NEXT-GEN FUR DESIGN

PRIORITISING MATERIAL PROPERTIES

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Abstract

Fur, valued for its various natural qualities, has historically been a staple in fashion, often signifying status. However, traditional animal-based fur is a controversial material increasingly subject to governmental and organisational bans. Alternatives include synthetic and next-gen materials. Although synthetic fur is more sustainable than animal fur regarding carbon footprint and animal welfare, it still contributes significantly to environmental issues, including microplastic pollution. Next-gen furs are animal- and petrochemical-free alternatives. However, their success is challenging to compare with synthetics due to their natural properties and the substantial time and financial investments already made in the latter. Based on traditional secondary research employing a 'capture-edit-search' approach, this investigation explores the potential of defining material properties to be prioritised or avoided when designing a next-gen fur. Starting from an analysis of the traditional material's properties, the attributes commonly associated with animal-based fur are explored to help formulate strategies to consider when designing next-gen alternatives. As demonstrated, it is unlikely that a next-gen replacement for animal fur will fully replicate the material's characteristics. However, in a design-driven transition, knowing what to avoid is as important as knowing what to achieve. Therefore, establishing honest design priorities could contribute to a more prosperous fashion future.

Keywords: *Next-gen textiles, Textile production, Material design, Design research, Circular economy*

INTRODUCTION AND CONTEXT

Unlike other animals, humans create their clothing, symbolising their deep connection with the natural world (Kwasny, 2019, p. 1). Fur, valued for its various natural qualities, has historically been a staple in fashion, often signifying status (Faiers, 2020, p. 82). However, traditional animal-based fur is now closely linked to animal welfare concerns (Bijleveld et al., 2011) and is increasingly subject to governmental and organisational bans (Fur for Animals, n.d.). Alternatives include synthetic and next-gen materials (Gladman et al., 2024). Although synthetic fur is more sustainable than animal fur in terms of carbon footprint and animal welfare (Bijleveld, 2013), it still contributes significantly to environmental issues, such as microplastic pollution, which is particularly damaging to ecosystems like coral reefs (Huang et al., 2021). To address this, innovators are developing next-gen furs free of animal products and petrochemicals (Material Innovation Initiative & Mills Fabrica, 2021). However, the success of next-gen materials is challenging to compare with fossil-based ones, not only due to the inherent properties of the raw materials but also because of the substantial time and financial investments already made in the latter (Lee et al., 2021). Additionally, there is a significant gap between the number of innovations in next-gen fur compared to other traditional animal-based materials like leather, which could be an advantage for next-gen fur innovators (Rawling et al., 2024). This disparity may be due to the complex range of properties needed for a next-gen material to be a viable substitute for animal or synthetic fur (Gladman et al., 2024).

Hasling & Bang (2015) discuss associative meanings and their impact on designing new materials that embrace aesthetic, technical, functional, and sustainable concerns because materials' physical and social worlds are equally important. While the first is more technical and related to material performance, the second is abstract, created through interaction and experience-based but also essential to the success of a material. Hasling & Bang (2015) also propose a model that outlines materials' attributes split into five groups that range from physical properties to experiential characteristics, including compositional properties, technical properties, sensorial attributes, associated characteristics, and emotional characteristics. Compositional properties cover the natural qualities of the material (e.g. at a molecular level); technical properties cover production processes; sensorial attributes refer to subjective perceptions promoted through interaction with the material; associative characteristics are self-explanatory and cover the associations promoted by a material, including previous experiences; and emotional characteristics relate to emotions, negative or positive. Though subjective, perceptions about a material are important in defining its personality (Ashby & Johnson, 2014). With the understanding that the properties of materials — particularly fur — should be viewed as a gestalt, including the emotions they evoke, waiting for a perfect next-gen replacement could result in a significant loss of valuable research time. This research aims to assist next-gen fur innovators in developing strategies that prioritise honest material goals by emphasising that in a design-driven transition, knowing what to avoid is as important as knowing what to achieve (Tonkinwise, 2014). Thus, next-gen materials should be appreciated for their own unique potential rather than merely as substitutes (Carole Collet, cited in Trinquier, 2024).

METHODOLOGY

To begin this research, it was important to build a foundational understanding of the aims of the scientific study of materials - material science - which is to "understand the fundamental origins of material properties, and, ultimately, to manipulate them" (Ashby & Johnson, 2014). Typical methods used to guide material selection in product design are selection by analysis, synthesis, similarity, and inspiration (Ashby & Johnson, 2014). Considering that selection by similarity consists of looking for alternatives that mimic the traditional material in 'all important respects, except, of course, the reason for wishing to replace it', Ashby & Johnson (2014) propose employing a 'capture-edit-search' approach, which starts by mapping the properties of the traditional material, followed by editing constraints and priorities, to search for satisfactory alternatives later. To start this 'material editing' process, the designer should 'capture' the material's properties to then 'edit' them. This led to the employment of traditional secondary research to define qualities commonly associated with animal-based fur and fur alternatives and the factors that disconnect or connect consumers, which was achieved by reviewing relevant academic papers and grey literature, including fashion websites and online articles to include different points of view on fashion trends concerning animal-based fur and fur alternatives. To build a foundational knowledge of animal-based fur, the book '*Fur: A Sensitive History*' was essential (Faiers, 2020). In the book, Faiers discusses the material's long history, associated properties, controversy, and cultural importance, including its association with status, fashion, art, and politics (2020). Concerning fur alternatives, this study highlights current synthetic and next-gen materials. In the case of next-gen fur's potential and expected properties, reports focused on next-gen materials published by the Material Innovation Initiative were of extreme value (Gladman et al., 2024; Rawling et al., 2024; Material Innovation Initiative & Mills Fabrica, 2021). For instance, in a report entitled '*What Makes Fur, Fur?*', Gladman et al. (2024) explore the potential benefits of designing a next-gen fur and the current market gap the material is placed at. Supported by an iterative process, through a literature review, findings were synthesised to map attributes commonly associated with animal-based fur and possibly help material innovators establish priorities (to achieve or avoid) when designing next-gen fur alternatives.

PRIORITISING MATERIAL PROPERTIES

Based on the 'capture-edit-search' approach (Ashby & Johnson, 2014), the first step was to conduct a study of the properties of animal-based fur and create the material's 'own vocabulary' based on the most common words used to describe it (Ashby & Johnson, 2014; Rognoli & Parisi, 2021), which led to the definition of thirteen themes (see Figure 01). These themes, covering physical and abstract attributes, are open to the designer's needs and their research findings and interpretation. Still, they can serve as a guide to help material innovators define and group material properties to prioritise (and potentially achieve or avoid) when designing next-gen fur. The themes, which will be individually explored throughout this section, include: application, appearance, natural properties, attributes related to culture, production, construction, finishing, and maintenance, as well as end-of-life, impact, price, market/industry, and alternatives.

When designing a next-gen material, the application can be defined at the start (Rawling et al., 2024), or later, based on the properties achieved throughout the material's creation (Rognoli & Parisi, 2021). For this investigation, the application is the starting point due to its great importance in the establishment of priorities. For instance, a next-gen fur intended to be applied on handbags does not need to provide the traditional material's thermal-related attributes.

APPLICATION

Fur can be applied to a diverse range of products, including garments, accessories (Stansfield, 2015), furniture (Faiers, 2020, p. 188), footwear (Matthews, 2020), and even toys (Steiff, n.d.). "*Anything cloth can do, fur can do wittier*" (Jacques Kaplan, 1968, cited in Faiers, 2020, p. 58). For instance, the fur coat (Faiers, 2020, p. 119) and the beaver hat are some of the most significant fur products in the history of the material, especially due to associated ecological, economic, and political consequences (2020, p. 114). Still in fashion, fur coats were once essential for human survival due to the material's thermal attributes (Faiers, 2020, p. 82), and even though advances in living conditions reduced the need to wear fur indoors, the social use of fur-based garments was already an established status symbol (2020, p. 100).

APPEARANCE

Each animal species presents specific hair properties mainly due to the hair composition, arrangement, colour, and structure (Meyer et al., 2002). In addition, the structure of fur stimulates sensations of infiniteness due to the absence of demarcation lines (Faiers, 2020, p. 119). Techniques such as intarsia can produce artificial patterns (Faiers, 2020, p. 144). Concerning colour, fashion trends affect preferred furs (Faiers, 2020, p. 91). During the 1920s, as a celebration of the advances in synthetic dyes, colourful furs became a trend (Faiers, 2020, p. 134). Soon, colours became a means of disguising the real as fake with the rise of anti-fur campaigns (Faiers, 2020, p. 135). Additionally, the tail, commonly used to embellish garments, "by its very structure is an extension that is simultaneously independent of and integral to the body" (Faiers, 2020, p. 110).

NATURAL PROPERTIES

Fur is a natural material composed of skin and fibre (Rawling et al., 2024); however, synthetic finishings added to the material affect its degradation (Debeer, 2018). It also combines three hair types: underfur, awn hair, and guard hair; each with a specific function (Faiers, 2020, p. 16). A clear difference between human hair and animal fur concerns follicle concentration. For example, while humans present an average of approximately three hundred follicles per square centimetre, chinchillas present about twenty thousand. Humans grow one to three hairs from each of those follicles, while chinchillas grow fifty to one hundred hairs (Faiers, 2020, p. 16). Moreover, animal-based and synthetic fur can usually get wet without promoting any damage to the material (Gladman et al., 2024). Apart from being one of the most thermally insulating animal-based materials, fur is also naturally flame retardant, which usually exempts the material from standard flammability testing requirements (Gladman et al., 2024).

CULTURE-RELATED

Human behaviour results from a person's values, which are composed by their personality and the society and culture they are exposed to (Rokeach, 1973). The relationship between humans and fur is ancestral; research demonstrates that fur clothes became a part of human history, likely during migration from Africa to Europe and Asia due to the colder climates encountered (Kittler et al., 2003). To survive, humans wore and mirrored animals (Kwasny, 2019, p. 5); so, it incites proximity, simulating transferring the animal's characteristics to the wearer (Faiers, 2020, p. 52). For instance, the Yupik women in the Artic justify wearing beautifully decorated furs 'so that the animals can see them' (Kwasny, 2019, p. 8).
Moreover, fur has been historically used to

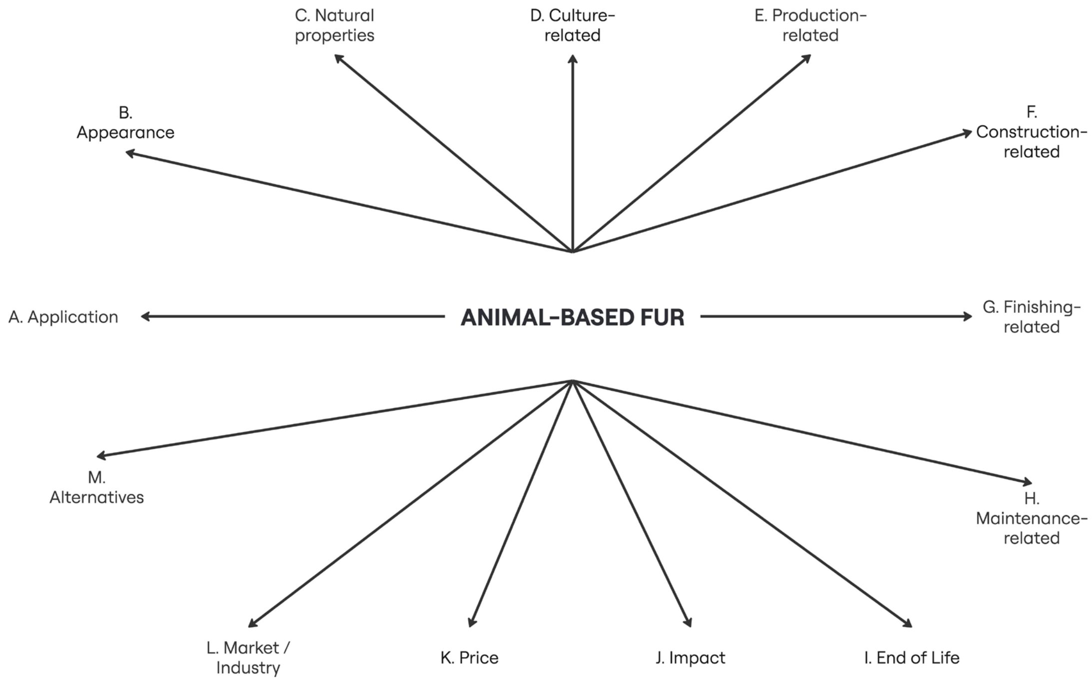

Fig. 01

demonstrate high status through portraits (Faiers, 2020, p. 93), and even today, ermine-lined robes are still worn during British kings and queens' coronations (Taylor, 2024). In the Bible, fur clothing represents Adam and Eve's transition from 'holy innocence to sinful knowledge' in Genesis (Faiers, 2020, p. 88). For black communities, especially African-American consumers, it is a 'vestimentary mechanism of affirmation' (Faiers, 2020, p. 74), often portrayed as a symbol of success for rap music (Faiers, 2020, p. 77). Just wearing fur may already feel like a promotion as it usually instigates perceivers' curiosity concerning how the wearer sourced the material (Taylor, 2024). In addition, there is a strong connection between fur, fashion and film (Faiers, 2020, p. 135) due to the material's ability to 'transport its fashionable wearers to imagined spaces' (Faiers, 2020, p. 120); it is 'what stars wear' (Faiers, 2020, p. 77). Even Cinderella's shoes might have been originally made of fur because the similarities between the French words vair (squirrel) and verre (glass) may have caused a mistranslation that incorrectly defined the material (Faiers, 2020. p. 117). Fur also incites a 'primitive sexual intensity' (Faiers, 2020, p. 133) that relates it to fetishes such as for pubic hair (Faiers, 2020, p. 176). Additionally, fur as a material can be perceived as relatively sustainable since it makes sense to use every part of the animal, including its skin; however, as highlighted by Ramchandani & Coste-Maniere (2017), killing animals for their fur cannot be considered sustainable, especially from the perspectives of ethicality and morality.

PRODUCTION-RELATED

The most significant steps in the production of fur involve slaughtering animals, skinning, and further material processing, such as dyeing or bleaching (Ramchandani & Coste-Maniere, 2016). Additionally, not only the animals that will be skinned must be raised but also other animals that are needed to become their food, such as fish and chickens. For instance, according to Bijleveld et al. (2011), minks are bred for approximately eight months. This process is inefficient since producing one full-length coat consumes approximately fifty-five mink, demanding almost three tonnes of feed (Bijleveld et al., 2011; Gladman et al., 2024).

CONSTRUCTION-RELATED

Skilled fur garment production has historically been a small-scale, labour-intensive process and even though the invention of the sewing machine in the nineteenth century facilitated the production of clothes, making fur clothes still requires a series of high-skilled manual processes that cannot be substituted by mechanical means (Faiers, 2020, p. 142). Such employment of handcrafted traditional techniques in making fur garments is one factor that influences the high cost of fur as a material (Ramchandani & Coste-Maniere, 2016). Fur sewing machines also differ from standard ones; instead of moving vertically, the needle moves horizontally to form a strong chain-stitched seam (Faiers, 2020, p. 143).

FINISHING-RELATED

Prior to being applied to fashion products, animal-based fur requires extensive processing, treatments, and finishing, which involve using electricity, transportation fuel, and toxic chemicals, which sometimes even exceed regulations (Bijleveld et al., 2011). Fibre finishes can be classified based on their nature, mode of action or achieved results, including basic/routine finishes, functional finishes that alter appearance, and functional finishes that alter performance, such as antipesticide and antimicrobial finishes (Sekhri, 2022).

MAINTENANCE-RELATED

The fur's surface enables repairs, which are only visible on the reverse if unlined (Faiers, 2020, p. 154). However, animal fur is a high-maintenance material and specialised cleaning is always recommended (Gladman et al., 2024). Consequently, fur garments can be perceived as the opposite of fast fashion, as they not only last a much longer time but also in regard to their model of service and aftercare (Faiers, 2020, p. 226).

END OF LIFE

Animal-based fur is a natural material (Popescu & Hoecker, 2007) that is part of nature's carbon cycle, which refers to the natural activity of carbon exchange involving the atmosphere, oceans, and land (Ghiat & Al-Ansari, 2021). However, its production and finishing may involve toxic substances that affect its natural biodegradation (Bijleveld et al., 2011; Debeer, 2018). If properly maintained, fur garments can last for decades (Pologeorgis Furs, 2022). However, at the end of life, even though fur garments can be turned into other products (Ramchandani & Coste-Maniere, 2016), most end up in landfills (Gladman et al., 2024).

IMPACT

Fur is an extremely controversial material (Gladman et al., 2024) often associated with environmental and ethical concerns, including animal welfare (Bijleveld et al., 2011). Thus, it is subject to specific legislation and several bans, classified as either governmental or organisational, that promote full or partial bans on fur sales or fur production (Fur for Animals, n.d.). Additionally, fibre shedding from textiles naturally occurs during various stages, including production (Cai et al., 2020), use (De Falco et al., 2020), maintenance (Mahbub & Shams, 2022), and end of life (Zhang et al., 2021). While fibres from animal-based fur could theoretically be considered biodegradable and natural, synthetic finishes alter their natural properties and affect the material's degradation (Debeer, 2018). When compared with cotton, polyacrylic, polyester (virgin and recycled), and wool fabrics, the production of mink fur presents the highest carbon footprint, and it is also likely to promote freshwater and marine eutrophication (Bijleveld et al., 2011).

Apart from constant exposure to toxic chemicals involved in the production of fur, workers involved in 'authorised killing practices' have been reported to be more likely to present mental health issues, especially anxiety and depression, as well as support violent behaviour, which often leads to the employment of negative habits (e.g. substance abuse) to cope with the workplace-related stressors (Marchand, 2007; Slade & Alleyne, 2023). Regarding environmental risk, animal fur is rated high in a recent report investigating opportunities to reduce the impact of textile-based goods purchased by the city of New York prepared by the Local Law 112 Task Force (Gabriel et al., 2024). The risks associated with animal-based fur include animal cruelty and slaughter, deforestation, carbon dioxide emissions, water intensity, land use, eutrophication, forced labour/worker exploitation, and toxic chemical exposure. The report also covers synthetics, such as acrylic fibres, and associates them with several environmental risks, including microfibre pollution and limited end-of-life solutions. In addition, fur farming can be considered a public health risk (Warwick et al., 2023).

PRICE

Seidu et al. (2024) examined sustainable material innovations in a circular fashion, finding that cost is a primary consideration for consumers when selecting bio-based materials or recycled clothing. Consequently, being part of the luxury market segment, fur holds greater potential to achieve price parity with next-gen alternatives (Gladman et al., 2024). In addition, considering that producing one kilogram of mink fur (equivalent to eleven mink) demands over five hundred kilograms of feed (Bijleveld et al., 2011), a rise in feed costs could potentially impact the production cost of fur (Ramchandani & Coste-Maniere, 2016). Fur products are also usually not a good investment and start to depreciate after being bought, losing up to 25% of their value per year (Gladman et al., 2024).

MARKET/INDUSTRY

The sale of raw pelts typically occurs through auction houses, often close to fur-producing areas; however, before being sent to auction houses, animals are skinned, stretched and dried (Ramchandani & Coste-Maniere, 2016). The fur dressing trade is overseen by the International Fur Dressers and Dyers Association (IFDDA) (Kopenhagen Fur, n.d.). Like international agreements and institutes, such as the Fur Institute of Canada, fur federations work to promote a more ethical and sustainable industry and often incentivise new designers to use animal-based fur by supplying them with the material (Ramchandani & Coste-Maniere, 2016). In 2014, the International Fur Federation valued global trade at over forty billion dollars; in 2019, it was estimated at twenty-two billion dollars, which represents a forty-five per cent decrease (O'Connor, 2021).

ALTERNATIVES

Synthetic fur fibres are usually made of fossil-fuel-derived polymers like polyester, acrylic, and modacrylic (Gladman et al., 2024). By mimicking natural fibres, the petrochemical origin of synthetics, which is responsible for their successful properties, is usually forgotten when garments are worn (Stanes & Gibson, 2017), especially considering that the density of synthetic fur can be very similar to that of natural fur (Bijleveld et al., 2011). At the expected pace, the global market size of synthetic fur is estimated to grow at a Compound Annual Growth Rate (CAGR) of almost 18.92% from 2024 to 2028, representing a significant growth of USD 184.2 million (Technavio, 2024). Since animal-based and synthetic fur are associated with environmental and ethical concerns, next-gen fur aims to solve these issues by offering high performance through animal- and petrochemical-free alternatives (Gladman et al., 2024). Some of the earliest known alternatives to animal-based fur include a woollen-cloth hat found in Denmark, attributed to a Bronze Age warrior, dating back to 1365 BCE (Faiers, 2020, p. 151), and a 'fake leopard skin' found in Tutankhamun's tomb, which included supplies for his journey to the afterlife (Faiers, 2020, p. 200). These fur alternatives were likely considered expensive due to the intricate skill and significant time required for their production; instead of merely mimicking fur, they celebrate fur's potential to be reinterpreted into a new, skilful expression (Faiers, 2020, p. 151). Hence, from this perspective, fur substitutes do not need to be direct replacements but can be used honestly and hold a unique value.

NEXT-GEN FUR SUGGESTIONS

Based on the findings outlined throughout this section, the initial map (Fig. 01) was expanded (Fig. 02) to demonstrate how establishing themes can be helpful to group and visualise the material's main attributes. This is where the 'edit' stage of the capture-edit-search (Ashby & Johnson, 2014) approach starts. The aim is to define which elements should be avoided, possibly achieved or 'neutral' areas of opportunity. The latter are neither negative nor positive but offer opportunities for material innovators. For example, a material's carbon footprint can be considered an area of opportunity because a material will always have a carbon footprint, but there might be room for improvement (Liu et al., 2023). To visualise this process, each 'attribute' was coloured, as shown in Figure 03. Green represents attributes to possibly achieve, red represents attributes to avoid, and yellow represents 'neutral' areas of opportunity. When designing next-gen fur, it is essential to consider both the aesthetic and tactile qualities of the traditional animal-based material (Gladman et al., 2024). While not emphasising warmth could make the next-gen alternative less seasonal, an additional benefit could be the ability to replicate animals not typically available, such as polar bears (Gladman et al., 2024). In addition, since animal fur is high-maintenance, next-gen materials could be designed to reduce care requirements

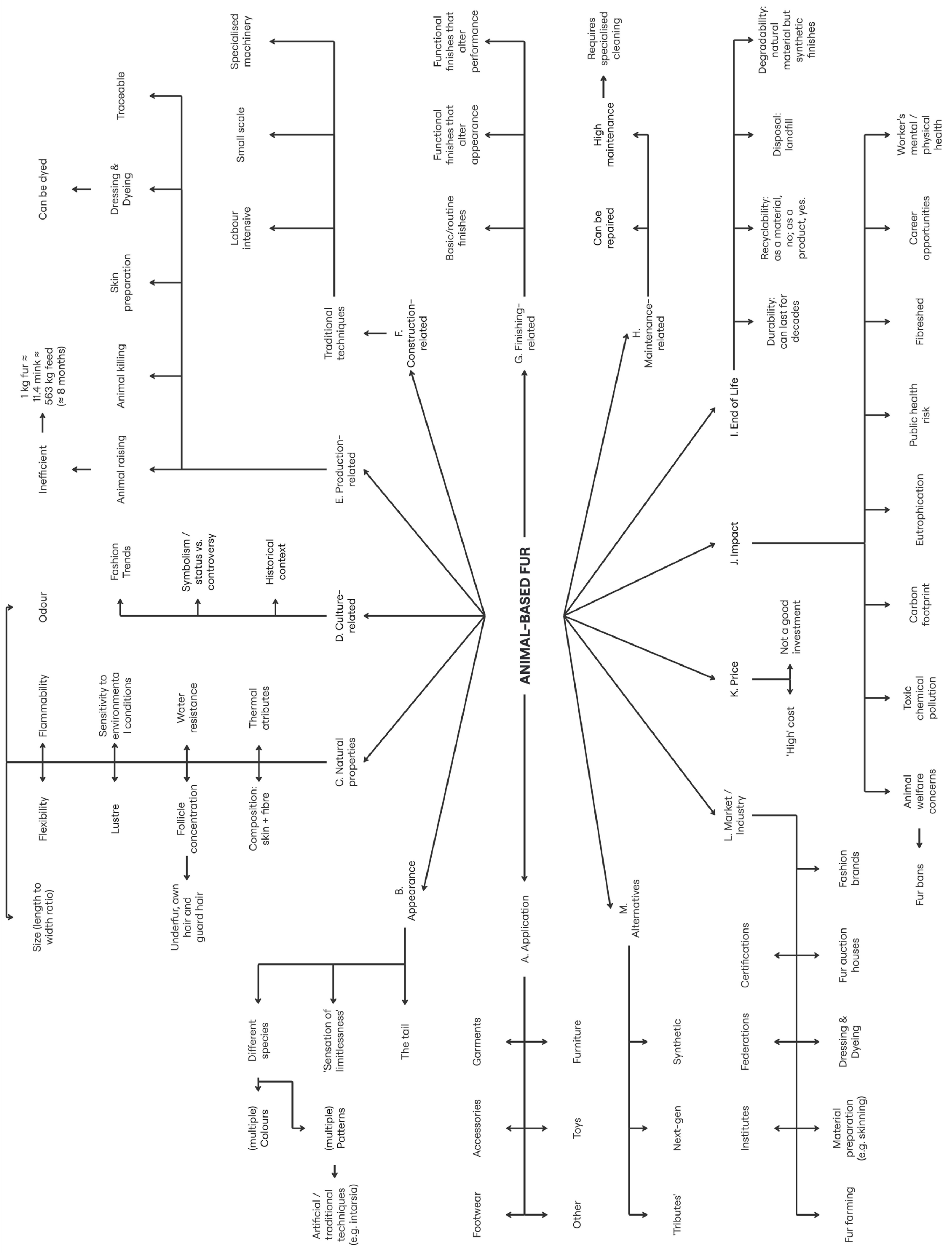
ANIMAL-BASED FUR
A. Application
Footwear
Accessories
Garments
Other
Toys
Furniture
B. Appearance
Different species
'Sensation of limitlessness'
The tail
(multiple) Colours
(multiple) Patterns
Artificial / traditional techniques (e.g. intarsia)
C. Natural properties
Size (length to width ratio)
Flexibility
Flammability
Odour
Lustre
Sensitivity to environmental conditions
Follicle concentration
Water resistance
Underfur, awn hair and guard hair
Composition: skin + fibre
Thermal atributes
D. Culture-related
Fashion Trends
Symbolism / status vs. controversy
Historical context
E. Production-related
Animal raising
Animal killing
Skin preparation
Dressing & Dyeing
Traceable
Inefficient
1 kg fur ≈ 11.4 mink ≈ 563 kg feed (≈ 8 months)
Can be dyed
F. Construction-related
Traditional techniques
Labour intensive
Small scale
Specialised machinery
G. Finishing-related
Basic/routine finishes
Functional finishes that alter appearance
Functional finishes that alter performance
H. Maintenance-related
Can be repaired
High maintenance
Requires specialised cleaning
I. End of Life
Durability: can last for decades
Recyclability: as a material, no; as a product, yes.
Disposal: landfill
Degradability: natural material but synthetic finishes
J. Impact
Animal welfare concerns
Toxic chemical pollution
Carbon footprint
Eutrophication
Public health risk
Fibreshed
Career opportunities
Worker's mental / physical health
Fur bans
K. Price
'High' cost
Not a good investment
L. Market / Industry
Institutes
Federations
Certifications
Fur farming
Material preparation (e.g. skinning)
Dressing & Dyeing
Fur auction houses
Fashion brands
M. Alternatives
'Tributes'
Next-gen
Synthetic

Fig. 02

or necessitate specialised care like the incumbent (Gladman et al., 2024). Given next-gen fur's diverse potential applications, including home goods, fashion accessories, and children's toys, brands must support innovators, define potential uses, and determine which properties to prioritise (Rawling et al., 2024). For scalability, it can be helpful to identify suitable manufacturing partners to ensure material properties align with manufacturing and garment use standards. Early selection of cut-and-sew factory partners can also be an advantage to ensure the textile can undergo traditional construction processes effectively (Gladman et al., 2024).

DISCUSSION

As an example (Fig. 04), a next-gen fur material in which the hair is replaced by hemp fibre and the 'skin' is made of bacterial cellulose could present several advantages including a biodegradable 'skin and fibre' structure. Other benefits could cover workers' mental and physical health, as well as the material's reduced carbon footprint, animal welfare concerns, and the impact related to fibreshed, which are the main challenges associated with animal-based fur and synthetic fur alternatives (Alevato et al., 2024). If applied to handbags or similar accessories, thermal attributes should not be required. Additionally, the market/industry stakeholders would include hemp farmers and kombucha breweries rather than fur farmers and pelt skinning companies. Concerning the price, by being part of the luxury market segment, fur holds greater potential to achieve price parity with next-gen alternatives, which can be an advantage (Gladman et al., 2024). However, other challenges (similar or not to the traditional material) could emerge, such as the material's odour (one of the main challenges associated with bacterial cellulose concerns its acidic smell (Wang et al., 2011), legislation (due to links to marijuana, special licenses that allow hemp cultivation are usually still required (Dhondt & Muthu, 2021)), and finishing (it is possible to produce hydrophobic bacterial cellulose 'with minimal quantities of hydrophobic agents' (Araujo et al., 2015)). In addition, certain attributes such as the material's durability, which is seen as positive when analysing animal-based fur, could become questions or areas of concern in regards to next-gen alternatives. For instance, even though such a material could present a series of advantages, a bacterial cellulose and hemp fibre-based handbag will likely have a shorter durability than an animal-based one. This highlights that comparing the impact of traditional materials as opposed to next-gen ones is a complex challenge because it still seems unlikely that next-gen feedstock could provide all the physical advantages of traditional materials. Thus, due to the complexity of this problem, it becomes necessary to overcome the counterintuitiveness of this non-linear calculation (Langhe et al., 2017) and appreciate next-gen materials for their unique potential (Carole Collet cited in Trinquier, 2024) rather than waiting for perfect replacements.

CONCLUSION

As this research demonstrates, it is unlikely that a next-gen replacement for animal fur will fully replicate all the characteristics of the natural material. Therefore, it is crucial to establish honest design priorities to ensure continued progress in the next-gen materials industry. Waiting for a perfect replacement could result in a significant loss of valuable research time. By emphasising the idea that in a design-driven transition, knowing what to avoid is as important as knowing what to achieve (Tonkinwise, 2014) and that next-gen materials should be appreciated for their unique potential rather than merely as substitutes (Carole Collet cited in Trinquier, 2024), this research seeks to assist next-gen material innovators in developing strategies that focus on attainable material properties. This approach could help accelerate the growth of the next-gen materials industry, contributing to a more prosperous fashion future.

ACKNOWLEDGEMENTS

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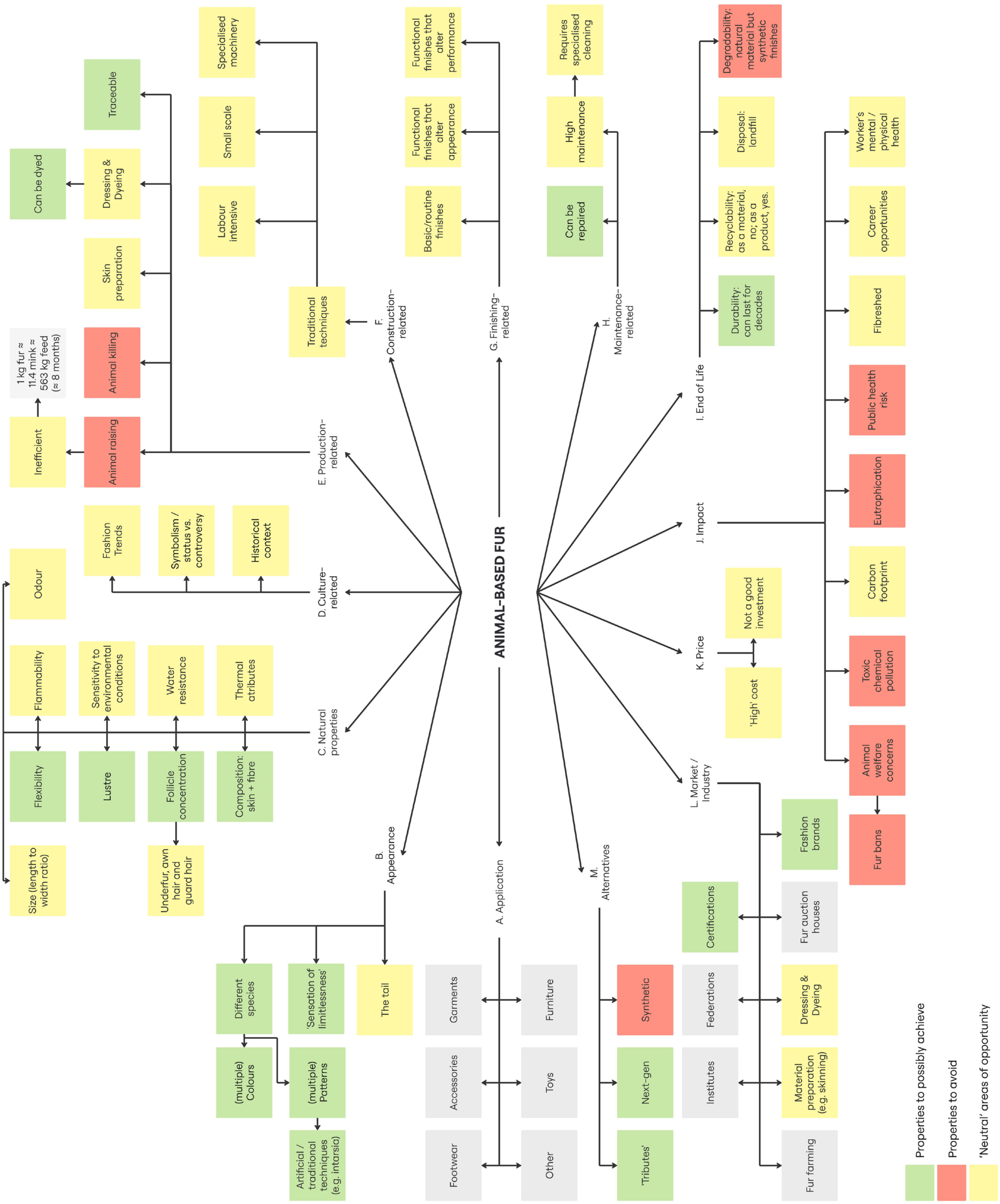
CAPTIONS

[Fig. 01] Thirteen themes covering physical and abstract attributes associated with animal-based fur that can guide material innovators to define and group material properties to prioritise (and potentially achieve or avoid) when designing next-gen fur (Author/designer: Isabella Alevato).

[Fig. 02] The thirteen themes associated with animal-based fur are expanded, highlighting their main attributes based on secondary research findings (Author/designer: Isabella Alevato).

[Fig. 03] To visualise the process, each 'attribute' was coloured as illustrated; green represents (positive) attributes to possibly achieve, red represents (negative) attributes to possibly avoid or areas of concern, and yellow represents 'neutral' areas of opportunity (Author/designer: Isabella Alevato).

[Fig. 04] As an example, attributes that could possibly be related to a next-gen fur alternative composed of bacteri-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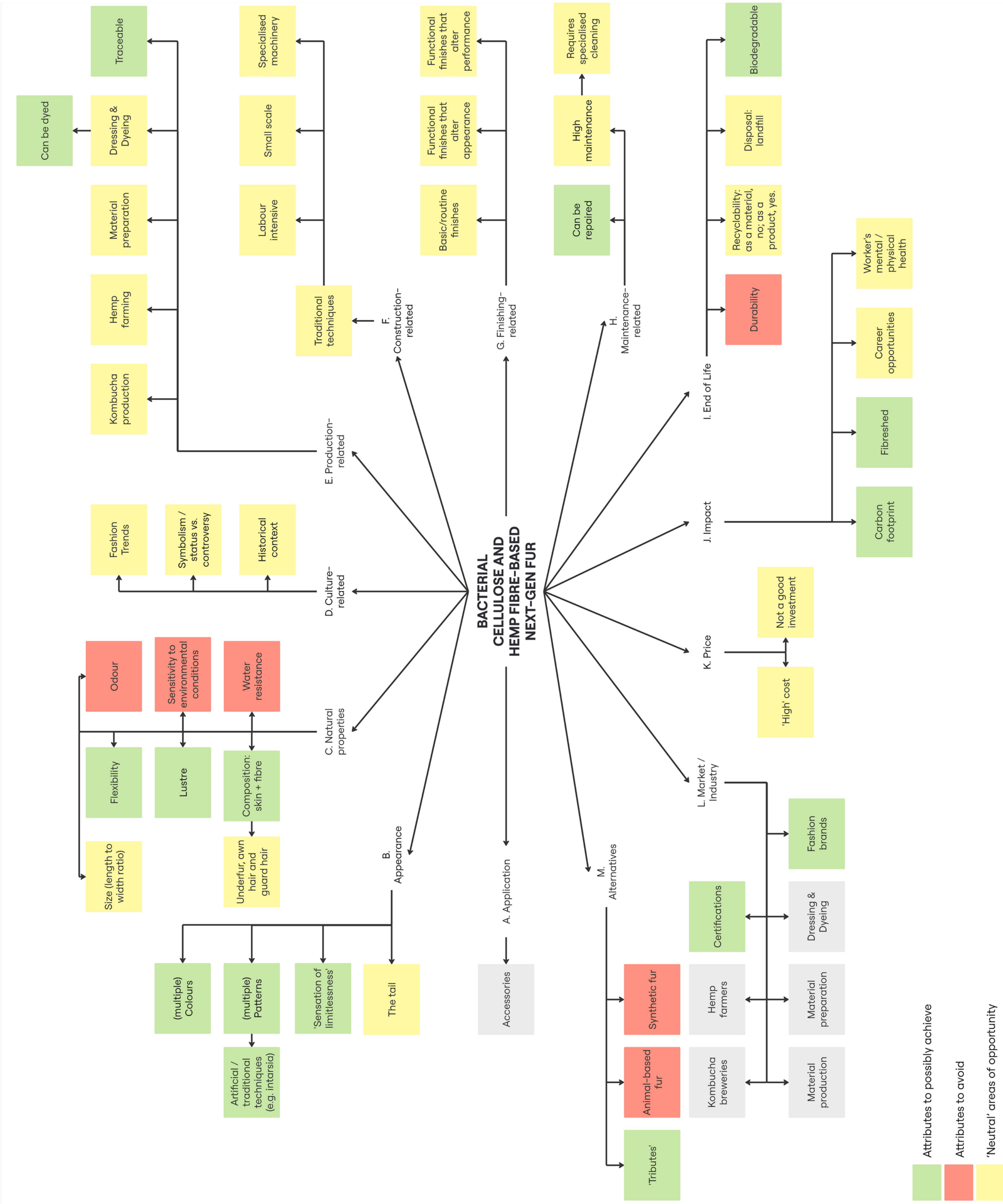
Fur farming
M. Alternatives
Synthetic
Next-gen
'Tributes'
Properties to possibly achieve
Properties to avoid
'Neutral' areas of opportunity

Fig. 03



BACTERIAL CELLULOSE AND HEMP FIBRE-BASED NEXT-GEN FUR
A. Application
Accessories
B. Appearance
The tail
'Sensation of limitlessness'
(multiple) Patterns
Artificial / traditiional techniques (e.g. intarsia)
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D. Culture-related
Historical context
Symbolism / status vs. controversy
Fashion Trends
E. Production-related
Kombucha production
Hemp farming
Material preparation
Dressing & Dyeing
Can be dyed
Traceable
F. Construction-related
Traditional techniques
Labour intensive
Small scale
Specialised machinery
G. Finishing-related
Basic/routine finishes
Functional finishes that alter appearance
Functional finishes that alter performance
H. Maintenance-related
Can be repaired
High maintenance
Requires specialised cleaning
I. End of Life
Durability
Recyclability: as a material, no; as a product, yes.
Disposal: landfill
Biodegradable
J. Impact
Carbon footprint
Fibreshed
Career opportunities
Worker's mental / physical health
K. Price
'High' cost
Not a good investment
L. Market / Industry
Fashion brands
Dressing & Dyeing
Material preparation
Material production
Certifications
Hemp farmers
Kombucha breweries
M. Alternatives
'Tributes'
Animal-based fur
Synthetic fur
Attributes to possibly achieve
Attributes to avoid
'Neutral' areas of opportunity

Fig. 04

al cellulose and hemp fibre highlight both advantages and new challenges that could emerge if compared to traditional materials; green represents (positive) attributes to possibly achieve, red represents (negative) attributes to possibly avoid or areas of concern, and yellow represents 'neutral' areas of opportunity (Author/designer: Isabella Alevato).

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