

Chromatic Imperfection: Reimagining Colour as a Catalyst for Sustainable Fashion Design

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ABSTRACT

In the contemporary fashion world, where synthetic and standardised colours dominate, embracing colour imperfection challenges conventional notions of quality, desirability, and value. Accordingly, this paper explores the strategic role of visible colour imperfection in advancing sustainable practices within contemporary fashion design. Moving beyond chromatic ideals rooted in consistency, reproducibility, and standardisation, it interrogates how intentional colour irregularities can operate as expressive, ethical, and ecologically attuned design strategies. Situating colour as a medium of communication, material storytelling, and aesthetic value—rather than a purely decorative or technical attribute—the research draws from historical, cultural, and industrial perspectives to critique the dominance of mass produced, synthetic colour systems. It foregrounds the environmental impact of conventional dyeing practices while proposing alternative models that reframe chromatic variation as a meaningful aesthetic and ethical choice. The concept of the “aesthetics of imperfection” is employed to valorise irregularity as a quality that enhances product authenticity, sensory depth, and emotional resonance. Particular attention is given to recycled and repurposed colours, whose unpredictable and non-uniform qualities reflect material histories and embody principles of circularity. Through case studies and theoretical analysis, the paper identifies four design strategies that mobilise colour imperfection to communicate sustainability: expressive manual dyeing, mismatched combinations, natural ageing effects, and digitally or mechanically induced randomness. These approaches challenge consumer expectations, extend product lifecycles, and embed sustainability into fashion’s visual and material language. Ultimately, the study repositions colour imperfection not as a flaw, but as a vital dimension of ethical and resilient design innovation.

KEYWORDS: (Colour Design, Colour Imperfection, Sustainable Fashion, Imperfection Aesthetics, Design for Sustainability)

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1. Introduction

A contemporary perspective on design recognises colour as a multifaceted and influential element that extends well beyond mere visual appeal. It operates as a powerful tool capable of shaping perception, facilitating communication, and influencing both consumer identity and commercial viability. Colour communicates individual values, attitudes, personality traits, and orientations toward the environment, rendering it central to the emotional and psychological impact of design (Sullivan et al., 2017). Colour specialists understand the nuances of colour perception—how hues are experienced, why they may shift under varying conditions, and the diverse meanings they can embody. This expertise allows for the strategic deployment of colour to enhance both the desirability and marketability of products. Consequently, colour often plays a decisive role in determining a product's reception and commercial success (Holtzschue, 2017). The communicative power of surface and material colour is particularly striking: it can convey the essence of a design before its form is fully perceived (Kopacz, 2012). This pre-verbal, almost instinctive recognition underscores the potency of colour as a fundamental element of design.

Within fashion design, colour holds significant relevance across aesthetic, economic, and manufacturing domains. For example, colour forecasting is a core component of the collaborative practice known as fashion or trend prediction. This process involves anticipating the colours, fabrics, and styles that will resonate with consumers approximately two years in advance (Diane & Cassidy, 2005). Colour is among the first considerations in the development of seasonal collections and remains central to shaping aesthetic direction and engaging consumers (Jackson, 2007). It is also one of the most decisive factors in consumer purchasing decisions. In the context of garment manufacturing, effective colour management is essential to mitigate production issues and prevent the unnecessary consumption of natural and material resources. Challenges such as multiple dyeing processes, poor colour selection, rejection of flawed applications, production delays, increased costs, and elevated stress levels can all stem from inadequate colour control (Best, 2012). Thus, in fashion, colour is not merely a stylistic choice but a strategic and intrinsic component that communicates, evokes emotion, drives sales, and increasingly, intersects with sustainability concerns.

In parallel, colour also plays a pivotal role in advancing sustainable design practices (de Medeiros et al., 2025; Premier & Gasparini, 2014). Imagining a sustainable design future necessitates a critical evaluation of how colour is applied—promoting reflection and concrete actions such as reusing, recycling, and recovering colours

(Otiepková, 2021). Sustainable colour design must confront the environmental implications of the technological processes involved in colour production and reproduction (Perryman & Conway, 2021). This requires reimagining the role of the colour designer not just as a creative professional, but as a systems thinker (Calvo Ivanovic, 2025). Within this expanded framework, designers make strategic decisions that embed colour application and management within broader sustainability initiatives, ensuring alignment with environmental and ethical goals.

In the context of contemporary design and fashion, the pursuit of sustainability has emerged as a critical challenge, increasingly shaped by consumer perception and expectations. As ecological awareness rises, so does scrutiny over the environmental and ethical implications of production processes, including those related to colouration (Palumbo, 2023; Pansera & Owen, 2018). Colour, a seemingly aesthetic detail, is deeply entangled with industrial systems, cultural narratives, and economic imperatives. Synthetic and standardised colours dominate the visual landscape of modern consumer goods, reflecting a broader historical trajectory in which efficiency, reproducibility, and market consistency have become paramount (Casciani & Chen, 2023).

The prevalence of synthetic colours in industrial design and fashion is not incidental. Rooted in 19th-century innovations in chemical dyeing, the widespread adoption of synthetic pigments was driven by their cost-efficiency, durability, and chromatic intensity (Gage, 1999). These attributes aligned with the logic of mass production, enabling brands to maintain visual uniformity and recognisable identities across global markets (Donato, 2025). The Pantone Matching System, among others, epitomizes the industrial ambition to control and codify colour perception, ensuring predictability in production and branding (Neumann et al., 2023). Culturally, standardised colours reinforce aesthetic norms and consumer familiarity, contributing to perceived product reliability and brand trust. Economically, they reduce variability in manufacturing and facilitate transnational supply chains by offering a shared chromatic language (Palumbo, 2023).

However, this rationalisation of colour also marginalises local dyeing traditions and natural palettes, often associated with artisanal, slower, and more sustainable modes of production (Donato, 2025). Despite their industrial appeal, synthetic colours are increasingly scrutinized for their environmental impacts, particularly in water pollution and chemical toxicity (Pansera & Owen, 2018). In response, designers and scholars are exploring alternatives rooted in bioregional colour practices, plant-based dyes, and regenerative design principles. Yet,

shifting consumer perceptions away from synthetic colour aesthetics toward more ecologically attuned sensibilities remains a significant barrier (Neumann et al., 2023). Ultimately, the hegemony of synthetic and standardized colour in design and fashion exemplifies the tension between industrial efficiency and ecological integrity. Understanding the socio-technical systems underpinning this dominance is crucial to reimagining more sustainable chromatic futures that are both culturally meaningful and environmentally responsible.

2. The Research Background and Context

2.1. Beyond Perfection: Reframing Beauty Through the Aesthetics of Imperfection

The concept of the aesthetics of imperfection refers to the appreciation of aesthetic value in objects or experiences that diverge from traditional ideals of perfection. Throughout the history of aesthetic thought, debates have persisted regarding whether perfection constitutes a fundamental condition for beauty (Saito, 2017). This perspective challenges that assumption by attributing value to the incomplete, the flawed, and the non-standardised (Calvo Ivanovic, 2025). In this context, imperfection is not regarded as a deficiency, but rather as a meaningful and expressive quality. It often emerges through irregularity, disorder, complexity, and rough or textured surfaces (Saito, 2017). Marks of wear, damage, or signs of ageing—whether the result of natural processes or accidental occurrences during creation—are similarly embraced. Materials such as wood or leather, which acquire a patina over time, are particularly valued for their ability to record traces of use (Rognoli, 2015). Within sustainable design, this sensibility extends to visible recycled colour—stains, inclusions, or fragments of waste material—which function as visual records of a product's environmental history (Calvo Ivanovic, 2025).

Historically and culturally, the aesthetic of imperfection has deep and varied roots. In 18th-century Britain, the notion of the picturesque celebrated aesthetic irregularities such as architectural ruins, overgrown gardens, and textured or weathered surfaces (Saito, 2017). Similarly, the Japanese concept of *wabi-sabi*, which emerged in the 16th century through the practice of the tea ceremony, embraced irregularity, asymmetry, and surface flaws as signs of authenticity and transience. In this tradition, imperfections were sometimes even introduced intentionally, reinforcing the idea that imperfection could be an aesthetic principle (Salvia et al., 2010).

The attraction to imperfection unfolds across several dimensions. First, there is a dimension of sensory enrichment, in which irregular forms and complex textures expand the range of sensorial qualities that may be

appreciated, producing richer and more layered visual, tactile, or material experiences (Saito, 2017; Leone, 2018). Second, imperfection can serve to stimulate the imagination by prompting reflections on an object's original condition, the processes that shaped its transformation, or the impermanence of material existence (Saito, 2017). Third, a close relationship can be drawn between imperfection and authenticity. The traces of human touch, artisanal labour, and the passage of time contrast markedly with the polished uniformity of mass production, which is often perceived as sterile or depersonalised (Rognoli, 2015; Adamson, 2013). A fourth dimension involves the generation of aesthetic tension, arising from the contrast between pattern and anomaly—between regularity and the unexpected emergence of a crack, deformation, or singular feature (Leone, 2018). Appreciating such qualities requires a refined aesthetic sensibility, grounded in openness and a willingness to encounter objects on their own terms, without imposing idealised standards of perfection.

Beyond the aesthetic, this approach to imperfection carries significant ethical and environmental implications. It encourages the acceptance of transience and cultivates a more humble, less controlling relationship with the material world (Saito, 2017). Valuing imperfection aligns with sustainable practices by reducing the demand for flawless uniformity and encouraging the visible use of recycled, bio-based, or hybrid salvaged materials. The use of recycled pigments, for instance, not only reduces environmental impact but also allows the visual characteristics of a product to communicate its ecological values (Calvo Ivanovic, 2025). Nonetheless, this perspective is not without challenges. Cultural preferences for perfection continue to dominate, particularly in sectors where uniformity and precision—such as colour consistency and material performance—are non-negotiable. Shifting these expectations necessitates a deep cultural transformation. Moreover, the aesthetic of imperfection must be applied judiciously. The notion of a “negative aesthetic” reminds us of how certain imperfections—such as urban decay, broken infrastructure, or distressed clothing—can signify social neglect or systemic inequality. Taking aesthetic pleasure in such manifestations, risks overlooking or trivialising the underlying issues (Saito, 2017).

Ultimately, the aesthetics of imperfection offers a valuable framework for recognising the sensory richness, authenticity, complexity, and expressive tension inherent in what is not perfectly uniform, pristine, or flawless. It broadens the horizon of aesthetic experience while establishing links with ethical and ecological values. Properly understood, imperfection is not a flaw, but a site of meaning.

2.2. Rethinking Chromatic Perfection: The Dimensions of 'Good Colour'

To explore the concept of imperfection in relation to colour, it is first necessary to examine the parameters that define chromatic perfection—typically associated with the notion of 'good colour quality' in product design and manufacturing, including fashion. These parameters encompass a complex interplay of historical, technical, commercial, and sustainability-related factors. The idea of 'good colour' is relatively modern, emerging in the eighteenth century alongside the development of synthetic pigments, colourants, and dyes, and with them, an increasing ability to control the colouring process with precision. Before this period, colour production relied exclusively on bio-based materials. As Anita Quye notes, one of the earliest known uses of natural dye—estimated to be around 6,200 years old—is a piece of woven cotton dyed blue with the *Indigofera* plant. She further argues that the ancient practice of dyeing textiles has profoundly influenced the evolution of fashion (Atkinson, 2022).

Although natural colouring methods were foundational to early textile production, they presented several limitations when assessed against today's quality benchmarks—particularly in terms of colour fastness, such as resistance to light, washing, perspiration, and abrasion. Nevertheless, these limitations were not perceived at the time as shortcomings; rather, they were seen as inherent characteristics of each colouring technique. The rise of global trade in the sixteenth and seventeenth centuries expanded access to diverse dye sources, making vibrantly coloured textiles more widely available. However, as Quye observes, the distinction between social classes was maintained through the quality of materials and the longevity of colours: "The difference between wealthy and poor would have been in the craftsmanship – how long the colours lasted and the quality of the material" (ibid). Dyeing was a highly skilled practice, involving the use of mordants—additives that enhanced the vibrancy and fixability of dyes on fabric.

The discovery of synthetic aniline dyes by William Perkin in 1856 marked a turning point in colour production. These synthetic alternatives enabled mass production of coloured textiles, offering consistent colour between batches and simplifying integration into industrial processes. By the nineteenth century, 'good colour' had become defined by three core attributes: it had to be aesthetically appealing, durable, and suitable for application with ease and efficacy (Lowengard, 2006). Although economic considerations such as cost and perceived value often influenced these standards, the foundational criteria—beauty, permanence, and fitness for purpose—have remained largely consistent over time.

From a technical and manufacturing standpoint, colour management is now a fundamental component in ensuring colour quality and achieving chromatic perfection (Best, 2012). This process typically begins with the creation of precise colour standards, which serve as benchmarks against which reproduced colours are evaluated (Calvo Ivanovic, 2022). The closer a reproduction comes to matching the original standard, the higher the perceived quality of the dyeing process. In addition, good colour must exhibit consistency across varied lighting conditions, from natural daylight to artificial store or home lighting. Such colour constancy is essential for maintaining uniform visual outcomes across different fabric types and qualities. Equally critical is a colour's performance in terms of fastness. A high-quality colour must resist fading from sunlight, washing, or general wear, and must not transfer onto other garments (Best, 2012). Evaluation of these qualities involves both expert visual assessments—conducted under standardised conditions—and instrumental testing using colourimeters and spectrophotometers. These instruments generate numerical values that correspond to colour perception, allowing quantifiable comparisons between a colour sample and its standard (Best, 2012; Calvo Ivanovic, 2022). A colour is generally regarded as high-quality when the differences between the standard and the sample are either imperceptible to the human eye or fall within acceptable tolerances (Calvo Ivanovic, 2025).

From a commercial standpoint, consumer perceptions of 'good colour' are closely aligned with prevailing fashion trends, but also encompass enduring classics such as black, navy, and taupe. Consumers expect a wide range of aesthetically pleasing colours that also meet performance demands across various use cases. Moreover, the perceived quality of colour contributes directly to a product's overall value, particularly concerning price expectations. In this sense, colour perfection in fashion and product manufacturing is defined by visual appeal—whether trendy or timeless—as well as by technical reproducibility, consistency, and durability.

This paper aims to critically examine and challenge prevailing assumptions about 'good colour' and chromatic perfection by introducing environmental concerns into the discourse. As the colour industries become increasingly responsive to ecological and ethical imperatives, notions of quality and perfection may shift. While traditional fastness remains important, sustainable approaches—such as designing colour to fade appropriately within a product's lifecycle—may redefine what constitutes a high-quality colour. Ultimately, a contemporary understanding of good colour must integrate aesthetic, functional, ethical, and environmental values into a cohesive and responsible framework.

2.3. The Semiotics of Visible Recycled Colour

In contemporary fashion discourse, colour is not only a visual or aesthetic element but a communicative medium capable of narrating values, identities, and ecological awareness. Within this framework, recycled colours—those derived from post-consumer or post-industrial waste or reclaimed through material recovery processes—are gaining attention for their storytelling potential in sustainability-focused fashion design (Siamwalla, 2021). As the fashion industry seeks to mitigate its environmental impact, recycled colours offer both symbolic and material responses to the imperative of circularity. Unlike synthetic standardised hues, recycled colours emerge from unpredictable chromatic sources, including dyed textile scraps, industrial residues, or organically pigmented waste streams (Lara et al., 2022). Their variability, far from being a limitation, is intrinsic to their narrative capacity. These colours embody the history of previous material lives and production systems, conveying a story of transformation, waste revalorisation, and resistance to homogenised aesthetics (Furferi et al., 2022). They foster a deeper connection with consumers who seek authenticity, transparency, and emotional engagement with the products they wear (Gilmore & Pine, 2007). Recycled colours also contribute to the semiotics of sustainability in fashion branding. Their often-muted, earthy, or uneven tonalities visually communicate an alignment with natural processes and resource-conscious manufacturing (de Medeiros et al., 2025). As such, they become visual markers of ethical commitment and environmental values—particularly appealing to the growing segment of consumers who align their purchases with sustainability-driven lifestyles (Glasper et al., 2024). The uniqueness of each recycled batch challenges the paradigm of mass production by celebrating imperfection and temporal variation, reinforcing narratives of uniqueness and craftsmanship. From a systems perspective, recycled colours function as both a material and a symbolic node in the transition to circular fashion. They support upcycling initiatives and reduce the need for virgin dye substances, thus decreasing water use and chemical discharge (Bianco et al., 2022; Harmsen et al., 2021). Moreover, their incorporation into design practices invites new forms of co-creation between designers, suppliers, and recyclers, expanding the role of storytelling beyond marketing and into the realm of supply chain innovation and transparency (Niinimäki & Karell, 2019). In sum, recycled colours offer a multisensory storytelling medium in sustainable fashion—embodying the histories of materials, the ethics of production, and the aesthetics of ecological care.

2.4. Research objectives and relevance to sustainable practices

According to the aforementioned context, this paper investigates the role of visible colour imperfection as a design strategy that aligns aesthetic innovation with sustainable development in the fashion industry. By challenging dominant norms of colour standardisation, it explores how intentional irregularity and chromatic unpredictability can enhance material storytelling, extend product lifecycles, and redefine consumer perceptions of quality and value. The research is situated within the broader discourse on circular design, proposing that embracing colour variation not only reduces environmental impacts—by avoiding intensive dyeing processes and valorising recycled materials—but also fosters more authentic, emotionally resonant connections between products and users. The structure of the paper follows a progressive exploration, beginning with a theoretical overview of colour and imperfection in fashion, followed by an in-depth analysis of selected design strategies and case studies that integrate visible colour irregularity. Each section reflects on the cultural, material, and perceptual implications of these practices. Ultimately, this paper argues that moving beyond uniformity in colour use offers an opportunity to reimagine sustainability as a visible, expressive, and desirable dimension of contemporary fashion.

3. Methodology

The research adopted a qualitative methodology, primarily conducted through desk research, literature review, and case study analysis.

The first phase involved a scoping literature review to provide a preliminary assessment of the scope and scale of existing research. This review aimed to identify the nature and extent of available evidence, including ongoing studies and emerging research (Grant and Booth, 2009). The literature search spanned both academic and non-academic sources, using keywords such as “imperfection,” “aesthetics of imperfection,” “colour sustainability,” “sustainable colour,” “ethical colour,” “circular colour,” “sustainable fashion design,” and “circular fashion,” among others. Sources included academic journals (indexed and non-indexed), conference proceedings, books, sustainability reports, blogs, and other relevant publications across the fields of colour, design, sustainability, and fashion. Through a systematic screening process, the initial pool of 56 sources was refined to 22 relevant studies. The results of this phase are presented in the Main Findings section.

Building on the literature review findings, the second phase of the research involved a case study analysis. As defined by Teegavarapu and Summers (2008), this is a

systematic and empirical approach used to examine contemporary phenomena within their real-world context—particularly when the boundaries between the phenomenon and its context are not clearly defined. Drawing from both the fashion design practices identified in the literature review and the authors' expertise—particularly in colour design and fashion design for sustainability—a final selection of twenty case studies was made. These include fashion brands, designers, collaborations, and projects from Africa, Asia, Europe, Oceania, and America. These were chosen according to specific inclusion criteria designed to ensure relevance to the core themes of colour imperfection and sustainability in fashion design (see Table 1).

The first criterion was (i) the intentional use of colour imperfection as a design strategy. Only cases in which designers deliberately employed imperfect or non-uniform colours for aesthetic purposes were included. Instances where colour irregularities resulted from production errors or poor-quality processes were excluded. This ensured that colour imperfection was considered a purposeful and meaningful design tool. The second criterion was (ii) a demonstrated commitment to sustainability and circular design. Each case had to reflect environmental responsibility, such as the use of recycled materials, upcycling, natural dyes, low-impact processes, or waste-reduction strategies. This alignment with circular design principles was essential to the research framework. A third criterion was (iii) transparency regarding process and material origins. Selected cases needed to clearly communicate the sources of their materials and the processes used to achieve colour variation. This could be through documentation, storytelling, or other forms of public-facing communication. Transparency not only underscores ethical design practices but also educates consumers about the environmental and social impacts of material choices. The fourth criterion was (iv) the use of innovative or experimental colour techniques. Case studies had to explore unconventional colour aesthetics—through unexpected pairings, unpredictable results, or materials that naturally yield imperfect hues. This helped ensure that innovation in colour design was a key feature of the selected examples. Finally, (v) recognition or impact within the field was considered. Cases were selected based on their contribution to the discourse of sustainable fashion—whether through exhibitions, publications, awards, or citations in the broader sustainability community.

The selected case studies were then categorised into four design-driven approaches that illustrate how colour imperfection is integrated into contemporary fashion design:

Material-led design, which emphasises the innovative use of recycled colour through material experimentation, such as repurposing textile waste or post-consumer fibres;

Pattern and texture strategies, where colour irregularities are employed to create distinctive patterns, gradients, and textures that convey sustainability narratives;

Modular and adaptive colour design, which explores how modular garment construction enables flexible colour combinations based on material availability, supporting both assembly and disassembly;

Colour unpredictability and spontaneity, where designers embrace variation and irregularity, rejecting uniformity in favour of dynamic and expressive outcomes.

These approaches provide a framework for understanding how designers engage with colour imperfection—not only as a creative tool but also to challenge traditional aesthetics, enhance sustainability narratives, and shift consumer perceptions. Through these design approaches, the case studies illustrate how colour imperfection can redefine material aesthetics and support a more sustainable, circular fashion system. Then, the analysis of case studies included 'within-case observation', identifying key sustainable approaches, colour techniques and imperfection patterns, and sustainable fashion design insights within each case. After that, a 'cross-case observation' was conducted, looking for common themes, variations, contradictions, and comparing how themes and patterns appeared across cases.

Case Study	Location	Description / Relevance	Reference
Faber Futures - Assemblage 002	United Kingdom	Faber Futures is a biodesign lab fusing design thinking with living biological systems to generate scalable models for sustainable textile dyes	Link to Faber Futures
BioChromatic - A biannual capsule collection with biogenic dyes	Germany	This project by Loreto Binvignat and Vienna Textile Lab was born out of the impending need to reverse the textile dyeing industry's biggest problem: the water waste and pollution problem	BioChromatic Project
Kaliko Collective	Germany	Kaliko is a natural-dye studio based in Berlin. Founded in 2016 by Ania Grzeszek, with the mission to spread love for natural textiles and educate about healthy processes of making cloth	Link to Kaliko Collective
Make Fashion Clean (MFC), Tie-Dye Inc.	Ghana	MFC is a non-profit organisation whose mission is to reduce global fashion pollution by upcycling denim and tie-dye products out of textile waste sent to Ghana from the Global North, and educating about pollution	Link to Make Fashion Clean
Shibori Australia	Australia	With a focus on colour, texture, and innovation, Shibori has garnered acclaim for its art-based sustainable textiles and fabric manipulation, maximising the use of dyes and minimising waste	Link to Shibori Australia
Yohji Yamamoto	Japan	His philosophy of longevity, quality, anti-consumerism, and respect for imperfection offers a deeply rooted, holistic approach to sustainability, one that critiques the fashion system itself	Link to Yohji Yamamoto
Fili Pari	Italy	Fili Pari is an Italian textile-tech startup that transforms unconventional raw materials, like marble powder, into innovative, sustainable fabrics. The brand combines creativity with scientific research to offer vegan, water-resistant garments with a strong focus on circular economy and local craftsmanship	Link to Fili Pari
Tu Lizè	Italy	Tulizè embraces sustainability through local Italian production, upcycling surplus military uniforms, and valuing slow fashion with handcrafted crochet and embroidery, merging eco-conscious choices with artisanal luxury	Link to Tu Lizè
Romance was Born - Forever	Australia	The RWB Forever project is leaning into the collection and reuse of vintage fabrics, using a treasure trove of fashion remnants while closing the loop on waste	Link to Romance Was Born
Desigual x Ecoalf	Spain	This collaboration embraces sustainability by upcycling existing garments using recycled materials, reworking designs with new colours and denim elements, and creating a limited 500-piece collection that reduces waste and promotes reuse	Link to Desigual x Ecoalf
Rei Kawakubo	Japan	Her radical approach to fashion critiques the systems that make the industry unsustainable in the first place. Her designs promote longevity, creativity, and thoughtful consumption—all fundamental to a sustainable future in fashion	Link to Rei Kawakubo
BODE	United States	BODE embraces sustainability by repurposing vintage textiles, prioritising material traceability, reducing waste, and crafting one-of-a-kind garments that honour cultural history and resist fast-fashion's mass produced model	Link to BODE
Verabuccia	Italy	Verabuccia's materials transform discarded pineapple peels into innovative, 100% plant-based textiles through a patented, plastic-free process, promoting the circular economy and reducing agricultural waste	Link to Verabuccia
Benét Mattias	United Kingdom	Benét uses recycled and dead-stock yarns, embracing imperfections, and crafting bold, ethical knitwear that challenges norms, celebrates individuality, and minimises environmental impact through conscious design	Link to Benét Mattias

WRÅD, Graphi-Tee Project	Italy, United Kingdom, Denmark	WRÅD promotes sustainability by using recycled materials like graphite powder, reducing harmful chemical use. It drives awareness, innovation, and action, merging fashion with environmental and social responsibility	Link to WRÅD
Lebiu	Italy	Lebiu upcycled cork waste into bio-based, cruelty-free materials. Their process reduces CO ₂ emissions, supports local communities, and preserves Sardinian cultural heritage	Link to Lebiu
Greg Lauren	United States	Greg Lauren champions sustainability by upcycling vintage military fabrics and scraps into unique garments. His "GL Scraps" initiative ensures no material is wasted, blending artisanal craftsmanship with eco-conscious design	Link to Greg Lauren
Polybion x Ganni Lab - Celium	Mexico, Spain	Polybion and GANNI's collaboration introduces Celium™, a bacterial cellulose material derived from fruit waste. This innovative, plastic-free leather alternative is carbon-negative, biodegradable, and showcases a sustainable future for fashion	Link to Polybion
Eva Sonneveld - Green Whisper Project	The Netherlands	This project transforms banana agricultural waste into biodegradable textiles, reducing environmental impact, supporting local economies, and minimising resource consumption	Link to Eva Sonneveld
Boro Boro	United States	Boro Boro revives vintage kimono and traditional mending practices, reducing waste, preserving endangered Japanese textile arts, and encouraging mindful, inclusive fashion rooted in cultural heritage and craftsmanship	Link to Boro Boro

Table 1. The twenty selected fashion design case studies and their relevance to the research.

4. Main findings

Phase one of the research, the literature review, revealed the following key insights:

- a) A significant lack of specific, peer-reviewed academic literature defining the concepts of “colour perfection” and “colour imperfection”, concerning design or related fields.
- b) A notable scarcity of studies exploring the role of colour as a catalyst for ethical and sustainable practices in design broadly, and fashion design.
- c) An emerging body of work discussing “imperfection” and the “aesthetics of imperfection” concerning contemporary design and fashion practices.
- d) A collection of ongoing, yet largely unconnected, design and fashion practices and cases —often individual or collective efforts—aimed at adopting more ethical and sustainable approaches to colour use across various stages of the design and manufacturing process.

The outcomes of phase one highlight a critical gap in current academic and design discourse around colour, particularly in the context of sustainability and ethics. This reveals a conceptual blind spot. This lack of terminology not only limits theoretical development but also meaningful dialogue around how colour functions within value systems of contemporary design practice. Furthermore, the scarcity of research examining colour as a tool—or even a site—for ethical and sustainable transformation

underscores a missed opportunity within design. While material choices and production methods have received significant attention in sustainability discourses, colour remains largely under-explored as an agent of change. This indicates a pressing need to reposition colour not merely as an aesthetic outcome, but as a strategic and ethical design element.

- e) On the other hand, the emerging body of work around “imperfection” and the “aesthetics of imperfection” suggests growing critical interest in counter-narratives to perfectionism in design. However, this discourse remains largely fragmented and rarely intersects with colour-specific concerns. This fragmentation is mirrored in practice: while there are many innovative and inspiring examples of designers and collectives embracing more sustainable and ethical approaches to colour, these efforts are often isolated, lacking the cohesion or visibility that would support broader cultural or systemic shifts.

Building from these findings, the case study analysis described above resulted in the definition of four key strategies for using colour imperfection as a visual driver for communicating sustainable fashion design practices and decisions.

4.1. Strategy 1: Uneven, expressionist, or irregular colour applications

Essence: Human-made irregularity through traditional and innovative colour techniques.

This strategy centres on hand-made processes and techniques, often emerging from the recovery, reuse, and

upcycling of textiles, fabrics, and garments through manual re-colouring. It also embraces the unpredictable experimentation with both traditional and innovative natural dyeing methods—approaches that preserve not only material and immaterial heritage but also local knowledge and practices. The resulting surfaces are marked by uneven and unexpected outcomes. Visually, this strategy is defined by colour irregularities: hand-painted aesthetics, expressive brushwork, subtle shifts in hue from manual application, and uncontrolled colour transitions. Organic spreads and spontaneous patterns emerge from techniques that inherently embrace randomness—such as tie-dye, dip-dye, shibori, and batik. Colour variations also result from hand-mixed pigments rather than precise mechanical systems, along with accidental splashes or freehand strokes. At its core, this approach celebrates imperfection, highlighting the artisanal, tactile, and organic qualities of colour (see Fig. 01).

We find this strategy mainly in the following cases: Faber Futures - Assemblage 002, BioChromatic, Kaliko Collective, Make Fashion Clean (MFC), Shibori Australia, Yohji Yamamoto.

4.2. Strategy 2: Asymmetric, mismatched, unconventional pairings.

Essence: Colour chaos through unexpected combinations and imbalance.

This strategy embraces unconventional colour combinations and juxtapositions, deliberately moving away from hegemonic theories of colour harmony and traditional selection methods. It emerges from practices of recovering, reusing, repairing, and repurposing cloth and garments—often through patchwork, asymmetry, collage, and mix-and-match techniques. The approach favours unorthodox, clashing, or instinctive colour choices over carefully curated palettes. Visually, it results in unexpected contrasts and unbalanced compositions—where one area may be intensely saturated while another remains muted—evoking a raw, improvised aesthetic. Disharmonic pairings, such as bright neon set against earthy tones, or deliberately mismatched fabrics and textures, challenge conventional notions of taste and cohesion. Visible construction and repair are key elements as well, with contrasting threads or fabric patches intentionally highlighting flaws—reminiscent of Kintsugi, but for fashion. The outcome is often seen in upcycled garments, streetwear, or expressive, experimental fashion that resists polish in favour of individuality and disruption (see Fig. 02).

We find this strategy mainly in the following cases: Fili Pari, Tu Lizè, Kaliko Collective, Romance was Born - Forever, Desigual x Ecoalf, Rei Kawakubo, BODE.

4.3. Strategy 3: Natural and weathered colour effects

Essence: Timeworn, faded, or naturally distressed colour changes.

This strategy stems from embracing the natural shifts in colour that occur over time—changes brought on by lifespan, wear, and exposure. It celebrates the aesthetics of colour imperfection and relativity, where garments and fabrics show visible signs of ageing: sun-faded surfaces, attrition marks, and colour loss from repeated washing. These garments carry the traces of their past, revealing layers of colour, patina, stains, and discolouration. Textiles may appear rust-dyed, distressed, or show uneven dye absorption, all of which contribute to a sense of depth and character. Bleached effects, gradients, and fading introduce unexpected transitions and organic patterns, often shaped by weather and environmental conditions. The result is a palette of naturally softened tones that evoke a lived-in, timeworn look (see Fig. 03).

We find this strategy mainly in the following cases: Verabuccia, Benét Matthias, WRÅD, Graphi-Tee Project, Lebiu, Greg Lauren.

4.4. Strategy 4: Unpredictability and Spontaneity: Rejecting Uniformity

Essence: Colour randomness and imperfection due to mechanical, digital, or disruptive technological effects.

This strategy arises from a spirit of experimentation with innovative sustainable materials and colouration technologies, embracing process over perfection. Bio-based, composed, waste-fibres often offer heterogeneous and textured surfaces, where visible recycled colour inlays can be perceived. The outcome is characterised by visual noise, textural and grainy finishes, colour distortion, and material or surface inconsistencies, offering a stark contrast to flat, clean, or smooth colour applications. Irregular colour effects also emerge through digital imperfections such as pixelation, colour shifts, glitches, and printing misalignments. Techniques like block printing, screen printing, and stamping introduce additional irregularities, including accidental colour bleeds and ink variations, which disrupt otherwise seamless gradients and perfect hues. At its core, this approach reclaims value in the imperfect—garments and fabrics that might otherwise be discarded as flawed, erroneous, or waste. Instead, it frames spontaneity, surprise, and disruption as central design values (see Fig. 04).

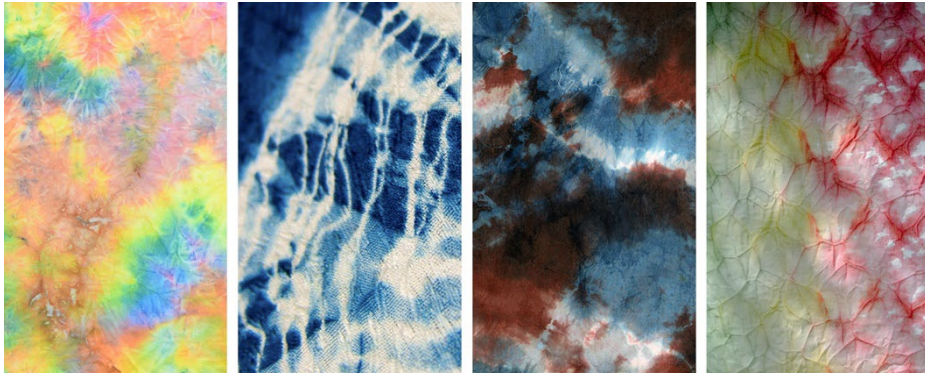


Fig. 01: Examples of Colour Imperfection according to Strategy 1. From left to right, photos by Stephen Ally, Naukhel, Yuha Park, and Teona Swift, respectively.



Fig. 02: Examples of Colour Imperfection according to Strategy 2. From left to right, photos by Shimo Yann, Erik Alfaro, Alpha Paul, and Engin Akyurt, respectively.



Fig. 03: Examples of Colour Imperfection according to Strategy 3. From left to right, photos by Clay Leconey, Enging Akyurt, Second Breakfast, and Creative Morghan, respectively.

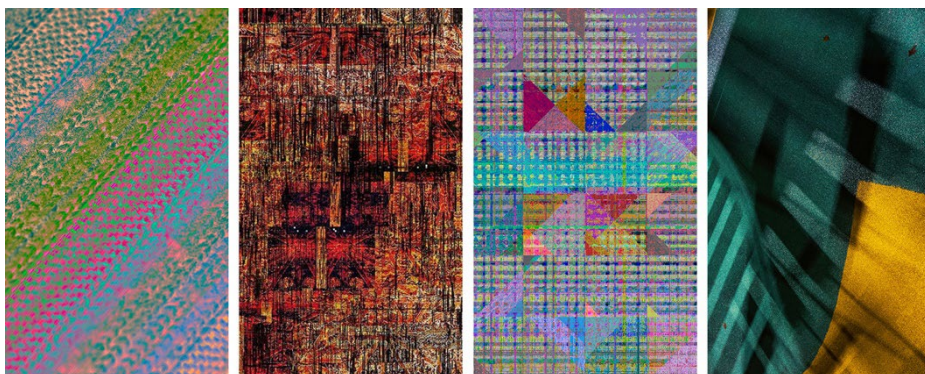


Fig. 04: Examples of Colour Imperfection according to Strategy 4. From left to right, photos by Daniela Paola Alchapar, J. Bushnell, Ignotus, and Marjan Blan, respectively.

We find this strategy mainly in the following cases: Polybion x Ganni Lab - Celium, Eva Sonneveld - Green Whisper Project, Boro Boro.

5. Conclusion

This research has critically examined the role of visible colour imperfection as a deliberate and meaningful strategy in contemporary sustainable fashion design.

By challenging dominant paradigms of chromatic uniformity and industrial perfection, the study reframes colour irregularity not as a flaw, but as a potent design methodology operating at the intersection of aesthetic disruption, ethical engagement, and ecological sensitivity. In doing so, it addresses a critical gap in design discourse: the limited recognition of colour as a transformative agent in advancing sustainable practices.

The study demonstrates that embracing colour imperfection can provoke a substantial shift in aesthetic values. It challenges deeply embedded associations between perfection and desirability, proposing instead a more expansive and inclusive visual language that recognises irregularity, variability, and unpredictability as sites of creative and ethical potential. Through the lens of the “aesthetics of imperfection,” chromatic inconsistencies—be they the result of manual dyeing, mismatched compositions, ageing processes, or experimental techniques—become visible expressions of process, provenance, and temporality. These aesthetic strategies not only contest normative standards of acceptability in fashion but also suggest new pathways for visual pleasure, emotional connection, and authenticity in design.

This reframing has important implications for sustainable fashion practices. The four strategic approaches identified—material-led design, pattern and texture variation, modular chromaticity, and spontaneous imperfection—demonstrate how colour can communicate values of transparency, circularity, and ecological responsibility. When designers embrace colour variation as a material narrative, they extend the lifecycle of garments, valorise waste materials, and resist homogenised production models. For the fashion industry, this implies a fundamental shift in how quality is defined and marketed, encouraging innovation in dyeing processes, supply chain transparency, and consumer education.

At a broader cultural level, the research reflects and contributes to an ongoing shift towards embracing imperfection as a value rather than a limitation. In positioning chromatic irregularity as both a visual strategy and an ethical proposition, it challenges prevailing assumptions about what is acceptable or desirable in

fashion. This cultural shift—while still emergent—holds transformative potential for design education, branding practices, and industry standards, fostering a more inclusive and materially engaged vision of sustainable fashion.

Further research is needed to explore consumer perceptions of colour imperfection in greater depth, particularly in relation to emotional durability, trust, and perceived value. Empirical studies could investigate how irregularity influences purchasing behaviour or post-consumer garment care. Additionally, there is scope for developing practical frameworks to support the integration of colour imperfection into scalable design and production systems. Collaborative approaches across disciplines—design, material science, cultural theory, and sustainability studies—will be essential in advancing this emerging field.

Ultimately, by repositioning colour imperfection as a site of aesthetic innovation and sustainability engagement, this study invites a reimagining of fashion practice—one that is materially honest, ecologically aware, and culturally attuned to the beauty of the imperfect.

6. Conflict of interest declaration

The authors declare that there is no conflict of interest regarding the publication of this paper.

7. Funding source declaration

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8. Short biography of the authors

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