This issue of the **diid** opens reflections on the current relationship between Design and Science. It aims to observe whether Design, leaving its consolidated areas, leans to denaturalize itself and lose its disciplinary skills or if, rather, it leans to acquire new ones by investing in the dialogue with Science not only the technological skills, but also the germinating ones from the relationship with Biology, Chemistry, Medicine, etc.
The open dialogue between Design and Science seems to prefigure a new sphere of knowledge which, alongside that of humanistic and scientific culture, today offers interesting spaces for action and interaction: real experimental laboratories, see the white coats of scientists in contact with the designer work overalls. So, scientists discover the envisioning ability of design, designers, for their part, change their approach by becoming "homo faber" and manipulators not only of matter, but also of living organisms.

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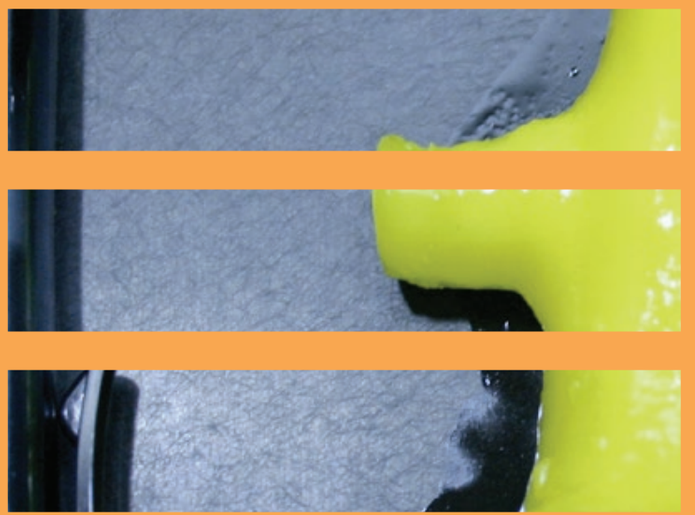

Focus

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Designing Evolution

Scientific progress enables us to expand knowledge and consciousness of the world around us, shortening the gap between the artificial and natural world, starting from Biomimetic imitative approach and coming to the co-creative one of Bio-design, and leading to the gradual dissolution of the boundaries between nature and culture.
The application of scientific results for progress rather than evolution had a strong negative impact that is considered existential even before being material and environmental (Sommariva, 2016), as in the case of using plastic for disposable products that, combined with the trend of overproduction and overconsumption, lead us to the current environmental crisis.
The use of biotechnologies makes even more evident the necessity of ethical principles to orient the project. Approaching to biology for the sake of random experimentation involves an array of risks, such as repurposing a future characterized by the same social and ecological issues of today (Ginsberg & Chiesa, 2018).
In this scenario design assumes the crucial role of filter, looking at artifacts as part of a system, and at organisms as nodes in a network of relations (Naess, 1973), identifying conscious and appropriate applications translating the results of scientific research into real and tangible products (Lucibello, 2018; Van Deer Leest, 2016).
With the introduction of the ecosophy notion, Arne Naess affirms that we should not act if we don't know how our actions can affect other living beings – whether humans, animals or plants. Cooperating with science design has now the opportunity of rethinking the relationship between living species, nature and technology, shaping a world where nature and culture are melted together into a symbiotic evolutionary process.

[biodesign, biofabrication, synthetic biology, evolution, progress]

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Dissolution of boundaries between Nature and Artifice

The term artificial means everything that derives from human techno-cultural activity. According to Manzini, however, the difference between what we perceive as artificial or natural lies in the evolutionary time of the laws that produce them which, in the case of artificial, run so fast that from our perspective everything else looks static (Manzini, 1986). With the technological and scientific progress, human artificial production gradually got closer to the natural one, realizing increasingly complex morphologies and processes. The imitation of nature is actually an ancient occurrence rooted in Vitruvian's search for harmony, and found a widespread use with Art Nouveau, developing at first with decorative, symbolic and semantic function. Subsequently, with Biomimetic, the nature becomes model, measure and mentor in designing the artificial, starting from the morphological field, up to the procedural and systemic ones (Benyus, 1997).
Science and technology have the ability to reshape the understanding we have of ourselves and our relationship with nature and other living species. The advent of biotechnologies and the progress in life sciences showed us how human life depends on the microscopic life of trillion of cells, making each individual a miniature ecosystem (Myers, 2012), leading in this way to the awareness that every human activity or artifact is always part of a system, and determining an indissoluble interconnection between artificial and natural systems.
Over the last decades, through biodesign and biofabrication, nature has been actively engaged in the creative process, no longer using it as a mere model, but creating a collaboration between design and science and, above all, between man and nature, moving beyond shapes and processes imitation and approaching to living matter as a «programmable material» (Van Der Leest, 2016). We are then in Biology 2.0 era, synthetic biology that radically changes its mission compared to the last century. The main objective is not to search for knowledge and understanding of biological processes anymore, but to modify them with the aim of perfectioning them and solve problems (Carr, 2010), with a brand-new approach that allow tangible applications for design.
In the emergent scenario we can identify two main ways of approaching to Biodesign: a first based on the collaboration, that looks at nature as a co-worker (Collet, 2017), where the designer is not an autonomous subject which shapes the matter through the creation of artifacts anymore, but determines the interaction between the intentional project and living systems' autopoiesis; a second approach based on "hacking", that aims at acting on nature itself, reprogramming it and giving birth to a synthetic nature. In both cases, the ancient separation of nature and culture dissolves, foreshadowing a symbiotic future as well as its potential dystopic impact.

Design of nature

Biology then recalibrates its methods and its purposes and becomes a design discipline in the name of progress, moving away from evolutionary dynamics (Elfick,

2017). Progress and evolution obey to different rules. Progress has the capability to plan ahead, on a linear and cumulative trend, to a "better" future focusing on one single point of view: the human being. Evolution responds to contest rather than intention and acts through a rhizomatic model that covers all the living species. History shows us as scientific research's results have been often applied with the aim of progress without considering the scale of consequences not only on the ecosystem but even on humans themselves. There are indeed known cases of diffusion of revolutionary materials, substances and processes, whose consequences and risks hadn't been studied enough, like ethernit for buildings, cocaine for medical and therapeutic use, lead, whose application varied from gasoline to pencils, and last but not least the use of synthetic plastics for disposable products, to name a few.

With biodesign and synthetic biology, intention is now involved in the evolutionary process; design therefore affects nature and evolutionary patterns – until now based on mutations as a result of accidental genetic combination – that today don't pursuit anymore the purpose of survival but can be driven by humans.

The issues and methods of design affects therefore nature; the design approach, based on problem finding, problem solving, identification of targets, productive processes and business plans, can be applied to genetic programming and to nature and it could modify the evolutionary paths guided by intrinsically human needs, desires and ambitions. The risk is real and increased by the accessibility of biotechnology, both in terms of affordability and usability for "non-insiders". The standardization of DNA components, the bio-bricks (Carlson, 2010), allows "bio-hackers" to create real biologic circuits, giving birth to the «garage biology» (Delfanti, 2013), this means that everyone could potentially modify the genetics of organisms and increase growth processes.

Different are the risks when determining nature's own design; the most reprehensible of them is the one aimed by a total absence of utility. The project "all that I am" by Koby Barhad belongs to this last category; the London designer introduced Elvis Presley's genetic material, obtained from his hair, into a mouse that was subsequently placed into different environments, reproducing Elvis Presley's life key moments, to encourage reflections around life's moments responsible for the creation of self-identity. The project of the transgenic artist Edoardo Kac follows the same direction by "constructing" a bioluminescent rabbit using fluorescent proteins and engineered bacteria, making it an actual work of art (Eskin, 2001).

The complexity of the issue doesn't change in relation to interference on nature that are considered necessary or useful; the introduction of mosquitoes genetically programmed to die soon after the egg hatching could be an excellent way of fighting malaria, but it would impact irreversibly the whole ecosystem in an unpredictable way. The risk of satisfying human needs at the expense of the natural system we live in is constantly round the corner and it is not easy to determine when the nobility of the aims is enough to justify the means, as in the project "Life Support" by R. Cohen e T. V. Balen, where pets are used as external organs like life support devices for patients with respiratory and kidney disorders, replacing the inhuman traditional treatments, or, from the same authors, the project "Pigeon D'or" that, using synthetic biology, redesigns and creates a bacteria able to modify pigeon's metabolism and produce soap rather than feces.

Design as ethical filter

Contextually to the scenario here described, there is a clear need for reflection upon the potential of available biological technologies, analyzing all the possible facets and projections through the envisioning ability of design. With Bio-design, the role of designers evolves, becoming mediators between scientific research and society. They are not anymore limited to the formal or stylistic features of the final product, but they systematize all the different skills and disciplines involved in the creative process elaborating a synthesis. Designers draw from scientific imagery overcoming disciplinary boundaries, bringing together cultural realities once considered distant. They become interpreter of socio-cultural phenomenons beside project developers, and aspire to an aware and forward-looking innovation, which takes into account long-term and long-range effects. Their activity is focused on one hand on the application aspects – developing new processes, identifying new applications and prefiguring new scenarios – and on the other hand on the communication ones, easing the comprehension of complex topics contributing to overcome fears and closures that often accompany what is new and unknown, at the same time pushing to reflection making physically visible the possible consequences of the application of certain processes.

Resources and Processes

As a result of the growing awareness of the scarcity of resources at our disposal, designers started researching alternative systems of production based on bio-fabrication. Establishing symbiotic processes with living organisms, it is now possible to produce new biodegradable materials through carbon-negative processes. This is the case for Mogu, a company that realizes products and materials for interior design, from mycelium grown on agro-industrial waste, turning low-value raw matter into valuable resource. The waste water from coconut production instead, responsible of water pollution and soil acidification if traditionally disposed of as industry waste, turn out to be a nutrient rich substrate for bacterial nanocellulose culture which, added with natural fiber, gums and resins, is transformed into Malai, a composite material available in different textures and colors. Besides fungi and bacteria, we then encounter algae, employed for the production of biopolymers through extraction of substances – as alginate or agar-agar – as well as for the development of textile fibers as with AlgiKnit, which uses Kelp algae to produce biodegradable yarns.

Algae and bacteria are revealed to be a new resource also for the production of inks and dyes. The discovery of synthetic dyes in back in 1856, supplanted completely the employment of dyes and pigments extracted from natural sources, at the expense of the huge amount of chemicals and contaminants released into the environment and

in contact with our own body through the textiles we wear. With the project "Faber Futures" Natsai Chieza realized a textile collection screen-printed with bacterial dyes; Victoria Geaney made a "living" dress able to glow a blue light exploiting the bioluminescence of photobacteria. As regards inks indeed, the company Living Ink has developed a range of pigment extracted from algae to be used with different kinds of materials, from paper to textiles.
Furthermore, such new forms of collaboration between nature and artifice, find application into products able to affect our everyday life. "Moss Table" by C. Peralta, A. Driver and P. Bombelli, exploits the opportunity of producing electricity from moss: a biophotovoltaic system is embedded in a coffee table with a small lamp attached, powered by the photosynthetic activity of moss combined to the one of bacteria contained into the soil, with the help of carbon fibers and a battery in order to store the electricity produced. "Growduce" by G. Graves and A. Jane, is a real micro-factory which produces bacterial nanocellulose that can be shaped into objects of everyday use directly at home, without the need of further material production for packing and sale. The user, directly involved into the production process, is then able to test the potential scenario of a bio-fabricated future and is integrated into a process of familiarization and demystification of bio and nano technologies based on their knowledge.
Moving beyond cooperation and arriving to hacking, we can see how synthetic biology too can be used in collaborative forms: the project "Synthetic Biology: the Future of Adaptive Living Environments" developed by the Design Futures Lab of Drexel University of Philadelphia, prefigured a biofabricated world exploring how synthetic biology can be implemented for architecture to make bio-smart surfaces impregnated with engineered bacteria, such as a kitchen counter that communicates the presence of pathogens or allergens into food, a bacterial nanocellulose wall that reacts to human movement, or a floor that removes dirt and toxins from feet. "E. Chromi" by Alexandra Daisy Ginsberg, James King and a team of student from Cambridge University, is an example of harmless hacking where also if acting through genetic modifications, there is no involvement of animals turned into tools in human hands as for the projects mentioned in the previous paragraph. In this project, results of the collaboration between designers and scientists, E. Coli bacteria are engineered to produce different pigments when in contact with specific chemical markers and inserted into a probiotic yoghurt that once ingested becomes a tool for self-diagnosis, producing colored feces indicating different kinds of diseases.

Design Fiction and Speculation

The knowledge technology entails however examining all the possibilities and scenarios, its potential harmful developments besides its benefits; through the practice of design fiction design explores with a critical look the possible projections, imagining speculative and often provocative realities, through the making of prototypes able to generate interaction, reflection and debate around unforeseen futures straddling techno-scientific innovation and dystopia. To this category belongs Natasai Audrey Chieza's project "Design Fiction: Posthumanity in the age of synthetics" where the designer, placing herself in the debate around science and ethics, presents a collection of artefacts showing three potential scenarios of interaction with life. "Voluntary Mutations", one of the three scenarios, imagines the results of open-source and do-it-yourself synthetic biology applied for body modifications, which give rise to new signs and morphologies on human body.
The main feature of the design practice described is the ability of producing the so-called "diegetic prototypes", objects with a strong narrative value which can recount possible worlds, applying existing processes and technologies still too far away from collective imagery. An example is "Biolace" by Carol Collet, which illustrates a future, in the 2050, where textiles will be grown through genetic modification of aromatic plants that allows – or rather forces – plant's roots to weave into wefts and laces.
Displaying the possible applications of cutting-edge technology in an everyday context of use, such as the textile and fashion field, allows to shorten the gap between research and society both from the spatial perspective, as well as the temporal one, connecting the present to the possible future worlds.
The ability of design to fill the gaps between different fields of action appears to be widely recognized today, both within and outside the discipline: the global competition International Genetically Engineered Machines (iGEM) in 2009 inserted a specific track for design, opening up participation to art and design schools; in 2002 the Royal College of Art in London set a course of study focused on the design approach to synthetic biology where students are asked to imagine the possible problems and implications of a determined scientific research when getting from the lab to everyday life, and represent them through an artefact able to raise reflection and prompt debate. One of the results of this course is the project by the student James King "Dressing the Meat of Tomorrow" that, working with lab grown meat "Tissue engineered steak N.1", investigates the way through which confer specific textures, shapes and flavours to recall meat's source before its synthesis.
In all of the examples examined, the element of continuity is the will to contribute towards the creation of an informed and conscious population able to discuss these topics and make informed decision when necessary.

Perspectives and Projections

Nature follows a slow and accurate evolutionary process made of trial and error. Now that we have the possibility to design nature ourselves, by acting on it at different scales up to the deeper DNA manipulation and genomic editing, it is appropriate to identify the aims of the project and taking account of the large-scale consequences, avoiding the unconscious and aimless experimentations. This because there aren't objects on their own but only systems, and the designer will have to mature the ability of recognizing the whole in the part (MInati, 1998, Myers, 2012), for not perpetuating shortsighted logics and approaches that will negatively affect the world around us, as

happened so far. The future is in fact a multiplicity of of ideas and potential embedded in today's narrations, objects and practices, and not a space-time isolated form present (Kjaersgaard et al., 2016).

The ability of incorporating narrations into products represents an essential element that allows designers to act as «trim tab», by making small changes in everyday life able to have a long-haul impact on the global scale (Antonelli, 2009). Through materials and artefacts, designers can actively influence behaviours and thought patterns, modifying the way we relate to environment and society. For these reasons the ethical dimension is crucial in order to reconsider the techno-scientific progress from new perspectives and to avoid repurposing the same dynamics and scenarios that lead us to current issues.

Design historically responds to the needs of society by interacting with the methods and the technologies of the time. At the same time is «the most effective culture able to propose a strategy to change the destiny of the endless universe of products, signs, information and technologies surrounding man and that has become its alternative nature» (Branzi, 1990). Designing through synthetic biology, in response to contemporary urgency, requires us today to adapt and understand the natural world and life itself before treading uncharted paths. In this, light design and science try out a collaborative give-and-take relationship, aware that human intent will not be able to overcome the evolution.

References

> Antonelli, P. (2019). Broken Nature. In Antonelli, P. & Tannir, A. (a cura di), Broken Nature. XXII Triennale di Milano. Catalogo (pp. 16-42). La Triennale di Milano.

> Benyus, J. (1997). *Biomimicry: innovation inspired by nature*. Harper Perennial.

> Branzi A. (1990). *La Quarta Metropoli*. Milano: Domus Academy.

> Carlson R. (2010). *Biology is Technology*. Cambridge: Harvard University Press.

> Carr J. (2010). Biology 2.0. The Economist, 2010 (6). Retrieved from https://www.economist.com/special-report/2010/06/19/biology-20

> Collet C. (2017). "Grow-made" textiles. Paper presented at *Alive. Active. Adaptive. EKSIG 2017*. Rotterdam: Delft University of Technology, 24-37.

> Delfanti A. (2013). *Biohackers. The politics of open science*. London: Pluto Press.

> Elfick, A. (2017). Synthetic Biology: What it is and why It Matters. in Ginsberg D. A., Calvert J, Schyfter P., Elfick A., Endy D. (Ed.) *Synthetic Aesthetic. Investigating synthetic biology's designs on Nature*. Cambridge: The MIT Press.

> Eskin B. (2011). *The Next Wave: Ten Trendsetter to Watch*. ARTnews, 11, 118-119.

> Ginsberg, A. D., & Chieza, N. (2018). Editorial: Other Biological Futures. Journal of Design and Science, 4.

> Kjærsgaard, M. G., Halse, J., Smith, R. C., Vangkilde, K. T., Binder, T., and Otto, T. (2016) Introduction: design anthropological futures. In: Smith, R.C. Vangkilde, K. T., Kjærsgaard, M. G., Otto, T., Halse, J., and Binder, T., (eds.) Design Anthropological Futures. Bloomsbury, London, UK, 1-16.

> Lucibello, S. (2018). *Esperimenti di Design: Ricerca e innovazione con e dei materiali*. Barcellona-Trento: LISt lab.

> Manzini, E. (1986). *La materia dell'invenzione*. Milano: Arcadia.

> Minati, G. (1998). *Sistemica: etica, virtualità, didattica, economia*. Milano: Apogeo.

> Myers, W. (2012). *Bio Design*. New York: The Museum of Modern Art.

> Naess, A. (1973). The Shallow and the Deep, Long-Range Ecology Movements. A Summary. Inquiry, 16, 95-100.

> Sommariva, F. (2016). L'Ecosofia T di Arne Naess: tra ontologia della Gestalt e Autorealizzazione. Retreived October 2, 2019, from https://www.filosofiatv.org/downloads/279_Somm.%20NAESS%20(2)%20Ecosofia%20T.pdf

> van der Leest, E. (2016). *Form follows Organism: The biological computer*. Megan Hoogenboom.