DESIGNING TOMORROW

A WHITEPAPER ON INNOVATIVE AND CIRCULAR PIXEL-TO-PRODUCT PROTOTYPING AND ON-DEMAND FASHION PRODUCTION.

commissioned by
Berlin Department for Environment, Energy and Public Enterprises
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DESIGNING TOMORROW

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INTRODUCTION

In the vibrant tapestry of fashion — celebrated for its unparalleled artistry — loom shadows of pressing environmental and ethical quandaries such as overproduction, waste, and alarming carbon emissions. This whitepaper introduces the pixel-to-product microfactory as a beacon of hope, seamlessly blending technological prowess with sustainable imperatives to potentially revolutionise our industry’s operations.
INTRODUCTION

At this pivotal juncture, the fashion realm grapples with a myriad of challenges demanding transformative solutions. This treatise embarks on a journey to delineate these challenges, laying the groundwork for an in-depth exploration of avant-garde solutions. Paramount among them is the pixel-to-product microfactory, an innovative fusion of technology and sustainable ethos. Herein, we illuminate the transformative potential of digitisation and decentralisation, underscoring their dual impact on streamlining operations and reinforcing ecological commitments.

Central to our discourse is the embrace of the ‘prosumer’ model —a groundbreaking paradigm that intimately integrates consumers into the production narrative, fostering deeper brand resonance and engagement. Yet, our exploration transcends mere technological breakthroughs; it’s a clarion call to global ethical mandates. Emblematic of this is the microfactory’s alignment with globally recognized sustainability standards, notably echoing the ethos of the United Nations’ Sustainable Development Goals (SDGs).

On the economic front, our focus gravitates towards the microfactory’s promising fiscal prospects. Amidst a zeitgeist that champions diversification, the microfactory emerges as a beacon, presenting avenues for diversified revenue and reinvigorating European fashion production. Central to this transformative journey, however, is the essence of transparency — a cornerstone we ardently champion.

By the same token, we recognize the microfactory as a fertile bedrock for grassroots innovation, poised to herald a new epoch in fashion evolution.

Recognizing the contributions of key stakeholders, VORN - The Berlin Fashion Hub acknowledges its cooperative and social business nature. We express our profound gratitude to the Berlin Senate Department for Economics, Energy, and Public Enterprises for their funding, which has been instrumental in our mission. It’s also noteworthy that this whitepaper draws insights from the LabX feasibility study, generously funded by renowned industry entities like Zalando SE, Kornit Digital, and H&Mbeyond, and enriched by the intellectual contributions of eminent co-authors.

Our overarching aim with this whitepaper is to provide an incisive look into the microfactory paradigm, framed against the backdrop of the fashion industry’s challenges. We extend an invitation to all stakeholders, from industry pioneers to discerning consumers, to engage with this enlightening exploration of fashion’s prospective renaissance.
PROBLEM STATEMENT

The fashion industry, a cornerstone within the global economic framework, is currently confronted with a constellation of intricate sustainability challenges that cast shadows on its ethical and sustainability standing. Chief among these challenges are the issues of overproduction, substantial textile waste, and perturbing levels of climate emissions\(^1\). These predicaments are often exacerbated by conventional manufacturing modalities, prominently exemplified by the offshore bulk production paradigm. This mode, marked by protracted lead times and a detachment from rapid market oscillations\(^2\), engenders further complexities. In response, the pixel-to-product microfactory emerges as a sanguine panacea. It draws upon the precipice of advancements in 3D design, virtual prototyping, and the adroit fabrication of delimited product batches. This micromanufacturing milieu proffers a metanoia vis-à-vis the prevailing mass-production model, endowing it with heightened sustainability, streamlined operational efficiency, and enhanced adaptability\(^3\).

SOLUTION PATH 1
DIGITALISATION AND DECENTRALISATION

SOLUTION PATH 2
PROSUMERISM & CO-CREATION

SOLUTION PATH 3
MARKET & DIVERSIFICATION

SOLUTION PATH 4
CIRCULAR ECONOMY

SOLUTION PATH 5
REVENUE STREAMS AND SCALABILITY

SOLUTION PATH 6
SOCIAL & ENVIRONMENTAL IMPACT

SOLUTION PATH 7
DEMOCRATISE INNOVATION
In response to the traditional pitfalls of the fashion industry, the pixel-to-product microfactory introduces a transformative blend of digitisation and decentralisation\(^4\). By leveraging state-of-the-art 3D product development and sampling, this model diminishes barriers to entry and accelerates the design-to-market timeline. Furthermore, the decentralised nature of production not only streamlines processes but also reduces the need for extensive inventories, cutting down waste and associated environmental foot-prints\(^5\). Critically, in a volatile global market, the ability to employ mass customisation through automation and advanced digital tools equips businesses with the agility to weather economic downturns and swiftly adapt to fluctuating consumer demands, ensuring both resilience and sustained competitiveness\(^6\).

The rise of the “prosumer” – a hybrid of producer and consumer – reflects a significant shift in the dynamics of production and consumption in the modern marketplace\(^7\). By converging production processes with consumer interfaces, the prosumer model fosters heightened customization, potentially bolstering brand loyalty and deepening consumer engagement through participatory co-creation\(^8\). This paradigm resonates with evolving consumer preferences, marked by an increased appetite for bespoke, ethically-sourced products\(^9\). Leveraging this, the pixel-to-product microfactory stands not merely as a manufacturing hub but as an innovation catalyst, primed to ignite fresh product, service, and business model initiatives, all centred around the empowered, discerning consumer.

**Solution Path 1:**
**Digitalisation & Decentralisation**

**Solution Path 2:**
**Prosumerism & Co-Creation**
In today’s fragmented market landscape, characterised by the rise of micro-communities and niche audiences, the pixel-to-product microfactory stands as a beacon of adaptability and agility. Its multifaceted approach caters not just to the diverse tastes of independent brands and discerning corporate clientele, but also offers robust solutions tailored for industry suppliers, each with unique needs and aspirations. Beyond mere manufacturing, the microfactory functions as an intricate ecosystem, diligently mining data to provide a rich tapestry of market insights. Through rigorous analytics, real-time trend detection, and forward-looking forecasts, it empowers stakeholders to preemptively respond to market shifts, ensuring they remain not just relevant, but pioneering in their respective domains. The microfactory’s intrinsic B2B2C community orientation further underscores its strategic importance, crafting a collaborative space where businesses, consumers, and innovators converge. Here, opportunities are not just recognized — they are nurtured, fostering an environment that champions innovation scouting, product experimentation, and rapid iteration in an industry that is undergoing a systemic shift.
As global industries pivot towards more sustainable models, the pixel-to-product microfactory rises as a forerunner in championing the circular economy. Its specialisation in the judicious selection of circular materials, paired with a commitment to integrative circular design strategies, sets a new benchmark for responsible manufacturing. A built-in reverse logistics infrastructure further amplifies its sustainability credentials, making it a magnet for impact-driven entrepreneurs, ethical brands, and an increasingly eco-conscious consumer base.

Such an approach not only foregrounds the principles of responsible consumption but also aligns seamlessly with wider global initiatives. By dovetailing with mandates such as the UN Sustainable Development Goals, the EU Green Deal, and the visionary New Bauhaus frameworks, the microfactory model underscores its commitment to driving systemic change and ensuring a more sustainable, equitable future for the fashion industry.

In an era of rapid technological advancement and market fluctuation, the pixel-to-product microfactory stands out for its multifaceted approach to revenue generation. With a diversified revenue portfolio that encompasses software licensing, innovative pay-per-knit production modules, and synergetic collaborative R&D projects, this model ensures a stable financial foundation while allowing for agile growth strategies. The microfactory’s inherent scalability is further magnified as it looks to expand its operational capabilities, bolster product range versatility, and establish a decentralised micromanufacturing nexus across major global metropoles. This strategic expansion not only broadens its customer outreach but also positions the pixel-to-product microfactory as a leading paradigm, set to rejuvenate and redefine the European fashion manufacturing sector in a digitised world.
Pixel-to-Product prototyping is one of the most exciting topics in fashion retail due to its potential to reduce waste and disrupting the classical design process by harnessing technology. The VORN study encourages impactful actions on the way reaching global sustainability goals.

- OLIVER LANGE, HEAD OF H&M BEYOND.
- OPEN INNOVATION RETAIL LAB

**SOLUTION PATH 6:**

**SOCIAL & ENVIRONMENTAL IMPACT**

The pixel-to-product microfactory presents a holistic approach to sustainability, marrying both social and environmental imperatives. Its unwavering commitment to a CO2-free energy source reflects a proactive stance against climate change, while upholding labour rights and prioritising water conservation demonstrates a broader understanding of industry responsibilities. Equally noteworthy is the model’s emphasis on product recyclability, which serves to further diminish the fashion sector’s environmental footprint. However, to fully embed these ethical tenets, the establishment of a rigorous code of honour, an actionable circularity roadmap, and a robust reporting framework rooted in science-based targets is imperative. To ensure these standards are upheld and to promote transparency, third-party validations, carried out by reputable institutions, are pivotal. Such endeavours not only elevate the credibility of the microfactory model but also position it as a beacon of trust and accountability in the fashion industry.
The pixel-to-product microfactory model is poised to redefine innovation in the fashion industry by harnessing the myriad possibilities offered by Industry 4.0. Utilising digital twin applications, it paves the way for real-time product customization and prototyping, while blockchain-powered traceability mechanisms ensure unmatched transparency and security. Additionally, with the integration of web3 technologies, the model fosters an enriched community-driven co-creation experience. This not only cultivates a culture of inclusivity and creativity but also democratises access, especially for underrepresented entrepreneurial communities. Furthermore, by offering immersive customer experiences, the microfactory model holds the potential to transform the conventional paradigm of brick-and-mortar retail, heralding a new era of interactive and sustainable consumerism.

We are pleased to be part of the Fashion Microfactory project, because with our machines, which are predestined for efficient customisation through their enormous patterning flexibility, and with our digital solutions, which significantly shorten lead times, we have been focusing on the topic of made-to-order for a long time and hope to gain new impulses and contacts.

– MICHAEL HÄNDEL, VICE PRESIDENT SALES & SERVICE, KARL MAYER STOLL TEXTILMASCHINENFABRIK GMBH
**Action Recommendations**

01 **Embrace Digitization and Decentralization**

Stakeholders should invest in and promote digital twin technologies and decentralised manufacturing processes to enhance efficiency and flexibility in the production chain.

02 **Promote Prosumer Engagement**

Brands and manufacturers need to actively engage consumers in the co-creation process, offering them bespoke products and experiences, thereby fostering brand loyalty and advocacy.

03 **Align with Global Sustainability Goals**

Active steps should be taken to embed the UN Sustainable Development Goals, the EU Green Deal, and other global frameworks within business strategies.
ACTION RECOMMENDATIONS

**04 DIVERSIFY REVENUE STREAMS**

Explore opportunities beyond traditional manufacturing, like software licensing and collaborative R&D projects, to ensure resilience against market fluctuations.

**05 CHAMPION TRANSPARENCY**

Employ blockchain-based traceability tools and encourage third-party audits and validations to foster trust among consumers and stakeholders.

**06 PRIORITISE INCLUSIVITY AND DIVERSITY**

Actively lower barriers of entry for underrepresented communities, ensuring a diverse range of voices are included in the innovation process.

**07 REVITALISE PHYSICAL RETAIL SPACES**

As online and digital spaces continue to dominate, brick-and-mortar stores should be transformed into experiential hubs, promoting the co-creation and immersive experiences powered by the microfactory model.

**08 ACHIEVE A TRANSITION**

It is crucial to engage offshore manufacturing regions actively, fostering collaborations and knowledge exchange that consider their unique socio-economic contexts and challenges, thereby promoting equitable development in the fashion industry.

**09 CONTINUOUS LEARNING AND R&D**

The dynamism of the digital age requires constant upskilling and research. Stakeholders should invest in regular training and R&D initiatives to stay abreast of emerging trends and technologies.
The global fashion industry, at its current juncture, faces an array of multifaceted challenges, ranging from ecological to ethical concerns. However, the innovative pixel-to-product microfactory model serves as a beacon of hope, merging the cutting-edge paradigms of Industry 4.0 with a sustainable and inclusive manufacturing philosophy. Throughout this white paper, we’ve dissected the model’s key tenets, from its revolutionary approach to production through digitization and decentralisation to its advocacy for greater transparency and ethical commitment. Crucially, the model presents not only a solution to the current challenges but also paves the path for the future evolution of the industry.

In closing, the pixel-to-product microfactory model is more than just a response to current industry challenges; it’s a forward-looking vision for a sustainable, inclusive, and innovative fashion industry. The time to act is now, and the roadmap has been laid out. Stakeholders across the board, from grassroots designers to industry giants, are encouraged to seize this opportunity and collaboratively usher in a new era for fashion.

Overall, a pixel-to-product microfactory model holds immense innovation and transformation potential for the clothing and textile industry. Through its focus on sustainability, digitalization, and customer-centric services, the microfactory addresses industry challenges, fosters responsible consumption, and paves the way for a more sustainable and resilient fashion ecosystem.
ABOUT THE AUTHORS

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Marte Hentschel is the initiator and lead author of this feasibility study.

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KORNIT DIGITAL
Kornit Digital is the global leader in on-demand sustainable fashion production helping to define the future of fashion tech.

ZALANDO SE
Zalando is a leading European E-Commerce destination for fashion and lifestyle.

STOLL
STOLL is a family brand within the KARL MAYER GROUP, which pools expertise in flat knitting technology.

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