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Exploring Material Potentials for Product Design: In Pursuit of a Narrative-Based Approach

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Abstract: This research proposes a narrative-based approach and two corresponding strategies as part of an interdisciplinary project. The approach could be an initial step in understanding the user's first impression concerning materials experience and other material potentials, informing designers about translating them into product design decisions. The project combines Material-Driven Design (MDD) and user-centred research methods to develop composite Do-it-Yourself (DIY) materials by upcycling textile and plastic wastes. It aims to transform these materials into seven products designed for office environments that promote sustainability. The project's design brief includes the product's primary function, context, and target group. However, the MDD process follows the material exploration to decide on the product proposals formed towards the end. That calls for an alternative method that adapts MDD to broader product development scenarios, particularly those guided by a predefined design brief, to enhance the value of Materials Experience (MX) in conventional design processes. This research initially implements a design probe study to address this gap and to understand forty-six office worker participants' first impressions of DIY material. Based on the study's findings and initial material tinkering process within the research group, a need for a contextual elaboration of materials to address material potentials holistically, including experience, form, function, and affordance, became apparent. Hence, a narrative-based approach is grounded with materials agency in mind and strengthened with anthropomorphism and material journey mapping strategies to obtain insights for the abovementioned scenarios.

Introduction

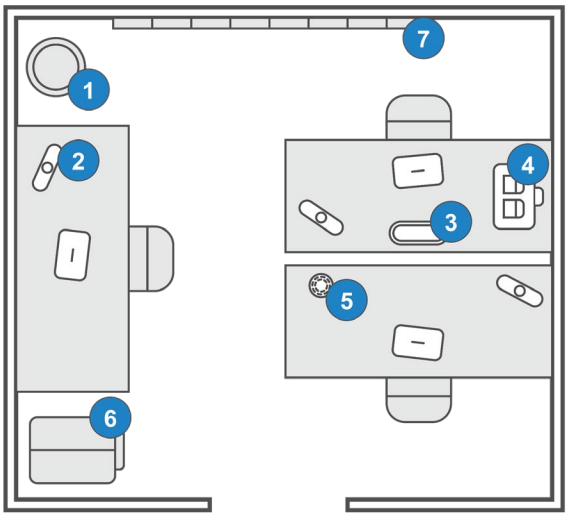
Designers increasingly participate in developing materials by exploring beyond form and function, considering experiential aspects and affordances (Barati & Karana, 2019). This shift enables sustainable alternatives (Vezzoli, 2014) and enhances product experiences within the user-centred design (Pedgley, 2014). Benefiting from the novel perspectives of Materials Experience (MX) (Karana, Pedgley et al., 2015), this research emerges from an interdisciplinary project developing Do-it-Yourself (DIY) composite materials (Rognoli et al., 2015) from polyethene (plastic bottle caps) and textile wastes. Aiming for material circularity (Moreno et al., 2016), the project combines Material Driven Design (MDD) (Karana, Barati et al., 2015) with user-centred research methods (Williams, 2009), involving design, textile engineering, and interior architecture experts (Efilti et al., in press).

During MDD, several user studies with materials are conducted. Accordingly, this paper first reports the findings of a part of a design probe pilot study with forty-six office workers. Based on these results and material explorations, we highlight the need for a narrative-based approach to investigate DIY material potentials—including form, function, and affordance—in scenarios with predefined design briefs, similar to our case. Therefore, this research aims to ground a narrative-based method for investigating material potentials where a predefined design brief is present by integrating strategies of material anthropomorphism and material journey mapping.

Research Context

Office environments were selected due to their potential role in promoting sustainable behaviours through design and product use (Stringer, 2010). The product line-up (Figure 1) addresses daily workspace needs, showcasing composite materials' versatility in function, structure, and usability. Starting with the commonly practised act of collecting bottle caps in Türkiye, the project aims to offer tangible

feedback to users by transforming collected bottle caps into useful products for sustainable behaviour change (Lilley, 2009).



1 Recycling Unit
2 Lighting Unit
3 Desktop Organiser
4 Personal Bag
5 Speaker
6 Cat House
7 Wall Panel

Figure 1. A plan drawing showing the products in an office interior.

Developing Materials

The global rise in plastic production highlights plastic's crucial role in everyday life due to its durable properties and cost-effectiveness. Extensive use and low recycling rates pose significant environmental risks, necessitating sustainable management strategies (Pandey et al., 2023). Recycling plastics presents a viable solution to mitigate pollution (Murat et al., 2020), with polyethene (PE) and polypropylene (PP) prominent in plastic waste streams (Streit et al., 2022). International polymer trade is predominantly influenced by PE, which is widely used in products like bottles and containers (Felgel-Farnholz et al., 2023).

Similarly, substantial cotton fabric waste is generated due to the growing global demand for cotton-based textiles. Challenges in transportation logistics and inefficient sorting and purification technologies hinder recycling, resulting in millions of tons being disposed of in landfills or incinerated globally (Tang et al., 2023).

Design practices can address these issues using innovative approaches such as DIY materials, allowing designers to repurpose waste through sustainable individual or collective initiatives (Rognoli et al., 2015). DIY materials fall into five categories (Ayala-Garcia et al., 2017), and the fourth category, waste-derived materials—including our composite—is notable for reflecting designers' sustainability focus and resource-conscious innovation. These materials promote material longevity by extending waste materials' lifespan and delaying disposal through upcycling (Santulli & Rognoli, 2020; Goldsworthy et al., 2018). From this perspective, plastic and cotton wastes were combined into composites.

For DIY material development, polyethene packaging, such as bottle caps and detergent bottles, was collected, cleaned, ground, or left intact and melted at 160°C under varying pressure using a hydraulic lamination heat press (Figure 2).

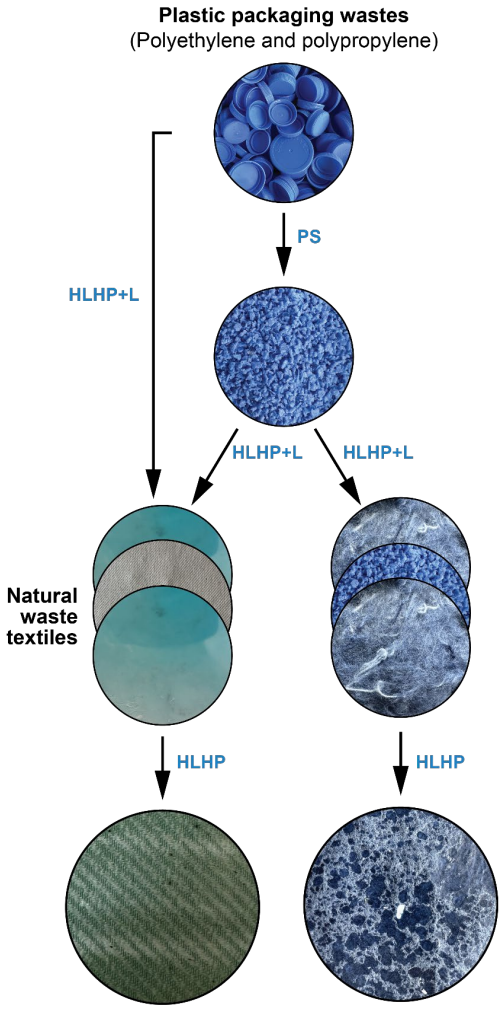


Figure 2. A diagram showing the production process of the materials.

That produced linear PE plates of varying thicknesses and colours, combined with various

fabrics to create composite structures. Using different forms (layers, fibres), materials (cotton, jute, flax), and weavings (twill, basketweave) of textiles, we aimed to develop diverse material proposals. Among explored combinations, the twill-weaved cotton fabric paired with high-density PE sheets arranged in varying layer counts proved most promising for further application (see Figure 2, left end). We proceeded to product development after identifying optimal composite compositions through initial experiments.

Developing Products

MX refers to how users interact with materials experientially and functionally, subjectively involving senses (sensorial level), meanings (interpretive level), emotions (affective level), and actions (performative level), depending on the object, context, and time factors (Giaccardi & Karana, 2015). Seeking meaningful MX, MDD provides designers with a structured method to explore material potentials—form, function, experience, and affordance—through four stages: understanding the material, envisioning experiential potentials, forming experience patterns, and developing product concepts (Karana, Barati, et al., 2015). MDD aligns well with DIY materials, providing an analytical, traceable approach to create meaningful material experiences and uncover new potentials (Karana et al., 2018).

The project's steps were planned to be conducted in two parallel channels: user-centred research and MDD. In the MDD channel, initial material studies began with visits to the material production lab. Then, a digital material chart study was conducted, primarily focusing on the two main components of the composite materials developed in the research. The primary purpose of this study was to inventory the materials expected to be used in the products. The MDD process began with technical characterisation, subjecting the materials to various tests to become familiar with their properties. Through multiple experiments, it was anticipated how the materials behaved under specific effects (e.g., burning, bending, punching, etc.). Then, the subsequent experiential characterisation within the research group members was conducted to have an initial idea of what to expect regarding experiential qualities.

The research group was already familiar with the material, and the design brief was at hand. That made pursuing the usual MDD process, which follows the material exploration to decide on the product proposals, inefficient for our case. Therefore, following the remaining MDD steps intact became less applicable to the project, highlighting the need for a complementary study to feed the remaining process for deeper insights.

Finding the Right Research Method

For our proposal of a narrative-based approach for investigating materials, we primarily benefited from analysing the pilot design probe study to ground our proposal and visited the narratives and materials agency. Also, it is worth noting that the Meanings of Materials (MoM) tool (Karana et al., 2010) and the Materials-to-Experiences at Four Levels (Ma2E4) toolkit were influential throughout the study, as the authors advised for MDD (Camere & Karana, 2018).

Pilot Study: Design Probe

Probing is a research approach that sensitises participants to observation. It leads them to reflect on, verbalise, and visualise their experiences and actions through various descriptive and exploratory tasks (Mattelmäki, 2008). A probe package is designed to comprehend the experiences of recycling, collective working, individual working, leisure time and interaction with non-humans in different office environments (see Efilti et al., in press for the details of the other pages of the probe kit).

Research Design, Data Collection and Analysis

The probe packages were distributed across ten professional office environments (ten separate firms). Five office workers from each office completed the tasks, resulting in 46 participants (n=46).

Besides tasks conducted over the first four days to understand users' perspectives toward predefined experiences, each design probe kit included an identical final-day task explicitly dedicated to material exploration. In this final task, participants interacted freely with a given DIY composite material sample (25×60×3 mm) taped to the page's right side (Figure 3). Participants were then prompted to reflect on their impressions and feelings through structured questions.

The structured task consisted of answering six questions (Table 1). The first question allowed participants to freely associate adjectives with

the material without directives. Questions 2, 3, and 4 were adapted from the Ma2E4 toolkit to gather targeted insights about pleasant, disturbing, and unique qualities. Questions 5 and 6 aimed to reveal participants' associative impressions about possible material resemblances and their potential for products.

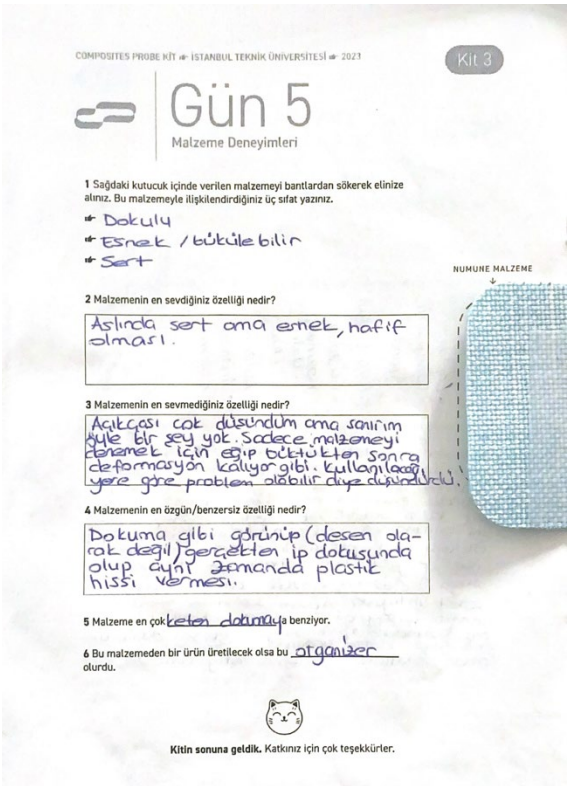


Figure 3. An image showing the last page of the design probe study with a material sample (in Turkish).

Take the material by removing it from the tapes given in the frame on the right.
1. Write three adjectives that you associate with this material.
2. What is the most pleasant quality of the material?
3. What is the most disturbing quality of the material?
4. What is the most unique quality of the material?
5. The material is like …
6. If a product were to be produced with this material, it would be …

Table 1. Tasks and questions on the final page of the design probe study.

Participant responses were qualitatively analysed by coding descriptive keywords, phrases, and comments in two interconnected channels:

- First, guided by the MX framework and its four levels (sensorial, interpretive, affective, and performative), the analysis identified keywords used by participants to describe the material experientially.
- Second, it focused on other material potentials because the data included more than MX-related comments. Participants moved beyond and further commented on the sample's other potentials, thinking of its embodiment as products.

The analysis revealed that participants primarily engaged with the material's visual and tactile qualities (sensorial keywords, 136 codes), with limited references to auditory aspects (1 code). Adjectives describing meanings (interpretive keywords) like *plastic* or *sustainable* appeared in 36 codes, while emotions (affective keywords) like *surprising* or *comforting* were noted in 12 codes (Figure 4). Rather than specific coding of performative level (action-related) insights such as *rubbing*, *scratching*, and *bending*, they were derived from evaluating the probe study concerning senses (e.g., bent because it is found stiff).

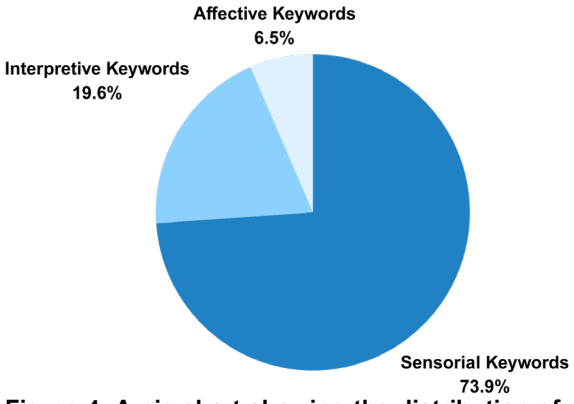


Figure 4. A pie chart showing the distribution of keywords of experiential levels.

Responses to the final two probe questions, designed to explore material potentials, highlighted participants' considerations of function and form. Functional qualities emerged in 68 codes, form-related aspects in 19 codes, and experiential qualities in 15 codes. It contrasted with the earlier probe responses to the first four questions, where experiential qualities (185 codes) were emphasised over functional aspects (13 codes). The study underscores the shift in focus from material qualities to contextual applications when participants are prompted to imagine material embodiment (Figure 5).

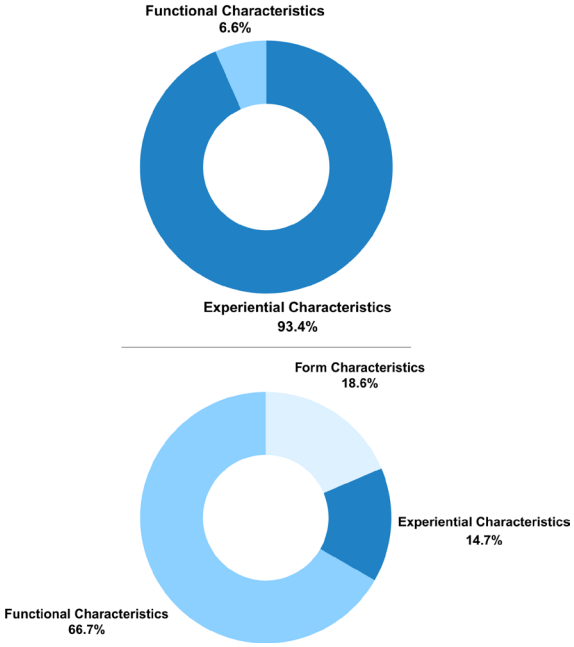


Figure 5. Two charts compare the emergence of material characteristics in the answers (Top: One to four; Bottom: five and six).

Points to Take from Pilot Study

Our exploration confirmed that our materials are primarily perceived through visual and tactile senses, as established by the MoM tool and supported by the design probe study.

Instead of focusing on meaning-driven material selection or altering material development, our research prioritises understanding how meanings and emotions, independent of specific sensorial qualities, can inform design decisions. To achieve this, we aim to assess how the sensorial level influences meanings and emotions instead of directly evaluating them on a scale (like in the Ma2E4 toolkit).

Since we did not give any background information or vocabulary to choose from, the participants were free to answer the questions as they wished. That led to intertwined assessments in terms of experiential levels rather than levelled and separate evaluations, which were more valuable in our case to feed design decisions. Furthermore, concerning all of the answers given on a probe page, the whole experience with the material presents a cohesive story concerning the materials' performative, affective and interpretive levels yet lacked detail due to the probe's scope. Therefore, the intertwined and cohesive assessments of experiential levels (senses, meanings, emotions and actions) could provide a holistic understanding of a material's experience.

On the other hand, although obtained emotion keywords were limited and often implicitly embedded in the answers, not providing them for experiential level participants and guiding participants to think towards such keywords could yield less obtrusive and richer results. For example, attributed meanings (interpretive level) by participants differentiated while analysing the probe study. We found different categories for meanings, going from shallow to deep, such as ambiguous expressions, comparative expressions, sensorial expressions, metaphorical expressions and contextual expressions, which could enrich the method proposal by providing different ways of obtaining meanings towards materials.

Most importantly, experiential qualities do not yield enough knowledge for us since the material is not the only focus and is separated from its context of being a product. Examining other material potentials could enrich these by shifting the focus from materials to products. The probe kit showed that the participants envisioned what materials could become despite not knowing the material's capabilities. The primary consideration has shifted from experiences to include function and form when it comes to the contextualisation of the material. Benefiting from that and our product proposals, including other material potentials, could help us understand the connection between all material potentials. Considering the contextualisation of material without concrete products, participants must be immersed in contextual representations to get context-driven insights regarding materials and their potential. Consequently, the findings from our pilot study underscored participants' holistic engagement with the materials, highlighting the importance of context for exploring material potentials. These insights prompted us to revisit narratives and material agency to develop complementary strategies.

Revisiting Narratives and Material Agency

Narratives and storytelling are subjects studied in depth within design research, and they can immerse people in contextual settings to investigate design possibilities (Coulton et al., 2017; Grimaldi et al., 2013). Regarding the investigation of materials, narratives are addressed in terms of their importance in understanding MX in a timeframe (Pedgley, 2021), enhancing materials knowledge and

materials selection (César Dutra & Schmid Calvão, 2024) and teaching sustainability regarding materials (Hasling & Ræbild, 2021) in design education, as well as communicating material characteristics (Rognoli et al., 2022) and materials visualisation (Alan & Pedgley, 2024). Two research papers used the power of material narratives in understanding material qualities. First, *The Material Connaissance* framework shows how storytelling and metaphor can convey sensory and emotional dimensions while encouraging co-creation and a deeper understanding of material interactions (Bofylatos & Boukouvala, 2023). Second, Landwehr Sydow et al. (2017) emphasise the significance of conceptualising materials as dynamic entities with histories and trajectories. They propose using narratives to integrate the sensory, emotional and functional aspects of material experience.

We reviewed numerous studies during this process to help us adopt a strategy. One of the most prominent and recent is material agency, referring to the capacity of materials to act or influence outcomes within a system (Bennett & Frost, 2010; Haraway, 2003; Ingold, 2012), acknowledging their *identities* and *biographies* (Rognoli et al., 2022) despite such notions being usually attributed to humans. Acknowledging materials as entities with their own agency (Parisi & Rognoli, 2016) that could help in qualitative research (Giaccardi et al., 2016), we identified anthropomorphism and personification (Iovino, 2015; Park & Nam, 2015; Wu et al., 2023) (of materials) as valuable strategies to let participants think in materials agency in a way that is easier to relate to and resonate with for the broader aim of immersing them in contextual narratives. Consequently, participants start thinking about the experiential qualities of materials through personal traits and actions by creating an *anthropomorphised material* that forms a smooth entry to a storyworld. Building upon our initial strategy, we then reinterpreted *material journey mapping* (Aktaş, 2023) to align with personification by positioning materials as actors taking an active role in shaping contexts and having a word on deciding its transformation.

In summary, we identified anthropomorphism and material journey mapping as strategic tools by recognising the importance of material agency and the narrative framing of materials. Based on these strategies, the following section aligns our narrative approach explicitly with the study's findings.

Discussion: In Pursuit of a Materials Narrative

We have yet to shape a detailed research design to decide which narrative method to use or how to implement the strategies. Nevertheless, this section discusses the alignment between the pilot study analysis and 1) a proposal for a narrative-based approach for the overall framework, 2) material anthropomorphism as the first strategy to enter the narrative and 3) material journey mapping as the second strategy to continue the narrative by considering material's becomings (Figure 6). The logic behind each alignment to meet our needs for holistically investigating all material potentials is explained accordingly.

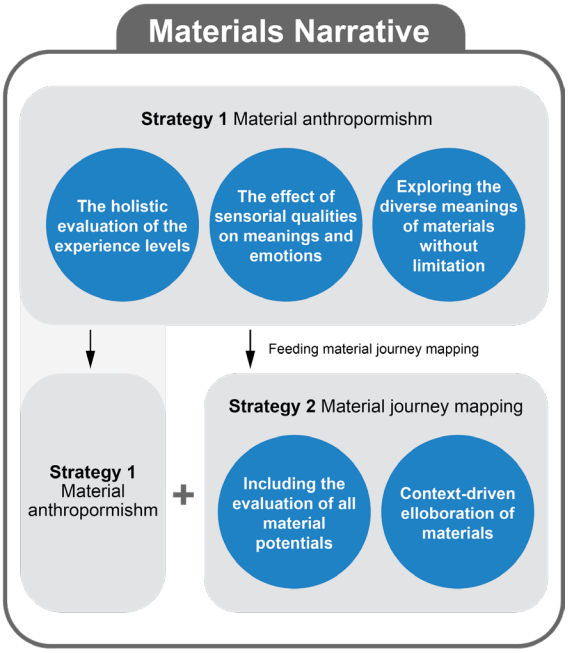


Figure 6. A diagram showing the outcomes of the design probe study and their alignment with the strategies for a narrative-based approach.

First, the research indicates that when the design briefs are predefined, following the MDD method intact remains irrelevant in generating deeper user-centred insights for product design ideas and exploring the interplay between materials, envisioned products, predefined users and the context in this specific case. Furthermore, the design probe study's findings suggest that the sensations, emotions, and actions a material evokes are inseparable and intertwined. Also, it emphasises the importance of considering how a material's other potentials beyond experience contribute to its ontology.

Lastly, it demonstrates that situating materials within realistic contexts is essential for fully comprehending their potential. In that regard, narratives can be helpful research tools for us to address such challenges and potentials by immersing participants in contextual settings, allowing them to think towards materials engagingly and imaginatively. That addresses our need for a deeper exploration of design possibilities with the materials at hand beyond exploring material possibilities.

Our first strategy of anthropomorphism stems from the idea of materials agency but in a more relatable way. Although anthropomorphism might appear reductionist, it facilitates a more relatable connection between the material and evaluators, leveraging metaphorical thinking and human tendencies toward empathy and understanding (Epley et al., 2007). Through this strategy, we address the probe's three findings regarding the experiences of materials. Namely, they are a) the holistic evaluation of the experience levels, b) the effect of sensory qualities on meanings and emotions, and c) exploring the diverse meanings of materials without limitation. When a human perceives material through their senses, it becomes the foundational input for creating meanings, eliciting emotions, and influencing behaviours (Karana et al., 2009). Using the power of metaphors, assigning human traits and behaviours to materials can be an effective tool in obtaining insights regarding meanings, emotions, and actions based on sensory interactions driven by creativity. By personifying materials, people can elaborate on them in a more relatable way, and the richness of experiential vocabulary could be enhanced through appropriate research design and prompts.

Following the first, our second strategy in the narrative is framed as *material journey mapping*, in which we reinterpreted the stages by Aktaş (2023), which investigates the materials' becomings in stages and corresponding systems. By focusing on the *design process* and *use phase*, we aligned it with the insights we took from the design probe study: d) including evaluating all material potentials and e) context-driven elaboration of materials. We employed anthropomorphism as the initial step, allowing us to envision the material as an active participant in office environments. By framing the material as a conversation starter and co-creator of interactions, we could effectively explore context-driven factors such as form, function, and affordance. It also can further enrich our understanding of the material's experiential potential. Mapping each stage of the material journey enables designers to see how materials evolve, respond to contexts, and inform design decisions.

Conclusion

This paper discusses an interdisciplinary project aimed at upcycling textile and plastic packaging waste into DIY materials through Material-Driven Design (MDD) and user-centred research. It emphasises the value of a narrative-based approach supported by anthropomorphism and material journey mapping.

The study has certain limitations: firstly, the narrative method and strategies rely on the researchers' interpretative analysis and need further empirical grounding; secondly, alternative methodological strategies could be derived from the current data; finally, the pilot study's design and analysis influenced the research direction, leaving it open to reinterpretation. Future research should address these limitations through detailed methodological justification and clear demonstrations of practical implementation.

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