



Ministry of Foreign Affairs

Innovation and sustainability in French Fashion Tech outlook and opportunities

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EXECUTIVE SUMMARY

This report presents an overview of innovation in fashion outlining possible opportunities for collaboration that address both economic and ecological sustainability. It also seeks to describe the conditions necessary for the fashion industry to achieve the United Nation's Social Development Goals (SDGs).

It investigates the current French fashion tech arena, its definition, evolution and main fields of technological innovation.

The first section takes a close look at how the French fashion industry is addressing sustainability, the impact of the UN's Sustainable Development Goals and how these are shaping the future of the industry. It presents the organisations that are leading change and the innovative solutions that reconcile economic and environmental sustainability.

The second chapter maps out innovation in the French fashion industry, with further indications referenced in the accompanying guidebook (annexes). It includes a description of the key players and organisations dedicated to innovation in fashion tech along with sources of funding and information.

The third section presents the contribution of research to the fashion industry. Fashion tech owes much to researchers and designers with many projects focusing specifically on textiles. Though fashion is not considered a key area for high-tech innovation, this report presents the research programmes that have potential applications in apparel. It looks at the main territories and objectives of research programmes related to fashion and their possible applications in the industry. These projects portray the dynamics at work in French fashion tech research.

INSEE¹ data indicates that the average budget spent on apparel by the French population has steadily decreased since the 1960s while the offering has continued to grow and has by matter of force become more elaborate. This has led fashion brands to turn to technological innovation for differentiation. It is seen as offering an opportunity to heighten its traditional aesthetic, wearer comfort and semantic drawing power with novel properties providing innovation in safety, health and "smart" functions.

¹ The National Institute of Statistics and Economic Studies (INSEE) collects and analyses information published in official reports on the French economy and society.

Does today's fashion tech have the ability to create tomorrow's efficient and sustainable fashion and replace functions currently delivered by mobile electronics and specifically smartphones? The fourth section of this report presents the main fields of research that may impact fashion (state of the art), their objectives (outlook) and conditions necessary to achieve these goals (keys to success).

The fifth and last section suggests potential collaboration opportunities for French and Dutch entities. The Netherlands has a vibrant innovative and sustainable fashion scene as seen in the examples described in this section and mentioned throughout the report. Three potential areas of specific competence stand out: the close connection between its fashion industry and research institutions, biomaterials and wearables. This report also details the challenges fashion tech development faces. It is conceivable that fashion tech address SDGs, as this report outlines, on condition that the industry be better armed to take into account varying visions and methods. Fashion tech projects tend to disrupt traditional research frameworks, as seen in the results of the pedagogical methods developed in the Netherlands. For innovation to align with sustainability, fashion education needs to be rethought and constructive dialogue be encouraged to allow both new models to emerge and new legislation be enacted. This section closes with suggestions of possible strategic collaboration.

Reducing pollution generated by the fashion industry requires the collective contribution of institutions, fashion groups and brands along with committed consumers but it should also be backed by funding for research into sustainable solutions. The emerging visionary fashion tech entrepreneurs can kick start progress, but they can only do so with the support and contribution of the leading industry stakeholders that have far greater economic means.

INTRODUCTION

This report presents a state of the art of the **French fashion industry** with regards to the key issues it needs to address and the future outlook of its innovation and research programmes. It takes a close look at how these new technologies and business models align with the **United Nations' Sustainable Development Goals** (SDGs). Its goal is to: identify the directions, projects, actions and programmes capable of addressing economic, social and environmental goals; investigate the role that innovation and the Fashion tech movement can play with regards to SDG compliance; and single out those that could be jointly developed by Dutch and French stakeholders.

01. DEFINITION AND KEY DATES

French fashion tech can be defined as: “any significant digital development in or for fashion”, it is a highly dynamic field that covers a broad array of technologies. Often assimilated with ‘wearables’, ‘smart textiles’ or ‘connected clothing and textiles’, the terminology commonly used in France, the relatively recent fashion tech movement encompasses a much wider range of innovative technologies that impact all stages of the supply chain. Fashion has become a field of exploration and co-creation for academia, designers, entrepreneurs and consumers.

The digital revolution and emergence of online platforms, pure players and social media have had a radical impact on many industries. Established French fashion companies were slow to embrace omni-channel strategies. For luxury labels, the ‘world wide web’ and e-commerce were considered unsuitable to delivering a rare and exclusive brand experience.

Ready-to-wear brands operating on other segments were slow to implement the structural changes required to achieve their digital transformation. French fashion companies have generally associated new technologies with automation, considered both unglamorous and ‘geeky’, and unable to convey the visual codes and authentic craftsmanship central to their desirability and success. Now that a digital culture is considered “trendy”, fashion companies have for the most part embraced technology², recognising its ability to personalise their brand experience on a large scale and optimise their value chain.

As the GAFAM³ internet giants took an interest in fashion, applying their design and marketing might to expand their reach, they struck a chord as, fittingly enough, this broader public is increasingly responsive to image and aesthetics.

This is also a time when pioneering designers helped fashion tech emerge: figureheads in France include Paco Rabanne, Olivier Lapidus, Elisabeth de Senneville, and a number of international designers whose influence has been felt in France: Hussein Chalayan, Iris van Herpen, Yin Gao, Anouk Wipprecht and Pauline van Dongen. This period also saw a growing number of small structures working on innovation or new thinking. These dynamics led to the coining of the term fashion tech boosted by a thriving start-up culture that ultimately gave birth to a “French Tech” attitude across many fields including food tech, fin tech, med tech and more.

² The Fédération de la Haute Couture et de la Mode commissioned a [report](#) on this subject.

³ GAFAM: acronym for US-tech giants Google, Apple, Facebook, Amazon and Microsoft.

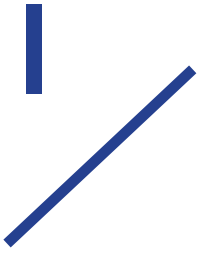
02. DUTCH FASHION TECH DYNAMICS

Though its presence in French media is rare and its global recognition low, Dutch fashion is intuitively associated with a conceptual approach to creativity and functionality linked to the country's strong design culture.

It is “**contemporary, innovative and fresh**,” says Michael Scherpe, President of Messe Frankfurt France; it also owes much to Lidewij Edelkoort's work on evolving sociocultural trends. Oscar Tomico and Vera de Pont confirm that **Dutch fashion tech** is “constantly evolving” thanks to the many projects initiated by scientists, designers and artists and opening up new possibilities in chemistry, nanomaterials, biotechnologies, digital manufacturing and artificial intelligence. Aurélie Mossé, one of the few designer / engineer / professors working at the intersection of textile design, architecture and new technologies, says that Dutch references were an important source of inspiration when she started, citing Hella Jongerius, Jurgen Bey, Droog Design and the Eindhoven Design Academy.

The Dutch tradition of combining art and design in its research programmes, its efforts to address sustainability with the development of new materials, technologies and architecture are a key source of inspiration for French fashion professionals.

Environmental issues are seen as a key asset of the Dutch fashion industry. Commenting on how Dutch fashion is perceived, Eco-TLC (see Part I. 01. a) mentions the Amsterdam-based Fashion for Good accelerator dedicated to sustainable fashion.



THE CONVERGENCE OF ECOLOGICAL AND ECONOMIC SUSTAINABILITY IN FASHION

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This section describes the context that has led to a reorientation of innovation towards achieving the UN's SDGs. Step by step, the fashion industry has come to realise that it needs to reduce its impact on the environment and improve its working conditions.

Leading fashion companies, including the many French ones, have begun to address what has become a global trend. They do however struggle to give up a dominant quantitative business model based on permanent growth and contraction of costs, generating much waste and pollution.

This contradiction in terms has favoured innovation in reducing production costs that have a 'clean' environmental image, yet these so-called 'virtuous' practices are increasingly under tension, with regards to energy use and geopolitics, and are no longer seen as future, but rather present, challenges. Global warming and the need for eco-responsible solutions have become key topics at many industry events.

It was mentioned throughout the Forum de la Mode⁴ organised by the French Ministry of Economy and attended by textile and clothing industry federations, associations, analysts and decision makers. Retailers are taking action (such as Lafayette Go for Good and H&M Conscious).

The industry's renewed interest in new technologies seems to be motivated mostly by the hope that they create opportunities for both economic and environmental sustainability. Often criticised for its unethical practices, can fashion lead the necessary ecological transition? This report suggests that it can, and does so, thanks to public and private support, citizen organisations, and changing trends and consumer attitudes. This section also details examples of eco-innovation and the challenges the industry faces.

I. 01. KEY PLAYERS

a. Public institutions and organisations

The Environment and Energy Management Agency (ADEME), a public institution linked to the Ministries of Ecological and Social Transition and of Higher Education, Research and Innovation, is in charge of public policy, provides guidance, collects data, publishes reports and finances projects dedicated to environmental, energetic and sustainable progress.

It published a report detailing the fashion industry's impact on the planet in 2018, "Le revers de mon look"⁵ with Universal Love⁶ an association founded by Isabelle Quéhée, a leading figure of responsible fashion in France. The industry-funded Eco-organisme du Textile, du Linge et de la Chaussure⁷ (Eco-TLC) is tasked with increasing the collection of used textiles, linens and shoes (TLCs) and finding higher value uses for them through recycling. Its research relies on reports such as those published by the Ellen MacArthur Foundation⁸ and UK-based Waste and Resources Action Programme⁹ (WRAP).

Every year since 2010, it has launched a call for projects¹⁰ to identify and fund the most promising waste recycling solutions. The city of Paris has also recently launched Paris Good Fashion¹¹, announced by Antoinette Guhl, deputy mayor of Paris in charge of social innovation and the circular economy. The brand new association is mandated with supporting local and sustainable fashion brands as part of a move to relocate manufacturing and promote craftsmanship.

France can also take advantage of its national production of linen and hemp, natural fibres requiring little water and few pesticides. A number of young brands seek to develop the use of hemp¹² in apparel, leading to innovation in its processing (adapting equipment to longer fibres, waterproofing, elasticity).

⁴ Specifically, in "Humanity: a new doctrine for responsible fashion?" a panel talk chaired by Clarisse Reille, General Manager of DEFI La mode de France.

⁵ <https://www.ademe.fr/sites/default/files/assets/documents/le-revers-de-mon-look.pdf>

⁶ <https://www.universallove.fr/>

⁷ Eco-organisme for Textiles, Linens and Footwear (Eco-TLC).

⁸ <https://www.ellenmacarthurfoundation.org/publications/a-new-textiles-economy-redesigning-fashions-future>

⁹ http://awsassets.wwffr.panda.org/downloads/guidewwf2011web1_111019102455_phpapp01.pdf and wrap.org.uk

¹⁰ <https://fr.fashionnetwork.com/news/Paris-Good-Fashion-une-association-qui-promeut-une-mode-durable-sou-tenue-par-la-capitale,1062559.html#.XGtYszNKjb0>

¹¹ <http://linetchanvrebio.org/> cf new members

b. Alternative online and offline initiatives [Annex 1.A]

Proof of growing interest for responsible fashion in society at large can be seen in the emergence of collectives, associations and working groups. Political and/or social in nature, these include the Colibris, Coquelicots, the petition #laffairedusiecle and “La marche du siècle” (Oxfam France). It can be seen as a sign of a shift away from the excesses of consumerism and the growing influence of alternative and collaborative movements (economy of functionality, hacker-makers, do-it-yourselfers) that seek to pool resources of all kinds, including knowledge (libraries, Creative Commons licenses, GitHub). Quick to respond any evolution in society, fashion has embraced these dynamics. The sharing economy relies on exchange and makes use of the possibilities offered by online platforms, forums and groups where individuals can share their experiences (examples related to fashion: Co-re-cyclage¹³, French Fashion Union¹⁴).

Environmental catastrophes and health scandals have triggered many political **sustainability movements**. The Rana Plaza accident brought to light the negative impact of fashion to the masses. Campaigns exposing fashion’s darker side (the GreenPeace re-port on Toxic Fashion and the documentary The True Cost) have given birth to many new organisations including The Fashion Revolution, Changer la Mode pour le Climat¹⁵ (COP21 and 22) and the Anti-Fashion Manifesto.

They have not, however, instigated real change in consumer and retailer attitudes as confirmed by a poll conducted by the Institut Français de la Mode (IFM). It finds that the sustainable fashion offering exceeds demand and that consumers’ environmental concerns do not impact their buying choices, even though the market for second-hand clothing, a nebulous one, is said to have doubled between 2010 and 2018.

The report further finds that fashion consumption in France is slowing (-15% in value since the 2008 crisis), 44% of consumers bought less clothing in 2018¹⁶, stating budgetary reasons (60%) and choice (40%). The numbers point to a shift away from an era of accumulation to one of hedonistic ex-periences.

A loss of faith in pricing is identified as another reason for consumers’ reduced spending in fashion.

¹³ A platform for sharing.

¹⁴ A community sharing news and deals on Facebook

¹⁵ <http://changerlamodepourleclimat.fr/>

¹⁶ IFM report led by Gildas Minvielle and Thomas Delattre.

This indicates that **sustainable fashion brands** need to promote transparency, via social media, using new technologies such as blockchain, Near Field Communication (NFC) or Radio Frequency Identification (RFID). International NGOs (Greenpeace, the Fashion Revolution), national and local organisations (De l'éthique sur l'étiquette, Mode Estime, Manifeste 011, Une autre mode est possible) are rising to the challenge to raise consumer awareness. Many new initiatives seek to inspire change in consumer attitudes: third places and ressourceries¹⁷ for instance support DIY programmes, on-demand manufacturing and artisans, educate consumers on the real value of fashion manufacturing and pool their resources (Sew & Laine, La Textilerie, La réserve des arts, Hall Couture, Make Sense, Plateau Fertile and fab-labs such as ICI Montreuil, the Draft, WOMA-Ville de Paris, Makerz).

The development and leadership of these third places, demanding in time and personal investment is a research topic in itself. Other providers of novel services include: La réserve des arts (recycled supplies and materials, Coco & Rico (innovative manufacturing workshop without minimums near Paris, Tekyn (a supplier of machines and software for local on-demand manufacturing, French Fashion Bureau (a platform for sustainable fashion and 1.618 (a sustainable luxury trade event).

c. Corporations and SMEs: progress and challenges [Annex 1.B]

At the COP 24, held in the Katowice, Poland, 43 companies, including many of the world's leading names in fashion (Adidas, Burberry, Esprit, Guess, Gap, Hugo Boss, H&M, Inditex, Kering, Levi Strauss & Co., Puma and Stella McCartney) signed the Fashion Industry Charter for Climate Action, committing to eliminate all GHG emissions by 2050¹⁸. Measures taken by major French luxury groups in favour of the environment and biodiversity is detailed in the final section of Part II. With the exception of a few pioneers (Patagonia, Veja, Bonobo, smaller fashion brands recognise the critical nature of climate change but request time to implement the changes necessary to limit their impact on the environment. Younger companies have more readily embraced sustainability and actively promote their virtuous practices.

Many of the emerging **eco-responsible** 'Digital Native Vertical Brands'¹⁹ (DNVBs) have based their concepts on transparency, ethical and local sourcing and manufacturing (1083, De Bonne Facture, Atelier Bartavelle, Le Slip français,

¹⁷ French Ressourcerie network: <http://www.ressourcerie.fr/>

¹⁸ <https://unfccc.int/news/milestone-fashion-industry-charter-for-climate-action-launched>

About a Worker, Les Récupérables, Maison Cléo, Procède, Kelly Miller Paris and Adel Astrée). Some first began with blogs and DIY kits or tutorials (Make My Limonade, Louis & Antoinette). Up-and-coming designers (Marine Serre, AVOC, Nicolas Lecourt Mansion) also stand out for their sustainable vision but have often focused on SDGs through the promotion of inclusive non-binary styles.

Their key consumer base is nonetheless well aware of the issue and knows it needs to limit its impact. Signs of changing consumer attitudes are surfacing, as the social importance of appearance is increasingly outsourced to social media where one's responsible (and aesthetic) choices are the subject of many a post. Professor Danièle Clutier-Léauté, in charge of the European curriculum at the IFM and Secretary General of innovation hub R3iLab, believes that this trend may impact the market in units sold but not in value as sustainability aware consumers tend to buy fewer items but spend more.

I. 02. MONITORING IMPACT

Access to new “smart” technologies to measure and monitor the impact of the entire value chain, from sourcing and manufacturing to use and end of life, would help the industry better identify the actions it needs to take. A Life Cycle Analysis (LCA) is such a tool, but it does not yet generate information that can be displayed on a hang tag or label. It is also a costly process (in time and money) which does not make it popular among small brands. That said, Sophie Bramel, a specialised journalist, says that sports brands tend to use open-source LCA data to make material choices, without incurring accrued costs (though it is time-consuming for staff). Furthermore, this form of “environmental accounting” does not cover the possible impacts of a product on consumer health. This could be a problem for materials recycled from used clothing made before current standards, such as REACh, were implemented.

I. 03. SUSTAINABLE INNOVATION AND BUSINESS MODELS

The fashion system itself could arguably be a “natural” leader of change. The R3iLab's future fashion Scenarii 2030 programme found that fashion consumers are increasingly impatient and creative but also more attuned to human and social issues. As social media platforms are used to voice political opinions, these trends can have an impact on business, influence executives and inspire innovation.

Novel solutions the fashion industry is applying at all stages of the supply chain to lighten its footprint:

- **Processes to transform textile waste:** disassemble clothing to facilitate recycling using microwaves (DECOLTEX, a Carat project); automated sorting of used clothing by colour to avoid re-dyeing (CETI), recycled yarns (Care-fil), generating energy from leather scraps (Thermicuir²⁰).
- **“Clean” biotech dyes and materials:** some of which were featured in the Pompidou Centre exhibition “La Fabrique du vivant”, organised with the Netherlands (known for its advance in this field).
- **Product design:** using 3D modelling (zero waste fashion design).
- **Innovative functional products:** thermoregulating concepts, reducing the need for heating and air conditioning (Clim8), garments with pollution sensors to analyse air quality and raise awareness, electromagnetic radiation shielding underwear and accessories.
- **On-demand manufacturing:** Tekyn, Lectra Made 4.0 Customization.

Support for innovation in sustainable fashion in France

Incubators, labs and accelerators specialising in sustainable fashion research have been created [Annex 7]. With the notable exception of the Toulouse White Biotechnology²¹ platform, few provide advanced technical support for scaling up, after proof of concept. The EU is an important source of funding for cross-border innovation. It backs, in a limited time frame, fashion-specific programmes such as the Textile & Clothing Business Labs (TCBL). Other programmes support sustainable innovation across all sectors, as does the Fabrique Aviva (an insurer) focusing specifically on projects address-ing “social and environ mental sustainability”. Many eco-responsible fashion brands nevertheless rely on self-financing or crowdfunding. Le Slip Français, 1083 and Les Récupérables launched campaigns on Ulule and KissKissBankBank. These can help upstart brands fund pre-production runs, eco-brand Panafrica’s campaign scored 1,970 orders allowing it to launch. HubMode (a provider of MOOCs) raised funds on the WeDoGood crowdfunding platform that rewards shareholders with royalties. The Socially Responsible Invest-ment (SRI) fund is another option for ethical fashion brands.

¹⁹ A Digitally Native Vertical Brand (DNVB) is a vertically-integrated internet-based direct-to-consumer brand relying on a strong and direct relationship to consumers via social networks and storytelling.

²⁰ <https://www.ecotlc.fr/actu-15-283-la-8eme-edition-des-chemins-de-l-innovation-the-8th-edition-of-the-roads-to-innovation.html#a283>

²¹ <https://www.toulouse-white-biotechnology.com/> The TWB programme disposes of a 10-year €80 million budget (part of the state’s investment in the future) and promotes collaboration among laboratories and industries (L’Oréal, Veolia, Total) for the scaling up of synthetic biology projects.

CASE STUDY

Labo Algues ²²:

An example of successful cross-disciplinary FR-NL collaboration in design with possible applications in sustainable fashion.

Project concept: manufacturing a non-biodegradable biopolymer from locally sourced micro- and macro-algae. Algae filter seawater, absorb CO₂ and produce biomass as a by-product.

Benefits: replace non-biodegradable plastics (in 3D printing for instance) and reduce carbon dioxide emissions. “Algae produce much of the oxygen that we breathe by binding carbon dioxide molecules and converting them into biomass, as they absorb carbon (C) and produce O₂ as a waste product: clean air. In a relatively brief period, humans released vast amounts of CO₂ into the atmosphere from organic matter that lay buried in the ground for millions of years. With effects such as global heating, acidification of the oceans as a result, it’s important to capture atmospheric CO₂ as quickly as possible. And this can be done by binding carbon to biomass. Instead of zero emissions we need ‘negative’ emissions.”

Genesis: a 3-year research project led by Eric Klarenbeek and Maartje Dros with Salga Seaweeds, Danvos, Wageningen University, Avans Biobased lab (Breda) and others.

Partners: Atelier Luma (Arles, France), a non-profit program seeking to experiment with design and creative intelligence in rethinking more ecologically sound and regional forms of production; Studio Klarenbeek & Dros (Zaandam), specialising in algae; MAVA Foundation (funding).

Prospects: in principle any product from shampoo bottles to tableware and rubbish bins can be made from this algae polymer. AlgaeLab tableware for local restaurants and catering companies has already been launched.

Possible fashion tech applications: this project illustrates how designers can help turn a research project into a product having real market uses. It is also a good example of an international collaboration operating on a local scale leading to a cradle-to-cradle solution.

Distinctions: Atelier Luma’s Algae Lab won a New Material Award²³ and was nominated for a Beazley Design of the Year Award (London Design Museum).

²² <https://atelier-luma.org/projets/lab0-algues>

²³ <https://www.newmaterialaward.nl/>

04. THE IMPACT AND LONG-TERM INFLUENCE OF SDGs

The United Nations promotes its Sustainable Development Goals as “a plan of action for people, planet and prosperity”. It is based on a set of 17 global goals which include ending poverty, combating climate change, protecting the environment and ensuring prosperity for all. Each goal is backed by specific targets to be achieved by 2030, with clear indicators to assess progress at regular intervals.

Now more than ever, the textile and clothing industry needs to look beyond the short term to find viable solutions for the detrimental effects its manufacturing, distribution and consumption models have on people and the planet. It is not only recommended but necessary to mobilise all stakeholders and foster cross-disciplinary collaboration to address the SDGs (access to affordable housing, education, employment, hygiene) and impacts specific to the fashion industry.

These include human rights violations, gender and ethnic inequality and the destruction of natural environments by waste generated at all stages of the supply chain. Retailers, investors, manufacturers, decision-makers and consumers are responsible for the dire situation and can, individually and collectively, help achieve the SDGs.

However, the innovative solutions designed to reduce the fashion industry’s impact and find smart uses for the waste it generates need to be scalable to be adopted by manufacturers. This is the crux of the matter as the trend to consume less is paradoxically offset by pressure to produce more quantities (without increasing their impact). In practice, when a company reduces its use of resources, it tends to manufacture more products!

As the notion of “sustainable development” makes progress, French fashion companies are progressively thinking on a longer term basis. Fashion tech innovation can contribute to these science-based targets, but it will not be able to achieve the environmental goals of the COP 24 without a global shift in attitudes. Change may come as fashion schools add technological and sustainable innovation to their curriculums.

2



THE FRENCH FASHION INNOVATION LANDSCAPE

II

THE FRENCH FASHION INNOVATION LANDSCAPE

With its rich heritage and new wave of visionary companies, France can claim a leading role as a catalyser for change in the current fashion tech landscape. Its many assets include:

- **The long-standing status of Paris as the world's leading fashion capital and its unrivalled cultural heritage that has made it a time-honoured artistic hub;**
- **Its globally acclaimed technical expertise in fashion and schools that attract students from around the world;**
- **It is the birthplace of many historical textile industries and of a leading textile manufacturers;**
- **Iconic fashion houses that can draw on a prestigious past and experience;**
- **It is an economic powerhouse that exports its products globally, driven by its reputation for high-quality products;**
- **Political recognition of the need to support and transmit craftsmanship and expertise in fashion;**
- **Investment in advanced technological research, though fashion is not always central to academic research;**
- **A thriving start-up environment and favourable conditions for budding fashion entrepreneurs;**
- **Accelerators, incubators and innovation labs specialising in textiles and apparel.**

This section describes the multifaceted French fashion tech landscape. It presents the programmes dedicated to its development and its contributions to academic research, culture and the economy. The first chapter specifically investigates the innovation strategies of its leading luxury groups. It also details the institutions, companies and accelerators investing in the future of fashion.

Fashion and technology share a common history with regards to the evolution of their techniques and tools (cf. the often-cited connection between the jacquard loom and the first perforated card computing machines).

The term “**fashion tech**” however refers to a recent trend to integrate technological innovation into clothing. Before its advent, interactive fashion designs were few and far between. Up till recently, research in fashion was practically non-existent with the exception of a few pioneers who augmented their designs with electronic and/or mechanical properties. In 2014, the French government launched a vast industrial innovation plan, allocating a €3.5 billion budget to 34 selected projects.

Bioserenity and Cityzen Sciences were deemed the most promising in fashion tech, attracting major public funding and high media attention.

Despite real industrialisation issues, their claimed goal of augmenting the human body with practical, lightweight wearables not requiring any change in user attitudes tapped the zeitgeist. 2014 was also the year that a collective of women entrepreneurs organised the first Paris FashionTech Week with the goal of merging the fashion and digital innovation eco-systems. It led to the emergence of a new form of fashion offering novel functions that at first met with resistance. Leading French fashion houses considered it too far removed from its main preoccupations, but gradually viewed it more favourably and made it a strategic orientation.²⁵

This budding field attracted companies from other sectors, including makers of flexible materials, electronics and software for high-tech industries that viewed it as a promising field for diversification. Prodways, a supplier for the automobile and medical industries, invested in 3D printing machines and services for fashion applications.

The French textile industry has in great part shifted its production to technical textiles to counter competition from low-cost labour countries, while others in the industry saw in the robotization and optimisation solutions developed by Fashion tech an opportunity to relocate apparel manufacturing.

The innovative projects the French fashion industry deemed as the most promising were those having reached proof of concept and those capable of modernizing traditional manufacturing processes.

These often require a competence and aptitude to work in interdisciplinary teams. Educational institutions formed partnerships to address the need for these new skills: the IFM merged with the Ecole de la Chambre Syndicale de la Couture Parisienne and created a PhD programme²⁶ with Paris 1 Panthéon-Sorbonne University, the CARAT²⁷ network was formed (with 3 Carnot Institutes, 70 laboratories and 17 technological platforms) and the Ecole Nationale de Mode et Matière (EnaMoMa)²⁸ founded.

A report by the IFM and Politecnico di Milano on the skills the fashion industry will need in the future confirms that companies will seek to hire candidates having multidisciplinary backgrounds and capable of managing complex projects involving “techniques, design and data”. This also includes business skills to bring innovation to market, a proven concept of the Design Academy Eindhoven.

²⁴ “Textiles, innovations and active materials”, by Florence Bost and Guillermo Crosetto, published by Editions Eyrolle, discusses a number of these.

²⁵ <https://www.welcometothejungle.co/articles/la-technologie-boulverse-l-artisanat-du-secteur-mode-luxe>

²⁶ <https://www.ifmparis.fr/fr/recherche-academique>

²⁷ <http://www.carats-innovation.com/>

²⁸ <http://enamoma.psl.eu/>

II. 01. TECHNOLOGICAL INNOVATION AT LEADING FRENCH FASHION COMPANIES

The preservation of its historical heritage and expertise is a priority for France, but the country is well aware of the need to develop new technologies to maintain its relevance, leadership and employment. Major fashion houses have built their success on creativity and craftsmanship. They seek to continually perfect their expertise to maintain their ability to offer exceptional products that are rooted both in tradition and technological innovation.

Fashion tech is seen as a source of inspiration (the data centre backdrop of a Chanel catwalk), a solution to create a 'high-tech' product (Hussein Chalayan) or as strategic for market intelligence and innovation (LVMH and Nanovia).

But the greater part of luxury brands' digital transformation has been dedicated to e-commerce platforms and augmented services. They are present on social media and seek to optimise the data collected thanks to progress in machine learning, blockchain and RFID systems, used for tracking and anti-counterfeiting purposes, to guarantee product quality and reassure customers. Their innovation strategies are also designed to adapt to evolving consumer attitudes, especially in key markets such as China.

The technological innovation strategies of major fashion and luxury brands include:

- **Minority capital investment:** Chanel has invested in e-commerce site Farfetch, in exchange for the creation of a joint think tank on innovation in retail, and in Evolved By Nature²⁹, a company specialising in new applications for silk proteins; Chanel Parfum Beauté acquired a stake in Sulapac, a Finnish start-up in biodegradable packaging.
- **Partnerships with technology companies:** Louis Vuitton and Sigfox collaborated to make Echo, a smart suitcase tracker; Dior partnered with DigitasLBi to develop the Dior Eyes VR headset. Tech companies have collaborated with fashion designers; Dassault Systèmes with Julien Fournié, Sculpteo with the start-up Endeer, the Comité de la bijouterie joaillerie created the Francéclat research lab.
- **Accelerators and awards:** LVMH's Maison des startups at Station F, its DARE programme for employees and yearly hackathons³⁰; Lafayette Plug & Play accelerator; Kering's partnership with Plug and Play-Fashion for Good; Hermès Fondation d'entreprise³¹ and Académie des savoir-faire, which selected biotech dyestuff start-up Pili for a year of mentoring.

- **Labs and foundations:** launched in 2018, the Gucci Art Lab promotes craftsmanship and R&D in design and leather goods; the Kering Foundation.
- **Patent acquisition:** LVMH acquired Nanovia's patent for a biopolymer oyster shell 3D printing filament.
- **High-tech accessories:** a special edition of the Louis Vuitton Keepall features optic fibres by Artistic Director Virgil Abloh; Chanel's release of an Old Boy Bag with an LED screen.
- **Recruiting "tech" profiles:** Louis Vuitton and Hermès have hired research and innovation staff.

Start-ups seeking to work with luxury brands must have a thorough understanding of their heritage and DNA. Fashion houses place great value in their 'culture' and draw on their past (and present) successes to maintain their leadership. Technical skills, knowledge of intellectual property rights, a strong artistic and fashion culture are essential to collaborate with them.

Their success is also the result of state-of-the-art financial strategies, and their shareholders are likely to favour long-term growth over riskier investments in new technologies. Many have taken controlling stakes in suppliers upstream (tannery acquisitions by Kering and Chanel) and downstream (retail investments by Chanel and Dior, Kering brought e-commerce inhouse) to secure long-term profitability. They will give priority to digital transformation³² and e-commerce for their investments in new technologies.

Collaborating with a large company can set a start-up on the road to its first successes but it can also be a rocky road to navigate. Large corporations tend to seek to bind start-ups in exclusive contracts.

When accepting these agreements, start-ups must keep in mind that it can be a successful launching pad on condition that the first contract lead to others or that it engage the partners in the long term. Raise and Bain&Co created the David and Goliath Award to foster fruitful partnerships between large companies and small structures. Its latest report, "David and Goliath 2017: what if we worked together?", found that the relationships between start-ups and large corporations had deteriorated. "Despite a favourable environment and efforts by big companies to better structure these partnerships, compared to 2016, 27% of the 'Davids' said they were less satisfied, and only 18% had a satisfactory experience." It is therefore essential for start-ups to anticipate these risks from the start, carefully negotiate contracts and compensation terms to avoid losing time with indecisive prospects.

²⁹ <https://www.evolvedbynature.com/>

³⁰ <https://www.lvmh.fr/actualites-documents/actualites/hackathon-louis-vuitton-supply-chain-connectee/>

³¹ <https://www.fondationentreprisehermes.org/fr/>; <https://www.fondationentreprisehermes.org/sites/default/files/programmes/Programme%20site%20web.pdf>

³² Louis Vuitton has equipped sales teams with an iPad app made by Quark https://www.quark.com/pdfs/03621CS_LouisVuitton_IE_Web.pdf

While many of the technologies adopted by fashion brands are ornamental more than functional, the situation is changing. **Their innovation strategies**, as seen in Courrèges' heated coats, are mostly motivated by a fear of missing out on a radical change in market demand.

Were these initiatives more numerous, it could inspire research labs and manufacturers to develop fashion applications, instead of focusing, as they do now, on the more mature markets of health, military and transportation.

Luxury brands fear that poorly designed high-tech products could impair their prestige and that they risk losing a clientele devoted to the historical and stylistic DNA their success is founded on. Innovation in retailing and image building is considered a safer option, their immaterial nature is deemed easier to manage and scale up as opposed to product innovation which often implies a change in traditional production processes.

A luxury brand such as Hermès, whose products are made to last, will view unfavourably the incorporation of electronics, by nature obsolescent and requiring regular maintenance. Furthermore, their R&D processes are often externalised.

For an **innovative project** to be greenlighted internal staff needs to be convinced it will meet consumer expectations and align with the brand's values. Many 'pure players' therefore tend to focus on enhancing the consumer experience. Trend agency Nelly Rodi created a division dedicated to Internet data and has partnered with Google to develop a search engine for fashion based on key words. Internet visibility being dictated by the GAFAM, they are courted by major fashion brands to assist them in digitalising their user experience, along with optimising data collection and brand communication.

Sustainability strategies of leading fashion groups

France's leading fashion groups are also taking measures to address sustainability in all of its many facets. In 2019, Chanel made headlines when it declared it would stop using fur and exotic animal skins³³.

The company also says it will publish a climate action plan and Kering has announced a plan to reduce its environmental footprint by 40% by 2025. The group was the first to launch an Environmental Profit & Losses (EP&L)³⁴ platform, which will be the subject of a hackathon in October 2019, and organises yearly "Caring Days" dedicated to environmental issues for its staff. As if to emphasise the importance of this issue in its corporate strategy, "sustainability"³⁵ is the central tab of its official website.

LVMH has published a code of conduct for responsible sourcing³⁶ and has created an in-house library of eco-materials. Luxury groups' interest in new ecological materials (Kering's Material Innovation Lab, Chanel's acquisition strategies) could be an opportunity for start-ups. They also seek to tap current consumer aspirations for self expression by encouraging collaborative models and personalisation drawing on data collection and analysis, as seen in the start-ups LVMH³⁷ has chosen to support.

II. 02. PUBLIC INSTITUTIONS AND FEDERATIONS

France launched a competitiveness cluster³⁸ programme in 2004 to strengthen its textile and apparel industry, boost regional economies and employment.

Designed to encourage collaboration between businesses, research centres and educational institutions, it is backed by public funding (the Fonds Unique Interministériel and regional authorities), a favourable tax regime and member companies. Representing 90% of investments in R&D and 80% of exports, the sector is a strategic source of innovation and competitiveness for the country. Of the 56 existing clusters, 46 have secured 4-year funding to 2022.

The clusters identify and assess proposed R&D projects to ascertain that they align with scientific goals and meet market demand. Most of these clusters operate on a regional level, though inter-regional initiatives do exist [Annex 2].

These confirm that the cluster policy has been successful in encouraging collaborative innovation and R&D.

³³ <https://edition.cnn.com/style/article/chanel-fur-ban-scli-intl/index.html>

³⁴ <https://kering-group.opendatasoft.com/pages/home/>

³⁵ <https://www.kering.com/en/news/kering-launches-digital-ep-l-and-hackathon-to-drive-greater-transparency-and-innovation-in-sustainability>

³⁶ https://r.lvmh-static.com/uploads/2017/12/lvmh-code-of-conduct-2017_122017.pdf

³⁷ <https://www.usine-digitale.fr/article/avec-la-2e-promotion-de-start-up-lvmh-accelere-sa-transformation-digitaleN805475>

³⁸ <http://competitivite.gouv.fr/>

³⁹ <https://competitivite.gouv.fr/en/clusters-policy/about-249.html>

Seven competitiveness **clusters dedicated to textiles**, including Techtera and Euramaterials, are now a part of the EU-Textile 2030 programme⁴⁰ with a mandate to support innovative textile manufacturers in international markets. Industry technical centres⁴¹ and other research centres for apparel are listed in [Annex 3].

Designed to encourage the transfer of **expertise and technology** within the apparel and textile industry, they provide state-of-the-art platforms and technical advice. Fashion organisations linked to the Comité professionnel de développement économique (CPDE) include: DEFI, FRANCE-CLAT and CTCCM [Annex 4]. Enacted into law on June 22, 1978, their mission is to promote the international development of companies.

The promotion of the French fashion industry is also supported by some 10 federations and chambres syndicales [Annex 5].

Founded in 1863 and headed by Ralph Toledano since 2014, the Fédération de la Haute Couture et de la Mode (FHCM), sets the dates of the Paris Fashion Weeks and recommends the brands that comply with Haute Couture criteria to the Ministry of Industry.

Other public organisations:

- **Institut National des Métiers d'Art (INMA)⁴²: dedicated to the métiers d'art.**
- **Ateliers de Paris⁴³: a start-up incubator offering advice and guidance along with a gallery for artisans and designers in Paris.**
- **Village des créateurs⁴⁴ (Greater Lyon metropolis, Région Auvergne-Rhône-Alpes): for fashion designers, designers and interior decorators.**
- **Maisons de Mode⁴⁵ (Lille, Roubaix): provides assistance to fashion designers**

³⁹ <https://competitivite.gouv.fr/en/clusters-policy/about-249.html>

⁴⁰ <https://www.eu-textile2030.eu/>

⁴¹ <https://www.entreprises.gouv.fr/secteurs-professionnels/liste-des-centres-techniques-industriels-cti>

⁴² <https://www.institut-metiersdart.org/>

⁴³ <http://www.ateliersdeparis.com/>

⁴⁴ <https://www.villagedescreateurs.com/accueil/>

⁴⁵ <http://www.maisonsdemode.com/>

⁴⁶ F&T portal : <https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/home>

II. 03. FUNDING PROGRAMMES

A number of public and private sector programmes support fashion start-ups and are open to international candidates, among these, the Institut pour le financement du cinéma et des industries culturelles (IFCIC) and Banque publique d'investissement (BPI) fund innovative projects and publicise national or international tenders that promising fashion tech structures can apply for. The European Commission has also allocated budgets for the development of innovative projects in apparel and textiles⁴⁶. Programmes listed below are organised in four categories.

Research grants [Annex 6]

Sources of grants for research are scouted out by competitiveness clusters and BPI France. These are open to collaborative research groups. Foundations, including the Bettencourt Foundation and Théophile Legrand Foundation, also offer grants fashion and textile research projects.

Accelerators, incubators and funding for digital transformation

[Annex 7]

A number of incubators and accelerators have been set up in France to support innovation in the creative industries, including fashion.

Among these, Station F “the world’s largest start-up campus” houses several fashion programmes including the ADNxIFM program, Vente Privée Impulse, La Maison de startups LVMH and the Adidas “Platform A” with Plug & Play. In 2018, France launched an industrial plan, backed by a €500 million budget ⁴⁷, to assist SMEs from all sectors in making their digital transition.

Awards and competitions [Annex 8]

Awards and competitions increasingly include a focus on technological innovation and entrepreneurship in fashion, including the ANDAM Prix de l'innovation, Hyères Festival award winner Clara Daguin and Festival de Di-nan award winner Armine Ohanyan, and various other awards for budding designers and artisans.

⁴⁷ One half expensed as amortisation, the other delivered as funding by the Programme Investissements d'Avenir (PIA).

European programmes⁴⁸ [Annex 9]

Access to EU-funding for innovation is restricted to cross-border consortia, start-ups must therefore connect with suitable partners in other European countries and ideally include an organisation capable of handling these programmes' demanding administrative requirements. The EU Horizon 2020 funds international projects in innovation and sustainability. Examples of projects involving French and Dutch companies are detailed below:

Horizon 2020⁴⁹

- **WEAR SUSTAIN**⁵⁰ includes Dutch projects Mycotex (Aniela Hoitink); Techposture⁵¹, the first shoulder and spine monitoring smart shirt; 3D footwear scanner Solemaker⁵²; Domicro⁵³, an automated microsystem technology; Elitac BV⁵⁴, a developer of textile wearables using stretchable electronics.
- **TCBL**⁵⁵ includes Dutch biotech textile dye project Bioshades⁵⁶ a collaboration between TextileLab, Amsterdam (Cécilia Raspanti) and Making Lab Athens.

COSME for SMEs⁵⁷

Both of the following programmes (funded in part or in whole by COSME) support innovation in fashion and textiles, at time of writing they remain active and European start-ups and companies can apply:

- **DeFINE**⁵⁸ (Developing a Fashion tech Innovation Network for Europe) until June 2021: a leading European network for innovation in the fashion industry with a strong mentoring programme and networking possibilities with investors, schools and brands.
- **WORTH**⁵⁹ **Partnership Project**: a transnational design-driven collaboration programme for designers, businesses (SMEs) and technological companies.

⁴⁸ https://ec.europa.eu/info/funding-tenders_en

⁴⁹ http://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-leit-ict_en.pdf

⁵⁰ <https://wearsustain.eu/>

⁵¹ <https://www.techposture.com/>

⁵² <https://solemaker.io/>

⁵³ <http://domicro.nl/>

⁵⁴ <http://elitac.nl/>

⁵⁵ <https://labs.tcbl.eu/>

⁵⁶ <https://zine.tcbl.eu/special-issues/call-for-contributions-special-issue-on-dyeing-with-bacteria/>

⁵⁷ https://ec.europa.eu/growth/smes/cosme_en

⁵⁸ <https://define-network.eu/>

⁵⁹ <https://www.worthproject.eu/worth-project/>

These networks and programmes have set up websites and organise events that can be a source of new business opportunities for start-ups. Qualified stakeholders, including schools, regularly apply for grants in partnership with other European structures.

II. 04. INDEPENDANT STRUCTURES, ASSOCIATIONS AND START-UPS

Fab-labs (Electrolab), hacker-maker spaces (Data Paulette), collective laboratories (La Paillasse), third places and incubators [cf. Annex 10], associations and business networks (Culture[s] de Mode, La FashionTech, TextiLab) foster the emergence of innovative ideas, projects and fashion tech start-ups.

They have varied goals (artistic, scientific, social, political, commercial) and are headed by entrepreneurs, scientists or designers.

Independent designers that contributed to the emergence of the fashion tech movement in France include: Olivier Lapidus⁶⁰ founder of a digital couture house and whose clients can follow the design process of his e-couture online; Elizabeth de Senneville, a techno-designer whose work has focused on fashion applications for piezoelectricity⁶¹, photovoltaic panels and smart textile interfaces and who has also merged technology with ecology in pollution-monitoring clothing; Florence Bost, designer, author and lecturer in fashion and design schools, whose research centres on innovative materials and surfaces; Maurin Donneaud who applies interactive design to explore human-machine interaction with coded physical objects, he is also an author and co-author of innovative textiles and a lecturer at ENSCI Paris, ENSAAMA Paris and ESBA-Le Mans.

France also has a dynamic young generation of creatives working with new technologies and fashion [Annex 16]. Many of these projects, it is useful to note, will vary in their objectives as they adapt to external input, changing market conditions and consumer demands.

These new generation designers often first met at events such as the FashionTech Weeks⁶², trade fairs, incubator programmes (Lafayette Plug&Play⁶³, Look Forward⁶⁴) or, for the pioneers, at hackerspaces and TextiLab events organised by Hall Couture at La Paillasse.

⁶⁰ <https://www.forbes.fr/luxe/rencontre-avec-olivier-lapidus-directeur-artistique-de-lanvin/?cn-reloaded=1>

⁶¹ Electricity generating by body movement.

⁶² <https://www.fashiontechweek.fr/>

⁶³ <https://www.lafayetteplugandplay.com/>

⁶⁴ <https://www.lookforwardproject.com/>

II. 05. SPECIALISED TRADE EVENTS [Annex 11]

Trade events organised in France have made moves to promote innovation in fashion independently or in partnership with federations and associations: Avantex, Traffic, Wearable Lab by Première Vision, VivaTech, FashionTech Weeks/Days, the UIT's Cap sur le Futur forum and R3iLab events.

These events have become key opportunities to discover the latest developments in fashion tech, suppliers of innovative components and meet possible partners. The IFM also organises a yearly Perspective Forum presenting the latest economic data of the French fashion market.

II. 06. SPECIALISED MEDIA [Annex 12]

French media covering fashion tech include specialised media (Futur404, Modelab, le Boudoir Numérique), publications focusing on innovation in industry (l'Usine Nouvelle), start-ups and internet (Maddyness), the fashion industry (Fashion Network), alternative cultures (Makery, Socialter), design (Soon Soon Soon), and prospective trends (Uzbek & Rica, Up le Mag).

II. 07. BUSINESS NETWORKS

A number of business networks promote collaboration and innovation in apparel and textiles. These include R3iLab: a network of textile, fashion and creative industry executives present in eight regions; Mode Grand Ouest, promoting the development of some 106 members located in the west of France; the Cholet-based EMODE platform focuses on creative technologies, it is part of the certified Plateforme Technologique (PFT) of the Ministry of Higher Education and Research.

II. 08. TECHNOLOGICAL PLATFORM [Annex 13]

There are also a number of technological platforms dedicated to applied research in fashion in France. Among these, the Troyes-based 3D knitting platform is a technical centre specialising in seamless knitting and development of flexible 3D materials.

3



FASHION AND SCIENTIFIC RESEARCH: CURRENT AND FUTURE OUTLOOK

III

FASHION AND SCIENTIFIC RESEARCH :

Most innovative projects in fashion arguably derive from, are inspired by or the direct result of scientific research. This section takes a look at the key role it plays in **French fashion tech**.

Fashion lacks a clear status in scientific research. But it does play an important role as a source of innovation in apparel and textiles and many fashion tech projects are the result of doctoral theses, research working groups and R&D structures.

Organised by department and discipline, these structures tend to specialise in a specific field of research (materials science and physics, nanotechnology, robotics...), and rarely on fashion as a field of study per se. Most scientific research addresses the needs of high-tech industries (military, aerospace, aeronautics...), and fundamental research projects are not always conducted with a specific field of application in mind.

The greater part of research programmes involves textiles, considered a useful substrate in many different industries. Beyond the strict confines of academic institutions, smaller independent structures have the liberty of taking a wider view and conduct research projects addressing a broader scope of fields.

The development of interdisciplinary research could lead to closer connections between scientists and artists involving creative fields, including fashion applications. The case of the CRI (Center For Research and Interdisciplinarity in Paris) is an interdisciplinary research model in science that would be interesting to apply to the design and fashion model.

Fashion as a new field of investigation for research. The fashion and luxury industries are important economic sectors for France and a key soft power asset. Fashion and scientific research may not share the same goals, but they can at times converge.

The fashion industry's expertise in spreading knowledge, raising awareness and communicating on innovation not often a forte of scientific research teams and structures. Innovation in fashion tech also has the potential to attract greater public attention compared to traditional research fields, as its “showcase” products can serve as new technology demonstrators.

Trade fairs Première Vision and Avantex have opened up their floors to innovative fashion and textile designers and start-ups, encompassing both artistic / artisanal projects and concepts that could be scaled up and industrialised.

Conversely, scientific research projects can at times be re-oriented to address apparel applications, a situation that often requires (lengthy) new research into the user experience and possible benefits in everyday contexts.

New certification programmes, such as the one created by Les Mines-Carnots, promote these industry-led research projects. Carat is expanding its innovation programme to fashion and luxury by backing projects that could be of interest for these markets. It currently covers materials, nanotechnologies, biotechnologies, new machines and digital technologies for e-commerce.

III. 01. MAPPING OF RESEARCH PROJECTS

[Annex 14.A]

In the many categories of scientific research, those that could have apparel applications include fundamental, scientific and theoretical research along with applied, action or design research.

The latter is a relatively new field. Many of these operate on a regional or major urban centre level and involve multiple structures: universities, technical centres, manufacturers and business clusters. Three key territories in France specifically focus on research in apparel and textiles:

NORTH: (Lille, Marcq en Barouel, Roubaix, Tourcoing)

The geographical area around Lille is an active research hub drawing on its textile engineering school (ENSAIT and its GEMTEX lab, UpTex) and competitiveness clusters (Euramaterials⁶⁵). It has a strong textile heritage (Fourmies eco-museum, Théophile Legrand Award, internationally recognised ENSISA⁶⁶ in Alsace).

PARIS: (Paris and its 'banlieues')

A number of prominent fashion, design, engineering (Polytechnique, Mines ParisTech, Central, and more) and business schools are located in or near the capital of fashion. Its historical legacy, world famous fashion weeks, commercial avenues (golden triangle) and department stores and its many trend consultancies, make Paris a leading city in the world of fashion. Its rich artistic and scientific heritage also make it a highly stimulating environment for the possible fusion of fashion and science (cf. the recent launch of fashion and engineering school EnaMoMa).

LYON:

The city and its region is home to ITECH, one of the oldest textile engineering schools, where much research on new textiles is conducted, the IFTH and Techtera competitiveness cluster. The region also has several major universities and research centres specialising in various fields with fundamental and applied research programmes.

GRENOBLE:

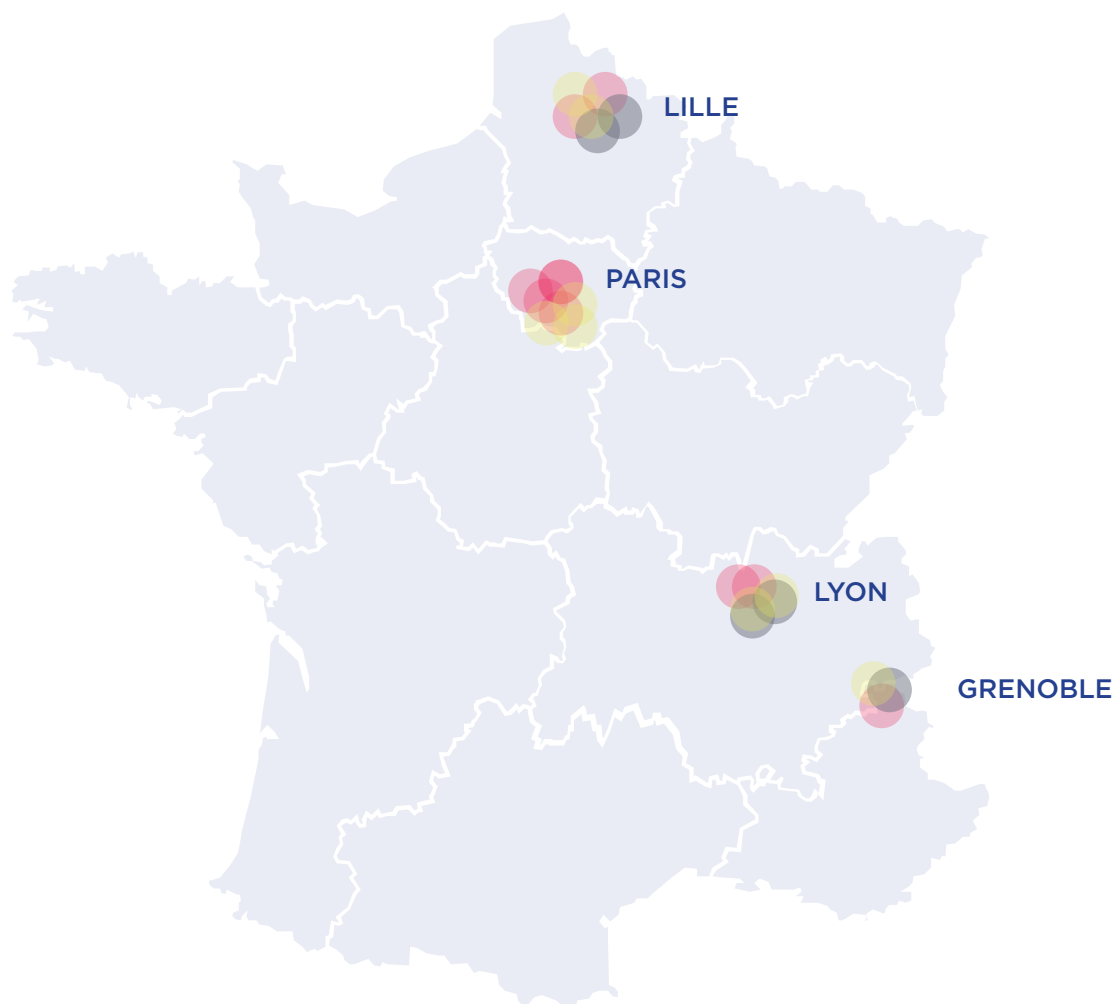
This city is an important player in nanotechnologies.

⁶⁵ Euramaterials (formerly UP-Tex) focuses on barrier textiles (thermal, acoustic, protection), complex structures, eco-materials (recycling) and e-textiles. The market is growing despite an uncertain future. (\$5.5 billion in 2014). 400 people attended Futex in 2017. UP-Tex and Matikem recently merged to form Euramaterials.

⁶⁶ ENSISA: Engineering school of the University of Haute Alsace, founded in 1980.

MAPPING OF RESEARCH

FASHION
AND
SCIENTIFIC
RESEARCH
CURRENT
AND
FUTURE
OUTLOOK



- RESEARCH INSTITUTE
- ENGINEERING SCHOOLS
- COMPETITIVE CLUSTER

III. 02. STATE OF FASHION RESEARCH IN FRANCE

A number of competitions and awards have been created to help research projects make the shift to entrepreneurial start-up.

Trade associations and industry organisations (ACIT⁶⁷ and UIT⁶⁸) hold forums and conferences where current research projects are showcased.

Their fields of research follow conventional practices: scientific, fundamental or applied research, along with research in social sciences that increasingly focuses on design (design thinking), and “action research” (applied research related specifically to products and processes).

a. SCIENTIFIC RESEARCH [Annex 14.B]

Science laboratories will at times set up collaborative research programmes for apparel and textiles that can have an impact on the future of fashion. It is, however, difficult to obtain precise information on these projects if they intend to be patented and commercialised.

Traditionally specialising in **high-tech markets**, scientific research rarely focuses on apparel applications, though some projects can be reoriented to art or fashion if deemed of interest. This has led to the emergence of research programmes in art and science (at the CNRS⁶⁹ lab and the CEA⁷⁰ technological research centre design lab) which could inspire scientists to conduct fashion-oriented studies.

Calls for projects or certification will promote research in specific markets, including fashion, when it is believed to generate an economic or ecological advantage. Some laboratories are highly specialised. The Laboratoire de Physique et Mécanique Textiles (LPMT) at ENSISA has a strong expertise in the elaboration and characterisation of fibrous materials and textiles. Its BioMemTex project studies interactions between materials and biological environments.

b. FUNDAMENTAL RESEARCH [Annex 14.C]

Fundamental research is useful to structure a project and pursue work on a process. GEMode (Groupe d’Etude et de recherche sur la Mode) has undertaken a historical analysis to better anticipate the future digital transformation of fashion. Culture[s] de mode promotes research in fashion, encourages synergies between disciplines and seeks to support scientific research in the textile and apparel industries.

The Fashion Research conference organised by FashionTechWeek brings together scientists and designers to foster interdisciplinary collaboration in fields not used to working with each other as a source of innovation (ex: Samuel Poincloux's physics of knitting project, with EnsAD⁷¹).

The conference "**Researching a New Luxury**" presented fashion as a field of infinite experimentation for science. It can be argued that fashion is interdisciplinary by nature and there's no reason why it should not continue to be so.

Higher education institutions, including the IFM/Université Panthéon-Sorbonne and Ecole des Hautes Etudes en Sciences Sociales (EHESS, School of Advanced Studies in Social Sciences) tend to focus on theoretical research in textiles and apparel. Examples of topics covered:

- **Fashion business and management:** the theoretical and practical study of fashion and luxury for business and management sciences.
- **Fashion historiography:** fashion history methodology and fashion design, arts and aesthetics: innovative processes.
- **Legal questions and sustainability:** The institute of the Present Time (IHTP) and CNRS (with Culture[s] de Mode) organise yearly "SemMode" conferences covering contemporary and historical social studies related to fashion.

c. DESIGN RESEARCH [Annex 14.D]

The three main categories of design research include fundamental, industrial and creative research, the latter leading to designer-researcher or artist-researcher positions. French institutions do not yet recognise design as a formal field of research. Few projects are even designated as pertaining to design and are more often considered applied research.

Though French researchers suffer from this lack of legitimacy, change is in the air. EnsAD is part of the newly created PSL/SACRe doctoral programme for design and fashion. It is expected that it will inspire designers to work on more scientific topics. As these projects are often related to applied research, they can lead to actual business opportunities, and their proximity with market trends and consumer expectations can be a source of added value.

⁶⁷ ACIT: Association of Textile Industry Chemists

⁶⁸ UIT: Textile Industry Union

⁶⁹ CNRS: National Science Research Centre

⁷⁰ CEA: Atomic and Alternative Energy Commission

⁷¹ EnsAD: Ecole nationale supérieure des Arts Décoratifs

What remains to be done is to better anticipate possible end uses and foster collaboration across different fields to take advantage of France's strong technological culture, market pull and industry willing to invest, as Lattice CEO and engineer Julien Payen points out in an interview for this report.

The multidisciplinary nature of research in design can help link creation and engineering from the very start of a project. Jeanne Viceria has for example designed a machine with engineers at Mines ParisTech that address-es a fashion need and was led by a multi-disciplinary team.

Fashion researchers interviewed for this report, including Aurélie Mossé, point out that lack of recognition by the State and its institutions can make it difficult to find funding and expand internationally. The French fashion tech movement needs to consolidate, promote collaboration, develop its expertise and better promote its purpose to industrial partners, though these also need to be more open to innovation.

III. 03. KEY FIELDS OF RESEARCH IN FASHION TECHNOLOGY AND SUSTAINIBILITY

The key areas of French expertise in research and innovation include:

- **Technical yarns and textiles:** with the possibility of finding support from textile manufacturers and trade organisation (UIT, Fédération de la maille, Techtera) to promote research and connect with business partners. Main projects: smart systems and technological innovation in SDGs (resources, health and the digital transformation of traditional trades and know-how); composite materials, including nanocomposites (e.g.: self-cleaning textiles, IGEM73 for biotech research).
- **Machine solutions**
- **3D printing** (e.g. Gemtex's bio-sourced filament for 3D printing)
- **"Smart" solutions for e-commerce, industry 4.0 and medical textiles:** a domain backed by competitiveness clusters and technical R&D centres (the CETI material library); a topic of doctoral theses (the physical state of material by Samuel Poincloux) and industry research (Brochier Technology's fibre optic fabrics).

Research funded by the private sector is strong in France, as seen with Lectra's digital solutions and the many awards French companies won at the 2019 edition of ReMode.

Fashion tech research focuses on three key areas: new materials, smart textiles and the quantified self.

a. New materials [Annex 15]

Research into new materials with possible fashion applications include: fibre research, fibre science (mechanical and physical properties of textiles and composite materials) and the functionalisation of textile surfaces (microelectronics; encapsulation; state of the art of photovoltaic technologies adapted to applied constraints, Yannick Vischetti, CEA-INES⁷⁴; Novacell, new solar cell architecture for integration into textiles, David Munoz-Rojas, LMGP⁷⁵; stretchable micro-battery for applications in textiles and flexible materials, Thierry Djenizian, École Nationale Supérieure des Mines de Saint-Etienne; microencapsulated phase-change materials for thermal energy storage and solar photocatalysis, Zohir Younsi, Haute Ecole Industrielle).

b. “Smart” textiles

Few labs specialise in textiles, with the exception of ENSAIT and the Lad-HyX Hydrodynamics Laboratory (Polytechnique). Research here is most often conducted by microelectronics engineers, as seen in Esma Ismailova’s work on organic electronics (Centre Microélectronique de Provence - Mines Saint-Étienne).

Orgtex is a project to study the potential of organic materials in wearable biomedical tracking systems. It intends to develop a low-cost biocompatible interface for electronics and the human body.

The multidisciplinary field of electronic textiles is not limited to the characterisation and development of new materials and devices. It also seeks to develop electronic technologies to create smart networks and hybrid solutions combining flexible materials and hardware. As opposed to most emerging smart systems, e-textiles call on one of humanity’s oldest technologies.

Textile and apparel industries therefore play a key role in the development of new materials and processes, and not only in projects having a specific market application. This unique connection with the industry makes electronic textiles a fascinating and dynamic field of research in which universities and the private sector work hand in hand to further technological progress.

⁷² http://www.textile.fr/wp-content/uploads/2017/03/livre_blanc UIT_2017_web.pdf

⁷³ IGEM: International Genetically Engineered Machine competition

⁷⁴ CEA-INES: solar research institute of the CEA

⁷⁵ Laboratoire des Matériaux et du Génie Physique

c. Quantified self

Monitoring and quantifying biometric data calls on various technologies including sensor miniaturisation, optimised energy use, and their possible integration into clothing. It is a subject of research at the Institut Mines-Télécom. Christian Person, an engineer at Télécom Bretagne, is working on capturing energy in the ambient environment and placing antennas close to the body as a part of the Smart Sensing consortium that develops innovative technologies for “smart” connected clothing and has presented the D-shirt, a digital T-shirt for athletes ⁷⁶.

III. 04. APPLICATION DOMAINS OF TEXTILE RE-SEARCH PROJECTS

Medical applications are a leading field of textile research programmes into fibres and their biocompatibility, and patient monitoring systems or devices (AI, IoT), believed to have a major impact on medical practices. Sports applications are another key area for textile research, along with personal protective equipment (PPE) related to workwear.

Finally, research in wearables and augmented systems also target military applications, though these are generally covered by Nonn Disclosure Agreements (NDAs) and rarely publicised. The fields that could be the most relevant for possible applications in fashion are health, sports and PPE.

Medical and health applications: Current medical textile research projects include the e-health department of Cap Digital, a business cluster dedicated to digital innovation, which assists start-ups and scientists in gaining access to hospital testing to accelerate development. ENSAIT is working on a project targeting post-operative rehabilitation designed to help physiotherapists better diagnose and treat patients.

Other projects in development at textile competitiveness clusters and scientific research centres include Somnonaute, NeoMedLight and Context (a CNRS-GEMTEX project). They are in the process of applying smartphone features and new technologies in development to textiles. They tend to focus on technology issues more than specific functions or the user experience.

- **Somnonaute** seeks to develop a smart textile platform for long-term medical diagnosis. It has recently presented a sleep-monitoring pyjama, the first example of a new generation of electrode-embedded smart clothing to collect biometric data.
- **NeoMedLight** uses Brochier Technologies' patented Lightex technology. Designed to treat neonatal jaundice, it delivers phototherapy via a light-emitting fabric embedded with optic fibres.

Sports: Medical applications have the potential to be transposed to athletic performance and thus expand the possibilities of these research programmes to deliver advanced functions. The two fields often converge, leading to the creation of new laboratories, working groups and incubators linked to research institutions (INSERM, INRIA, Paris Bio-tech). There are also a number of independent structures such as Sport Control Ergomedical, a medical/technical innovation centre focusing on projects related to health and sports. This company, like many in its field, works with scientists and PhD students and is supported by the National Association of Research and Technology (ANRT).

Personal Protective Equipment (PPE): High-tech textiles for PPE and technical textiles are used in many different markets and classified by sector. Those that could apply to fashion include oekotech (environmental protection), sportech (sports and leisure), protech (personal and structural protection) and hometech (smart home) [Annex 14.B]. Technical textiles are increasingly being used in everyday clothing, though much innovation in PPE will find additional applications in the military. New developments in augmented and smart textiles for transportation could also be of interest for fashion, such as Nanomade's capacitive textiles.

Others: Some research projects are conducted without a specific goal in mind. The MecaWet team at the PMMH laboratory (ESPCI Paris, PSL University, CNRS, Sorbonne University, Paris Diderot University) is investigating a "baromorphic" material with air channels that can be inflated in a non-homogenous manner to give an object its final shape. This project recently published its findings in Nature Materials and could find applications in flexible robotics as well as sports, health and possibly fashion. More research would be needed for many of these emerging new technologies to find their place in everyday clothing.

Research completion & market pull: For many reasons, **research projects** do not always lead to a real-life market application either in industry or in everyday life. When a project is launched without having a specific product in mind, its possible practical uses can be difficult to identify.

Furthermore, **innovative and commercial projects** are not only conducted by scientific research laboratories but also by various other organisations, in partnership or not with an institution. When made public, these applied and scientific research projects can be, and are increasingly, a source of inspiration.

III. 05. FOSTERING RESEARCH IN FRANCE

Partnerships between manufacturers and scientists stimulate entrepreneurship in technological innovation and lead to the creation of numerous start-ups every year. A patent with a view for future commercialisation is filed on average every week.

Competitiveness clusters and industry networks (Armines, Clubtex...) specifically seek to support and assist in the industrialisation of research projects that have possible product and/or market applications.

The challenge is then to integrate the new technology or innovation into a company's existing organisation. Genius Object, a maker of a smart zipper, has successfully developed its products with French manufacturers. Some companies, as seen at Brochier Technologies, will hire engineers and PhD students to develop their theses in house. Carat assists companies seeking to recruit PhD students via a CIFRE⁷⁷ convention to develop and industrialise a research project. In most cases, however, researchers will establish their own companies to develop their innovation, as Lattice has done.

Fashion companies may be more attracted to applied research projects as they generally address a specific market need and/or an economic concern. Textile innovation for medical applications is by far the most dynamic field of research in France and the one that generates the most spectacular medium-term research projects as seen in developments in textile encapsulation (antibacterial, waterproof-breathable functions), biopolymers, bio-communicating textiles and organic electronics that have promising applications in next-to-skin technologies. Several departments of the Institut Mines Télécom (micro-electronics and bioelectronics) specialise in these fields.

Research topics are posted on some open source platforms, though the industry is not often aware of these.

From innovative idea to prototype

Technological innovation is most often the result of scientific research, as seen with Citizen Science, one of the first textile projects developed at the CEA in Grenoble. They are generally brought to market by the engineers or scientists that invented them.

Nanomade, a maker of tactile sensors on flexible materials, was identified by the fashion industry as being compatible with textiles, even though this was not an application it initially targeted. This signals that brands should keep an eye on possible technology transfers, which can imply their redirection, from an automotive to a fashion application, for instance.

Esma Ismailova's electrocardiogram project has such potential and its transposition to fashion could be of interest, as is the broader field of exploring textiles as interfaces. That said, possible use scenarios in fashion are less obvious than applications in health, where new technologies have clearly identified added value and are perceived as such by medical professionals and patients alike.

With regards to **smart textiles** for **medical uses** and **sustainability**, France's strengths lie in advanced technical textiles that focus specifically on their physical properties: **"the sensor is the fibre"** as Mehdi Ammi would say.

European research programmes have the advantage of promoting collaboration on large-scale projects. They drive innovation per se but do not necessarily address the fashion industry's short-term needs as their results are rarely made public. The EU-funded Bioserenity project focuses on a specific medical application without having any known potential use in other sectors.

⁷⁷ CIFRE: Industry Conventions for Training through Research, a National Agency for & Technology (ANRT) programme.

⁷⁸ https://www.entreprises.gouv.fr/files/files/directions_services/secteurs-professionnels/etudes/dossierpresse.pdf

Since 2005, France has dedicated much effort to the **development of nanotechnologies**, but research projects rarely go beyond a theoretical stage. This could be due to lack of private investment in nanosciences and nanotechnologies (cf. La documentation française).

Also, the geographic location of the main research centres (CEA, CNRS, Orsay) does not correspond to that of key textile engineering and competitiveness clusters, and is not conducive to collaboration.

This is the result of the regional specialisation of research centres in France: the North focuses on technical textiles (ENSAIT), while Lyon and Grenoble are dynamic centres for innovation in fashion and technology.

Paris is at the heart of international business development. Therefore collaboration across France is important, especially when a project requires a broad base of expertise and the input of specialised laboratories.

It is positive to note that schools and research centres are increasingly working together, forming interdisciplinary groups that focus on fashion as a field of study and business.

4



NEW TECHNOLOGIES TO INNOVATE IN THE FRENCH FASHION SECTOR

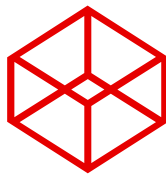
IV NEW TECHNOLOGIES TO INNOVATE IN THE FRENCH FASHION SECTOR

The French fashion industry has a vested interest in fostering technological innovation to maintain its competitiveness and global influence.

Major French luxury groups understand the need to keep abreast of new consumer attitudes, specifically in China, a highly technophile and high growth market. The areas of technological innovation that are earmarked as being the most promising for start-ups, SMEs and industry leaders are 3D design and printing, immersive technologies, artificial intelligence, biofabrication, robotics, electronic textiles and blockchain.

This section describes the strategies of key companies and start-ups [Annex 16] and provides specific examples in fashion. For each strategic technology identified, a “state of the art” is outlined at time of publication; the “outlook” presents expected goals and the “keys to success” explore possible contributions by Dutch stakeholders to achieve these.

As discussed in Part III, the final end-use of an innovation is not always clearly identified by start-ups or companies having research and development facilities. Many start-ups end up pivoting their project as they evolve and discover more suitable outlets for it. Progress in the collection and treatment of data can also have an influence on research, proof of the interdependent nature of technological innovation.



3D PRINTING

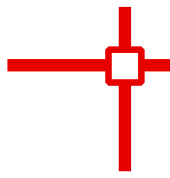
STATE OF THE ART A diverse array of 3D printing machines and services is available on the market and the technique is currently used to make eyewear frames and bag components. Despite its rapid evolution, additive manufacturing, another term for 3D printing, is not yet suited to the serial production of voluminous objects. Its main short-term potential is on-demand manufacturing (shoe heels at Eram), made-to-measure production and fast prototyping. Designers have found it useful to experiment with new materials and shapes (embroidery atelier Flory Brisset 3D prints motifs and sequins). Suited to the on-demand personalisation of small components, it is used to make orthopaedic soles (the start-up Scientifeet works with Initial by Prodways) and to design prostheses.

OUTLOOK **Additive manufacturing** could be used to “print” clothes and reduce stitching and finishing processes to make personalised, recycled and/or biodegradable clothing. A safe, clean, fast and low-carbon manufacturing method, it can work with a wide array of materials having varied textures and properties. The prospect of individuals 3D-printing their own clothing will however remain unlikely until the ratio of manufactured product to energy (time, space and supplies) spent is not reversed. The development of 3D printing depends on its ability to mass produce larger items faster and having varying colours and textures combining flexibility, solidity and ease of care. The size limits of current printers need to be addressed with the development of smaller, more mobile, easier to use and clean printers. This sector also has to phase out toxic solvents and reduce long post-production processes.

KEYS TO SUCESS The development of better performing software made for fashion design; expanding the number of 3D-printable materials, an issue which could be solved by progress in biotech. Dutch designers could contribute to both these areas. Adapting printers to new materials and exploring new machine formats, specifically mobile ones, as seen at architecture start-up XTREE ⁷⁹.

EXAMPLE Prodways Group is a vertical 3D-printing 70 company owned by Groupe Gorgé. Its newest printer allows the use of a wide range of sintering pow-ders, including recycled/recyclable materials certified for medical and aeronautical applications. Its high precision machines offer quality stan-dards suitable for luxury products (jewellery) and textiles (flexible me-chanical systems).

⁷⁹ <http://www.xtreee.eu/>



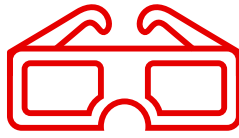
3D AND CAD DESIGN

STATE OF THE ART The strikingly realistic rendering of current 3D modelling for the design and virtual fitting of clothing and accessories has made it a key asset for brands and manufacturers. The technology has even been used to create digital muses (Balmain's Virtual Army). A number of leading French companies have developed software for the fashion industry but their cost, training requirements, poor product visualisation and somewhat unappealing interfaces have limited their adoption. 3D modelling is being used to create zero waste designs, as seen at MILAN AV-JC, a company offering 3D modelling training for fashion designers. Smaller and more agile companies operating in other sectors, such as video games (CLO 3D, Browzwear) have experienced slow growth in fashion despite the pertinence of their technologies, as fashion companies, used to working in 2D and having often invested in older solutions, are reluctant to make the shift. Similarly, the necessary training of personnel relies mostly on private (or personal) funding. Conversely, younger generations familiar with intuitive and responsive interfaces and seeking to use faster processes more readily embrace 3D design software.

OUTLOOK Improved rendering of certain textiles in movement in a virtual 3D environment is needed, but the sector is making progress fast. What remains to be seen is how and when brands and manufacturers will adopt the technology. A VR headset can be used to project an image of oneself wearing a virtual 3D garment, but it is far from offering the experience of reality and sensation of touch. One potential market application is trying on clothing sold online in virtual reality using a hologram-projecting device or a VR system to view a 3D avatar.

KEYS TO SUCCESS Endorsement and adoption by brands and manufacturers; the development of more advanced technologies by open-source communities; 3D design training in fashion schools; improved peripheral devices (VR headsets, smart mirrors). Virtual fashion house The Fabricant⁸⁰ already sells virtual clothes on social networks. Start-ups looking to create virtual fashions may find B-to-B-to-C market opportunities, as this is an area that has high potential for traction and is viewed favourably by VCs.

EXAMPLE DASSAULT SYSTEMES' 3D Experience Lab specialises in 3D design and graphics, life cycle management solutions and develops software allowing brands to test, validate, programme and simulate manufacturing processes in a virtual environment. This reduces the need for physical prototypes and facilitates manufacturing processes. The CATIA Creative Design solution allows designers to share ideas and concepts with other members of the community on social media. Its limitation is that it applies only to prototypes and production monitoring.



IMMERSIVE TECHNOLOGIES

STATE OF THE ART Immersive technologies are mainly being used for events and performances. They are often shorthand for VR/AR headsets (Oculus, Samsung, Google, Magic Leap, Homido to mention a French maker), but these are just one element of the total immersive experience environment. Content (3D design) and sound production along with various other mobile sensor-based devices (remote controls, etc.) are also needed. France is a leading player in the creation of immersive environments thanks to its many specialised agencies and studios⁸¹. It is also attracting international companies, US-based EON Reality recently opened a Training Hub & VR Innovation Academy in Laval. In conjunction with 3D design software, these technologies can be used by designers to visualise a product before launching production. Barriers to adoption include the high cost of the devices needed for immersive experiences, gamers are presumably the only consumers to have invested in a personal headset. Most applications target video games and simulation for medical, training and security purposes more than fashion. Yet these technologies are operational and relevant for merchandising and events. Start-ups seeking financing use them to present their projects, and brands to visualise projected store architecture, merchandising and display unit designs. As immersive reality spaces open (Eydolon), it is possible to avoid investing in the equipment.

OUTLOOK An augmented experience can offer a competitive advantage for e-commerce platforms and could be the future norm. In the long term, pending improvements in VR/AR technologies, they may help reduce traveling for sourcing, design and sales teams. The revenues of French immersive reality companies grew by 50% between 2010 and 2017, and 8% yearly growth is expected on average by 2020⁸².

KEYS TO SUCESS In the short term, VR can provide online experiences that are better aligned to luxury brands' needs. This is why it is important to support the efforts of start-ups, as they face unfavourable negotiating conditions due to the market draw of headset makers – Samsung (Gear VR), Sony (PlayStation VR), HTC (Vive) and Facebook (Oculus Rift). The necessary high-speed graphic computing capacity to produce content (bugs) and the headsets' restricted field of vision may hinder the development of these technologies. Comfort of use and accessible prices are keys to future success, and a promising area for Dutch design studios. For a complete experience, better tactile response could be useful to limit business travel and improve communications with remote design and production teams. In this area, US-based start-up Ultrahaptics⁸³ has made progress in the quality of tactile perception with an ultrasound-based system capable of creating elaborate three-dimensional shapes and textures that cannot be seen but can be sensed. The development of headset-free accessories and immersive environments (cyber-shoes were presented at the CES 2019 edition in Las Vegas).

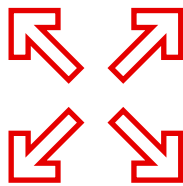
Start-ups in this field possess high expertise in electronics and interaction design. A physical shopping experience, however, calls not only sight and touch but also on sound and scents. To convey an optimal immersive experience (expressing the sensorial touch of a fabric for instance) all these dimensions would need to be combined.

EXAMPLE Digital imagery and interactive installation specialist Orbys is a leading French start-up in hologram-based in-store experiences and events. These can take many forms thanks to the start-up's rapid prototyping services.

⁸¹ <https://blog.lehub.bpi-france.fr/mapping-startups-francaises-realites-virtuelle-augmentee/>

⁸² https://www.xerfi.com/presentationetude/Le-marche-de-la-realite-augmentee-et-virtuelle-a-l-horizon-2020_7SAE30

⁸³ <https://www.ultrahaptics.com/>



VIRTUAL FITTING AND SIZING

- STATE OF THE ART** The market for automated sizing services is thriving. The main players have developed solutions offering near-optimal levels of precision (margin of error <1%) particularly suited for underwear, semi-bespoke and made-to-measure markets (designers, tailors, wedding dresses). Mobile apps such as Fitizzy and Fitle can be useful for e-commerce platforms, but they rely on data provided by consumers, based on photos of themselves wearing close-fitting clothing, which has its limits. Digital measuring cabins provide better data, but they are also more expensive and their design may not conform to a brand's visual environment. Despite the claimed efficiency of these measuring systems, if a brand does not offer a wide array of sizes or if a garment does not indicate its precise measurements, adoption of these body scanning technologies will remain low.
- OUTLOOK** Users will know their body size at a given moment and receive suggestions of garments adapted to their body shape and style preferences by their favourite brands, designers or tailors. Combined with an after-sales retouching service linked to a fitting station, the garment can be immediately adjusted for a perfect fit. An automated made-to-measure manufacturing system based on 3D avatars and combining body scan, 3D design and patternmaking, laser cutting and stitchless assembly can then be envisioned.
- KEYS TO SUCCESS** Successful development is conditioned to brands providing more precise information on their sizing (using QR codes, NFC or RFID), progress in digital measuring systems, combined with made-to-measure design based on 3D avatars or made-to-measure on-demand manufacturing. As 3D avatar-based design is operational, what remains to be developed is a precise, accessible and fast virtual made-to-measure design system.
- EXAMPLE** Sizomatic's virtual fitting stations feature minimalist designs and a level of precision not possible with apps based on data or photos supplied by users. Once inside the cabin, users enter their height and weight into an app before launching the scanner that generates a measurement graph and 3D avatar, which can then be used to 3D design an item of clothing. This start-up is open to collaboration.

⁸⁴ <https://www.tg3ds.com/>



ARTIFICIAL INTELLIGENCE FOR COMMERCE AND LOGISTICS

STATE OF THE ART **Artificial intelligence** (AI) is a powerful tool that can enable brands to generate recommendations on e-commerce platforms, optimise inventory management and predict sales, on condition that they are programmed to interpret data with caution and eliminate bias. AI can prevent errors, save resources (notably time), and promises fashion companies economies of scale. Many innovative services have emerged seeking to link data with sales and production cycles. Machine learning is already widely used by trend agencies and e-commerce platforms seeking to harness Big Data to develop ultra-personalised marketing campaigns. It has already resulted in a transfer of labour to robots, chatbots and consumers.

OUTLOOK Marketing and sales teams will be able to outsource repetitive tasks to machines, procurement services reduce risks and inventory management will have access to better tools to predict sales and optimise product assortment. Fashion brands expect that the development of AI will enable them to better identify and anticipate changing consumer attitudes, but they must also respect the ethical and legal limits of cognitive and predictive marketing. Predictive insight to imagine future scenarios using AI-based collaborative human-machine processes is by nature based on data from past events⁸⁵ and will require finer analysis by human emotional intelligence. Shoe brand Eram is working with the start-up Datakalab to measure its consumers' emotional engagement.

KEYS TO SUCCESS **Progress in nanotechnologies**, computing speeds and storage capacity to treat ever larger datasets for increased AI accuracy will be seen as useful in all sectors, including fashion. Quantum computing is viewed as a positive prospect as the algorithms that underly AI need to be able to access large quantities of data. For creative processes, however, humans rely on personal experience, emotions and the context in which they live. These represent an enormous amount of data, long learning processes, and considerable energy and means (which is why AI is often specialised). Our ability to use AI intelligently to address large-scale issues, instead of creating new gadgets, is essential to its adoption by creative industries. An opportunity for start-ups therefore lies in applying AI to real problems fashion retailers face. The market pull of identifying future best-sellers, developing smarter inventory solutions and improving stock management is thriving but also intensely competitive.

EXAMPLE Prevision io has developed a machine learning platform applied to historical and exogenous data to anticipate consumer behaviour, with accompanying equipment monitoring and maintenance services. Founded by well-known data scientists, the start-up has worked with Chanel and La Redoute. Its stated goal is to create an AI for each use case and democratise predictive intelligence in company value chains.

⁸⁵ See the design experience of Robbie Barat for Balenciaga: <https://robbiebarrat.github.io/o th/ bale.html>.



BIOFABRICATION, BIO- ICALS AND MATERIALS

STATE OF THE ART Few **biotech projects** in France target fashion applications and rarely do they go beyond prototype stage. Most often they focus on health applications⁸⁶, though some do have apparel end-uses in mind (PILI, see example below). A few biomaterial projects for fashion applications exist, but no French candidate was featured at the latest Biofabricate Summit⁸⁷. There is a strong link between medical and textile innovation in France [Théophile Legrand Award for Textile Innovation⁸⁸]. Research into alternative leather-like materials is another key area for many start-ups: such as Open Bio Fabrics.

OUTLOOK Living organisms will undeniably find applications in apparel and their ability to replace petrochemical processes has high potential. Other possible applications include biodegradable materials, garments that react to various stimuli including sweat or warmth or generating a wellbeing or style effect (thermochromic inks). Biotech textiles could be of interest to reduce the fashion industry's reliance on fossil fuels though their complex manufacturing processes make their scaling up difficult and costly. Bio-fabrication can provide alternatives to cotton, leather and petrochemical materials without requiring brands to change their business models.

KEYS TO SUCCESS Innovation programmes being sectorial by nature, a biotech research project must identify a potential end-market and make the right connections early on, or transpose a biotech innovation developed for another market to fashion, as does MateriO' for all materials. In France, biosynthetic fibres (as those developed by DuPont) are not viewed favourably as they rely on agro-industry GMOs and have been negatively portrayed in many documentaries. To address these issues, it is necessary to promote the responsible use of genetically modified micro-organisms in compliance with official guidelines⁸⁹. The cultivation of living organisms (bacteria or enzymes) requires elaborate high-temperature processes that are not carbon neutral. Further research and an analysis of the impacts of petrochemical and leather processing compared to biotech ones is recommended.

EXAMPLE PILI is a biotech start-up working on a promising alternative to petro-chemical dyes and inks. It has already reached proof of concept and ability to scale up, but still requires heavy investment in high-tech equipment.

⁸⁶ <http://www.france-biotech.fr>

⁸⁷ <https://www.gesundheitsindustrie-bw.de/en/article/dossier/innovative-textiles-made-possible-by-biotechnology/>

⁸⁸ <http://www.theophilelegrand.w1w.fr/>

⁸⁹ <https://www.ecologique-solidaire.gouv.fr/organismes-genetiquement-modifies-ogm-0>



ROBOTICS

STATE OF THE ART

With France's strong robotics industry, robot use is expected to become a common feature in fashion retailing. The market leader and pioneer in the field, Aldebaran Robotics (maker of humanoids Nao and Romeo) was recently acquired by Japanese investment group SoftBank. A dozen prototype delivery, surveillance and reception robots were presented at VivaTech in 2019. Whether these devices should have human-like features or not is still under debate.

The humanoid robots Erica and Sophia, launched respectively by Vogue US and Elle Brazil, raised violent reactions in an era calling for models resembling real women. Designers working in robotics are often linked to DIY circles, as seen in InMoov, a 3D-printed robot created by French designer and sculptor Gaël Langevin with a community of maker-designers, and in Nicolas Huchet's prostheses. Artificial limbs and exoskeleton-like structures are being experimented with in fashion (Hearing; U-exist).

OUTLOOK

Robotic assistants will provide various services to humans, their use for dangerous, repetitive or exerting tasks could help reduce workplace injuries. In fashion, possible applications include stock management and mass manufacturing (implying repetitive gestures). In stores, robots could relieve staff of elementary tasks.

KEYS TO SUCCESS

Thinking robots not as human clones but as assistant co-workers. A key to success for customer services is accepting the complementary nature of human/machine interaction. The question of workers being replaced by machines raises economic and societal issues that policymakers have yet to address. It is also necessary to anticipate hacking, data protection and privacy, as is the case for AI. The Dutch hardware and interaction design expertise could be an asset in this field.

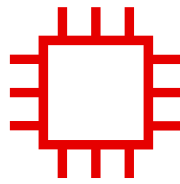
EXAMPLE

Euveka's smart mannequin is designed to change shape to adapt to all morphologies offering brands a precious made-to-measure design tool. Linked to a virtual dressing room in a brand's boutique, it could help reduce the need for fittings and limit store returns. The start-up intends to "work with a local ecosystem to build a product that is made in France and respects social and ethical principles".

⁹⁰ <https://spectrum.ieee.org/automaton/robotics/humanoids/aldebaran-robotics-sells-majority-stake>

⁹¹ <https://fandd.studio/>

⁹² <http://www.u-exist.com/>



WEARABLE, ELECTRONIC TEXTILE

STATE OF THE ART The market for **electronic textiles and components** for integration into clothing (aka **wearables**) is making slow progress as suppliers tend to favour more mature markets, and many interactive garment projects never go beyond prototype. A number of issues have yet to be addressed, including the safety (and CE certification) of electronic systems worn close to the body along with wash and care, end of life, data management and privacy. Smart interactive systems are however being integrated into accessories (Pechdo's Easy Touch, Eram's #choosesneakers). When a start-up presents a significant smart clothing or textile, they tend to draw high media attention and support from French authorities. Bringing these projects to market often requires that start-ups pivot or simplify their concept make it industrialisable. Wearables are nonetheless a launchpad for many new applications and functions as seen in the effervescent healthcare market (ex: Torqlabs' smart leggings help avoid knee injuries).

OUTLOOK Using **connected clothing** instead of various functions delivered by smartphones, the development of clothes that can diagnose and treat various health issues including vitamin deficiencies, incorrect posture or send an alert to medical staff. Garments or accessories that automatically adapt to changing conditions (weather, temperature, time). Other possible fields of development include electronics combined with interactive clothing made with living organisms as seen in the MIT Tangible Media Group's fascinating BioLogic project⁹⁷ (US).

KEYS TO SUCCESS The creation of multidisciplinary working groups, development of low-energy and biodegradable electronics and further research into real-life applications are some of the practical issues that need to be resolved. Social concerns, such as an evolution in education and practices that would lead scientists to have a better understanding of political issues and politicians a better grasp of scientific matters, are also recommended to encourage the adoption of smart clothing. Finally, technical progress remains to be made in batteries (that don't explode), nanotechnologies, biotechnologies (biocompatibility), cybersecurity and regulation to boost the development of wearable technologies (and body implants).

Barriers to their adoption include health risks, privacy risks and hacking of intended uses, unintended social consequences (on civil liberties, equality of access), as well as other unresolved technical issues (system transparency, energy, laundering). The Netherlands leads in these fields, but heavy investments will be necessary to successfully develop B-to-B projects, and the GAFAM may pre-emptively pick up the best.

EXAMPLE TopTex3 (pronounced TopTex Cubed) is an industrial development design studio that specialises in innovative, technical and smart textiles (clothing and accessories) with services spanning concept design to small production series. It has invested in seamless or near seamless manufacturing equipment. Its key customers are sportswear (Lafuma), health and luxury brands and it has launched its own brand (Aouro). It seeks to train and hire technical professionals.

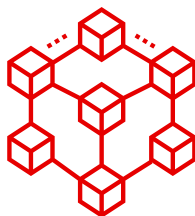
⁹³ <https://www.tanneries-pechdo.fr/tanneries-pechdo-presente-easy-touch-le-1er-cuir-conduc-teur-pour-ecrans-tactiles/>

⁹⁴ https://www.eram.fr/blog/actu_eram/choose-la-chaussure-qui-change-de-couleur/

⁹⁵ Cityzen Sciences first developed a prototype smart T-shirt, but now provides data management services for companies operating in body based IoT (sport, health...). Maison de Rigueur is no longer a brand but a manufacturer for companies looking to scale up their interactive leather goods. (The fastgrowing start-up is looking to hire system engineers).

⁹⁶ <https://torqlabs.com/>

⁹⁷ <https://arts.mit.edu/biologics-living-textile/>



BLOCKCHAIN

STATE OF THE ART With clear applications in fashion (traceability and legal protection), blockchain-based solutions are currently being tested by major brands. A blockchain is a distributed ledger of 'blocks' in which each block contains all the others and forms a 'chain'. It is a disintermediated method to protect data and transactions⁹⁸. An open blockchain secures business dealings without requiring a third party, creating a traceable, signed and timestamped data chain. In fashion, it can be used to combat counterfeiting, protect authors, guarantee certifications and standards (labels), provide smart contracts and safely transmit data collected by wearables. Experimentation in blockchain for cooperative governance⁹⁹ could be useful in fashion research projects.

OUTLOOK Offer workers in the fashion and textile industry a trusted and democratic management model, encourage best practices and generate good business and sales relations.

KEYS TO SUCCESS With regards to storage, a system of ledger parcelling and the development of overlay protocols are in the works. Currently, transactions are validated by resolving a problem (an energy-intensive process) and the blockchain is replicated in all of the network's nodes, which requires large storage capacities. Products and services associated with blockchain can have security faults, a key to success is the development of stronger signature and hashing algorithms. The advent of quantum computing as a vehicle to hack blockchains is another issue that needs to be addressed. There is however a move to create 'quantum-resistant' blockchains, and the goal would be for the two technologies to work together.

EXAMPLE Launched in 2018, Arianee is global ledger of digital certificates allowing any user, be it a brand or a consumer, to access information on a product's entire production process. It is Ethereum compatible (second blockchain after Bitcoin).

⁹⁸ A blockchain requires a network of contributors, an economic incentive protocol, a distributed database in real time, an algorithm and a cryptography system.

⁹⁹ <https://www.maddyneess.com/2017/07/25/blockchain-management/>

All of the above-mentioned **technologies** have the potential to increase the adoption of **more sustainable and efficient production and retail practices**. Wearables remains a special case due to their complex industrialisation processes, but the data they collect is still vital for some of the other technologies.

Major challenges include time needed for research, the difficulty of scaling up, securing funding (textile 3D-printing start-up Electroloom says its long development phase was one reason it folded) and security issues. In all cases, and whatever the economies of scale they generate, their potential to resolve social inequality depends on how they are used. A case in point is placement systems that reduce fabric waste but allow brands to produce greater quantities that could exceed demand and have a negative environmental impact. Many innovative projects can have an ecological and economic advantage provided that they be used responsibly.

Sustainable innovation in fashion can, if backed by legislation that protects workers and a societal change in the definition of success currently equated with ownership, could help achieve this goal by reducing accumulation, increasing sharing and limiting waste. The development of tools to measure the impact of different options is also necessary. For example, the techniques used to “grow” and dye clothes with bacteria (cf. Suzanne Lee and Aniela Hoitink) require temperature conditions that are not carbon-neutral but may have a lower impact than current leather-making and dyeing processes.

One key takeaway is the need to combine varied technologies (cf. LVMH Innovation Award winner 3Dloom) and approaches (artistic, scientific, technical) to open up new possibilities. This is why collaboration is key and common practice among tech giants. Luxury brands can use blockchain technologies to emphasise their authenticity, as they do on social media, and augment “behind the scenes” campaigns with immersive technologies. Blockchain can improve interaction and remote teamwork in design and production processes, as well as in securing customer guarantees.

Electronic textiles make it possible to monitor a product’s use, trace it and combat counterfeiting. Immersive technologies can allow retailers to offer unique customer experiences. A report by the IFM Observatory polled French consumers on their ideal garment of the future and found that it should be carbon-neutral, or better yet reduce pollution, made-to-measure, customisable and/or modular, and it should look good, be cared for without water or ironing and adapt to need in real time (temperature, opacity, waterproofness). Providing medical or wellbeing services would be all the better! This confirms the need for further research into how these technologies can be combined for enhanced user experiences and how they can be used to reduce the fashion industry’s impact on the planet.

¹⁰⁰ <http://www.primante3d.com/imprimante-3d-vetement-17082016/>

5



OPPORTUNITIES FOR STRATEGIC COOPERATION IN SUSTAINABLE FASHION TECH

V OPPORTUNITIES FOR STRATEGIC COOPERATION IN SUSTAINABLE FASHION TECH

This final section presents a French view of the possible contributions of Dutch stakeholders to the development of sustainable fashion tech internationally. It also covers potential challenges the fashion industry faces to achieve economic sustainability and address the SDGs. Furthermore, it highlights the importance of innovation as well as the need to create favourable conditions for research into innovation. It closes with a series of opportunities to collaborate with French stakeholders in a short, medium and long-term for Dutch fashion tech players. Together, the Netherlands and France can create a more innovative and sustainable fashion tech sector.

V. 01. DUTCH FASHION ASSETS

The Netherlands can contribute to the evolution of fashion with French partners at many levels.

In research

- **The multidisciplinary pedagogical approach** applied at the Eindhoven Design Academy¹⁰¹ encourages students to choose research topics that address fundamental needs (food, housing, communication) and has led to eloquent fashion projects. The institution's alumni demonstrate high inventiveness, an ability to adapt and self-train, three high value skills in the world of work, and a true asset for those looking for employment at French fashion companies. Dutch fashion projects are often grounded in global design thinking and focus not only on a product's aesthetics but also its functions and manufacturing tools and processes (cf. the Fabricademy¹⁰²).
- Due to their **innovative and entrepreneurial spirit**, Dutch designers can define "luxury" on their own terms and the country has pioneered bold approaches to fashion and design education (cf. ArtEZ Future Makers).
- The country's many fablabs¹⁰³ offer opportunities for experimentation and the creation of multidisciplinary fashion tech working groups.
- The country's territorial management, focus on eco-mobility and development of alternative multi-service spaces, like the workshop/factory/boutique created in Eindhoven by designer Piet Hein Eek or the TextielLab Museum in Tilburg are also key assets.

In biofabrication

A number of Dutch designers and labs are working on biotech materials, these include ArtEZ Future Makers¹⁰⁴, Mycotex by NEFFA¹⁰⁵ (Aniela Hoitink) and Living Colour¹⁰⁶ (Laura Luchtman & Ilfa Siebenhaar). Fashion brands and luxury conglomerates see this area as having high potential, cf. H&M's Global Change Award winners, start-ups enrolled in LVMH's Maison des start-ups, research supported by CARAT, and projects select-ed by the Futur Tech Lab.

In CO2 technologies

- Dutch company DyeCoo¹⁰⁷ has developed a high-tech waterless system to dye fabrics on an industrial scale.

In wearables

- Many Dutch designers/researchers are working on advanced projects at the intersection of science, engineering and fashion including: Pauline van Dongen, Karin Vlug, Aniela Hoitink, Marina Toeters, Cecilia Raspentì (textilab), Labelledby, Vera de Pont, Oscar Tomico, etc.
- The Netherlands excels in result-driven thinking combining traditional methods and new technologies¹⁰⁸. Collaboration with French manufacturers in the likes of TopTex3 and SATAB could lead to the mass production of connected garments.
- TNO and IMEC chose to locate the Holst Center¹⁰⁹, a leading research centre on flexible electronics and autonomous sensors, in the High Tech Campus Eindhoven and it collaborates with scientists and designers such as Marina Toeters, founder of fashion tech studio By-Wire¹¹⁰.

¹⁰¹ 24th in the QS world university rankings 2018 for art and design

¹⁰² <https://textile-academy.org/>

¹⁰³ <https://fablab.nl/>

¹⁰⁴ <http://futuremakers.artez.nl/>

¹⁰⁵ <https://neffa.nl/>

¹⁰⁶ <https://livingcolour.eu/>

¹⁰⁷ <http://www.dyecoo.com/dyecoo/>

¹⁰⁸ <https://theculturetrip.com/europe/the-netherlands/articles/top-ten-designers-from-the-netherlands/>

¹⁰⁹ <https://www.holstcentre.com/about-holst-centre/holst-centre-in-a-nutshell/>

¹¹⁰ <http://www.by-wire.net/>

V. 02. CHALLENGES TOWARDS SUCCESSFUL FASHION TECH COLLABORATION

Collaboration in innovation for more sustainable fashion faces a number of obstacles. French fashion companies do not seem to fully realise the potential of collaboration with Dutch counterparts despite their recognised contribution to many fields in design (automobile, textile, furniture) and architecture.

Beyond a handful of high-profile designers and brands (Iris van Herpen, Viktor & Rolf, G-Star, Scotch and Soda and C&A), the French know few Dutch apparel and textile companies. Those who follow innovation in fashion do usually have knowledge of the work of Iris van Herpen, Pauline van Dongen, Anouk Wipprecht or Rushemy Botter and Lisi Herrebrugh, winners of the Hyères 2018 Festival. The ArtEZ Fashion Institute Arnhem has trained many talented and internationally recognised fashion designers (ex: Lucas Ossendrijver), but it is not as well as known as other European fashion schools.

However, it is no secret to the growing number of insiders who visit the Dutch Design Week¹¹¹ that the country plays a key role in opening up fashion to innovation, but it is not (yet) recognised as a key centre in this field.

Despite their potential with regards to the future of fashion, French fashion tech structures also face various challenges:

POLITICAL

- Policymakers tend to address a problem by creating new public structures, leading to inertia and the need to navigate multiple intermediaries.
- Government decision-makers rely on information provided by advisers who are not directly operating in the field.

GEO-STRATEGIC

- Delayed awareness of data management issues: France was slow in developing its own search engine, this means that all French (and European) companies need to optimise their presence on Google's search engine (whose market share is more than 90% compared to Qwant's 0.63%).

LEGAL

- Within the European Community, the GDPR can be seen as a victory for civil society, but other countries have not applied similar measures and this can be a disadvantage for fashion companies with regards to their international competition.
- For reasons of confidentiality major luxury groups are reluctant to partner with other companies in R&D projects, which is unfavourable to innovation¹¹².
- Identifying and protecting an innovation is a long, arduous and costly process for start-ups. This is all the more critical that France lacks jurisprudence in fashion technology¹¹³.
- Defining intellectual property rights when several authors are involved in an innovative project is a complex matter. Rightful legal holders, the initiator and person in charge of its creation, must however be established, while the person(s) contributing to technical or manufacturing aspects will be excluded, if these processes are found to have no relation to the product's design or purpose¹¹⁴.
- Innovative fashion or textiles need to communicate easy-to-understand information on use and care: including wash & care guidelines, indications on how to remove electronic components before laundering, advice on the safe handling of the garment's electronic components, says Naïma Alahyane-Rogéon. Europe is not leading player in the development of new standards¹¹⁵ for e-textiles.

ECONOMIC

- Insufficient support and funding for applied research and exploratory design phases.
- Since 2008, the average French budget for clothing and footwear has decreased, a trend that began in 1960, small and medium-sized companies often do not have the funds to invest in R&D¹¹⁶.

¹¹¹ <https://www.ddw.nl/>

¹¹² Source: UIT

¹¹³ Source: Naïma Alahyane-Rogéon, Cabinet Lexing Alain Bensoussan Avocats

¹¹⁴ Source: Naïma Alahyane-Rogéon, Cabinet Lexing Alain Bensoussan Avocats

¹¹⁵ <https://www.modedintextile.fr/laatcc-publie-norme-internationale-textiles-electroniques/>

¹¹⁶ Source: INSEE

MANAGERIAL

- Difficult collaboration and communication conditions between major groups and smaller innovative structures.
- To date, few high-tech products addressing real fashion market needs have been developed. It is therefore all the more important to encourage interdisciplinarity. New dynamics are at work as seen in the partnerships between educational institutions and between companies and start-ups, with the support of competitiveness clusters and fashion tech competitions.
- On a human level, in addition to technical training, companies should encourage favourable career evolutions and offer training opportunities to make technical fashion professions more attractive to young people and to provide workers with the ability to adapt to an evolving job market. Employees will be all the more invested in a company if it allows them to contribute to creative strategies and decision-making, yet these are often lacking.
- Coworking spaces and third places could be conducive to improved working conditions and collaborative innovation in fashion, but they do not always possess the necessary dynamics.
- Educational institutions often separate practice and theory, which can lead to poor understanding and interaction in professional contexts and affects performance. Efficient management and research processes are limited by educational programmes, particularly in the social sciences, as these are too far removed from the daily reality of the fashion industry. Still, steps have been taken to fluidify relations between scientists, entrepreneurs and fashion companies, driven by the need to better align technological innovation with market demands.
- As in other industries, the development of new fashion products calling on innovative technologies is met with fear that it upset established orders of power.

V. 03. FORMING STRATEGIC PARTNERSHIPS WITH FRENCH KEY PLAYERS

PLACE	French key players
National	R3ILAB
Ile-de-France region	<p>Ecole Nationale de Mode et Matière (EnaMoMa) Réseau CARATS Institut Français de la Mode (IFM) Eco-TLC l'Union des Industries Textiles</p> <p><i>Innovative showroom structures</i> Lafayette Anticipation Designers Apartment l'Exception</p> <p><i>Foundations</i> Fondation Bettencourt Schueller Kering Fondation d'entreprise Hermès</p> <p><i>Incubators/Accelerators</i> Vente-Privée Impulse la Maison des startups LVMH Station A by Adidas</p> <p><i>Networks</i> Culture[s] de Mode</p>
Hauts-de-France region	<p>Centre Européen des textiles innovants (CETI) Nord Crea Lilliad research centre</p>
Rhône-Alpes	<p>TopTex3 Techtera</p>
Occitanie	Toulouse White Biotechnology
Provence	Atelier Luma
Nouvelle Aquitaine	Sew & Laine

V. 04. OPPORTUNITIES IN FRANCE FOR DUTCH PLAYERS

Company	Startup	Incubator	School	Research institute	Public organisation	Region	Cluster	SHORT TERM	LONG TERM	
/	/	/	/	/	/	/	/			Creating Fashion Tech Weeks in cities known for their innovation in fashion and textiles, ideally with the support of the concerned Dutch municipalities, to increase French attention to the sector.
/	/						/			Exploring the possibility to participate in transnational partnership programmes, e.g. through BPI France.
/				/						Collaborating with the many French consortia to advance research & development in fashion tech and sustainability.
/		/								Launching or expanding innovation incubators open for European entrepreneurs to develop and accompany innovative projects.
/										Attending major trade fairs and alternative events dedicated to fashion in France, including fabric shows, the IFM's Perspective Forum, the UIT's Cap sur le futur forum, Fashiontech Weeks, Fashion Green Days (Roubaix), Big Blue Project.
/			/	/	/					Organising bilateral competitions and hackathons for French and Dutch stakeholders to stimulate collaboration and knowledge exchange.
	/			/		/	/			Developing technological innovation in sustainability in collaboration with fashion tech start-ups and research institutes in France (e.g. Techtera with the Grenoble-based energy cluster TENERDIS on energy efficiency).
				/	/					Mapping to create a database of fashion research and expertise in the Netherlands to inform French stakeholders about collaboration opportunities, following the French examples of the DEFI's directory of French fashion tech players or the online magazine for responsible fashion 'The Good Goods'.
					/	/				Exploring how to strengthen the Dutch textile recycling ecosystem in collaboration with France's Eco-TLC.
			/	/	/	/	/			Forming strategic partnerships with French organisations (see the report's annex for a comprehensive overview of stakeholders in different areas of the fashion sector).
			/	/						Investigating the role that fashion education can play to address the Sustainable Development Goals, such as EnaMoMa has done to adapt their curriculum and expand internationally.
			/	/		/	/			Exchanging best-practices with the French research community to improve consortium building.

CONCLUSION

Clear signs of renewed commitment to sustainability are seen at all levels of the French fashion value chain. **The French fashion industry** is well aware that it can play a key role in influencing the future of fashion with its research centres, schools, business clusters, and of course its status as fashion capital. It can keep its lead, if it encourages interdisciplinary research and fosters synergies and partnerships.

Fashion innovation can contribute to sustainable development or can on the contrary be an aggravating factor if applied without care. New technologies applied to apparel end-uses can, depending on how they are used, allow the industry to make progress in sustainability and productivity. Many innovators in fashion seek solutions that address both environmental and social issues, and these often coincide.

But it is also true that some companies choose to apply new technologies to increase volumes without taking into account their ecological impact and thus generate more waste. Investing in structures and frameworks supporting collaboration between research institutions and the fashion industry can help economic and ecological objectives converge. Emerging technologies will be considered all the more attractive if they address a widespread productivity issue.

In the short term, there is undeniably an **opportunity in fashion** for leading start-ups in artificial intelligence and augmented or virtual reality particularly to anticipate demand (AI-based predictive marketing) in conjunction with on-demand and/or made-to-measure manufacturing (3D design, IoT, AI, robotics), biotech materials, immersive and personalised experiences (VR, AR, AI, wearables), garment functionalisation (wearables), and supply chain certification (blockchain, RFID, NFC, QR codes).

The state of research in fashion suggests that there is a business opportunity at the intersection of textile innovation and fashion design. However, textiles with augmented properties, be they biotech or technical, do not yet correspond to fashion brands' aesthetic criteria and are slow to launch (facing various technical, financial or legal obstacles). A brand seeking to launch innovative fashion products will need to invest and take risks, due to the costly nature of producing electronics in small runs and uncertain returns on investment. Health applications appear relatively more promising as the required investment in research tends to target known and measurable needs.

Several factors indicate that French companies will be more willing to innovate and partner with research entities, these include pressure from global markets and the GAFAM, the decrease in consumption in France and the evolution of production and demand in China. In the future, dedicating the greater part of marketing budgets to a brand's image will no longer suffice if its products do not have advanced functions. It is conceivable that the experience a brand offers and its ability to address fundamental needs will reduce the attractiveness of big-name brands. This transition in favour of a virtuous, functional and aesthetic product offering (a challenge similar to that of innovation), can make fashion a tempting investment for more demanding consumers.

Research and innovation have the potential to disrupt established business models. Research projects are increasingly addressing fashion applications, though they would benefit from closer collaboration between creative and scientific structures. The gap between research and industrialisation is closing, as innovative tools addressing designer needs, the result of lengthy R&D processes, emerge.

As this report demonstrates, there is no lack of structures, tools nor ideas, but what could be strengthened is the convergence of objectives and means for existing projects in research, entrepreneurship or avantgarde design. Creating balanced win-win relationships between innovators and large structures is not trivial as any type of innovation is the fruit of the minds and conditions that brought it to life and these need to be valued and managed in the long term to allow them to deliver their full potential.

The EU funds cross-border collaborative projects in favour of innovation that can help the fashion industry be more sustainable. The decision to establish the most promising international incubators for innovation in fashion in France, the Netherlands, Germany and Italy, sends a strong signal that the EU understands the potential of its member states to invest in research for its textile and apparel industries.

Finally, to achieve **environmental and social goals**, innovation must be applied both on a managerial and manufacturing level. The fashion industry should therefore also be open to new forms of leadership. Technical innovation alone will not be able to find solutions for resource depletion and pollution. To effectively address these challenges, innovation needs to be accompanied by a change in practices and this can be achieved through European partnerships involving all stakeholders and dedicated to the development of a more promising, thoughtful and **sustainable fashion tech**.

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I. THE CONVERGENCE OF ECOLOGICAL AND ECONOMIC SUSTAINABILITY IN FASHION

ANNEX 1.A ALTERNATIVE ONLINE AND OFFLINE INITIATIVES

A. Distribution (online/offline)

PHISICAL MULTI-BRANDS & CONCEPT-STORES

- ✓ Centre Commercial: www.centrecommercial.cc
- ✓ Dressing Responsable: www.dressingresponsable.com
- ✓ Front de Mode: frontdemode.com/fr/
- ✓ Hall Couture: www.hallcouture.com
- ✓ Manifeste 011: www.shop.manifeste011.com
- ✓ Noyoco: www.noyoco.com

ONLINE MULTI-BRANDS

- ✓ Alter Mundi: www.altermundi.com/fr
- ✓ Face to Face: www.facetofaceparis.com
- ✓ Kabanés: www.kabanes.com/fr
- ✓ Klow: www.klow.co.uk
- ✓ Mae Sue: www.maesue.com/fr (founded by a Dutch woman)
- ✓ Modetic: www.modetic.com
- ✓ The Matter: www.forthematter.com
- ✓ Wedressfair: www.wedressfair.fr

MAINLY ONLINE SECONDHAND STORES

- ✓ Lablaco: www.lablaco.com
- ✓ Les Cachotières: www.lescachotieres.com
- ✓ Onceagain: www.onceagain.fr
- ✓ Panoply: www.panoplycity.com/fr
- ✓ place2swap.fr: www.place2swap.fr
- ✓ Tale me: www.taleme-shop.com
- ✓ Vestiaire Collective: fr.vestiairecollective.com
- ✓ Vide Dressing: www.videdressing.com

B. Services

NON-PROFIT ORGANIZATIONS

- ✓ Association Mode Estime: www.modeestime.fr
- ✓ Association Jean-Luc François: association-jeanlucfrancois.blogspot.com
- ✓ Le collectif démarqué: www.lafabriqueideale.eu
- ✓ Le collectif Ethique sur l'étiquette: www.ethique-sur-etiquette.org
- ✓ Emmaüs: www.emmaus-paris.fr
- ✓ La fabrique idéale: www.lafabriqueideale.eu
- ✓ La fabrique nomade: www.lafabriquenomade.com
- ✓ Fashion Revolution France: www.fashionrevolution.org/europe/france/
- ✓ Plateau Fertile par Nord Crea: www.plateaufertile.fr
- ✓ Les ressourceries: www.ressourcerie.fr
- ✓ La réserve des arts: www.lareservedesarts.org
- ✓ La Textilerie: www.latextilerie.fr
- ✓ UAMP (Une autre Mode est possible): www.uneautremode.fr
- ✓ Universal Love: www.universallove.fr

ANNEX 1.B SUSTAINABLE FASHION PLAYERS

ESTABLISHED BRANDS

- ✓ EKYOG: www.ekyog.com
- ✓ VEJA: www.veja-store.com

RISING BRANDS

- ✓ LE SLIP FRANCAIS: www.leslipfrancais.fr
- ✓ 1083: www.1083.fr

ESTABLISHED DESIGNER BRANDS

- ✓ Andrea Crews: www.andreacrews.com
- ✓ Marine Serre: www.marineserre.com
- ✓ Sakina M'Sa: www.sakinamsa.com
- ✓ Valentine Gauthier: www.valentinegauthier.com

EXAMPLES OF UPCOMING BRANDS AND DESIGNER BRANDS

- ✓ Aatise: www.aatise.com/fr
- ✓ About a Worker: www.aboutaworker.com
- ✓ Adel*Astrée: www.adelastree.com
- ✓ Atelier Bartavelle: www.atelierbartavelle.com
- ✓ Atelier de Nîmes: www.ateliersdenimes.com/fr
- ✓ Atelier unes: www.atelier-unes.com
- ✓ Atode: www.atode.fr
- ✓ Femme d'Interieur: www.femmedinterieur.com
- ✓ Gaëlle Constantini: www.gaelleconstantini.com
- ✓ Gorfoo - RBX Creation: www.gorfoo.net/fr
- ✓ La vie est Belt: www.lavieestbelt.fr/fr
- ✓ Les Récupérables: www.lesrecuperables.com
- ✓ Madame Yvette: www.madameyvette.com
- ✓ Noémie Devime: www.noemiedevime.com
- ✓ Olly lingerie: www.olly-lingerie.com
- ✓ Patte de Loup: www.pattedeloup.fr
- ✓ POST DIEM: www.postdiem.com/collections/all
- ✓ Procède Paris: www.procedeparis.com
- ✓ Umöja: www.umoja-shoes.com
- ✓ Wylde: www.wylde-paris.com

OTHER NOTABLE INITIATIVES

- ✓ The app Clear-Fashion: www.clear-fashion.com
- ✓ Chaussettes Orphelines - Marcia des Carvalho: www.chaussettesorphelines.com
- ✓ L'indispensac - Tissages de Charlieu: www.indispensac.com

INNOVATIVE SPECIALISTS IN ZERO WASTE FASHION DESIGN

- ✓ HODEI en partenariat avec ECO-TLC
- ✓ Marie Labarelle: www.marie-labarelle.com
- ✓ MILAN AV JC: www.milanavjc.com

DIY BRANDS EXAMPLES

- ✓ Louis Antoinette Paris: www.louisantoinette.com
- ✓ Make my Limonade: www.makemylemonade.com
- ✓ République du Chiffon: www.republiqueduchiffon.com/fr

II. THE FRENCH FASHION INNOVATION LANDSCAPE

ANNEX 2. CLUSTERS (FR: *PÔLES DE COMPÉTITIVITÉS*) RELATED TO FASHION-TECH

Cluster	City	Website	Textile	Sustainable	Retail	Digital	Biotech / health
Techtera	Lyon	www.techtera.org	/				
UPTEx	Tourcoign	www.uptex.innovationstextiles.fr	/				
TEAM ²	Loos en Gohelle	www.team2.fr		/			
PICOM	Marcq-En-Baroeul	www.picom.fr			/		
CAP DIGITAL	Paris	www.capdigital.com				/	
Medicen	Paris region	www.medicen.org					/

ANNEX 3. RESEARCH CENTRES FOR APPAREL

Research centre	City	Website	Textile	Accessories
CETELOR: Centre d'Essais Textile Lorrain	Epinal	www.cetelor.univ-lorraine.fr	/	
CETI: Centre Européen des Textiles Innovants	Tourcoing	www.ceti.com	/	
CLUBTEX/UPTEx	Tourcoing	www.clubtex.innovationstextiles.fr	/	
IFTH: Institut Français du Textile et de l'Habillement	Paris	www.ifth.org	/	
CTC GROUP: Cuir, Chaussure, Maroquinerie	Lyon	www.ctc-services.org		/
FRANCÉCLAT	Paris	www.franceclat.fr		/
Pôle ATEN	Caen	www.pole-aten.fr		/

ANNEX 4. FASHION ORGANISATIONS LINKED TO THE COMITES PROFESSIONNELS DE DEVELOPPEMENT ECONOMIQUE (CPDE)

- Comité de Développement et de Promotion de l'Habillement (DEFI) www.defimode.org
- Centre Technique du Cuir, chaussures, maroquinerie (CTC) www.ctcgroupe.com
- Professional Committee for the Development of Watchmaking, Jewellery, Goldsmithing and Tableware (Comité FRANCECLAT) www.franceclat.fr

ANNEX 5. FEDERATIONS AND CHAMBRES SYNDICALES

Federation	Website	Couture	Clothing	Leather goods	Shoes	Other
UFIMH: Union française des industries mode & habillement	www.lamodefrancaise.org	/	/	/	/	/
FHCM: Fédération de la Haute Couture et de la Mode	www.fhcm.paris/fr/la-federation	/	/	/	/	/
Fédération Française de la Création Couture Sur Mesure-Paris	www.ccouture-paris.com	/				
Office de Promotion de l'Habillement Masculin	www.promas-international.fr	/				
L'UNACAC: l'union nationale artisanale de la couture et des activités connexes	www.unacac.fr	/				
Fédération nationale de l'habillement	www.federation-habillement.fr		/			
Fédération du prêt-à-porter féminin	www.pretaporter.com		/			
FEH: Fédération des enseignes de l'habillement	www.f-e-h.com		/			
Fédération de la Maille, de la Lingerie & du Balnéaire	www.la-federation.com		/			
UIT: Union des Industries textiles de France, fédérations et sections professionnels membres	www.textile.fr/les-federations-sections-professionnelles					/
CTC: conseil national du cuir	www.conseilnationalducuir.org/ctc			/		
Fédération de la Tannerie-Mégisserie	www.leatherfrance.com			/		
Fédération des Syndicats de Négociants en Cuirs et Crépins de France et Professionnels connexes				/		
Fédération Française de la Maroquinerie	www.maroquineriefrancaise.com			/		
Chambre Syndicale des Bottiers de France	www.artdubottier.com				/	
Fédération Française de la Chaussure	www.chaussuredefrance.com/sites/fr/index.html				/	
Fédération Française de la Ganterie	www.gantdefrance.fr					/
Syndicat National des Acteurs du Marché de la Prévention et de la Protection	www.synamap.fr					/
UFAC: Union Française des Arts du Costume	madparis.fr					/

ANNEX 6. UPCOMING RESEARCH GRANTS

- Au fil de l'eau (Closing: April 30, 2021): www.pia3.auvergnernhonealpes.fr
- INNOV'R® ET INNOV'R® EXPÉRIMENTATION (Permanent calls): www.innov-r.org/en/
 - Contact: projet@techtera.org
- Académie des savoirs-faire Hermès: www.fondationentreprisehermes.org/fr/programme/lacademie-des-savoir-faire

ANNEX 7. INCUBATORS, ACCELERATORS AND FUNDS FOR DIGITAL TRANSFORMATION

Incubator programmes

Incubator programmes	City	Duration	Website	Fashion	Design	Textile	Retail	Sustainable	Tech	Sports	Other
ADN / IFM entrepreneur et IFM Label	Paris Station F	1 year	www.adnxifm.com	/			/				
Look forward	Paris region	1 year	www.lookforwardproject.com	/			/				
Modes et métiers	Lyon		www.modeetmetiers.org	/	/						
Association JLF	Paris region		www.association-jeanlucfrancois.blogspot.com	/	/						
Usine.IO (Station F)	Paris		www.usine.io		/						
Sew & Laine	Bordeaux		www.sewetlaine.com		/	/	/	/			
La Caserne	Paris	Opening soon	www.lacaserneparis.com	/				/			
MAKESENSE	Paris		www.makesense.org					/			
La Ruche	Paris, Bordeaux, Montpellier, Marseille		www.la-ruche.net					/			
EURATECHNOLOGIES	Lille		www.euratechnologies.com						/		
Filiale du Groupe ELOANE	Angers		www.societe.eolane.com						/		
Paris Tech	Paris	18 months	www.paristech-entrepreneurs.fr						/		
Programme Platform A Adidas X Plug&Play	Paris		www.stationf.co/fr/programme-s-start-up							/	
Creatis	Paris	6-12 months	www.residencecreatis.com								/
Paris&Co	Paris		www.parisandco.paris								/
WILLA	Paris		www.pionnieres.paris								/

Residences and fab labs

Residences / fab labs	City	Duration	Website	Fashion	Design	Textile	Retail	Sustainable	Tech	Sports	Other
Atelier Meraki	Paris		www.instagram.com/atelier.meraki	/							
Maison de Mode	Lille	2 years	www.maisonsdemode.com	/							
Le Village des Créateurs	Lyon		www.villagedescreateurs.com	/							
Hall Couture	Paris		www.hallcouture.com	/	/						
Les Ateliers de Paris	Paris	2 years	www.ateliersdeparis.com	/	/						
Make Ici	Paris region		www.makeici.org		/						
Woma	Paris		www.woma.fr		/						/
Plateau Fertile	Roubaix		www.plateaufertile.fr	/	/	/					
Sew & Laine	Bordeaux		www.sewetlaine.com		/	/	/	/			

Accelerators

Accelerators	City	Duration	Website	Fashion	Design	Textile	Retail	Sustainable	Tech	Sports	Other
INNOTEX	Roubaix	1 year	www.innotex.fr/	/		/					
Impulse / vente privée	Paris	9 months	www.impulse.vente-privee.com/				/				
Lafayette Plug & Play	Paris	1 year	www.lafayetteplugandplay.com/fr/				/				
La maison des startups LVMH - Station F	Paris	1 year	www.lamaisondesstartups.lvmh.com/				/		/		
Arts et Métiers	Paris	1 year	www.am-acceleration.hivebrite.com/								/
The family	Paris & Berlin		www.thefamily.co/								/
HEC	Paris	1 year	www.hec.edu/fr/accélérateur-ess-idf								/
Microsoft	Paris		www.startups.microsoft.com/fr-fr/scale-up/								/

ANNEX 8. CALLS FOR PROJECTS, CHALLENGES AND AWARDS

FASHION

- ✓ LVMH Innovation Award (Heuritech): www.lvmh.fr
- ✓ Challenge ANDAM (Euveka): www.andam.fr
- ✓ Festival d'Hyère (Clara Daguin): www.villanoailles-hyeres.com
- ✓ Festival des jeunes createursDinan (Armine Ohanyan): www.festivaldemode.fr
- ✓ E-fashion awards: www.e-fashionawards.com
- ✓ IFM / TCBL Awards: www.ifmparis.fr/fr/actualites/institut-francais-de-la-mode-tcbl-awards
- ✓ Grand prix maison de mode: www.maisondemode.com
- ✓ Avantex fashion pitch: www.avantexfashionpitch.fr
- ✓ Prix FashionTech Expo / Fashion Pitch Night: www.fashiontechweek.fr

TEXTILE

- ✓ Prix Théophile Legrand avec l'UIT: www.theophilelegrand.w1w.fr/page/14138
- ✓ Challenge Innovation Textival: www.textival.fr

DESIGN / CREATION

- ✓ Price of creation of the city of Paris: www.ateliersdeparis.com/prix/
- ✓ Price for Business with Attitude: www.madame.lefigaro.fr/business/prix-business-with-attitude-240816-115964
- ✓ Price from the Bettencourt Foundation 'l'intelligence de la main': www.fondationbs.org/fr/culture/metiers-dart/prix-liliane-bettencourt-pour-lintelligence-de-la-main

ENTREPRENEURIAL

- ✓ Prix PEPITE: www.pepite-france.fr/c-prix-pepite
- ✓ Total EDHEC Entreprendre: www.concourstee.fr
- ✓ BFM Awards: www.bfmbusiness.bfmtv.com/bfm-awards
- ✓ Moovjee: www.moovjee.fr
- ✓ David avec Goliath: www.davidavecgoth.com
- ✓ 3DEXPERIENCE Lab social challenges: www.3dexperienclab.3ds.com/fr/homepage/

SUSTAINABILITY

- ✓ La Fabrique AVIVA: www.aviva.fr
- ✓ Scholarship Declic Jeune: www.fondationdefrance.org/fr
- ✓ Scholarship Fondation Kering: www.kering.com/fr/groupe/kering-for-women/la-fondation-kering/
- ✓ Award: Price Made in France Social: www.madeinfrancesocial.fr
- ✓ Award: Price Gabriel de Live for Good: www.live-for-good.org
- ✓ Award: Price for Social Entrepreneurship BCG and Fondation Schwab: www.entrepreneur-social.bcg.fr

TECHNOLOGY

- ✓ BPI France: www.bpifrance.fr
- ✓ Trophée Industrie & Services Cap'tronic: www.captronic.fr/Lancement-de-la-13eme-edition-des-Trophees-CAP-TRONIC-2019.html
- ✓ Grand Innovation Price of the City of Paris: www.grandsprixinnovation.paris

ANNEX 9. EUROPEAN PROGRAMS

EUROSTARS

- European funding for bilateral projects for R&D companies: www.eurostars-eureka.eu/about-eurostars

INTERREG: www.interreg-fwvl.eu

- CLUBTEX UP-TEX: www.uptex.innovationstextiles.fr

COSME

- WORTH: www.worthproject.eu
- TEXTILE 2030 (extension TEXTILE 2020): www.eu-textile2030.eu

HORIZON2020 (soon to be renamed Horizon Europe)

- SmartX: www.smartx-europe.eu
- Flexible materials and robotics:
www.ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/dt-fof-12-2019.html
- Enhanced European Innovation Council (EIC) Pilot: part of Horizon 2020 that provides funding, advice and networking opportunities for those at cutting edge of innovation.
ec.europa.eu/research/eic/index.cfm

TECHNOLOGICAL PLATFORM FOR THE FUTURE OF TEXTILES AND CLOTHING IN EUROPE:
founded by the three major European organizations involved in textile research and technological development: Euratex, Textranet et AUTEX. www.textile-platform.eu

ANNEX 10. NON-EXHAUSTIVE LIST OF INITIATIVES PROMOTING INNOVATION SYNERGIES IN FASHION AND/OR SUSTAINABLE FASHION

Initiative	Website	Maker spaces / labs	Collaborative networks	Associations / incubators	Exhibition / fair	Other
Datapalette	www.datapalette.org	/				
l'Electrolab	www.electrolab.fr	/				
La FFU French Fashion Union	www.frenchfashionunion.com		/			
TextiLab	www.fr-fr.facebook.com/pg/Textilab/photos/		/			
Association Jean-Luc François	www.association-jeanlucfrancois.blogspot.com			/		
Plateau Fertile	www.plateaufertile.fr			/		
La Petite Rockette	www.lapetiterockette.org			/		/
Sew & Laine	www.sewetlaine.com			/		
Hall Couture	www.hallcouture.com			/		
Atelier Meraki	www.instagram.com/atelier.meraki/			/	/	
La Fashiontech	www.fashiontechweek.fr				/	
Ateliers Draft	www.ateliers-draft.com			/		/
La Paillasse	www.lapaillasse.org	/				/
Les Compagnons du devoir	www.compagnons-du-devoir.com					/
Make Sense	www.makesense.org					/
Woma	www.woma.fr	/				/

ANNEX 11. SPECIALIZED TRADE-EVENTS (NON-EXHAUSTIVE LIST)

Event	Period	City	Website	Fashion	Fashion tech	Other
Forum de la Mode	November	Paris	www.fhcm.paris/en/	/		
Journée perspectives internationales Ifm	December	Paris	www.ifmparis.fr/fr/actualites	/		
Paris Retail Week	September	Paris	www.parisretailweek.com	/		
Premiere Vision	September	Paris region	www.premierevision.com/en/	/	/	
Traffic	April	Paris	www.salontraffic.com/categories/actualites/lang/en	/		
Culture de Mode	Several	Paris	www.culturesdemode.com/agenda/evenements	/	/	
GEMode	Several	Paris	www.gemode.org/calendrier-des-seminaires-gemode-de-lautomne-2019/	/	/	
Avantex	September February	Paris region	www.avantex-paris.fr.messefrankfurt.com/paris/en.html			/
Avantex Fashion Pitch	September	Paris region	www.avantexfashionpitch.com			/
Chaire Mode et Technologie Lectra	March	Paris region	www.escpeurope.eu/fr/faculte-recherche/chaire-instituts/chaire-mode-technologie			/
Colloque Textile Cap sur le Futur de l'UIT	March		www.textile.fr			/
Big Bleu Project	April		www.thebigblueproject.com			/
E-textile Summercamp			www.etextile-summercamp.org			/
Fashion Green days	May	Roubaix	www.fashiongreendays.fr			/
FTdays Roubaix	September	Roubaix	www.fashiontechdays.fr			/
FTweek Aquitaine	October	Biarritz	www.chaire-bali.fr/fr/fashion-tech-week-biarritz			/
FTweek Paris	October	Paris	www.fashiontechweek.fr/le-programme/			/
Enova	April	Nantes	www.enova-event.com			/
Futur en Seine	June	Paris	www.futures.paris			/
Hello Tomorrow	March	Paris	www.summit.hello-tomorrow.org			/
Viva Technology	May	Paris	www.vivatechnologyparis.com			/

ANNEX 12. SPECIALIZED MEDIAS

FASHION TECH

- Fashion Network: www.fr.fashionnetwork.com/news/type/innovations
- Futur 404: www.futur404.com
- Le boudoir Numérique: www.boudoirnumerique.com
- Modelab: www.modelab.fr
- Smooth Wearable (blog): www.smooth-wearable.com/fr/
- T3nel: www.t3nel.fr
- 3D Native pour l'actualité de l'impression 3D: www.3dnatives.com

SUSTAINABLE FASHION

- Mûe Magazine: www.mue-magazine.fr
- Slow we are: www.sloweare.com
- TheGoodGoods: www.thegoodgoods.fr

PROSPECTIVE, DESIGN, DIY CULTURE & SHARING ECONOMY

- ADN: www.ladn.eu
- Makery, le média des makers auteur d'une carte des labs: www.makery.info/labs-map/
- Soon Soon Soon: www.soonsoonsoon.com/fr/
- Trend Tablet: www.trendtablet.com
- Up le Mag: www.up-inspirer.fr
- Usbek & Rica: www.usbeketrica.com

ECONOMY

- Le Blog du Defi: www.defimode.org/le-blog/
- L'Observatoire de l'Institut Français de la Mode: www.ifmparis.fr/fr/actualites/
- L'Usine Digitale: www.usine-digitale.fr
- Mode in Textile: www.modeintextile.fr

Fashion-Tech reporting

- ARTE "Fashion Geek" film: www.arte.tv/fr/videos/RC-014292/fashion-geek/

ANNEX 13. TECHNOLOGICAL PLATFORMS

Platform	Focus	Website
Club Textile Intégral	Seamless integral knitting Production of flexible and 3D materials	clubtex.innovationstextiles.fr // www.textile-technique.com
E-mode	Digital workshop	www.emode.fr
Le Centre Européen des Non Tissés (CENT)	Non-woven materials	www.ceti/plateforme-nontisse/

III. FASHION AND SCIENTIFIC RESEARCH: CURRENT AND FUTURE OUTLOOK

ANNEX 14.A RESEARCH IN TEXTILE

List of researchers in textile

Name	Cluster	Focus	Website
Amélie Canivet	Techtera	Fashion and design	www.techtera.org
Delphine Crampon	CARATS	Caratsinnov	www.carats-innovation.com
Bernard Monnier	Ecole Polytechnique Association MIM, Aristote	Research valorisation	www.association-aristote.fr
Bruno Mougin	Techtera	Smart textiles et wearables	www.techtera.org

Researchers working on projects relevant to the fashion sector

Name	Cluster	Website	Textile	Tech	Healthcare	Production
Wael Ben Messaoud	Polytech Lille	www.l2ep.univ-lille1.fr/?page_id=102&var=9	/			
Constance Moretti	Brochier Technologies - département textile	www.brochiertechnologies.com	/			
Laurence Schacher	Professor of Fiber science, ENSISA, Alsace	www.ensisa.uha.fr/accueil/blog/actu/l-schacher-presidera-la-fiber-society-en-2017/	/			
Mehdi Ammi	CNRS- saclay	www.mehdi-ammi.eu		/		
Ludovic Burgnies	-	www.dblp.org/pers/hd/b/Burnies:Ludovic		/		
Camille Duprat	École Polytechnique	www.theses.fr/143410075		/		
Esma Ismailova	researcher at the Centre Microélectronique de Provence of Mines Saint-Étienne	www.mines-stetienne.fr/author/ismailova/		/		
Samuel Poincloux	CNRS / ENS	www.ens.fr/actualites/au-coeur-de-la-physique-du-tricot		/		
Julien Payen	Lattice Medical ENSAIT	www.lattice-medical.com			/	
Guillaume Tartare	ATER, Laboratoire Gemtex- ENSAIT Roubaix	www.gemtex.fr/careers/ater-full-time-cnu-section-60			/	
Benjamin Cabanes	Postdoctoral Research Fellow at MINES Paristech	www.benjamincabanes.net				/

ANNEX 14.B GLOSSARY OF ABBREVIATIONS FOR SCIENTIFIC RESEARCH

Agrotech: agriculture, aquaculture, horticulture et forestry
Buildtech: building and construction
Clothtech: technical components of shoes and clothing
Geotech: geotextiles for gardening and public works
Homotech: technical components of furniture, home textiles and flooring
Indutech: leaks, transport, cleaning and other industrial uses
Medtech: hygiene and medicine
Mobiltech: automobiles, transport, railways and aeronautics
Oekotech: protection of the environment
Packtech: packaging
Protech: personal protection and property
Sporttech: sports and leisure

ANNEX 14.C FUNDAMENTAL RESEARCH

- Maude Bass-Krueger: researcher IHTP-CNRS and CHS Sorbonne / Leiden University
- Geraldine Blanche: PhD Science Po, teacher
- Manuel Charpy: fellow researcher CNRS, Lille 3/IRHIS
- Emilie Coutant: fashion sociologist, founder of Gemode, Paris
- Marlène Van de Castele: PhD Lyon II, Teacher EnsAD

ANNEX 14.D DESIGN RESEARCH

- Christine Browaeys: "Texturgist" engineer and author of the book « *Les enjeux des nouveaux matériaux textiles* », EDP Sciences, May 2014.
- Claire Eliot: research engineer at the Centre de Recherche Interdisciplinaire, Paris
- Aurélie Mossé: teacher-researcher, co-director of the research group Soft-Matter, ENSAD, PSL
- Jeanne Vicérial: PhD SACRE, ENSAD-PSL

ANNEX 15. RESEARCH IN TEXTILE

- Mistral: a high-tech platform dedicated to textiles: www.ifth.org
Two interesting projects:
 - TEXTRONIC: large volume industrialization of connected textiles
 - THESEE: development of an industrial chain of connected clothing that automatically incorporates an RFID (radio frequency identification) textile yarn at the manufacturing stage.
- ESCPI (Ecole supérieure de conception et de production industrielles): www.espci.fr/fr/
 - Capsum: www.capsum.net/fr/
 - MECAWET, bio-inspired materials: blog.espci.fr/jbico/
- INTERREG: www.interreg-fwvl.eu
 - RETEX, eco-design/less waste: www.dotheretex.eu
 - MDtex, Medical Textiles Cluster: www.interreg-mdtex.eu

IV. MUTATIONS RESULTING FROM NEW TECHNOLOGIES BY STRATEGIC SECTOR

ANNEX 16. STARTUPS AND YOUNG GENERATION OF CREATIVES WORKING WITH NEW TECHNOLOGIES AND FASHION

3D PRINTING

- ✓ Anastasia Ruiz: www.anastasiaruiiz.com
- ✓ Armine Ohanyan: www.armine-ohanyan.com
- ✓ Exocet: www.exocet-paris.com/#Welcome
- ✓ Laura Deweilde (Mlle 3D): www.mlle-3d.com
- ✓ Marisa Garnier: www.marisa-garnier.com

3D MODELING

- ✓ Change Of Paradigm: www.changeofparadigm.com
- ✓ Milan AVJC: www.milanavjc.com

ARTIFICIAL INTELLIGENCE

- ✓ Cleed: www.cleed.com
- ✓ DACO (Vente-Privée): www.daco.io/fr/
- ✓ Heuritech: www.heuritech.com
- ✓ VEKIA: www.vekia.fr/
- Wishibam: www.business.wishibam.com

BIO FABRICATION / R&D TEXTILE

- ✓ Atelier Sumbiosis: www.atelier-sumbiosis.com
- ✓ Greeny Bird Dress: www.greenybirddress.fr
- ✓ INDUO: www.induo.fr
- ✓ Open BioFabrics: www.openbiofabrics.org
- ✓ SERICYNE: www.sericyne.fr

ROBOTICS

- ✓ Euveka: www.euveka.com/fr/
- ✓ Spoon: www.spoon.ai

WEARABLES AND ELECTRONIC TEXTILES

Designers / researchers

- ✓ Alice Giordani: www.smooth-wearable.com/fr/
- ✓ Audrey Briot: www.audreybriot.fr
- ✓ Claire Eliot: www.claireeliot.com
- ✓ Clara Daguin: www.claradaguin.com
- ✓ Fandd.studio: www.fandd.studio
- ✓ Martin de Bie: www.martindebie.com

Brands

- ✓ Arsayo: www.arsayo.com
- ✓ Clim8: www.myclim8.com/fr/accueil/
- ✓ Endeer: www.endeer.fr
- ✓ lolo: www.lolo.paris
- ✓ Wair: www.wair.fr/fr/
- ✓ Urban Circus: www.urban-circus.fr
- ✓ Nemmès: www.nemmes.com/home

Agencies

- ✓ De Rigueur Lab: www.derigueur.tech
- ✓ Future 404: www.futur404.com/fr/
- ✓ Genius Object: www.genius-objects.com/fr/
- ✓ La Morétaine: www.lamoretaine.com
- ✓ Loeve: www.loeve.fr
- ✓ Martian agency: www.martian-agency.com
- ✓ QuatreCarre: www.quatre carre.fr
- ✓ Sable Chaud: www.sablechaud.eu
- ✓ Studio Twins Paris: www.studiotwinsparis.com
- ✓ StudIOTech: www.studiotechparis.com

BLOCKCHAIN

- ✓ Arianee: www.arianee.org
- ✓ Cypheme: www.cypheme.com/?lang=fr
- ✓ Ownest: www.ownest.io
- ✓ Traceparency: www.traceparency.com

CONCEPTUAL INNOVATION

- ✓ Elisabeth Jayot: www.fragmentsgarments.com
- ✓ Pierre Renaux (PRX): www.instagram.com/prx_industries/?hl=fr
- ✓ Jeanne Viceria: www.villamedici.it/fr/residences/jeanne-viceria/

→ Check [this directory](#) published by le DÉFI and Modelab for an annual listing the players in the French fashion tech industry.

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