

22



FASHION AND  
TEXTILE DESIGN  
AMBIVALENCES



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via Festa del Perdono 1 – 20122 Milano – Italy  
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info@padjournal.net – editors@padjournal.net

**Publisher****Aiap Edizioni**

via A. Ponchielli 3 – 20129 Milano – Italy  
aiap@aiap.it – www.aiap.it

PAD © ISSN 1972-7887

#22, Vol. 15, June 2022

[www.padjournal.net](http://www.padjournal.net)

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# NEW/OLD FEATURES

# Fashion-Oriented Bio Textiles

## The New Speculative Aesthetics of Biocouture

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### Keywords

Bio Textiles, Biohacking, Sustainable Fashion, Aesthetic, Formless.

### Abstract

The paper investigates some recent manufacturing processes of biohacking and synthetic biology applied to the fashion textile sector, comparing their laboratory practices, intentions and appearances.

By linking heterogeneous knowledge in a transdisciplinary vision, the paper analyses their potential, combining case studies, processes, and arising aesthetics. In this scenario, the laboratory practices are configured as open study processes, oriented toward a new way of conceiving fashion manufacture, perfectly integrated with the planet's ecosystems.

Among the most interesting aspects, new forms of awareness, intimately linked to the nature to which humankind belongs, emerge, pushing the designer to the role of a catalyst of a sustainable and multispecies vision.

Through an analysis of case studies, the contribution finally reflects the rise of an aesthetic-sensorial paradigm: the formless. All biomaterials and dyes deriving from living organisms seem to relate to this aesthetic category since they lead to a different conception of shape, color, and substance.

In contrast to a classical aesthetic perfection, biomaterials and bio textiles often reveal textures that are dotted, shaded, imperfect, anti-hierarchical, opaque, unpredictable, and for this reason, they shake the viewer, destabilizing him.

The contribution aims to promote an investigation into fashion-oriented bio practices connecting transdisciplinary knowledges to fascinating aesthetics for the consolidation of new fashion imagery.

## 1. Rethinking Textile Fashion Sustainability

The planetary crisis concerning the survival of many living species due to the industrialization of human activities, which is pervasively affecting the balance of nature, does not leave the fashion industry indifferent. On the contrary, it is deeply involved, both because of the profound co-responsibilities it represents and concerning the potential role it could play in restoring these imbalances.

In accompanying the lives of human beings, clothing is probably among the most widespread consumer goods that people buy around the world, but the frequency of purchase has changed radically over the centuries. In relation to what was previously consumed by each individual over a lifetime, a study by McKinsey & Company shows that the number of garments produced annually has doubled since 2000 and exceeded 100 billion by 2014 (Remy, Speelman & Swartz, 2017). A statistic that, if reported on the numerical value of the population, shows how many garments, sometimes in excess, each individual owns.

The textile industry's impact on the environment is devastating and is determined by three main types of pollution: air pollution, solid waste, and water pollution. Concerning air pollution, the clothing industry accounts for 10% of the world's CO<sub>2</sub> emissions through the release of harmful substances such as nitrogen oxides, sulfur dioxide deriving from the energy production phases, volatile organic compounds (VOCs) produced during coating, drying, coloring, aniline vapors, hydrogen sulfide, chlorine dioxide produced during coloring and decolorization.

On the other hand, about the quantity of solid waste, the global textile industry throws about 90 million garments into landfills every year where, in addition to the actual clothes – unsold or discarded – all the processing residues also end up, such as fragments, fabric scraps and production waste.

Finally, water pollution invests almost all stages of production – such as washing the fabric, bleaching, coloring, and washing the finished product – in the continuous release of highly harmful substances to the environment such as formaldehyde, chlorine, and heavy metals which, absorbed by watercourses in high concentrations, are responsible for about 20% of global water pollution. Another problem emerges from the release into the environment of waters not decontaminated and rich in microplastics that, in the case of synthetic fibers, they continue to be released in subsequent washes.

In the light of these brief premises, it is clear that a different approach to the production, consumption, and disposal of textile products is urgently needed. It is a behavior required not only by natural ecosystems that are now rebelling but also by consumers themselves, who are increasingly sensitive to these issues. In addressing these critical issues, the role of fashion designers and manufacturers is becoming crucial.

In reversing these trends, a variety of virtuous practices are emerging, including upcycling of materials, biocouture, and biodesign for sustainable fabrics and dyes.

Through these new practices, the fashion processes, tools, and production materials are beginning to be rethought according to a different ethic and aesthetic, more akin to nature and its regenerative modes.



The biodesign trends associated with biocouture, in particular, lead to forms of awareness intimately connected with the living ecosystem to which humankind belongs together other forms of life, pushing the fashion designer to the role of catalyst for a renovated sustainable vision.

Different corals, different people, different populations are involved, together and for each other. Either prosperity will be cultivated as a multispecies responsibility, without the arrogance of the celestial gods and their emissaries, or the biodiverse Earth will slip into something extremely sticky, like any overloaded complex adaptive system that no longer has the strength to take one insult after another. [...] We are all lichens. (Haraway, 2016, pp. 86-87)

## 2. Biohacking and Growing Textiles

Starting from 2000, the growing access to the web and technological information, the transdisciplinary overlap, the exponential convergence of scientific knowledge, the spread of independent DIY Biology and biohacking practices are just some of the causes that increasingly intersect project, technology, and nature. In the most advanced textile design laboratories, the production paradigm is evolving towards a new horizon of living manufacturing. It is a research scenario on the borderline between biology and technology, where fashion envisions and experiments new interactions with the concept of living organism and its genesis processes, according to a hybrid and intercrossed design perspective.

Among the pioneering experiences in this direction, in 1997, Martin Margiela was one of the first designers to collaborate

with a Dutch microbiologist to cultivate parasitic organisms on clothes from previous collections - from 1989, when he founded his atelier, until 1997. Exhibited at the Boijmans Van Beuningen Museum in Rotterdam, the collection saw 18 dresses in white, cream, and grey color grades in wooden cases and plastic film, presented in their decadent and transitory beauty (La Maison Martin Margiela, 1997).

They result from a combined action between man and nature, aimed at a total dissolution of the garments. From a conceptual point of view, the mutations that living agents were able to trigger in the external environment - such as germination, sedimentation and colorings - characterized the clothes in unexpected ways and were intended as evidence of the passing of time and life.

More than a decade later, in 2012, the exhibition *Bio Design. Nature, Science, Creativity*, organized by MoMA in New York was one of the first international exhibitions curated with the intention of collecting and cataloguing such experiences to explore “an emerging and often radical approach to design that draws on biological tenets and even incorporates the use of living materials into structures, objects, and tools” (Myers, 2012, pp.168-171). By involving organisms at every scale, such as plants, bacteria, algae, fungi, the designer radically transforms the use of the object into a different kind of intellectual experience, taking on the role of mediator of collaborative research.

Among the research, we find many experiments on microbial cellulose, which consists of a new type of skin made by bacteria, whose image is as intriguing as it is repulsive.



Figure 1. *La Maison Martin Margiela*, Rotterdam 1997.



**Figure 2.** Suzanne Lee, *BioCouture* in microbial cellulose, 2010.





**Figure 3.** Carol Collet, *BioLace*, London 2013.

It is a biological substance of very ancient origin but has only recently been rediscovered by contemporary design. Through a special treatment of cultivation, drying, and finishing, Suzanne Lee has made it her trademark, then directing her research to the foundation of an agency called *BioFabricate*, focused more generally on the new frontiers of bio-industries.

We can build our world differently. Advances in biotechnology enable us to move away from factory farming, intensive agriculture, and fossil resources to produce the raw materials for a more sustainable material world. Sectors such as fashion, sport, wellness, mobility, interiors, construction are all embracing materials and ingredients derived from microbes. *Biofabricate's* vision is 'Our material world. Built with biology'. (Lee, 2020)

Among the most critical bio textiles researches, in this perspective, we remember Sonja Bäumel's fabrics, Oron Catts & Ionat Zurr's artificial leathers, Naja Ryde Ankarfeldt's microbial skins machines, Carole Collet's laces, up to the most recent fungi leather by Officina Corpuscoli, Bold Treath's synthetic spider silk, and the cow stomachs leathers by Studio Billie van Katwijk.

The constant increase of these design experiences reveals how synthetic biology (Ginsberg et al., 2014) and biohacking can represent research impulses of extraordinary interest for the fashion sectors. The modality of transmitting this knowledge and the sharing of scientific protocols and procedures is accelerating the speed at which these innovations occur. Hacking a previously closed and regulated system,

deconstructing it and rebuilding its rules, these designers work as biohackers (Delfanti, 2013), breaking down wetware and forms of life, working with plants, small organisms and organic waste. Everything is shared online within the community and reconnected to what already exists, activating a virtuous circuit of open innovation that democratizes the relationship between designers, citizens and science.

Although adhering to international protocols prohibiting experimentation with organisms or substances that are dangerous to humans or ecosystems, the handling of living substances, however, highlights a whole series of ethical and philosophical issues. It is “life” that is the main object of the laboratory, and in this sense, organisms such as cells, bacteria, algae and plants become the material around which artists, designers and researchers are faced. “When art and science meet, unique connections arise. Scientists focus on factual knowledge production, whereas artists give meaning to this knowledge by connecting it to ethics, philosophy and aesthetics” (Evers, 2014, p. 3).

In the field of biocouture, for example, the reproductive character of cultivation processes is not pure standardized repetition but a continuous co-creation work that generates, thanks to the uniqueness of the natural element, always new and singular outputs. The use of microorganisms and natural substances, mixed with other organic materials, produce fabrics compliant with very high levels of biodegradability and compostability and according to parameters in line with the current principles of circular fashion.

From the analysis of these practices, it is interesting to observe how the designer looks at nature and its symbolic component in a dissimilar way from the pure scientist. Diversity consists mainly in a re-elaboration of meanings, processes and aesthetics from an artistic and sensitive point of view. Nature is interpreted in its double humanistic-scientific quality, and it is investigated as a process tool to redesign more sustainable production systems. The potential deriving from these researches is enormous, both for the ability to bring designers closer to the great themes of scientific research and for the possibility of building new fields of action in a shared way.

Expressing a sensitive design vision related to the deep relationship that exists between all living organisms, including human being, Ettore Sottsass give us this dreamlike image:

One day, I brought home a mysterious object, a kind of half- dead, dry worm, and forgot all about it. Then a wonderful insect came out of the dry worm, all green and wet with a stinking liquid, and I gradually realized that it was a grasshopper. I also realized that I was witnessing the inscrutable enigma of all life on the planet. Life is not born in perfume but into stinking liquids. (Sottsass, 2010, p.42)

### 3. Fashion-Oriented Bacterial Dyes

The ability of specific bacteria to generate pigments capable of dyeing fabrics is worth investigating, considering the urgent problems of environmental pollution caused by the textile industry. It could highlight how these productive biological systems could offer an attractive sustainable alternative.





From the analysis of bacterial dyes tested by independent researchers and designers – such as *ColorFix*, *Living Colour Collective*, *FaberFuture*, *Pila*, *BioShades* – it is possible to observe how these microorganisms, cultivated in a few days on agar plates or through different synthetic biology processes, can give back a wide variety of colour perceptions. For the vividness of the tones, among the most interesting bacteria, we can consider *Serratia Marcensces*, *Janthinobacterium Lividum*, *Vogesella Indigofera*: microorganisms that can be used both for dyeing natural fibers such as silk, wool and cotton, and some synthetic fibers, such as nylon, for example (Yildirim et al., 2020). These bio dyeing processes are all inside a certain biosafety level (BSL 1) and with a quite simple practicing, always using the right level of attention and cleaning, they can be explored in different ways. Their explorations, indeed, generate colors and textures, as unexpected as they are fascinating, as well as being extremely advantageous, from an economic point of view, compared to the already well-known dyes derived from plants (Graz et al., 2015). By a controlled manipulation that governs the tissue quality, the type of microorganism, the incubation the temperatures, surface and duration of cultivation, it is possible to obtain different color gradients, generating a singular aesthetic, the result of an interaction that is each time unique and living-based. Among the most interesting researches, we can examine some that differ in technology but lead to similar results, in terms of aesthetics, colors and intent.

Founded in 2016 in Norwich, *Colorifix* uses a synthetic biology technique that involves the sequencing of DNA, determining a specific natural color from an animal, plant or microbe.

The color is transferred into an engineered microorganism, which is later fermented by a fermentation process fed by sugar molasses, and multiplied in such a quantity that it can be used efficiently on large surfaces. According to the company's founders, with this technique, it is possible to obtain dyeing at 37 °C on both natural and synthetic fibers and a considerable reduction in water consumption (10 times less than the commonly used water). Confirming the high degree of innovation, among the various partners who have invested in the brand, we find the Swedish H&M group.

Based in Paris, the *Pili* company, on the other hand, adopts sophisticated biotechnology combined with the use of ancient fermentation processes, using enzymatic waterfalls to transform raw materials into textile dyes. The basic idea is to integrate enzymes into bacteria that are subsequently grown in bioreactors where sugar acts as the primary energy source.



Figure 5. Ginkgo Bioworks Laboratories, London 2020.

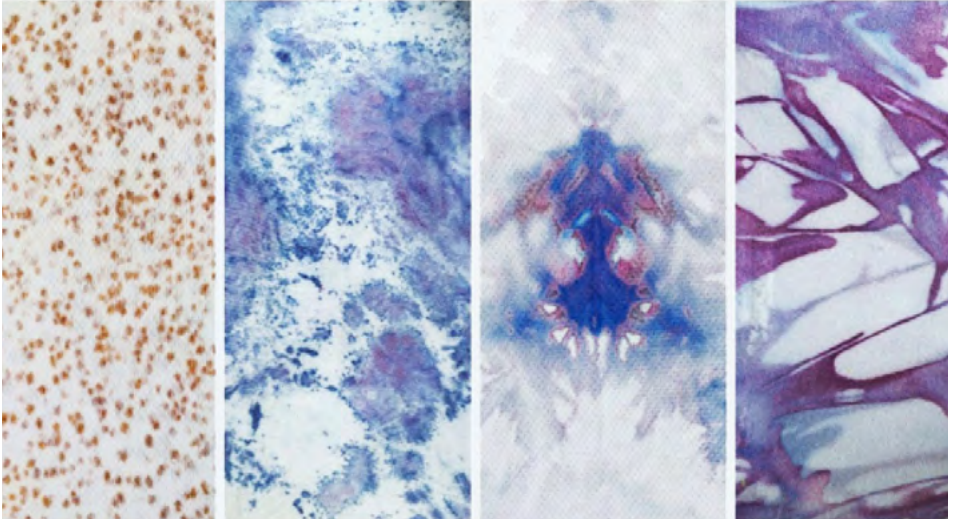


Figure 6. *Pili Company*, bacteria dyeing, Paris 2018.

This process does not require fossil fuels and does not produce dangerous by-products, making these biofactories highly efficient and non-polluting. Among the *Pili* brand's main exhibitions, we can nominate *Broken Nature* at Triennale Milano Museum, curated by Paola Antonelli (Antonelli & Tannir, 2019), and the *La Fabrique du Vivant* at The Centre Pompidou in Paris, curated by Marie-Ange Brayer and Olivier Zeitoun, both held in 2019.

Following a biohacking procedure, another research project in bacterial textile dyeing is *BioShaded*, driven by Cecilia Raspanti from the *Textile FabLab* of the *Waag Society* in Amsterdam. The project explores with an open and shared approach how textiles can be dyed in a less polluting way, working with pigments produced by living bacteria. Funded by the European Community, the project is based on a series



of workshops aimed at increasing the knowledge of designers and creatives in general, through the networking of a fully accessible documentation for the activation of such practices. Among the bacteria used in collaborative experimentations, there are the *Janthino Bacterium Lividum* (violacein), the *Serratia Marcenses* (prodigiosin) and the *Vogesella Indigofera* (indigodine), all always belong to the biosafety level 1, the safer one. In connection with this Dutch network, in 2019 the design collective *Living Colour* succeeded in obtaining a collaboration with the *Puma* brand, with which it will soon launch the first collection of sportswear dyed with bacteria.

Intersecting nature, biotechnology, and society to build a sustainable future, the *Faber Futures* agency in London can be considered one of the most advanced centers working in this realm. Combining biohacking techniques with synthetic biology, thanks to a global network of laboratories and scientists, *Faber Futures* exploits the biofabrication possibilities of organisms such as bacteria, fungi and algae to develop new materials, processes and applications in a wide spectrum of industrial sectors. Amongst these, textile design plays a central role. For example, the *Assemblage 001*, driven by Natsai Audrey Chieza, represents the world's first garment to incorporate bacterial dyes as the foundation of its construction. The project develops a special bacterial dyeing process that is highly customisable and versatile even for the creation of complex tailoring products (Natsai & Ginsberg, 2018).

Although these bio dyeing techniques are only at the beginning, it is important to understand how, their management

and further optimization can open in the future possibilities to explore new chromatic shades, applications and textures. In this sense, these practices can embody the forerunner studies of the sustainable dyes, perfectly oriented to a bio-based textile industry so much requested now from the circular fashion.

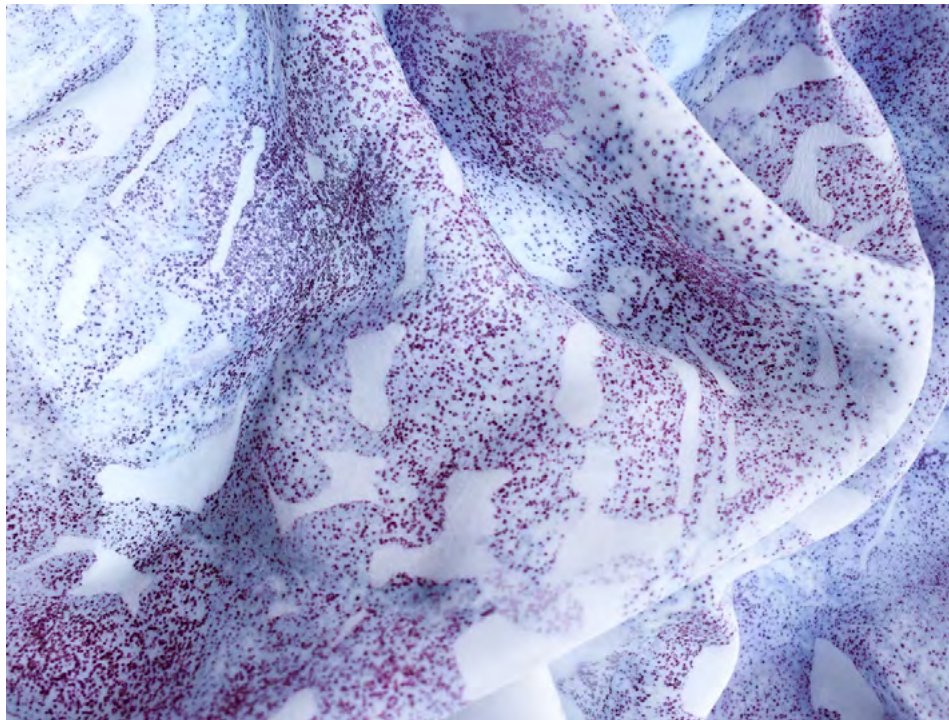


Figure 7. Natsai Audrey Chieza, bacteria dyeing from *Faber Futures*, 2017.

#### 4. Conclusions: the Emerging of Formless as a New Aesthetic Fashion Paradigm

In the light of the research described so far, both in the field of bio textiles and bacterial dyes, an unusual and fascinating aesthetic dimension emerges, which can be assimilated to the concept of the organic and the formless.

I sometimes thought of the formless. There are things, spots, masses, contours, volumes, that somehow have only a de facto existence: they are only perceived by us, but not known; we cannot reduce them to a single law, deduce their all from the analysis of one of their parts, reconstruct them with logical operations. [...] To say that they are formless things means not that they have no forms at all, but that their forms find nothing in us that allows us to replace them with an act of safe definition or recognition. (Valéry, 1936/1960, p. 1194)

Paul Valéry's reflections on the concept of formless are rooted in the definition-manifesto that Bataille firstly wrote in the programmatic entry contained in the appendix *Dictionnaire Critique* of the second issue of the magazine *Documents* of 1929. The formless is a universe that cannot be reduced to a precise form, "like a spit, a spider, a worm" (Bataille, 1929/1974, p.165). It is a subversive and anti-academic deconstruction of the prevailing classical aesthetic, indicating an attitude, a driving perspective from which to observe and understand the world. Away from a canonical image of industrial perfection, this world is analyzed by Bataille through key words somehow annexed to the living, such as black birds, mouth, aesthete, unhappiness, materialism, slaughterhouse, metamorphosis, eye, dust, space (Alemani, 2002).

The notion of formless was later, over the decades, investigated by art theorists as Denis Hollier, Rosalind Krauss, Georges Didi-Huberman, Yves Bois, and transformed into a critical and interpretative instrument of the contemporary artistic practices.



**Figure 8.** Natsai Audrey Chieza, *Project Coelicolor: Assemblage 001*. Faber Futures, London 2017.



The formless is today a point of view from which an attack by contemporary critics on a vision of modern art based on the idealism of both subject and work: purged by the irruption of the carnal, temporality, materiality, the concept of disorder and waste as well as the idea of fragment; based on a supremacy of the eye that excludes all the other senses and denies the tactility of matter. (Krauss & Bois, 2003, p.6)

Almost all fashion products made from the use of organisms such as bacteria, algae and fungi can be related to this category, since they lead us to a different conception of form, aesthetics and matter. In the light of these considerations, the contribution attempts to summarize this thesis through the explication of three speculative adherences to formless:

- *Imperfection*: At the antipodes respect to an ideal of classical geometry – whose canons are to be found in the Renaissance principles of harmony, symmetry, compositional equilibrium – the aesthetics of growing textiles and bio dyeing are punctuated, shaded, imperfect, anti-hierarchical, opaque, indefinite, unpredictable. In this sense, those new artifacts shake the spectator, destabilize him, stimulating his curiosity and thought.
- *Decadence*: Microbial leathers as well as bacterial dyes exist in the present, and then dissolve, disintegrating over long time, reflections of a changing and transitory contemporaneity. In the construction of these tissues and pigments, the living matter is explored as a process, through a scientific study of its dynamics and spectacularized mech-

anisms, by explicitly shifting reflection back to a level of transience, understood as a prerequisite of life.

- *Raw Matter*: Distant from a serial and asepticity imaginary, the materiality that emerges from such practices follows the logic of the living, according to a collaborative approach of co-creation with the organisms employed. In all its structure, the matter expresses itself naked without being covered up. It thus becomes a tangible manifesto of a design intention oriented towards a fusion with other forms of life.

In these multiple perspectives, still open to further investigations, organic textures and indefinite patterns are the mirror of a contemporary design that penetrates beyond the technological perfect surface of things to denounce, sometimes in a brutal way, the undisputed urgency of saving the planet, to save ourselves.

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Outside of the academic environment, she is a designer enjoying philosophy and politics readings from all over the world, with a strong attention to their related languages, be they carved in stone or posted on social media.

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**Gina Nadal Fernandez**

Gina Nadal Fernandez is a final year PhD student in the Design Department at Manchester School of Art, Manchester Metropolitan University. Her doctoral research is by practice, and investigates how emotional experience can be designed into digital jacquard woven textiles during a co-design process by using digital coding.

She takes a multidisciplinary approach that embraces design theory, textiles, digital coding, consumer behaviour and mass customisation in her weaving practice using a TC-1 loom and natural yarns.

Gina has presented her research at the PhD by Design workshop at the Design Research Society Conference 2018, at the Global Fashion Conference 2018 and 2020. She is also a member of the Textile Society and Design Research Society. She holds a master's degree in Fashion Graphics from Manchester School of Art, Manchester Metropolitan University that looked at the relationship between digital jacquard textile practice and emotional value using digital coding.

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**Beata Hamalwa**

Beata Hamalwa founded Fashion Design Diploma at College of the Arts, Windhoek, Namibia, and Fashion Design Certificate at City Varsity, Cape Town, South Africa, and co-founded the Heroes Primary School - all became imperative in employment creation. Her versatile educational background from Poland, Namibia and South Africa in arts and fashion design has provided a valuable foundation for her career in several art training programmes. She holds a Master of Technology in Design. Her Master's thesis, titled 'Beadwork and its impact on contemporary fashion in South Africa,' investigates the cultural wealth contribution to decolonizing fashion. She believes that modern arts and trends do not imply the demise of indigenous culture. Her latest endeavour is to investigate the possibility of sustainability in the current fashion industry in Namibia, which led me to PhD research at the Cape Peninsula University of Technology. As an artist, Hamalwa has showcased at premier fashion events in Namibia, Portugal, Germany, France, Poland, the United Kingdom, South Africa, Botswana, and Reunion Island.

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She started her academic career in 1995, was the coordinator of the undergraduation course in Textile Engineering at University Center of FEI (2001 to 2006), was the coordinator of the undergraduation course in Textile and Fashion at University of Sao Paulo (2010 to 2012), was the coordinator of the Master's Degree in Textile and Fashion at University of Sao Paulo (2012 to 2016).

She has been a professor at the School of Arts, Sciences and Humanities since 2006 and has been an associate professor at the University of São Paulo since 2011. She researches in the areas of textile materials, knitting technology and textile design.

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PhD student in the Textile Engineering course at the University of Minho (Portugal), master (2013) and graduated (2009) by the Textile and Fashion course at the University of São Paulo. Since 2012 acts as a researcher at the Technical Textiles and Protection Products Laboratory of the Institute for Technological Research, where has been working especially on the following topics: vegetable textile fibers, natural dyes, comfort, characterization and performance evaluation of technical textiles.

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### Adriana Yumi Sato Duarte

Undergraduate (2009) in Bachelor of Textiles and Fashion from the University of São Paulo, Master (2013) and PhD (2017) in Mechanical Engineering from the State University of Campinas (Unicamp). Conducted a period of Internship of Doctorate Sandwich Abroad (SWE) - Science without Borders Program (2015-2016) at Fachgebiet Datenverarbeitung in der Konstruktion (Dik), Technical University of Darmstadt, Germany.

She has experience in Mechanical Engineering with an emphasis on Mechanical Design and in Textiles and Fashion with an emphasis on product design methodology, sustainable product development, Brazilian natural fibers, knitting technology and Industry 4.0. She is currently Assistant Professor II at Nossa Senhora do Patrocinio University and Coordinator of the Fashion Design Course.

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### Chiara Scarpitti

Chiara Scarpitti, designer and PhD, is Researcher at the Department of Architecture and Industrial Design of the University of Campania "Luigi Vanvitelli". Since 2006 she has been working in the field of design and jewellery at an international level, obtaining numerous awards and exhibiting her works in museums and galleries including Triennale Design Museum in Milan, MAD Museum of Art and Design in New York and HOW Design Center in Shanghai.

Member of the Board of Directors of AGC - Association for Contemporary Jewellery, she taught jewellery design at IED Moda in Milan and at the Academy of Fine Arts in Naples.

In 2018 she has published the monograph "Multipli Singolari. Contemporary jewellery beyond digital" with ListLab, Barcelona, in double edition (ita/eng), and in 2020 "Oggetti pensiero. Storie di design, organismi e nature plurali" with Lettera Ventidue, Siracusa. Her theoretical research is characterized by a speculative hybridization between digital technologies and manufacturing excellence linked to contemporary design and fashion.

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He mainly works on the following topics: technical fabrics, characterization tests and performance evaluation of textiles and PPE's, weathering and microencapsulation applied to textiles.

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### Renato Stasi

Renato Stasi has been involved in the creation of clothing and accessories collections for the fashion segment for almost thirty years, as a designer and responsible for the development of the collection, he has worked for several companies including the LVMH Group, Redwall, Hettabretz. He is an adjunct professor at the DIDA - UNIFI Department of Architecture, in the CDL in Industrial Design and CDLM Fashion System Design. Lecturer at IED, where he is the coordinator of two three-year courses. He has carried out supplementary teaching activities at the Politecnico di Milano for several years. He has held seminars and workshops in various universities. Stasi is Coordinator of the Steering Committee of the Master's Degree Course in Fashion System Design of the University of Florence - School of Architecture - DIDA.

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Since 2008 she coordinates (with P. Ranzo e M.A. Sbordone) the Design for Peace Lab activities. The creative lab was established following the draft agreement signed by the Province of Naples - Councilorship to Peace and International Cooperation - and the Department with the purpose of sharing experiences and best practices in the field of international cooperation and the management of humanitarian emergencies.

She teaches from 2013 to now Social Design and Design for Cosmetic - Design for Innovation Degree Course at University of Campania 'Luigi Vanvitelli'.

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**PAD. Pages on a and Design**

International, peer-reviewed,  
open access journal  
ISSN 1972-7887

#22, Vol. 15, June 2022

[www.padjournal.net](http://www.padjournal.net)



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