such as stress, moisture, electric or magnetic fields, light, temperature, pH, or chemical compounds. This change is reversible and can be repeated many times. There is a wide range of different smart materials. Each offers different properties that can be changed. Some materials are very good and cover a huge range of the scales.

Smart materials are the basis of many applications, including sensors and actuators, or artificial muscles, particularly as electroactive polymers (EAPs).
Terms used to describe smart materials include shape memory material (SMM) and shape memory technology (SMT).

Three basic mechanisms of intelligent materials, namely, the sensor, Implementation of these in the processor and actuator functions are described. microstructure of various materials, as well as associated algorithms and techniques are illustrated. Different models, control algorithms and analyses developed by various researchers are reviewed and their potential applications in engineering materials are presented.

Mimicry

The action of copying or the skill of being able to copy the voice, movements, etc. of others. (Oxford Advanced Learner's Dictionary)

"an act of imitation in speech, manner, or appearance," 1680s; see mimic (adj.) + -ry. The zoological sense of "the external simulation of something else in form, color, etc." is from 1861. (Etymology Dictionary)

In evolutionary biology, mimicry is an evolved resemblance between an organism and another object, often an organism of another species.
Use of the word mimicry dates to 1637. Originally used to describe people, "mimetic" was used in zoology from 1851, "mimicry" from 1861.
Use of the word mimicry dates to 1637. It derives from the Greek term mimetikos, "imitative", in turn from mimetos, the verbal

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adjective of mimeisthai, "to imitate". Originally used to describe people, "mimetic" was used in zoology from 1851, "mimicry" from 1861.
The origin of the use of the word mimicry comes from the similarity in nature. In nature, mimicry functions to protect a species from predators, making it an antipredator adaptation.
The evolutionary convergence between groups is driven by the selective action of a signal receiver or dupe. For example, Birds use sight to identify palatable insects, whilst avoiding the noxious ones. Over time, palatable insects may evolve to resemble noxious ones, making them mimics and the noxious ones models.
In its broadest definition, mimicry can include non-living models. For example, animals such as flower mantises, planthoppers, comma and geometer moth caterpillars resemble twigs, bark, leaves, bird droppings or flowers.
Mimicry may evolve between different species, or between individuals of the same species.
The resemblances that evolve in mimicry can be visual, acoustic, chemical, tactile, or electric, or combinations of these sensory modalities.

Although the word mimicry is used so sometimes in the field of materials as a definition for technologies or /and materials that have copied characteristics and functionality to a natural origin, but the right word to use is Biomimicry.

Bio

word-forming element, especially in scientific compounds, meaning "life, life and," or "biology, biology and," or "biological, of or pertaining to living organisms or their constituents," from Greek bios "one's life, course or way of living, lifetime" (as opposed to zoe "animal life, organic life"), from PIE root *gwei- "to live." The correct usage is that in biography, but since c. 1800 in modern science it has been extended to mean "organic life," as zoo-, the better choice, is restricted in modern use to animals, as opposed to plant, life. Both are from the same PIE root.
short for biography, attested from 1961. Earlier shortened forms were biog (1942), biograph (1865). (Etymology Dictionary

Biomimicry

Biomimetics or biomimicry is the emulation of the models, systems, and elements of nature for the purpose of solving complex human problems

Biomimetics or biomimicry is the emulation of the models, systems, and elements of nature for the purpose of solving complex human problems. A closely related field is bionics.
Living organisms have evolved well-adapted structures and materials over geological time through natural selection. Biomimetics has given rise to new technologies inspired by biological solutions at macro and nanoscales. Humans have looked at nature for answers to problems throughout our existence. Nature has solved engineering problems such as self-healing abilities, environmental exposure tolerance and resistance, hydrophobicity, self-assembly, and harnessing solar energy.
Biomimetics could in principle be applied in many fields. Because of the diversity and complexity of biological systems, the number of features that might be imitated is large.

Maybe the first time that use of biomimicry was the study of birds to enable human flight from Leonardo da Vinci. Although never successful in creating a "flying machine", Leonardo da Vinci (1452–1519) was a keen observer of the anatomy and flight of birds, and made numerous notes and sketches on his observations as well as sketches of "flying machines''. The Wright Brothers, who succeeded in flying the first heavier-than-air aircraft in 1903, allegedly derived inspiration from observations of pigeons in flight. During the 1950s the American biophysicist and polymath Otto Schmitt developed the concept of "biomimetics".During his doctoral research he developed the Schmitt trigger by studying the nerves in squid, attempting to engineer a device that replicated the biological system of nerve propagation.He continued to focus on devices that mimic natural systems and by 1957 he had perceived a converse to the standard view of biophysics at that time, a view he would come to call biomimetics. (Vincent, Biomimetics: its practice and theory)

In 1960 Jack E. Steele coined a similar term, bionics, at Wright-Patterson Air Force Base in Dayton, Ohio, where Otto Schmitt also worked. Steele defined bionics as "the science of systems which have some function copied from nature, or which represent characteristics of natural systems or their analogues". (Mary McCarty, Life of bionics founder a fine adventure)

During a later meeting in 1963 Schmitt stated; Let us consider what bionics has come to mean operationally and what it or some word like it (I prefer biomimetics) ought to mean in order to make good use of the technical skills of scientists specializing, or rather, I should say, specializing into this area of research. (Otto Herbert Schmitt, In Appreciation, A Lifetime of Connections: Otto Herbert Schmitt)
In 1969, Schmitt used the term "biomimetic" in the title of one of his papers,and by 1974 it had found its way into Webster's Dictionary.

Biomimicry was popularized by scientist and author Janine Benyus in her 1997 book Biomimicry: Innovation Inspired by Nature. Biomimicry is defined in the book as a "new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems". Benyus suggests looking to Nature as a "Model, Measure, and Mentor" and emphasizes sustainability as an objective of biomimicry.

Bionics

Bionics (n.)
"the study of electronic systems which function in the manner of organic systems," 1959, from bio- "life" + second element from electronic;
bionic (adj.)
1901 as a term in the study of fossils, "quality of an organism that repeats its characteristics in successive generations," from Greek bios "life" (from PIE root *gwei- "to live"). Meaning "pertaining to bionics" is recorded from 1963, with ending from electronic. Popular sense of "superhumanly gifted or durable" is from 1976, from U.S. television program "The Six Million Dollar Man" and its spin-offs.(Etymology Dictionary)

Bionics or biologically inspired engineering is the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology.

According to proponents of bionic technology, the transfer of

technology between lifeforms and manufactured objects is desirable because evolutionary pressure typically forces living organisms fauna and flora to become optimized and efficient. For example, dirt and water repellent paint (coating) developed from the observation that practically nothing sticks to the surface of the lotus flower plant (the lotus effect).
The term "biomimetic" is preferred for references to chemical reactions,such as reactions that, in nature, involve biological macromolecules whose chemistry can be replicated in vitro using much smaller molecules.
Proponents argue that the selective pressure placed on all natural life forms minimizes and removes failures.
There are generally three biological levels in the fauna or flora, after which technology can be modeled:
. Mimicking natural methods of manufacture
. Imitating mechanisms found in nature (velcro)
. Studying organizational principles from the social behaviour of organisms, such as the flocking behaviour of birds, optimization of ant foraging and bee foraging, and the swarm intelligence (SI)-based behaviour of a school of fish.

Bionics entered Webster's Dictionary in 1960 as "a science concerned with the application of data about the functioning of biological systems to the solution of engineering problems".
After use of this word in some television series, the term bionic then became associated with "the use of electronically operated artificial body parts" and "having ordinary human powers increased by or as if by the aid of such devices".
However, terms like biomimicry or biomimetics are more preferred in the technology world in efforts to avoid confusion between the medical term "bionics."

Material

Mid-14c., "real, ordinary; earthly, drawn from the material world" (contrasted with spiritual, mental, supernatural), a term in scholastic philosophy and theology, from Old French material, materiel (14c.) and directly from Late Latin materialis (adj.) "of or belonging to matter," from Latin materia "matter, stuff, wood, timber".
From late 14c. as "made of matter, having material existence; mate-

rial, physical, substantial." From late 15c. as "important, relevant, necessary, pertaining to the matter or subject;" in the law of evidence, "of legal significance to the cause" (1580s).
material (n.)
Late 14c., "component substance, matter from which a thing is made," from material (adj.).

matter (n.)
c. 1200, materie, "the subject of a mental act or a course of thought, speech, or expression," from Anglo-French matere, Old French matere "subject, theme, topic; substance, content; character, education" (12c., Modern French matière) and directly from Latin materia "substance from which something is made," also "hard inner wood of a tree." According to de Vaan and Watkins, this is from mater "origin, source, mother". The sense developed and expanded in Latin in philosophy by influence of Greek hylē "wood, firewood," in a general sense "material," used by Aristotle for "matter" in the philosophical sense.
The Latin word also is the source of Spanish, Portuguese, and Italian materia, Dutch, German, and Danish materie, vernacular Spanish madera, Portuguese madeira "wood" (compare Madeira). The Middle English word also sometimes was used specifically as "piece of wood."
From c. 1200 as "a subject of a literary work, content of what is written, main theme;" sense of "narrative, tale, story" is from c. 1300. Meaning "physical substance generally" is from mid-14c.; that of "substance of which some specific object is or may be composed" is attested from late 14c. Meaning "piece of business, affair, activity, situation; subject of debate or controversy, question under discussion" is from late 14c. In law, "something which is to be tried or proved," 1530s. (Etymology Dictionary)

Bio-based material, Biological material or Biomaterial

A bio-based material is a material intentionally made from substances derived from living (or once-living) organisms. These materials are sometimes referred to as biomaterials, but this word also has another meaning. Strictly the definition could include many common materials such as wood and leather, but it typically refers to modern materials that have undergone more extensive processing. Unprocessed materials may be called biotic material. Bio-ba-

Image3.2
Water on the surface of a lotus leaf.

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sed materials or biomaterials fall under the broader category of bioproducts or bio-based products which includes materials, chemicals and energy derived from renewable biological resources. Bio-based materials are often biodegradable, but this is not always the case.
Examples include:
Cellulose fibers: Fibers made from reconstituted cellulose.
Casein: A phosphoprotein extracted from milk during the process of creating low fat milk, it is processed in various ways to make: plastic, dietary supplements for body builders, glue, cotton candy, protective coatings, paints, and occurs naturally in cheese, giving it a creamy texture.

Polylactic acid: A polymer produced by industrial fermentation.
Bioplastics: Include a soy oil based plastic now being used to make body panels for John Deere tractors.
Engineered wood: Products such as oriented strand board and particle board.
Zein: A natural biopolymer which is the most abundant corn protein.
Cornstarch: The starch of the maize grain, used to make packing pellets.
Grease: Lubricants made from vegetable oils, including soybean oil, that can replace petroleum based lubricants.

Biomaterial

mid-14c., "real, ordinary; earthly, drawn from the material world" (contrasted with spiritual, mental, supernatural), a term in scholastic philosophy and theology, from Old French material, materiel (14c.) and directly from Late Latin materialis (adj.) "of or belonging to matter," from Latin materia "matter, stuff, wood, timber".
From late 14c. as "made of matter, having material existence; material, physical, substantial." From late 15c. as "important, relevant, necessary, pertaining to the matter or subject;" in the law of evidence, "of legal significance to the cause" (1580s). (Etymology Dictionary)

A biomaterial is now defined as a substance that has been engineered to take a form which, alone or as part of a complex system, is used to direct, by control of interactions with components of living systems, the course of any therapeutic or diagnostic procedure.

A biomaterial is a material designed to interact with the body, contrary to what the word may implicate, a biomaterial is not necessarily biological or based on bio-related matter. The material itself can be anything from a metal to a plastic to varieties of composites, but it can also be bio-inspired and derived from nature. The definition of a biomaterial is a material that is designed with the purpose to interact with the body, i.e. it is designed to reside in a biological environment. (Malin Edvardsson, What is a Biomaterial?)

Environment

c. 1600, "state of being environed" (see environ (v.) + -ment); sense of "the aggregate of the conditions in which a person or thing lives" is by 1827 (used by Carlyle to render German Umgebung); specialized ecology sense first recorded 1956. (Etymology Dictionary)

Environment is the natural world in which people, animals and plants live.
Environment means anything that surrounds us. It can be living things (biotic) or nonliving (abiotic) things. It includes physical, chemical and other natural forces. Living things live in their environment. They constantly interact with it and adapt themselves to conditions in their environment. In the environment there are different interactions between animals, plants, soil, water, and other living and nonliving things. The living conditions of living organisms in an environment are affected by the weather or climate changes in the environment.

Some people call themselves environmentalists. They think we must protect the natural environment, to keep it safe. Things in the natural environment that we value are called natural resources. For example; fish, insects, and forests. These are renewable resources because they come back naturally when we use them. Non-renewable resources are important things in the environment that are limited for example, ores and fossil fuels after a few thousand years.
Ecological units which are natural systems without much human interference. These include all vegetation, microorganisms, soil,

rocks, atmosphere, and natural events.
Universal natural resources and physical phenomenon which lack clear cut boundaries. These include climate, air, water, energy, radiation, electric charge, and magnetism.

Many technological processes produce unwanted by-products known as pollution and deplete natural resources to the detriment of Earth's environment. Innovations have always influenced the values of a society and raised new questions in the ethics of technology. Examples include the rise of the notion of efficiency in terms of human productivity, and the challenges of bioethics.

Sustainable and Sustainability

The name sustainability comes from the Latin sustinere (to hold, to hold; sub, below). Since the 1980s, the term sustainability has begun to be used with the meaning of human sustainability on planet Earth, giving rise to the most famous definition of sustainability, that of the United Nations Brundtland Commission of 20 March 1987, which considered it as part of constitutive of the concept of sustainable development.
Sustainability is defined as a requirement of our generation to manage the resource base such that the average quality of life that we ensure ourselves can potentially be shared by all future generations. ... Development is sustainable if it involves a non-decreasing average quality of life. [Geir B. Asheim, "Sustainability," The World Bank, 1994]. (Etymology Dictionary)

sustain (v.)
c. 1300, "give support to," from stem of Old French sostenir "hold up, bear; suffer, endure" (13c.), from Latin sustinere "hold up, hold upright; furnish with means of support; bear, undergo, endure," from assimilated form of sub "up from below"+ tenere "to hold," from PIE root *ten- "to stretch." Meaning "continue, keep up" (an action, etc.) is from early 14c. Sense of "endure without failing or yielding" is from c. 1400. Related: Sustained; sustaining.

sustainable (adj.)
1610s, "bearable," from sustain + -able. Attested from 1845 in the sense "defensible;" from 1965 with the meaning "capable of being continued at a certain level." Sustainable growth is recorded from 1965. Related: Sustainably.

sustainability (n.)
1907, in reference to a legal objection, from sustainable + -ity. General sense (in economics, agriculture, ecology) by 1972. (Etymology Dictionary)

Sustainable is involving the use of natural products and energy in a way that does not harm the environment. (Oxford Advanced Learner's Dictionary)

According to “Our Common Future”, sustainable development is defined as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs.” (Wandemberg, Sustainable by Design: Economic Development and Natural Resources Use Paperback)
Sustainability can also be defined as a socio-ecological process characterized by the pursuit of a common ideal. An ideal is by definition unattainable in a given time and space. However, by persistently and dynamically approaching it, the process results in a sustainable system. Many Environmentalists and ecologists argue that sustainability is achieved through the balance of species and the resources within their environment. As is typically practiced in natural resource management, the goal is to maintain this equilibrium, available resources must not be depleted faster than resources are naturally generated. (Wandemberg, Sustainable by Design: Economic Development and Natural Resources Use Paperback)

Modern use of the term "sustainability" is broad and difficult to define precisely. Originally, "sustainability" meant making only such use of natural, renewable resources that people can continue to rely on their yields in the long term.

"Healthy" ecosystems and environments are necessary for the survival of humans and other organisms. Ways of reducing undesirable human impact may include environmentally-friendly chemical engineering, environmental resources management, environmental protection, and human-population control. Information is gained from green computing, green chemistry, earth science, environmental science and conservation biology. Ecological economics studies the fields of academic research that aim to address human economies and natural ecosystems. (Bakari, The Dilemma of Sustainability in the Age of Globalization: A Quest for a Paradigm of Development)

Moving towards sustainability can involve social challenges that entail international and national law, urban planning and transport, supply-chain management, local and individual lifestyles and ethical consumerism. Ways of living more sustainably can take many forms, such as:

. reorganizing living conditions (ecovillages, eco-municipalities and sustainable cities, etc)

. reappraising economic sectors (permaculture, green building, sustainable agriculture) or work practices (sustainable architecture and design)

. using science to develop new technologies (green technologies, renewable energy and sustainable fission and fusion power)

. designing systems in a flexible and reversible manner.

. adjusting individual lifestyles to conserve natural resources.(Black, Anti-consumption as part of living a sustainable lifestyle: daily practices, contextual motivations and subjective values)

Biodegradable

also biodegradable, "susceptible to decomposition by living organisms" (especially bacteria), 1962, from bio- + degrade + -able.

Bio

word-forming element, especially in scientific compounds, meaning "life, life and," or "biology, biology and," or "biological, of or pertaining to living organisms or their constituents," from Greek bios "one's life, course or way of living, lifetime" (as opposed to zoe "animal life, organic life"), from PIE root *gwei- "to live." The correct usage is that in biography, but since c. 1800 in modern science it has been extended to mean "organic life," as zoo-, the better choice, is restricted in modern use to animal, as opposed to plant, life. Both are from the same PIE root. Compare biology.

degrade(n.)

late 14c., degraden, "deprive of office, dignity, or honors; reduce from a higher to a lower rank," from Old French degrader (12c.) "degrade, deprive (of office, rank, etc.)," from des- "down" (see dis-) + Latin gradi "to walk, go, step" (from PIE root *ghredh- "to walk, go"). From the 1640s as "lower in character, cause to deteriorate." Intransitive sense of "degenerate, deteriorate" is by 1850. Related: Degraded; degrading.

The first known use of biodegradable in a biological context was in 1959 when it was employed to describe the breakdown of material into innocuous components by microorganisms. Now biodegradable is commonly associated with environmentally friendly products that are part of the earth's innate cycles like the carbon cycle and capable of decomposing back into natural elements.

Biodegradation is the naturally-occurring breakdown of materials by microorganisms such as bacteria and fungi or other biological activity. (Gómez, Biodegradability of conventional and bio-based plastics and natural fiber composites during composting, anaerobic digestion and long-term soil incubation)
Biodegradable material is capable of decomposing without an oxygen source (anaerobically) into carbon dioxide, water, and biomass, but the timeline is not very specifically defined.

Technically speaking, lots of things are biodegradable. That is because the term “biodegradable” has no time frame attached to it, meaning that if a given material will eventually break down, it can be described as biodegradable.
While everything that is compostable is biodegradable, not everything that is biodegradable is compostable.

Composting

compost (n.)
late 14c., compote, "mixture of stewed fruits, a preserve," from Old French composte "mixture of leaves, manure, etc., for fertilizing land" (13c.), also "condiment," from Vulgar Latin *composita, noun use of fem. of Latin compositus, past participle of componere "to put together," from com "with, together" (see com-) + ponere "to place".
The fertilizer sense is attested in English from the 1580s, and the French word in this sense is a 19th century borrowing from English. The condiment sense now goes with compote, a later borrowing from French.

compost (v.)
late 15c., "to manure with compost;" 1829, "to make into compost;" from compost (n.). Related: Composted; composting. (Etymology Dictionary)

Composting is a human-driven process in which biodegradation occurs under a specific set of circumstances. The predominant difference between biodegradation and composting is that one process is naturally-occurring and one is human-driven. The main difference is the term “biodegradable” has no time frame attached to it, but most composters would like the material they allow into their facilities to break down in fewer than 80 days.

Compostable material breaks down into carbon dioxide, water, and biomass; however, compostable material also breaks down into inorganic compounds. The process for composting is more specifically defined, as it is controlled by humans. Essentially, composting is an accelerated biodegradation process due to optimized circumstances.

Additionally, the end product of composting not only returns to its previous state, but also generates and adds beneficial microorganisms to the soil called humus. As an organic-matter resource, compost has the unique ability to improve the chemical, physical, and biological characteristics of soils.
This organic matter can be used in gardens and on farms to help grow healthier plants in the future.

Compost is produced through the activity of aerobic (oxygen requiring) microorganisms. These microbes require oxygen, moisture, and food in order to grow and multiply. When these factors are maintained at optimal levels, the natural decomposition process is greatly accelerated. The microbes generate heat, water vapor, and carbon dioxide as they transform raw materials into a stable soil conditioner.

The term “compostable” does have a time frame attached to it, though that time frame is defined by each individual composter and his or her specific operational requirements.

Renewable Material

renewable (adj.)
1727, from renew + -able. In reference to energy sources, attested by 1971.

renew (v.)
late 14c., from re- "again" + Middle English newen "resume, revive, renew"; formed on analogy of Latin renovare. Related: Renewed; renewing. (Etymology Dictionary)

The renewable things are replaced naturally or controlled carefully and can therefore be used without the risk of using it all up. (Oxford Advanced Learner's Dictionary)

Renewable materials are those which can be manufactured or generated quickly enough to keep pace with how fast they are used up. Non-renewable materials, including materials for energy sources, are those which take a long time to renew and are generally used faster than they can be re

Renewable materials are sustainable materials, which means, according to the Rutgers University Center for Sustainable Materials, these materials do not use up non-renewable resources. They can also be produced in high enough volume to be economically useful. Biopolymers are one such renewable material. A biopolymer is a naturally occurring polymer, such as carbohydrates and proteins.
Another kind of renewable materials is rapidly renewable materials that are plant-based materials that can be replenished within a period of 10 years or less, like Bamboo.

This topic also includes the discourse of renewable energy because it is a fairly important issue in the production process.
Renewable energy sources are those that can be replenished easily and are non polluting. Solar power, wind, water, geothermal and biomass are examples of renewable energy sources.

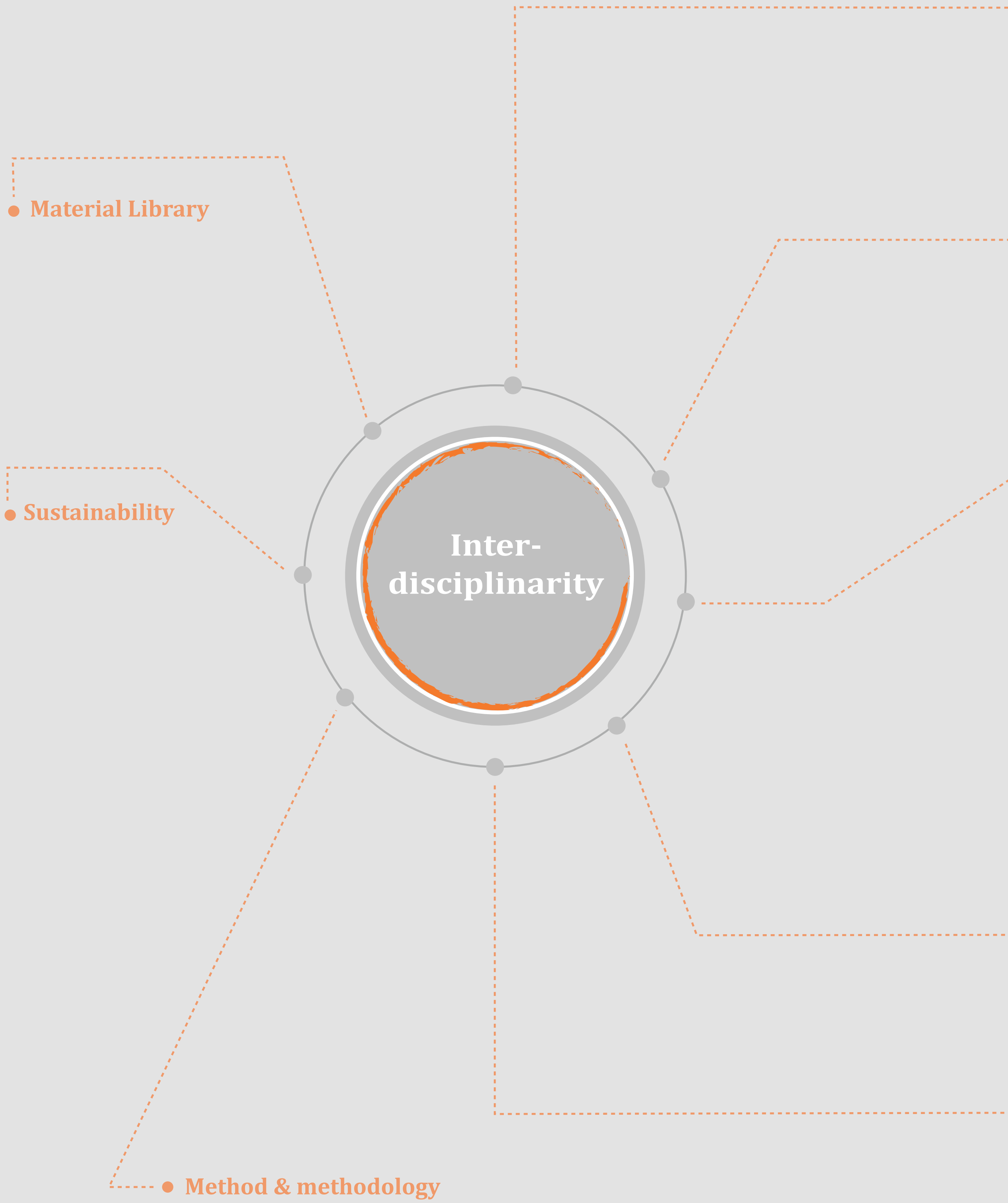
Eco-materials

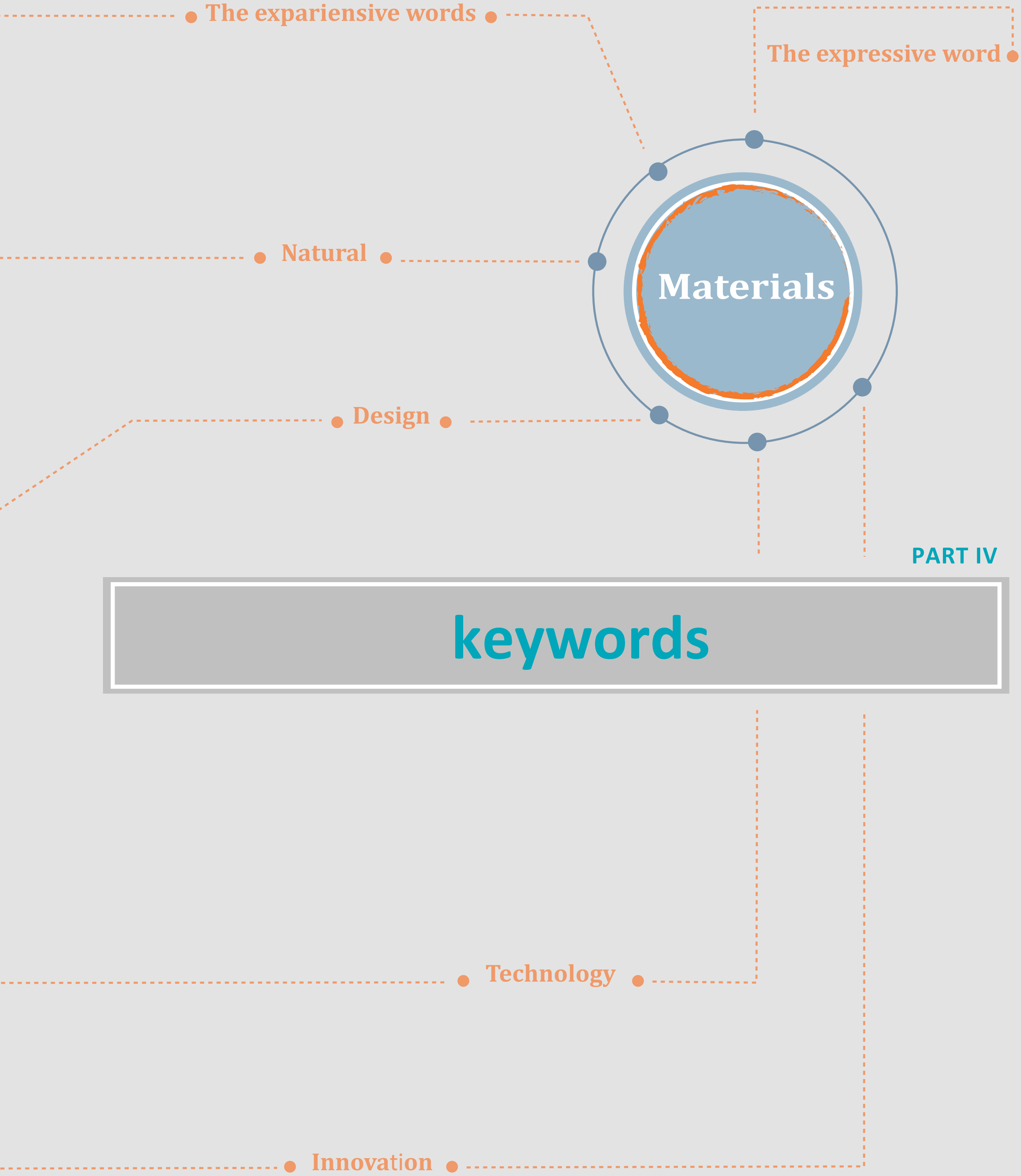
eco-
word-forming element referring to the environment and man's relation to it, abstracted from ecology, ecological; attested from 1969. (Etymology Dictionary

Eco-materials are defined as those materials that enhan- ce the environmental improvement throughout the whole life cycle, while

maintaining accountability performance (Halada and Yamamoto 2001). Eco-materials play a key role in material science and technology to minimize environmental impacts, enhance the recyclability of materials, and to increase energy and material efficiency.
In North America and Europe, eco-materials are often called "environmentally-friendly materials" or "environmentally preferable" materials.

The most comprehensive definition for eco-materials was proposed by Professor Yagi in 2000 (Yagi 2002). From the viewpoint of material science and engineering, an eco-material should pose at least one among ten superior properties compared to conventional materials.
1. Energy saving ability to reduce total life cycle energy consumption of a system or device.
2. Resource saving ability to reduce the total life cycle material consumption of a system or device.
3. Reusability to allow the reuse of collected products as similar functions.
4. Recyclability l to allow the use of collected products of material as a raw material.
5. Structural reliability to be used on the basis of its reliable mechanical properties.
6. Chemical stability to be used over the long term without chemical degradation.
7. Biological safety ability to be used without causing negative effects to the ecological system.
8. Substitutability to be used as an alternative to "bad" materials.
9. Amenity to ensure the comfort of the working environment.
10. Cleanability to separate, fix, remove and detoxify a pollutant for the environmental treatment process.


Material Library
Sustainability
Inter-
disciplinarity
Method & methodology



PART IV

keywords

CHAPTER 4:

Keywords

ABSTRACT

Delve into words and their role in design and from a designer's point of view, give examples to explain and show the designer's language in the keyword theme, as mentioned above.

Choosing the words that have a different way of use or meaning between scientist and designer or the way to express and explain them. The words that in the language of science are perceived and communicated in mathematical language but the same in the language of design are associated with sensory expression and perception of the mint with the senses of man.

ABSTRACT (italiao)
Approfondire le parole e il loro ruolo nel design e dal punto di vista di designer, fare esempi per spiegare e mostrare il linguaggio del designer nel tema delle parole chiave, come menzionato prima.
Scegliendo le parole che hanno modo di uso o significato diverso tra scienziato e designer o il modo di esprimergli ed spiegare. Le parole che nel linguaggio di scienza vengono percepiti e comunicati in linguaggio matematico ma gli stessi in linguaggio del design si associano con espressione sensoriali e percezione della menta con i sensi dell'uomo.

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4.1 Design, Method & methodology, Interdisciplinarity

Design

The meaning and etymology of the word design, declares the purpose of the designer and his method of working, his knowledge and skills. The Difference between art and design and engineering and their similarities. How the word design has been described, developed and integrated from a craft to a perception of the word design.

late 14c., "to make, shape," ultimately from Latin designare "mark out, point out; devise; choose, designate, appoint," from de "out" + signare "to mark," from signum "identifying mark, sign".
The Italian verb disegnare in 16c. developed the senses "to contrive, plot, intend," and "to draw, paint, embroider, etc." French took both these senses from Italian, in different forms, and passed them on to English, which uses design in all senses.
From 1540s as "to plan or outline, form a scheme;" from 1703 as "to contrive for a purpose." Transitive sense of "draw the outline or figure of," especially of a proposed work, is from 1630s; the meaning "plan and execute, fashion with artistic skill" is from 1660s. The intransitive sense of "do original work in a graphic or plastic art" is by 1854. Also used in 17c. English with the meaning now attached to designate. Related: Designed; designing.
design (n.)
1580s, "a scheme or plan in the mind," from French desseign, desseing "purpose, project, design," from the verb in French. Especially "an intention to act in some particular way," often to do something harmful or illegal (1704); compare designing. Meaning "adoption of means to an end" is from 1660s.
In art, "a drawing, especially an outline," 1630s. The artistic sense was taken into French as dessin from Italian disegno, from disegnare "to mark out," from Latin designare "mark out, devise, choose, designate, appoint" (which is also ultimately the source of the English verb), from de "out"+ signare "to mark," from signum "identifying mark, sign".

The artistic sense was taken into Fr. and gradually differentiated in spelling, so that in mod.F. dessein is 'purpose, plan', dessin 'design in art'. Eng. on the contrary uses design, conformed to the verb, in both senses. [OED]
General (non-scheming) meaning "a plan our outline" is from 1590s. Meaning "the practical application of artistic principles" is from 1630s. Sense of "artistic details that go to make up an edifice, artistic creation, or decorative work" is from 1640s.
Design is not the offspring of idle fancy; it is the studied result of accumulative observation and delightful habit. [Ruskin, Modern Manufacture and Design]

de-
active word-forming element in English and in many verbs inherited from French and Latin, from Latin de "down, down from, from, off; concerning", also used as a prefix in Latin, usually meaning "down, off, away, from among, down from," but also "down to the bottom, totally" hence "completely" (intensive or completive), which is its sense in many English words.
As a Latin prefix it also had the function of undoing or reversing a verb's action, and hence it came to be used as a pure privative — "not, do the opposite of, undo" — which is its primary function as a living prefix in English, as in defrost (1895), defuse (1943), de-escalate (1964), etc. In some cases, a reduced form of dis-.
sign (n.)
early 13c., "gesture or motion of the hand," especially one meant to communicate something, from Old French signe "sign, mark," from Latin signum "identifying mark, token, indication, symbol; proof; military standard, ensign; a signal, an omen; sign in the heavens, constellation."
According to Watkins, literally "standard that one follows," from PIE *sekw-no-, from root *sekw- (1) "to follow." But de Vaan has it from PIE *sekh-no- "cut," from PIE root *sek- "to cut" He writes: "The etymological appurtenance to seco 'to cut' implies a semantic shift of *sek-no- 'what is cut out', 'carved out' > 'sign'." But he also compares Hebrew sakkin, Aramaic sakkin "slaughtering-knife," and mentions a theory that "both words are probably borrowed from an unknown third source."
It has ousted native token. Meaning "a mark or device having some special importance" is recorded from late 13c.; that of "a miracle" is from c. 1300. Zodiacal sense in English is from mid-14c. Sense of "characteristic device attached to the front of an inn, shop, etc., to

distinguish it from others" is first recorded mid-15c. Meaning "token or signal of some condition" (late 13c.) is behind sign of the times (1520s). In some uses, the word probably is a shortening of ensign. Sign language is recorded from 1847; earlier hand-language (1670s).

"Design is an iterative process. The starting point is a market need or a new idea; the end point is the full specifications of a product that fills the need or embodies the idea. It is essential to define the need precisely, that is, to formulate a need statement, often in the form: 'a device is required to perform task X'. Writers on design emphasize that the statement should be solution-neutral (that is, it should not imply how the task will be done), to avoid narrow thinking limited by pre-conceptions." (Ashby, Materials Selection and Process in Mechanical Design)

"Whether regarded as indulgent, edgy, challenging or just downright funny, the material-centric products created by today's designers are not design as we once knew it. These days, a new generation is fighting against the backlash of bent shapes, rectilinear forms and mundane materials in order to explore strident sources of innovation. As they investigate the shifting relationship between object and user, designers challenge the premise that a fixed structure should constitute the basis of formation. As a result, interactive designs, retractable surfaces, technological interfaces and labile textile components are transforming everyday functional objects into dynamic tools for contemporary life." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

The developments and applications that are forging fresh directions for the creative industries, revealed the material research that is so essential to design practitioners today. "Most of these developments were masterminded by architects, designers and technologists, who revealed how materials' role in product innovation is paralleled by their ability to impact on the fabric of society. Just as these practitioners transform the materials of the past into fresh inspirations for the present, they also lead us to imagine how material innovation will unfold in the future." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

"What were once individual disciplines have become endlessly and increasingly subdivided as we learn more about substances and discover new ways of processing them. However, thanks to new discoveries, breakthrough inventions and on occasion, good marketing, certain trends in material development can be determined within this vast industry. These trends often cover more than one material category, as is the case for sustainability, where available solutions include all material families." ((Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

Throughout history, the design process has been in the form of a need and then the design of a product or service to meet that need, this need has always been on the part of the consumer. But with the passage of time and the industrialization of the world of production, the needs of the market also became a goal to produce a new product. This process continued for many years until today, when needs are divided into different parts; Consumer needs, market needs, technology needs and most importantly, the necessities of the environment and the planet at this time.
On the other hand, with the advancement of sciences and the expansion of their branches, the scientific disciplines each became more specialized and specialized in their working methods and language, and distanced themselves from each other. But the new generation of researchers and designers have a new perspective on the scope of science to meet needs, and that is the integration and collaboration of different sciences and the integration of technologies to achieve common values in their achievements.
Thus, design is no longer a separate and complete branch, but a part of a system of knowledge that combines and collaborates to complement and achieve the goal of other sciences. Here are some examples of these designs, from a new generation of designers.

Example

O, oxygen generator
Elements Collection VIA Carte Blanche

The Paris-based industrial designer Mathieu Lehanneur invents cerebral designs that appear to think for themselves. By mimicking the functions of biological reflexes, Lehanneur has created empathetic interactive objects that react and adapt to changes in temperature, light intensity, ambient noise and levels of oxygen.

Image 4.1, 4.2
O, oxygen generator

1.


NIVEAU MAX

Image 4.3
The Alchemist
Parfum Sustainable Bottles

Image 4.4
Flos
Sospensione Zeppelin
Marcel Wanders

A veritable domestic breathing machine, O generates pure oxygen in the home. In big towns, oxygen levels are 90% lower than those required by our bodies under optimal conditions. Using an oximeter sensor, O constantly monitors the oxygen level in the air, and when it detects that this level is insufficient, it instantly activates the micro-organisms it contains, Spirulina Platensis - a living organism with the highest yield in terms of oxygen production - and a light that favours spirulina photosynthesis. This emits native oxygen, which is diffused into the surroundings. As soon as the air oxygen level has returned to optimum, the light and agitation are interrupted and the spirulina falls back to the bottom of the container. It is highly likely that O will operate continuously on a day of high air pollution or during a party at the apartment. At present NASA is carrying out very detailed studies on this subject, in connection with long term trips for its astronauts.

And also the simple projects that make so much difference in the world of sustainability and the environment and packaging;

The Alchemist, Parfum Sustainable Bottles

" A pure glass bottle like a test tube. A wooden box, simple as a tree bark. The Alchemist is the shortest way between perfume and our senses." ML

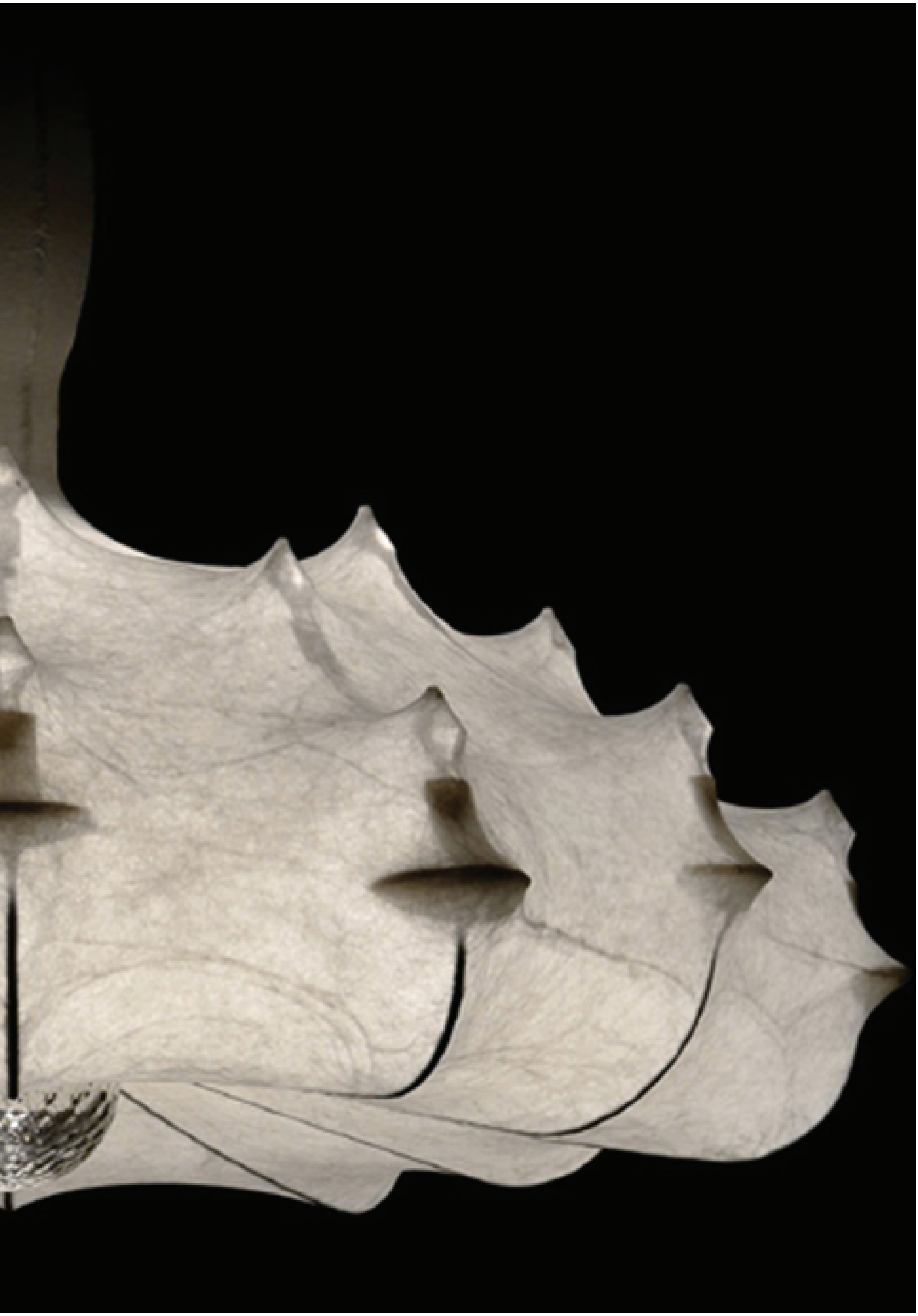
Marcel Wanders

“Designers are the advocates of the consumer: they have to fight for the quality of life of their public. If we help fulfill these needs for our customers we will contribute to their lives and be successful. The whole idea behind design is to create more value! Customization is the respect for the individual, the significance of variety, the connection to your clan, the security of perfection, to be part of a greater source.” (Marcel Wanders)

Although I don't share Wanders' style in his fun design, I agree with his method of thinking. to be free of everything and take everything with an open embrace to an unknown world, everything can be an old shape or a new material, what should be main for the designer

3.

4.



to have an open mind for everything like a child, an unsigned cloth, but with character that comes to his style and signature from a creative designer out of every scheme.

“As always, Wanders has the customer in mind, his eyes blinded, and his vision clear: l always begin with a dream and I always hope I can create the miracle without any material, sometimes miracles occur, most of the time I have to carry the weight| of the material world, I do this with love and respect." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

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4.2 Technology, Innovation

*"With so much richness in non-advanced materials and old-fashioned techniques, it is important to remember that we do not always need to look for answers in technology.
Putting up skyscrapers of 100 storeys and higher is no longer the zeitgeist of innovation, whereas buildings that use material innovation make a truly artistic and individual impact compared to the backdrop of other less interesting buildings. Likewise, reducing the size of electronic components in products can only encourage technological advances so far: Apple has pioneered the development of high-tech electronic components, but by focusing on design and materials (most notably on its design for the casing for the iconic iPod) it has spawned legions of followers and created one of the most recognizable visual identities and brands of today."* (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

*"The worlds of materials and design are merging. At the dawn of the 21st century materials advanced to become more adaptable, tactile and empathic, and the demand for objects with sculptural, aesthetic and multi-functional qualities rocketed. As high performance materials were reconceived as immersive webs, structural networks and technological interfaces, their ability to engage with the built environment resulted in a whole new paradigm of design. Today, the carbon-fibre matrices, woven wooden panels and metallic meshes of contemporary architecture have more in common with the high-tech filaments of techno fashion than they do with modernist monoliths. Membrane skins and pneumatic structures are as common in furniture design as they are in interior design and textiles, while tactile fibres and triaxial weaves are aligning vehicle design with public artworks. From the traditional to the intangible, from the technical to the tectonic, the exchanges taking place between materials and design are forging a uniquely multi-disciplinary arena.
Many advanced materials have fluid properties that engineers can synchronize in order to suit a product or environment. Interactive materials, such as photochromic pigments that change colour when subjected to daylight, light- emitting electroluminescent films,*

shape-changing polymer gels and shape memory alloys eliminate the need for technological triggers. The discovery of polymers, the invention of nanotechnology and recent developments in biomimicry have created the most technologically advanced materials imaginable. Yet, few new materials have proved their worth, because relatively few practitioners have been able to put them to the test." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

"It is usual to suggest that designers respond to market needs, but sometimes it is the designer who creates the need.
Revolutionary products take the market by surprise, few people felt the need for a Walkman, or a digital watch or a lasernter before these appeared in the marketplace. Here the designer anticipated a need, and by providing a solution, created it. The inspiration behind these concepts arose not from the market, but from advances in science and technology, the development of high-field magnets, of quartz oscillators, of solid-state lasers, to which we now turn." (Ashby,Materials and Design: The Art and Science of Materials Selection in Product Design)

"The least predictable of the driving forces for change is that of science itself. Despite periodic predictions that science is "coming to an end," it continues to expose new technologies that enable innovation in materials and processes.
As already said, it is structural applications that, in terms of tonnage, overwhelmingly dominate the consumption of engineering materials. Better materials for lightweight structures and for structural use at high temperatures offer such great potential benefits that research to develop them continues strongly. The drive toward miniaturization, too, creates new mechanical and thermal problems…." (Ashby,Materials and Design: The Art and Science of Materials Selection in Product Design)

While traditional scientists try to solve the problems of innovative materials, the research of interdisciplinary laboratories surpasses them and goes towards a future less expected of them. This is where innovation and advanced technology navigates between biology, materials science, designers and many other disciplines. And they create futuristic materials and processing techniques.

"No matter how good a material is, if it can't be formed into the right shape, or stuck to another material, or if even a small amount of it is

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too heavy to lift, it will not be a successful product. The material is only half the story. A major part of product innovation is how it is produced." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

It is right the material does not tell the whole story of technology and innovation. Finishes and surface treatments form part of the materials universe. The other piece of the production process that completes and creates the possibility of using a material. A material that is not new but outside the designers' scheme, which can re-enter or open a new world for the world of production thanks to a technology or innovation in technique or finishing process.

"innovative processing without mention of rapid prototyping. Originally developed as a tool for producing moulds for casting engineering parts, this process offers unlimited creativity of form, from intricate textiles to objects within objects, all built from powder. The basic process for all of the different types of rapid prototyping is as follows: create a three-dimensional CAD (computer aided design) model of the design you wish to produce; convert this CAD model into thinly sliced two-dimensional cross sections (the thinner the slices, the more accurate the final rendition); then physically build up each layer one on top of another in order to construct the model."
(Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

If you think that this example is recent and is changing the whole world of the product in design, architecture and many other sciences and still has many years to work, you must know Oxman's thought and design with the criticism of the use of CAD programs;

"The world of design has been dominated since the industrial revolution by the rigors of manufacturing and mass production. Assembly lines have dictated a world of standard parts that frame the imaginations of designers and builders who have been taught to think of their design objects and systems in terms of assembling parts with distinct functions. The assumption that parts are made from a single material and perform specific predetermined functions is deeply rooted in design and is usually undisputed; it is also dictated by the way industrial supply chains work. These centuries-old design paradigms have been reincarnated in Computer-aided Design (CAD) tools and Computer-aided Manufacturing (CAM) technologies in which homo-

geneous materials are formed into predefined shapes in the service of predetermined functions." (Oxman, Material ecology)

Esempio

"Touch-sensitive textiles developed by companies such as Eleksen have typically been used in outerwear as touch controls for MP3 players or mobile phones. Likewise, the commercial use of smart shirts', to monitor vital signs and message them back to the wearer's physician in order to ensure real time assessment of the patient's health, has also been developed. The US military is conducting research into this technology in order to create more interactive uniforms for soldiers. Mainly developed at the US Army Soldier Systems Center in Natick, Massachusetts, researchers have also looked at woven structures that contain a substance that is highly flexible under normal conditions, but which stiffens on impact from a bullet or other projectile, hopefully stopping the object." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

In the discipline of design, designers dependent on the method and trend of their work have created a very broad and varied network in the search for materials with technology and innovation.
present the group using advanced engineering materials and technology, which as Ashby (Material and Design, 2002) and Beylerian (ultra materials, 2007) explains, most are the leftovers of military research. This does not mean a discarded project but that normally cannot be a collaboration between creator and researcher with the material selector, in this area as explained they discard many materials in the research path that may be interesting for the field of application of design or architecture.
in addition, a group belonging to laboratories with designers and scientists who may be from only two disciplines of design and material science, or a multidisciplinary who lately are biologist, materials science, designer, engineer etc.
This type of interdisciplinary collaboration over the last decade has become a feeling of need on the part of designers and creators of materials, as an interactive work that completes the research as a whole.

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4.3 Natural

"The category of 'naturals' covers all materials that come directly from a plant or animal source. These include the obvious candidates such as wood, cotton or wool yarns, stone and animal hides that are not altered in form before use, and the natural-material derivatives such as paper from wood-derived cellulose, foams from soy precursors and starch- based plastics. Although it may not be possible to develop a new wood in the same way that new polymers are synthesized, there are nevertheless innovations in the area of natural materials that have utilized woods, agricultural by-products and fibers even in high-performance applications. These developments include new shaping processes for wood and wood veneers, alternative uses for fibers such as flax, hemp, flax jute, kenaf and sisal, and the creation of biopolymers from corn, potatoes and soy." (Beylerian, Material ConneXion: The Global Resource of New and Innovative Materials for Architects, Artists and Designers)

Nature as Inspiration
To "inspire" is to stimulate creative thinking. Inspiration can come from many sources. That for product design comes most obviously from other products and from materials and processes, particularly new ones. After that, nature is perhaps the richest source. The mechanisms of plants or animals, the things they can do and the way they do them continue to mystify, enlighten, and inspire technical design: Velcro, non slip shoes, suction cups, and even sonar have their origins in the observation of nature. Nature as a stimulus for industrial design is equally powerful: organic shapes, natural finishes, the use of forms that suggest, sometimes vaguely, sometimes specifically, plants and animals: all are ways of creating associations, and the perceived and emotional character of the product. Designs that are directly inspired by nature have a very unique point of view and often surprising behaviors (like the not-so-sticky but super-adhesives that mimic gecko feet)." (Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)

Natural is a good font for designers ,architecture and who wants to start on the right foot for a guaranteed future without problems with the environment. Using natural and renewable raw materials or an inspiration from nature has always been a method used by humans. As in the early days when the chemical and chemical combination of materials did not yet exist, it was easier to live with nature without destroying it. A fund of inspiration for every designer for a circular design to think how our beginning will have no end and our product enters a closed circle of consumption until it reaches nature and begins anew as a new raw material.

"Consider wood, with its excellent properties as a composite material, produced using only sun, water, soil and time. When disposed of, it feeds the next generation of trees. It is this type of production that we will need to strive towards if we hope to cease the over-consumption of our natural resources. We can see examples of this with the development of biopolymers - plastics created through biological processes using synthesized proteins from corn and lemon peel or even the production of plastics within the cells of growing plants. These alternatives to current plastics derived from petrochemical sources are also compostable, breaking down into food for future generations of plastic-producing plants without damaging delicate ecosystems.

Of all the natural materials currently used in production, bamboo is probably the most synonymous with sustainability. Its fast growth, exceptional hardness, and good fibre strength has led its use in a vast array of applications, from flooring to scaffolding to bicycle frames. Developments in the synthesis of the pulped bamboo fibre have also enabled the production of soft, colourable yarns ideal for garment production. Via the process used to create rayon from cellulose, bamboo is synthesized into spinnable fibres and either knitted or woven into textiles that are naturally anti- bacterial, and which offer improvements over both natural and synthetic alternatives in terms of strength and durability.

Other natural resources that are showing potential for greater use include waste from agricultural processes such as palm fibres following the extraction of palm oil, and the creation of dense, construction materials from recycled paper. Ultimately, however, the traditional need for recycling will be superseded by the simple, natural process of grow, use, then compost to aid the growing of the next crop, be it bamboo, plastic or a computer chip." (Beylerian,

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Ultra Materials: How Materials Innovation is Changing the World)

But that is only half the picture. A well designed product can outlive its design life by centuries, and, far from becoming unwanted, can acquire value with age. The auction houses and antique dealers of New york, London, and Paris thrive on the sale of products that, often, were designed for practical purposes but are now valued more highly for their aesthetics, associations, and perceived qualities. People do not throw away products for which they feel emotional attachment. So there you have it: industrial design both as villain and as hero. Let us look into this in a bit more detail because it is a complex maze, with the potential for many wrong turns. (Ashby, Materials and Design: The Art and Science of Materials Selection in Product Design)

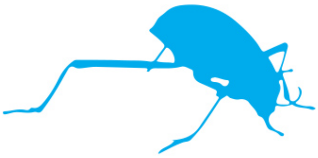
Biomimicry

"Janine Benyus, author of Biomimicry: Innovation Inspired by Nature, defines biomimicry as 'the process of learning from and then emulating life's genius. A range of examples are already available as commercial products." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)
Biomimicry is not just an inspiration of nature to create a material. This inspiration can become a source of innovation and technology to open a world of materials, such as the structure of wood.
The scientists studied the physical makeup of wood and then worked to optimize certain properties to develop composites, which include fiberglass or carbon fibre, such as increasing tensile strength or decreasing weight.
The structural forms are made by pultrusion: a process in which glass fibres are pulled through a liquid resin matrix to make a structural form that has excellent tensile strength and toughness. The resulting material surpasses wood in strength by improving on its composite structure.

warka water

A project to resolve the lack of clean water, inspired by a system of collecting water from fog of darkling beetles.

5.



BIOMIMICRY

LOCAL TRADITIONS

WARKA TREE

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Warka Tower is made of a bamboo frame that supports a mesh polyester material. It costs very little to make and is easy to build. Atmospheric water vapor from either rain, fog, or dew condenses against the cold surface of the mesh, forming droplets of liquid water that trickle down into a reservoir found at the bottom of the structure, similar to how a darkling beetle collects water from fog. A fabric canopy shades the lower sections of the tower to prevent the collected water from evaporating.
Warka Water is a team with members from Italy, Switzerland, Togo, Cameroon, Ethiopia, United Arab Emirates, India, Haiti, and the United States.
In 2015 the first pilot was constructed in Dorze, a rural community in south Ethiopia. After this successful initiative, they have founded the "Warka Water Inc."

Image 4.5
Warka Water
this is a project for an integrated village constructed only by using local and natural materials and ancient local construction techniques.
by designboom

4.4 Sustainability

The designers and architects who make the environment issues their first priority are highly conscious of the effects of their decisions and actions upon the environment. They include environmental impact as one of the central criteria for the selection of materials in their work. These issues include recycling, renewal, and the safe, efficient use of materic. As knowledgeable users of materials and technology, the designer and architect assume responsibility for protecting the environment from what is dangerous and for enhancing it through the use of renewable and recyclable resources.
The designers who call for recycling remind us that we must redefine our conception of "garbage." They reemploy existing materials by devising ingenious uses for what we have heretofore discarded, and discover ways to make new materials from those previously used. Some materials, they suggest, can actually be enriched by the recycling process.
As each author of this research has dedicated at least one book on the topic of sustainability and the environment, This indicates the sensitivity of the issue in the future field of design and also science.

“Sustainability can seem an overwhelmingly daunting prospect. Simpler concerns of recyclability or use of natural resources have been superseded by the need to understand the entire lifecycle of a material, from creation to disposal, or more "hopefully, from creation into something else. Tracking materials in this way requires information about extraction, synthesis, production into product, use as product, disposal and eventual re-use. In addition, it is necessary to factor in transport between all phases of production, to consider whether the product will use significant energy or other resources, and whether or not it will affect other products/materials in its use.
Simply put, sustainability encompasses the total combined impact of a material on its surroundings and attempts to ensure that this material can be used again and again with no adverse result on the environment. For creative professionals interested in lowering their impact on the environment, there are several promising attempts to

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create databases in order to help determine the total environmental impact of a material or product (typically referred to as LCA: Life Cycle Assessment or Life Cycle Analysis). LEED (Leadership in Energy and Environmental Design) is a US-based non-profit organization that uses a consensus- based assessment of materials and systems for construction, awarding points for individual products that can enable the assessment of an entire building. (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

"Consumer products can often prove to be more difficult to ensure sustainability for, due to limited lifespans and the number of parts used in the construction process. At least in the EU there has been legislation to remove all hazardous heavy metals such as cadmium and mercury from electronics, and to force manufacturers to list all chemicals used. Product packaging, however, has been one area to demonstrate significant improvements, with a number of manufacturers rethinking their primary and secondary packaging in order to reduce waste, allow for composting and remove toxic additives.

Compostability on an industrial scale has proved to be an equally important issue. Under the larger umbrella of biodegradability, it allows products to have a complete lifecycle with little or no loss in performance, but also ensures they will break down into harmless biomass when subjected to particular compositing conditions.

Perhaps one of the most noteworthy new ideas to come out of sustainable design is the general move towards simplicity in design. A reduction in the number of materials used in design, a refining of the complexity of construction (avoiding glues, complex fasteners etc) and an avoidance of unnecessary clutter has inevitably led to more sustainable and improved products. Making an office chair entirely from plastic so that it can be easily recycled is better than using combinations of metal and plastic. Enabling a product to be taken apart for disposal makes it more likely to be recycled and reused. Simplicity in design is harder to achieve, but no one said that being green was going to be easy." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

Example

Michael Braungart

"One of the most promising ideas for assessing sustainability in products is through the Cradle-to-Cradle system. Initially developed by architect and designer William McDonough, and materials chemist Dr Michael Braungart, and presented in a book of the same name, this system attempts to classify all materials as either technical or biological nutrients. The advantage of this approach is that synthetic materials are not discounted: in many cases they actually turn out to have less of an impact than those derived from natural resources. All products for which an exact chemical composition is not known (such as when a textile for a sports shoe has been purchased from another supplier) are tested by combustion and by analysis of the gases emitted. For any product that emits chemicals toxic to the environment, a change to a more benign additive is required before Cradle-to-Cradle certification can be granted." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

Michael Braungart , Regarded as one of the world's leading chemists, also founded the German-based scientific consultancy Environmental Protection Encouragement Agency (EPEA) International, and co-founded McDonough Braungart Design Chemistry (MBDC) in the US. Both EPEA and MBDC embrace intelligent, aesthetic and eco-effective design, and seek to optimize products through the Cradle-to-Cradle framework that MBDC has established. As Braungart explains, recycling biological and synthetic substances promises to outline a new paradigm for future materials.

The work of EPEA, is testing materials and products to assess their effects on the environment and offer alternatives that are beneficial to nature, rather than damaging. They have been testing polymers that can be reused up to 200 times with no loss of performance, which can be used again and again in the same application. In Herman Miller's Mirra chair, the polymers could be reused at least 200 times for similar purposes. Some polymers can last for the next 800 to 1,200 years. They can be used in a chair for five years, then used to make a window frame.

Image 4.6, 4.7, 4.8, 4.9

The Silk Pavilion Oxman
Neri Oxman's body of work
displayed in MoMA exhibition
Material Ecology

The MBDC project of William McDonough and Michael Braungart is an integration of design and science that put forward a design framework characterized by three principles derived from nature

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which inform our designs at all scales:
Everything is a resource for something else,
Use clean and renewable energy,
Celebrate diversity.

To survive the planet it is necessary to put together more materials and reinvent them as nutrients so that they become beneficial to biological systems. It is necessary to think about how to provide technical and biological nutrients for the future.

An innovation in the method and methodology of circular design and materials is essential. An interdisciplinary collaboration to create a circular and responsible design, between design, economics, materials science.

There are not a few projects and collaborations with these attributes, Oxman's work in the field of materials and ecology is another example.

Thanks to Oxman's ambitious experiment project, for Momo of New York, we have come to the conclusion, by no means taken for granted, that nature is perfectly capable of keeping up with technological innovation and that, indeed, it is innovative and innovative. avant-garde for much longer than us. Therefore, as demonstrated by the Silk Pavilion, eco-sustainability is possible in every area.

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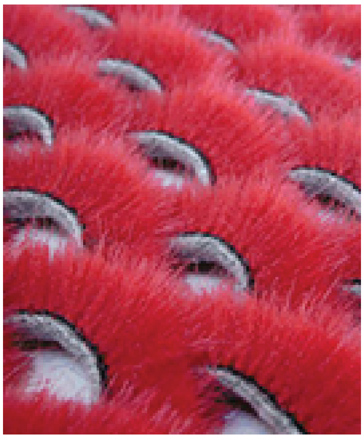
4.5 Material Library

"... Thousands of new materials are produced each year but our focus is only on the most innovative. Most of the materials were chosen with their intended consumer audience of artists, fashion designers, architects, interior designers, product developers and industrial designers in mind, but they all promise to inspire and inform everyone with an interest in materials, their application and the future of interior and exterior design." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

How an innovative material is judged for the companion of Material ConneXion; "To maintain objectivity, all materials in the Material ConneXion Library have been voted in by a panel of senior creative professionals who have judged the innovative qualities of each one individually. The panel, which sits monthly, includes both permanent and invited jurors. Judging innovation is neither a simple task nor an entirely objective one. The intended result is the acceptance of materials or technologies that have demonstrated use of a new material; offer an improvement on an existing process; create a solution through the use of less material or through a more sustainable methodology; or simply offer a solution that already exists in another industry. It is this last criterion that has provoked the most intriguing solutions to material issues, and such cross-fertilization of ideas continues to be an integral part of the Material ConneXion ethos." (Beylerian, Material ConneXion: The Global Resource of New and Innovative Materials for Architects, Artists and Designers)

In Material ConneXion, the materials organized into seven sections, the categories of materials designated herein provide a reference point for how individual materials are produced and applied.
This is not a classification of scientific material, but based on easily recognizable areas of material rather than their scientific nomenclature.
"Rather than defining a material solely in terms of its current use, these categories group materials according to chemical composition. In the case of composite materials,each one is categorized by the



This laminated resin incorporates a decorative inner layer. Applications include partitions, windows, lighting and furniture.

In the case of composite materials,each one is categorized by the material that comprises the largest percentage of its total composition." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

The studies on a dozen material libraries, important all over the world, reveal for this research a difference between the division of categories of materials for scientists and that of designers. laboratories and materials libraries that process and record materials for the purpose of use for architects, designers or other sectors that apply the materials, the categories of materials consist of
. Carbon
. Glass
. Cement
. Metal
. Polymer
. Ceramic
. Natural
but scientists divide the categories of materials with the absence of natural materials, which as explained is an important category for innovation, design, environment.

"Materials are mainly developed for specific use in a wide range of industries and products, and are often entirely unheard of by those outside these arenas." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

Another aspect that this research wants to emphasize is, when in the material library it enters the purpose of applying the material in the specific field, it could close the creativity of the designer or architect. A material is not born for a specific purpose but as a possibility for creatives to analyze its place in the field of design. like so many materials developed in the labors that have not been followed, to give a chance to show up on the materials panel for having failed the purpose of a scientist! but they could have the power to give life to an idea or become an idea for a designer.

However, that is not to say that these specific materials cannot venture outside their specific role. Indeed, the sensory knowledge of materials and cultural language of society will be one of the most important features of future developments in materials and innovation for the discipline of design.

keywords
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4.6 The expariensive words

"Our world is full of symbolism, and, looking at the myriad examples that demonstrate art imitating nature or one hemisphere taking inspiration from another, it is evident that the evolution of creative design is infinite. With so much richness in non-advanced materials and old-fashioned techniques, it is important to remember that we do not always need to look for answers in technology." (Beylerian, Ultra Materials: How Materials Innovation is Changing the World)

As Beylerian also says, we live in the world with symbols, symbols and meanings derived from cultures, from different societies or from different studies. Where a common word with a precise meaning in the dictionary has a precise scientific definition. But in design culture with a significant previous history use of materials in design, words are used and translated with a design language.
For a sensory perception such as a visual perception, the material or a product is judged for a characteristic that in reality does not match scientific measures and truth.
Or the designer to say this characteristic does not mean his definition literally that the artistic-sensorial perception.

A light material for a designer can be transparent, bright, with a reflective surface or simply a light color or a simple design.

Elastic, a material with an expression or texture that gives the feeling of soft and elastic even if the product is rigid.

Soft, a texture or a color that changes the observer's perception towards feeling the lightness and softness of a velvety material.

Luxury, here the importance of the selection of materials comes into play, the same design may seem elegant and luxurious with the polished steel material but with the plastic it shows a mass production project with a low price.

Image 4.10, 4.11
Melt Lamp for Tom Dixon

Image 4.12, 4.13
1994 Isaac Mizrahi
Green Aluminium Paillette Diet 7-Up Dress

Image 4.13
Animal Thing for Moooi

Light

Melt Lamp for Tom Dixon

Metallised, irregular lampshades in copper, silver or gold scatter the light, and give these globes the illusion of being made of molten glass. A new collaboration between Front and Tom Dixon. A project with its origin in a project with Stockholm Konst.

Morbido

1994 Isaac Mizrahi
Green Aluminium Paillette Diet 7-Up Dress

A dress created with recycled aluminum that moves and looks as soft as a sequin dress. Mizrahi recalls the arduous work that went into creating his recycled pieces, “It took us three years to make those dresses. We paid homeless people to collect Coke cans and Budweiser cans, two of my favorite things, and then 7Up cans, so it was green, red, white, and gold. We split them open and washed them, then shipped them to Paris to Langlois-Martin, who makes these beautiful paillettes, and then they were sent on to India to have them sawn onto panels. It took us years."

Stylish

Animal Thing for Moooi

today killing an animal to make a piece of furniture is no longer in fashion and is not even seen as a gesture of wealth and elegance, but still in the culture of the rich this Umbrian of elegant thought and taxidermy there is a relationship.
in the "Animal Thing for Moooi" project the animals in the 1: 1 scale become furniture and furnishings, which can also be playful and fun, but interesting how the scene of the arrangement is created to present the product;
A scenario of elegant and modern objects, which induce the elegance of the chandelier.

keywords
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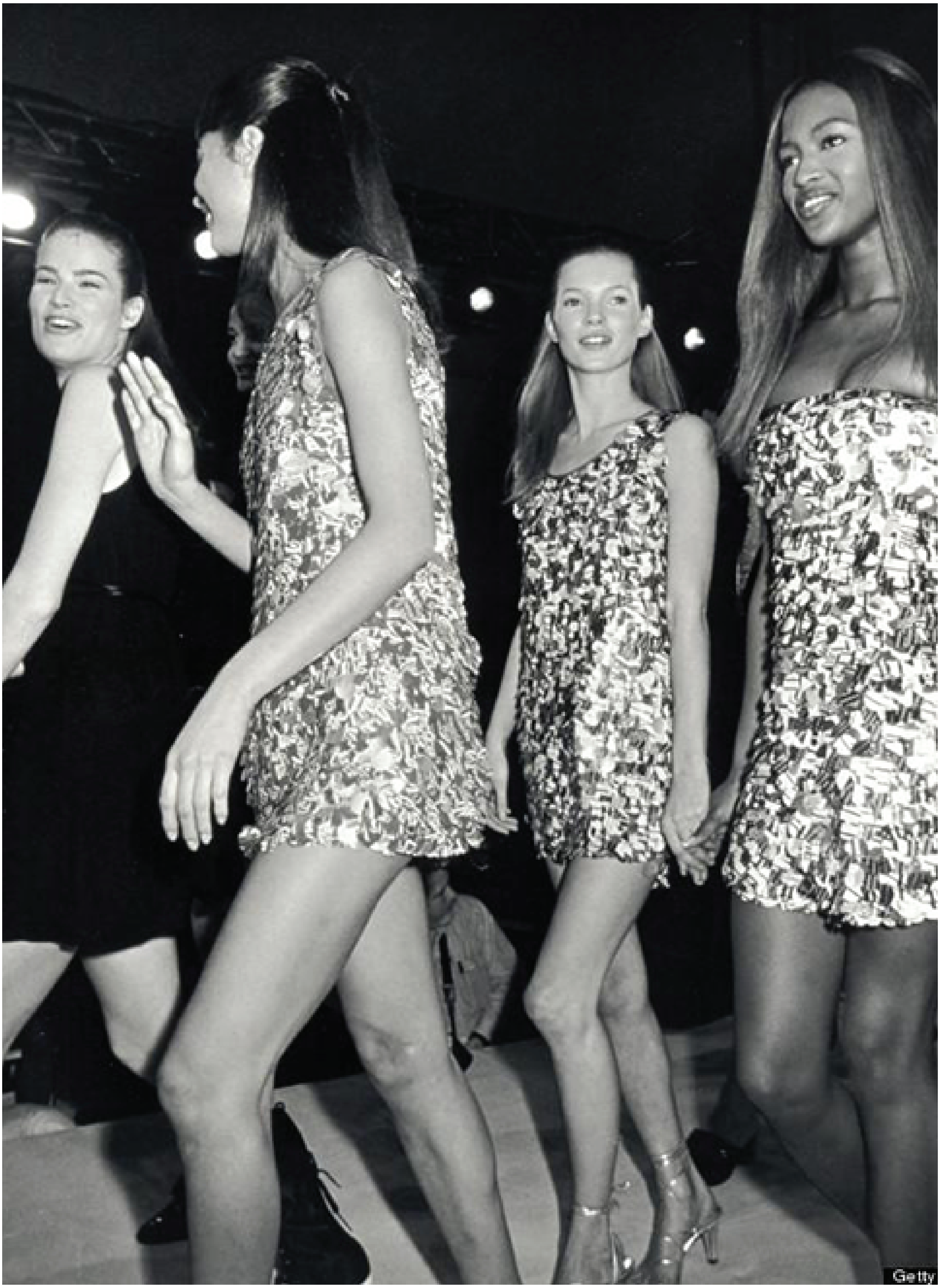

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PART V

CONCLUSIONI

5.1 CONCLUSIONS

Knowing the new materials, knowing how to use and work them and even knowing how to choose them, thus becomes one of the key points of design.
The world of materials includes a universe made up of many sub-categories that are constantly and rapidly updated, which develops new and hybrid materials which, however, is not possible knowing all for a designer or creator.

The designer has a lot of possibility to know or select its material. Choosing the material is no longer a process at the end of the project, there are various possibilities to create or develop, select the material or try and analyze a material to create an idea.

The world of material is offering a flood of possibilities of materials created in the laboratory or extracted from nature or a combination of laboratori from natural elements. bringing new and technological materials, alive or self-destructive, with variety of form and consistency, colors and textures, which leaves no space for the designer's imagination to waste time.

It is precisely the technology and innovations to create the materials in the last decade from this variety to the materials. That unfortunately if they were born in the laboratories of scientists without the presence of the designers, they may not have the slightest possibility of entering the scheme of laboratory materials only for not being suitable for the characteristics of the scientist's purpose. Either a designer who works with a material selected on a material library or a book or even a material palette, does not have this possibility to ask to change a non-fundamental characteristic of the material or does not know that the process of creating the material gives this possibility or to make his request it takes a long time, perhaps years, of research and work to communicate with the scientist. Faced with this situation, by collaborating together scientists and designers have the continuous possibility to create and change a material for a project or create an idea or project for a material created with interesting characteristics. According to this research it is a correct method that becomes a circular methodology to create and respond in step with the speed of technology and the user's need, without wasting the energy of designers or materials.

As explained in the research process, precisely because of the difference in the way of thinking, the way the brain is used between designer and scientist.
It also creates diversity in the need for tools and working methods and the diversity of language between the disciplines of design and science.
Created and raised in different languages with different characteristics and methods of communication, it separates the two worlds, even if they are constantly in relationship and dependent on each other.
So we know why the designers and scientists use completely different approaches and methodology, but both starting from the experimental/deductive approach.

In the world of design, there is no such thing as working only within one discipline, there are now many companies and laboratories that collaborate in a multidisciplinary environment. The topic of scientific research has become a broad path between different scientific knowledge.
The diversity of language and methodology are part of this scientific and inevitable network in the world.

The technological world creates its innovations and goals with a speed that has become impossible to keep up with all this information. Especially for us , designers, that information is a fundamental part of our work as creator and supplier of the bisigni of our territory with attention to the environment and resources.

Young students passionate in design, once they enter the design profession path, are trained and informed by the many elements useful for their future as creator or researcher. Teaching the methodologies for the appropriate use of work tools and the right languages to communicate well in its kind, designers, are fundamental components that by learning well, with their artistic talent, form a professional figure called designer. But we know that the language and methodology of design is necessary but not sufficient.

According to many discussions in this research and comparisons given in the design and engineering language, we have come to the conclusion that the specialized language is for quick, clear and complete communication between the members of the scientist group. The inadequacy or complexity of this language should not cause any space or disturbance to come into the design process.

But it takes a step further, more open thinking and a mind free from all limitations, to step out of the shell of the traditional discipline and enter and explore the other disciplines. also because this is the fundamental characteristic of a designer to be able to overcome his limits, break the law and enter unknown spices. the designer's mind gives this possibility to explore beyond the limits, just what is impossible for a scientist to break their law. what for a designer becomes the way of creation, madness. for an engineer or scientist it is outlawed and means collapsing everything and not being confident in the results.

As many successful designers and advanced labs, it is satisfying when this information exchange is circular and rapid. This is possible thanks to an interdisciplinary collaboration created by designers and engineers and scientists for product development or to provide a service for the design process as a material library. The method that the material conneXion works.(Beylerian, 2005)

Now multidisciplinarity is nothing new, it is a right way that first and you can all use this method to work for the best results.

The language of designers is a natural language, born from the senses and without efforts to call everything and give sensitivity to objects using the sensory expression of the users.
Created and developed from the language of the company, but changed to communicate more precisely and easier, become a product or service for pleasure.
This is how a designer's projects are signed by him, and the user can get to know a style or a designer through his design language.
Soft, light, transparent, poor etc., these are all the words of a designer concluded in his work that are not only artistic but also functional and practical.
Words that enter the culture of the company and become the

history of a style or movement.
If we do not have many words written over the years by the whole discipline of design, compared to many scientific disciplines, because their books are their works, the influence of the product on people's lives and the habit and loneliness of everyday objects that they surround every person every day in life.

According to other discussions conducted in this research, we have come to this truth that the future of science and that of design lies in nature and sustainability and the environment.
Technology and innovations, innovative or traditional methods, all turn on topics with the role of the environment, with the dictionary of words eco- or bio-.
It doesn't matter by copying and following nature, biomimicry or using nature, material biologic, but for now this is the solution to everything.

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