

# **AI, Haptics and 3D Modelling in Fashion: A Scoping Review**

## **ABSTRACT**

This review explores the integration of artificial intelligence (AI), augmented reality (AR), and three-dimensional modelling in the fashion industry, reflecting on the transformative capabilities. AI has revolutionized fashion design, production, and retail through a large number of uses. Machine Learning (ML) and Large Language Models (LLMs) such as ChatGPT facilitate complex tasks such as trend prediction, design automation, and consumer interaction. Generative AI (GenAI) also plays a significant role in creating new content, optimizing supply chains, and enhancing marketing strategies. The shift towards Small Language Models (SLMs) highlights a trend towards sustainability and specialization, offering energy-efficient solutions tailored to specific brand needs.

AI's impact extends to improving sustainability by managing production scales and reducing waste. Virtual fitting rooms and AR technologies enable consumers to visualize products in a realistic manner, enhancing convenience and inclusivity. However, the implementation of AI raises ethical concerns, particularly regarding data bias and inclusivity. The review includes emphasis on the need for training AI on diverse datasets to prevent perpetuation of harmful biases and ensuring that extra steps are taken to ensure diversity where bias in the data may not be representative.

Case studies of industry leaders such as Levi's and Reebok illustrate the practical applications and challenges of AI integration which are happening currently. Levi's collaboration with Lalaland.ai for AI-generated models aims to enhance diversity but faces criticism for not directly supporting marginalized communities. Reebok's partnership with Futureverse showcases the potential of generative AI in creating personalized digital experiences, merging traditional fashion with cutting-edge technology and allowing for personalization and a direct relationship with its consumers.

The review identifies gaps in the literature, particularly concerning the practical applications of SLMs and the role of user prompts in AI interactions. Effective prompts are crucial for generating accurate and useful outputs, especially in creative tasks. The iterative process of prompt chaining, where a sequence of prompts guides the AI through complex tasks, is highlighted as a method to refine AI-generated content.

This review's methodology employs a mixed-method approach, combining quantitative and qualitative data collection. This approach provides a comprehensive understanding of AI integration in fashion, incorporating insights from industry experts and case studies. The research aims to explore the future potential of AI, SLMs, and AR in fashion, addressing ethical considerations and practical applications.

The integration of AI, haptics, and 3D modelling will revolutionize the fashion industry. These technologies offer large opportunities for innovation, personalization, and sustainability. However, addressing ethical concerns, ensuring inclusivity, and navigating technological limitations are essential for realizing the full potential of these advancements. Ongoing research, industry collaboration, and a commitment to ethical practices will shape the future of fashion, creating a more inclusive, sustainable, and engaging industry landscape.

## **LITERATURE REVIEW**

Artificial Intelligence, or AI refers to computer systems that can perform complex tasks such as coding, problem solving and decision making, all tasks which historically, could only be performed by a human (Coursera, 2024). One useful branch of AI is machine learning, it implements the concept of memory in an AI (Kanade, 2022), allowing it to learn from past experiences, in addition, most MLs use deep learning, which focuses on unstructured data and makes use of artificial neural networks (Stöffelbauer, 2023). ChatGPT was released in late November of 2022 (Heaven, 2023), and by now, most of the public have interacted with it in some way or another (Fried, 2023). ChatGPT is a large language model (LLM), and possibly the most famous one (Stöffelbauer, 2023). LLM's are trained on large amounts of data, and hence they can understand and generate content and perform many tasks (IBM, 2023). However, they require a huge amount of computational power, raising environmental concerns (Beardshall, 2024), and in addition, they require a large amount of data to be trained upon (Donovan, 2024), this data will usually have signs of bias if not properly filtered (Mehra, 2023). Small language models (SLMs) are becoming a popular option for brands (Thomas, 2024), with specific tailoring in mind, allowing for the training process to be streamlined and efficient (Mok, 2024). SLMs are becoming an attractive option due to their better sustainability (Wang & Wang, 2024) and their ability to specialize in certain skill sets (Ghosh, 2023) due to streamlined data (Lee, 2024). Generative AI (or GenAI) are LLMs which are different from analytical AI as they create new content by taking the input of a prompt and generating a new output (Olson and Chen, 2023). It is easy to imagine that this will be extremely useful for creative prompts,

for example GenAI has vast uses in the fashion industry (Luce, 2019). Gen AI is also helping companies optimize their supply chains and production capacity (Baukh, 2024), allowing for analysis of raw materials (SANVT Journal, 2023), suggestions during the design process (Shakir, 2024), and AI simulations to virtually test the product (Hendrick, 2023). From here, AI can then be used in the marketing process (Harreis et al., 2023) and to analyze the required inventory, preventing overstocking (Jobe, 2024).

AI has significantly influenced the development of products in the garment industry by streamlining design processes (Opasinski, 2024), predicting trends (Luce, 2019), and enhancing production efficiency (Mohamed et al., 2023). Before AI, the design process consisted of large reliance on the work of fashion designers to design and create fashion pieces (Unik Team, 2023). There is a large amount of both academic (K.Hong et al., 2023) and applied industry (Young and Shahbazi, 2023) research being done on incorporating generative AI with product development (Guo et al., 2023), and the design process (Wu and Li, 2024): it is now being used to interpret sketches (Fang, Gu & Tan, 2020) and mood boards (Li & Zhang, 2021) to produce designs aligning with company values (Harreis et al., 2023). However, it is important for companies to ensure that AIs are being trained on filtered data, since the internet contains bias in the data which is available (Harreis et al., 2023), such as racial and gender biases (Gonsalves et al., 2023). Additionally, to ensure ethical practice, it is essential that diversity and inclusivity are prioritized, otherwise these LLMs run the risk of reflecting harmful norms and values (Reseleeve, 2023). One of the largest issues with GenAI at present is that it will ‘hallucinate’ when responding to a prompt, thinking that it is correct with the highest confidence, when it is not (Chui, Roberts and Yee, 2022). When used carefully, the uses of GenAI unlock the potential for the fast creation of professional level designs (An & Min Jung Park, 2023). By working in collaboration with this technology, speed and quality of product production (Noor et al., 2021) can be increased, along with hyper-personalization of products (Chui, Roberts & Yee, 2022). Whilst many who are worried that artificial intelligence will be a threat to creativity (OFU Lifestyle, 2023), using it as a tool (Shahidi, 2023) allows for suggestions to be made to a product (Tsao et al., 2023), enhancing durability and allowing for comparison with similar products (Marku, 2023) to advance the style (Csanák, 2020). In addition, 73% of fashion companies and brands say that generative AI will be a priority for their business as it develops (Shakir, 2024). Some brands are going a step further, such as Reebok (McDowell, 2024), who invite users to create their own digital sneakers, made with generative AI, and wear them either physically or digitally (biz community, 2024). @ReebokImpact invites users to message them a picture on Instagram, and uses GenAI to return their design (Lemire, 2024). Versace has also taken to the ways of AI (Bravo, 2023)

and is using it in short content development (SCD), which is content that can be digested quickly and is well suited to mobile devices (Mukherjee, 2024). Versace's AI generated SCD shows an 81% increase in engagement compared to human-generated (McDowell, 2024). Furthermore, the advancements in the digital world are proving to be a hugely beneficial area for creative processes (Jobe, 2024), such as the first AI fashion week in New York (Mubarak, 2023), closely followed by London's fashion week (Zwieglinska, 2024) which had also showcased many AI generated designs.

(Jobe, 2024) mentions how AI is incredibly useful in reducing waste and overstock issues. Responsible sourcing decisions can be made by incorporating machine-learning and cloud-based data (Ghamisi et al., 2021), allowing for measurement of key environmental metrics and the overall reduction of unnecessary waste (Shakir, 2024), a problem which is pressing in the fashion industry (Rossini, 2024), with between 15 and 45 billion clothes never even sold each year (Chan, 2023). In addition, social media can be used for gaining insights of user wants (Heinonen, 2011), allowing for predictive analytics of consumer demands (Ding et al., 2021), which is also a contribution to the reduction of overstocking (Luce, 2019), as well as recognition of patterns and trends (Harreis et al., 2023). AI algorithms are also able to identify the better use of resources during a design process (Ghamisi et al., 2021), with there being some possibility of incorporating natural resources (Debnath, 2016) to reduce microplastics in the ocean (Tian et al., 2023), a huge problem and sustainability consequence of current fashion practices (Oinam Roselyn Devi & Laimayum Jogeeta Devi, 2024). 3D morphotype mannequins also allow for garments which better fit customers' body types (Tan, Lin and Wang, 2024), providing insight to material characteristics and evaluating the optimal inventory level (Ramos et al., 2023), however this is limited by the high costs, model parameters, and dependance of quality of the scanner (Hamad et al., 2018). Computer vision tools are also important in the production process as AI can generate a range of potential prototypes and is able to test products by running virtual simulations (Jingyu et al., 2021). This allows for a good estimation of how a product is expected to act in real life (Seemsay, 2021), cutting out the middleman of physical testing, which is often a long and wasteful process (Gupta et al., 2022). AI can also find partners for collaboration by matching the values of the two companies, without intensive searching (Hendrick, 2023).

The fashion industry is one where consumers constantly feel the need to buy (Tarka, Kukar-Kinney and Harnish, 2022), this can be for a large range of reasons such as microtrends (Callery, 2023) and boredom of clothing (Kwon, Choom and Kim, 2019). Harvard proffessor

Gerald Zaltman even states that 95% of buying is unconscious behavior (Chierotti, 2018). However, this leads to many problems such as the environmental impact (Niinimäki et al., 2020), and contribution to fast fashion, which in turn encourages poor quality of products and poor human treatment (Karvonen, 2022). With throwaway culture being such a large contributor to waste in the fashion industry, it is important to implement intelligent knowledge-based systems which account for sustainable waste management (Ramos et al., 2023). When considering the needs of a consumer, and how AI can mitigate these (Wu and Kim, 2022), one of the biggest things that we consider is augmented reality, and the convenience of being able to visualize a product on our own bodies, and in our own surroundings, without needing to move from the comfort of our homes (Akram et al., 2022). Virtual try ons can be tailored to each customer (Liu et al., 2020), resulting in products which give the feeling that they are produced with the unique and personal considerations of the consumer (Harreis et al., 2023). (Shakir, 2024) also mentions how AR and the advancements of virtual fitting rooms allow customers to try on clothes and evaluate the fit and style, additionally allowing for representation of more body types (Ameen, Cheah & Kumar, 2022), and greater expression of self (Freeman & Maloney, 2021), all problems we see reflected onto the younger generation with the increasing use of social media (Keles, McCrae and Grealish, 2019). Another use of AI and 3D modelling techniques is allowing for fantastical content (Lee, Xu and Porterfield, 2020), which is fun, engaging and interactive for users, which is not usually accessible (McDowell, 2024). By implementing virtual fitting rooms and thereby providing more information about products (Idrees, Vignali and Gill, 2020), brands have seen a 36% reduction in return rates of products (Dopson, 2023). There are concerns about this technology being inaccessible to smaller businesses due to the large cost of implementing this technology (Snijder, 2024), and in addition, there are large limitations in the technology (Biswas & Visell, 2021), such as haptic feedback which does not mirror the way we experience the real world (Kim and Ha, 2019) and potential inaccuracies' in virtual representations of products (Eldin , 2022) that would need to be combatted before consumers would turn to virtual fitting rooms over shopping in person (Ingarozza, 2023). Table 1 shows an overview of various AI types and their applications within the fashion industry. Examples of brands that are implementing these AI technologies are provided, including companies such as Zara, H&M and Reebok.

Table 1: a summarization of various AI types, their applications in the fashion industry, best use cases, references, and specific examples of brands implementing these technologies.

AI type	Application within fashion context	Best use case	Reference	Brand example
Machine Learning (ML)	Learning from past experiences, predictive analytics, trend forecasting	Predicting fashion trends and consumer demands	(Luce, 2019), (Mohamed et al., 2023)	Zara is using ML for predicting behavior and market analysis.  (Piedrahita Orozco, Ochoa-Zezzatti & Delgado Lechuga, 2021)
Deep Learning	Handling unstructured data, using artificial neural networks	Enhancing production efficiency and design process automation	(Noor et al., 2021)	Tommy Hilfiger and Stitch fix have started making suggestions to customers wardrobes.  (Caroline, 2023), (Stitch Fix, 2023)
Large Language Models (LLMs)	Content generation, understanding and generating text, decision making	Automated customer service, marketing content creation	(IBM, 2023), (Beardshall, 2024), (Donovan, 2024)	Brands which have a personal chatbot use LLMs, and many brands are making use of ChatGPT.  (Dojo, 2023), (Baukh, 2023)
Small Language Models (SLMs)	Efficient text processing, lower computational resource requirements,	Enhanced customer interactions with personalized recommendations, scalable for smaller brands	(Thomas, 2024), (Mok, 2024), (Wang & Wang, 2024), (Ghosh, 2023)	No current examples.

	targeted content generation			
Generative AI (GenAI)	Creating new content based on prompts, fashion design, product development, and marketing	Fast creation of professional designs, optimizing supply chains	(Luce, 2019), (Baukh, 2024), (SANVT Journal, 2023), (Shakir, 2024), (Hendrick, 2023), (Harreis et al., 2023), (Jobe, 2024).	<p>Reebok uses GenAI in sneaker design according to an input prompt.</p> <p>CALA, a fashion design software, uses GenAI to help designers produce more than 100 sketches of design ideas in a single day.</p> <p>(McDowell, 2024), (biz community, 2024), (Lemire, 2024), (BoF Team and McKinsey &amp; Company, 2023), (Sgran, 2023)</p>
Computer Vision	Virtual simulations, prototype testing, fitting room technology	Accurate virtual try-ons, reducing return rates	(Jingyu et al., 2021). (Seemsay, 2021), (Gupta et al., 2022), (Hendrick, 2023).	Uniqlo has a mind reading kiosk which analyses neurotransmitters in the brain and suggests user designs and American Eagle uses interactive dressing rooms for

				<p>better customer experience</p> <p>(CEO.digital, 2020), (Unglesbee, 2023)</p>
Augmented Reality (AR)	Virtual try-ons, visualizing products on own bodies and surroundings	Enhancing consumer experience, personalizing fit and style	(Akram et al., 2022), (Liu et al., 2020), (Harreis et al., 2023), (Shakir, 2024), (Ameen, Cheah & Kumar, 2022), (Freeman & Maloney, 2021)	<p>Tommy Hilfiger has been using AR in smart mirrors to allow consumers to undertake virtual try ons in store.</p> <p>(FIM, 2023) (Caroline, 2023a)</p>
3D Modelling Techniques	Creating fantastical content, virtual fitting rooms	Increasing engagement, reducing product returns	(Tan, Lin and Wang, 2024), (Ramos et al., 2023), (Hamad et al., 2018).	<p>Levis has been trialing 3D models as an act of bringing in diversity which better reflected the desires of their consumers, especially those who are underrepresented .</p> <p>(Weatherbed, 2023), (Velasquez, 2023)</p>
Haptics	Providing tactile feedback, enhancing	Improving user experience, providing physical	(Kim and Ha, 2019), (Shebley , 2024), (Biswas	Volrose is a French haptic fashion brand,



	user interaction	sensations for better fit	and Visell, 2021)	<p>with each of their garments designed to play its own music or sound through haptic vibrations, intended for the wearer.</p> <p>CuteCircuit offers a similar promise, developing fashion with wearable music.</p> <p>(Mode In Textile, 2021), (Dimitrova, 2019)</p>
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## INTERMEDIATE PARAGRAPH

From the literature review, we can deduce that AI is being used in a vast number of ways in the fashion industry, from generative AI to production streamlining. It is also apparent that in each of these areas, there is room for hyper-personalization so that the brand is better able to appeal to the unique needs of an individual. Following on from this, advancements such as 3D modelling and the application of this with AR and virtual fitting rooms are being used by many brands, such as Tommy Hilfiger and Levis. The use of virtual fitting rooms is an important development for consumers since it allows for the ease and convenience of analyzing a product in a way which traditionally, we could only do in person, moreover it allows brands to cater to people with more vulnerabilities. There is also a large topic of conversation about how AI increases the sustainability of the fashion industry as it allows for managing the scale of item production and matching it to the demand. This is incredibly useful for reducing waste, however in turn requires an extremely large computational strain, this computing power will also in turn have large environmental impacts. Gaps in the literature include the mention of SLMs in the fashion industry, along with further expansion required on the idea of user prompts. LLMs require lots of data and in turn, bias

which is reflective of the bias we see in our cultures, such as race and gender prejudice, along with harmful norms in human nature. In addition, the type of bias is not universal but will differ depending on diverse cultures (Reseleeve, 2023). This poses the question of good and bad data, and if the definition of good data and bad data will also differ depending on the culture, since bias is not universal (Mehra, 2023). SLMs can allow brands to streamline and filter data, by choosing the data reflective of the brand's values, bias can be reduced significantly (Lee, 2024). However, this will pose the issue of making sure that the data chosen to train the AI, does not have bias, and that the group in charge of choosing the data are also not biased. Coming back to the idea of good data, an understanding is required to decide which data is acceptable to use to train a SLM. Despite there being many articles on how SLMs will be a gamechanger for the fashion industry, there seems to be a lack of companies explicitly saying how they will use SLMs to achieve these goals. Research is required to understand how industry professionals intend to use SLMs and what they hope to achieve by doing so, it would be interesting to hear their perspectives on topics such as hyper-personalization through SLMs, along with how they would filter the data. Looking past SLMs, another gap in the literature review was the use of prompts from the user. A large amount of GenAI, and hyper-personalization is based on the idea of the prompt from the user. Prompts are what will be used to navigate our interactions, as consumers, with AI software, so it is important to expand on what this means, and what prompts do. The power of a prompt will dictate the actions of an AI, and prompts will also contribute heavily to the design process (Olson and Chen, 2023). There should be discussion surrounding prompts, including how to structure a prompt, and how an AI interprets it. Furthermore, we need to consider the relations of SLMs and user prompts to 3D modelling software's, and virtual fitting rooms. It is also important to understand the ethical practices in the industry, ensuring that in training AIs, diversity and inclusivity remains a priority.

## **METHODOLOGY**

This methodology explores the research objectives of this report. We can analyze, from the literary report, the areas where more in-depth research and discussion with industry experts is required. Limitations in the research are inclusive of the fact that there is a lack of robust academic research and data to support findings. Objectives include the following: further information and discussion with industry experts about biases in AI and LLM training, with discussions in particular about where we will be going in the future and any mitigations which need to occur; insight about SLMs, and if they will be

able to help mitigate bias and to contribute towards sustainability fixes, issues we see rising with LLMs, and to analyze where existing companies are planning to integrate SLMs inside their systems, furthermore it is important to research how companies plan to successfully filter data given to a SLM; the use of GenAI in the fashion industry, taking a look at its fast development and having conversations about where it will go in the future, and then looking at how GenAI and AR will work together in the future, and how user prompts will influence these areas; A larger understanding of user prompts, with emphasis on how to structure a prompt, and how an AI interprets it, it is also important to consider how prompts play into the design process; lastly we will need to consider the areas of 3D modelling and virtual fitting rooms, an area being largely developed in many companies, and how SLMs will relate to these areas, if at all.

To undertake research, we employ a mixed method approach, as this will combine quantitative and qualitative data collection and analysis in one study (GOV.UK, 2020). Quantitative data will provide a broad overview and allow us to find measurable insights of AI integration within brands, while the qualitative interviews will delve deeper into individual opinions from industry experts and allow for an approach which better involves the viewpoints from people involved in the heart of the industry (Dewitt Wallace Library, 2021). See table 2 for research approaches, why they're being used, and challenges that come alongside encompassing them. Case studies will be conducted on large players in the fashion industry, giving insight into what course will be set in the future as we integrate technology with fashion. Given the fast-moving nature of AI tech, it is essential to communicate with leaders in the fashion industry to understand how this impacts us in a long term-context. My research will entail visiting the AI in fashion symposium, followed by the Fashion Innovation Agency 10 years talks, which consist of several panel discussions. These will allow me to gain firsthand ideas of what industry experts expect to see. During these events, I will also be able to make well-established connections in the industry and gain more insight into these topics. To have my specific objectives reached, a more hands-on approach is required, I will arrange interviews with members of the industry who specialize in my areas of interest, this will allow for a wider understanding of these topics. My interview plan involves conducting 30-minute to 1-hour sessions with participants, where we engage in organic discussions based on provided topic notes rather than pre-set questions. This approach aims to create a natural and fluid conversation, allowing participants to express their thoughts more freely and deeply, and hopefully leading to some interesting discussions which would not be available via other research methods. I chose this approach to foster an open dialogue, encouraging participants to share their genuine perspectives, which will provide a more comprehensive understanding.

Research approach	Why this approach is being used	Challenges from encompassing them	References
Industry engagement via attendance at symposiums	Development as a researcher, allows people to network and have more in-depth conversations with speakers, and provides updates on the latest advancements.	Conferences aren't disability friendly. In addition, travel can be costly, and symposiums can be time-consuming, especially when talks may not offer new information or be relevant.	(Gilyard, 2024), (Dunstan, 2017), (TYAGI, 2023)
In person interviews	Allows participants to express their feelings and opinions about different topics in a unique and personal way, it also allows for a more specialized list of questions and discussions	Interviewer's and participant's bias, honesty, rapport between interviewer and participant, language and cultural barriers	(Dunwoodie, Macaulay & Newman, 2022), (Nunkoosing, 2005)
Case studies of real-life applications of AI	Obtaining a more in-depth approach of an interest in its real-life context	Case studies will have a limited generalizability and are dependent on access to data.	(Crowe et al., 2019), (McCombes, 2019)

## CASE STUDIES

### LEVIS CASE STUDY

Levi's, a global leader in denim, is joining the AI world, and has announced their plans to implement realistic AI models in their marketing, starting 2024 (Velasquez, 2023). Levi's plans to do this by partnering with Lalaland.ai, a black owned AI company founded in Amsterdam in 2019 (Clark, 2023), who specialize in creating lifelike digital models to supplement human models and "diversify the fashion industry and challenge the status

quo when it comes to inclusivity, sustainability and innovation” (Magazine, 2023). Levi’s was driven by the aim of implementing a higher representation of body types, skin tones and age groups for each item of clothing, representative of their customer base (Johnson, 2023). This case study explores the motivations and implications of this decision, the responses from the public, and the implications for diversity and inclusivity in the fashion industry.

This move allows everybody to be able to see what an item of clothing would look like on their body shape and body type (Rees-John, 2023). Levi's also mentions how this is a big step in using AI for more diversity, an essential consideration as we see AI grow. However, this step from Levis has been met with a large amount of criticism, consumers are wondering why plus size and dark-skinned models cannot simply be hired, instead of being AI generated (Clark, 2023). Critics say that this step does not actually help people who are diverse but reads as performative activism instead (Ormesher, 2023). Levi’s historically have not explicitly been truly diverse, with their models often falling into the ultra-skinny and beautiful category, and typically showcasing each item on just one or two models from different size groups (Velasquez, 2023). This limited representation often fails to cater to the diverse body types, ages, and skin tones of their customer base.

The primary objective of Levi's collaboration with Lalaland.ai was to enhance diversity by through AI generated models which were representative of their consumer market, improve customer experience by allowing for consumers to see products on models who more closely resemble them (Magazine, 2023), allowing for more personalization and inclusivity, and to work towards a more sustainable future, by reducing logistical and financial constraints of traditional photoshoots. Following from this last point, Levi’s announced that AI models would not replace human models (Tehrani, 2023) but would be used on top of the traditional photo shooting practice. Levi’s intends to keep photoshoots and real models exactly as they are and implement AI on top to fill the gaps.

Despite stating their intentions clearly, Levis received public criticism along with criticism from industry experts. Consumers stated that the move was ‘lazy’ and ‘problematic’ (Weatherbed, 2023), and by using AI to generate diverse models instead of using real people, that it was a step backwards in terms of diversity (Holt, 2023). Critics even went as far to say that this approach perpetuated a form of digital blackface (Clark, 2023), and an avoidance of true inclusivity. Industry expert Jane Belfry highlighted the abundance of diverse talent available, and questioned Levi’s decision (Holt, 2023). Critics deduced that Levi's decision was not about diversity but was instead to cut costs. The overall consumer response had concerns about depersonalization of AI models, with most people mentioning how they would prefer to see real people (Clark, 2023).

After receiving backlash from the public, Levi's reiterated that their use of the AI models was not meant to replace human models but was meant to be used in addition (Johnson, 2023). They clarified that live photoshoots with diverse models would continue, and that their commitment to diversity, equity and inclusion is beyond the use of AI (Linley, 2023).

Levi's AI plan reflects the complexities and challenges of integrating AI technology into diversity and inclusivity efforts. While the use of AI models offers potential efficiencies and a broader representation of diverse body types, it also raises significant ethical and cultural concerns (Drayton, 2024). Advantages include the representation of more body types and skin tones without logistical constraints, and benefits to the consumers who are reflective of a diverse consumer base (Iovine, 2023). However, disadvantages include the diversity efforts as being viewed as insincere, without real, diverse models being supported. It also raises ethical concerns about representation, and exploitation of cultural and racial identities (Ormesher, 2023), representing the potential challenges we see as we work towards an AI driven world. While the intention is to create a more inclusive shopping experience, the initiative underscores the need for careful consideration of ethical implications and genuine commitment to diversity (Drayton, 2024). Moving forward, it is crucial for Levi's to engage with diverse communities and industry stakeholders to ensure their diversity efforts are both impactful and authentic (Ormesher, 2023).

Another way Levi's has been using AI is in sustainable product sourcing, evaluating the environmental impact of different materials and the feasibility of the recycling process (Meade-Palmer, 2023). This is much less controversial and contributes to sustainability in alignment with the brand's values.

## **REEBOK CASE STUDY**

Reebok is a renowned sportswear brand, focusing on athletic footwear. Reebok had started from Joseph William Foster designing shoes as a 14-year-old in 1895, and the name of the brand was based on the Rhebok, an African antelope (Zolanvari, 2024). Reebok has recently ventured into the digital wearable trend by partnering with leading AI and metaverse technology company Futureverse. This collaboration has resulted in the launch of "Reebok Impact," which is an interactive and innovative digital experience that allows customers to create custom digital sneakers (Walk-Morris, 2024). This case study explores the motivations from both Reebok and Futureverse behind this initiative, its impact on consumer interaction, and the broader implications for the fashion industry.

Reebok Impact is a cutting-edge platform where users can send a photo to @ReebokImpact on Instagram, and Futureverse's AI will use generative AI to create a

custom sneaker design based on the photo (Yadlos, 2024). This decision merges traditional fashion, such as Reeboks sneakers, with digital technology, making use of recent advancements in AI. By doing this Reebok Impact enables personalized, AI-infused digital wearables (Wagner, 2024). Users can create custom versions of popular Reebok models such as the Pump, Classic Leather, and Club C, which are compatible with virtual experiences such as Roblox and Fortnite, allowing for the user to download their digital file and wear these shoes in game (WEBWIRE, 2024). This project marks the beginning of a long-term collaboration between Reebok and Futureverse, with it being the first project announced from their collaboration. The partners aim to redefine consumer interaction with products in both physical and digital spaces (Lee, 2024).

Reebok's collaboration with Futureverse aims to expand the boundaries of sneaker culture in the fashion industry by making use of new and advancing technology. This puts advanced AI tools into the hands of everyday consumers and allows for customers to experience an engaging and interactive form of product development by immortalizing their photo memories in the form of a digital sneaker. Reebok goes on to say that the memory of the photo is stored in the sole of the shoe, reflective of an impact of the memory on the soul (WEBWIRE, 2024). The primary objectives include enhancing personal expression, bridging physical and digital worlds, driving user engagement and enhancing consumer interaction (Yadlos, 2024). By creating custom digital sneakers, Reebok invites users to experience this new immersive way of interacting with the brand, therefore appealing to a much wider audience. It allows users to showcase their individuality in virtual spaces, further promoting the brands ethos into both physical and digital realms, and furthermore offering game-ready files and AI-generated art and providing a seamless consumer experience (Lee, 2024).

Reebok Impact offers an easy-to-navigate user experience, meeting sneaker fans where they are—online and in virtual spaces (Haan, 2024). Instagram is an extremely current place for the young generation, with direct messaging being the new texting, and Instagram being at the forefront of social media (Durante, 2021). This allows for extremely easy navigation as the feature is easy to use, requiring no more than what users already know how to do, and meets potential consumers at a spot where they are already active. Reebok is hoping users can discover incentives for purchasing real-life sneakers through their digital interactions (Walk-Morris, 2024), as it offers a fun and interactive process for users who may not have originally been attached to the brand.

Reebok's initiative represents a significant step in the integration of AI and digital technology within the fashion industry. By offering up to four pairs of custom digital sneakers for free (Yadlos, 2024), Reebok provides a low-barrier entry point for consumers

to explore this new technology, providing them with a taste for the future and hence encouraging user commitment and retention to the brand (AIContentfy, 2023). While the company is not currently offering physical versions of these custom sneakers, Reebok is confident that the digital experience incentivizes real-life purchases (WEBWIRE, 2024), creating a bridge between virtual and physical consumer behavior.

The public response to Reebok Impact has been largely positive, with consumers appreciating the innovative approach to personal expression and digital engagement. Industry experts have spoken highly of the collaboration for pushing the boundaries of digital fashion and creating a roadmap for future integrations of AI and wearable technology (Silberstein, 2024). Through this collaboration, Reebok is setting a precedent for the future of digital wearables, highlighting the potential of AI to transform consumer interaction within the fashion industry (Takahashi, 2024).

## **DISCUSSION**

### **INTRO**

By analyzing the data gathered from attending discussions led by industry experts, we are able to answer some of the questions raised earlier. This methodology will focus on the potentials and challenges of implementing AI in the fashion industry, along with an understanding of how to combat any of these challenges. In addition, we will touch on discussions about SLMs, user prompts, bias and ethical practices in the industry, and the fast development of generative AI.

### **ETHICAL PRACTICES IN INDUSTRY**

As consumers, we must consider the ethical concerns that come with using AI technology, particularly in 3D capture and virtual humans. Industry leaders mention how ethical considerations, including data privacy, ownership, and bias, must be addressed to ensure responsible AI deployment: including the need to consider the people affected by AI-powered technologies and the broader ethical questions surrounding AI's impact on society (Roberts-Islam & others 2024). The panelists discussed that there should be an involvement of the people whose images are being captured and used in AI applications, to ensure that they consent and have ownership over their digital identities. In addition, there



was mention of where there have been ethical concerns from brands, including discussion of Levis partnership with lalaland.ai, and the digitization of models for digital presence. Panelists mentioned how the campaign had, by trying to install digitization in models across different races, it takes the jobs away from people already struggling to enter the positions, describing the process as a “double-edged sword” (Roberts-Islam and others 2024). There is a large emphasis of the importance of involving people whose images are captured and ensuring their consent and ownership of their digital images. Futurologist Paul Bratcher also emphasized the importance of ensuring responsible AI usage and maintaining genuine human connections, mentioning this will be crucial for the future success of these industries. He also stresses that balancing technical advancements with the development of soft skills and ethical considerations will be essential for navigating this evolving landscape (Bratcher 2024). Imran Farooq mentions how leaders should explore AI tools and encourage innovation within their teams to emphasize a curious mindset, and to help navigate the ethical considerations and risks when leveraging AIs capabilities for strategic advantage (Farooq 2024). The discussion of ethical practices leads into the concept of bias, with one of the largest ethical considerations being to address the potential biases in decision making (Lynch and Bassinder 2024). When questioned about how one would go about negating the biases we see in AI, industry experts answered, mentioning how a large part is just being resourceful about who you partner with, and thinking about what you own and what allowances you have to the data. Another panelist answered how bias can be a positive thing for the brand if your model is tuned on specific brand images and is provided by the brand (Roberts-Islam and others 2024).

## **DISCUSSION SURROUNDING PROPMTS**

Industry experts touched on the idea of using a ‘digital twin’ to predict regulatory changes. A digital twin is a computational model which has been designed to reflect a physical object or process, giving the digital identity of a physical product or entity (Dungate, 2023). One thing which IBM is using is the idea of creating personas using large language models and specifying products with their digital passport, we can see the importance of digital passports further by (Rollwagen 2024) as he mentions the need for the fashion community to adopt digital passports. IBM touches on the idea of using an in-depth and specific prompt to generate consumer profiles, able to analyze their consumer market and what their customers generally do daily (Lynch & Bassinder 2024). IBM goes a step further and mentions how you can interact with your consumer profiles and that by doing that, it allows for a simple way to interact with customer needs, and to gain understanding of if a

new idea appeals to them (Wallace & Weir 2024). See table 3 for the user's toolkit on how to replicate this. Paul Bratcher mentions how AI is becoming increasingly better at expressing empathy and learning how to talk in a way that is reflective of being human, and as it turns out, algorithmically, it's quite hard to spot AI writing. If the person writing the prompt is quite good, it can be difficult to detect. However, on the contrary, if the person writing the prompt has not taken the time to analyze specifics, then there would be a lot of words which are typically generated by AI, and it becomes quite easy to tell if it's not written by a human. Paul says AI “will be ten times more expensive to outperform humans, but then it will succeed, and humans will catch up again, and this cycle will continue forever until we reach the point where we just don't care anymore.” Regarding prompt power, and how humans will use it (Bratcher 2024). From Bratcher’s discussion, we can analyze that the quality of the work produced by an AI is dependent on the prompt power from the user. There is agreement from other industry experts that it is evident when a lazy prompt has been used in marketing, however there is a large room for development when time is taken to ensure AI is being used the right way (Williamson & others 2024). (Farooq 2024) demonstrates examples of advanced prompts to use alongside LLMs such as ChatGPT. The prompt showed a page with instructions on how to craft a buyer persona, with sections open to be changed by the user for more specifics.

Table 3: a user's toolkit on producing and interacting with consumer profiles to understand customer needs.

Step	Description	Detailed Actions	Notes
1	Find or create a detailed and reliable consumer profile creation prompt.	Create a large prompt, ensuring to give the LLM everything that it needs to create a consumer profile, this includes who you are, the product you're selling, the costs involved, the costs you'd expect from the consumer, and your aims in terms of interacting with the public.	<p>An example prompt would look like this (Golden, 2023):</p> <p>“I’m a <i>*what do you do for a living*</i> who is selling a <i>*product/service*</i> that <i>*what does it do*</i></p> <p>Here are other details of the service:</p> <ul style="list-style-type: none"> <li>– <i>*detail about the product/service*</i></li> <li>– <i>*detail about the product/service*</i></li> <li>– <i>*detail about the product/service*</i></li> </ul> <p>My USP is <i>*what is your USP*</i>. My <i>*product/service*</i> starts at <i>*pricing*</i></p> <p>I need to create <i>*number*</i> comprehensive ideal customer profiles.</p>

			<p>Be very specific about the details you provide.</p> <p>These should include the following:</p> <ul style="list-style-type: none"> <li>– job and industry information</li> <li>– demographics</li> <li>– psychographics</li> <li>– challenges and pain points</li> <li>– goals and aspirations</li> <li>– technological proficiencies</li> <li>– opportunities</li> <li>– content I should use to reach them</li> <li>– channels they’re on”</li> </ul>
2	Analyse the consumer profiles.	Look through the consumer profiles, this will allow you to get a good gauge of your target market and see if it aligned well with your expectations.	By asking the prompt to create several different profiles, it allows for a good overview of different areas that would fit into the demographic required.
3	Pick a consumer profile to interact with.	By looking at the prompts and analyzing them, you can see which one you’d like to gather more research about.	Consider which prompt has there not been enough information about in your research so far, and which prompts you would originally conduct interviews for.
4	Create a chatbot.	By asking the chatbot to interact with you, you can give it a name, and tell it the consumer profile which you want it to roleplay with you, asking it questions you would generally ask to an audience.	<p>Example of prompt:</p> <p>Please take on the identity of ideal customer profile 3: film and theatre student, call yourself Emily and have a conversation with me based on the customer profile written.</p>

5	Interact with the large language model as a chatbot.	You can now ask the chatbot about any specific questions, being trained on the consumer market, the chatbot will be able to reply with accurate data.	Example of prompt:  ‘Hi Emily, please can we discuss any gaps in the market for SFX makeup? Where would you like to see there be a larger focus. ‘
6	Ask ‘Emily’ to return to being chat GPT	This will allow you to ask questions to the original LLM to analyze the conversation had with the chatbot.	Example of prompt:  ‘Hi Emily, please go back to being ChatGPT’
7	Ask ChatGPT to create a review of the conversation had with the chatbot.	By asking the LLM to create a comprehensive review of the conversation, which will help identify trends and provide a clearer understanding of the target market's needs, preferences, and expectations.	Example of prompt:  ‘Please generate a comprehensive report on the interactions with Emily, highlighting trends and identifying areas for improvement to refine the consumer profiling process. Additionally, provide a detailed overview of the preferences and expectations of my target consumer market.’

## GEN-AI AND ITS FAST DEVELOPMENT

Generative AI is something which is being widely used through industry, academia, and even by the general public. Panelists mentioned how generative AI will cut across all areas of business, including sampling process, product design, and photorealistic images. One area in particular is social media, where there has been a rapid growth in using AI to create social meaning and social listening. The panel discussed that by leveraging this, they are able to expand on the idea of customer facing AI stylists which incorporate the knowledge around style and fashion within the AI stylists and can therefore be a trend led business

(Williamson & others 2024). Farooq agrees with the panelists, mentioning how ChatGPT has grown exponentially since it came out in November of 2022, and it is now capable of producing images to video, singing songs with your own voice, text generation, hyper realistic imaging, and more. From a fashion perspective, GenAI has been used in the fashion industry by models and users having created their own digital AI twin, which has been sent to be an influencer (Farooq 2024). Industry expert Matthew Drinkwater mentions how he believes that AI will be necessary in the future of the fashion world, touching on ideas such as visualizations becoming much quicker, and overall allowing a much more meaningful experience (Baron & others 2024). IBM mentions how generative AI is becoming incredibly useful in prototyping and producing designs, and allows them to create 1000 designs in minutes, as opposed to the long while it would have taken the design team originally. Speakers mention how IBM had previously partnered with adobe to create a generation with their firefly tool, this used all of adobe's images in the model, and the AI was able to create new designs based on the ones owned by adobe, this allows for an enhanced user experience as well as personalized content (Wallace & Weir 2024). They went on to highlight research from HFS, noting the critical skills needed for success in generative AI over the next few years. The study found that problem-solving and adaptability are at the top of the list, followed by skills in software and prompt engineering. These capabilities may already be present in many individuals, or it could be that the more inherently human skills are becoming increasingly valuable. Additionally, they pointed out that the mathematical formula being used to assess the impact of AI might be incorrect, indicating a need for further review and adjustment, they also pointed out how AI is dependent on the data we give it and how we train it, thinking of it as a child (Bassinder and Wallace 2024).

### **3D MODELLING SOFTWARES, AND VIRTUAL FITTING ROOMS**

There is a large movement towards the implementation of augmented reality for the everyday consumer, with industry leaders and academics being excited about clothing using VR and how we can use AR to enable fashion. Panelists discuss how it doesn't make sense to continue to perceive the digital world in such a two-dimensional way when we are used to perceiving the physical world in such depth, they build on this by saying how AR allows us to experience those layers in a much more seamless way. Panelist Ommy also mentioned how they found it extremely exciting how AR can render lighting, rapid prototyping and different fabrics, all in real time. These advancements allow for AI to

integrate with experimental work, being the key to developing more seamless and accurate AR experiences. There is a further discussion on the use of AI with body tracking, this started off being an extensive process in which you'd need to put on a "crazy suit" which came with tracking balls under different parts of your body, in order to track body movement, whereas it has developed so fast that it can now be done extremely easily and quickly with so little as a camera on your mobile phone. This allows for clothes to be tracked with movement, and hence makes this extremely current for fashion. Some challenges here include that cloth simulation is very difficult from a computational perspective. Following this, panelists discuss the future path of AI, agreeing that the age of AR is already here, with it already living in our phones, with apple software allowing the phone to understand where something is faced both positionally and rotationally. Panelists further explore the future possibilities, envisioning a scenario where everyone wears smart glasses, allowing them to interact with digital personas and access digital profiles of the clothes others are wearing as they pass by. These possibilities allow for a hybrid between virtual and reality and allow for a nice area for virtual fitting rooms to slot into the world of AI (Akhe & others 2024). Other industry experts working in the fashion innovation agency mention how they are inspired by using this technology to move in real time, able to stream them in at the same time they were captured, elevating fashion language and creating new layers within it: then integrating them within digital platforms so that they can identify new ways of storytelling. A panelist mentions how their coworker Costas Kazantzis had made an AR filter out of the clothes owned by people in the department, which were scanned onto the system, allowing for their own reactive reality. Panelists also mention how it 'just makes much more sense to visit forms and systems that integrate digital and physical layers together', and how AR is something which really allows this vision to come true. However, when delving onto further than our sense of sight as humans, panelist Moin Roberts-Islam was passionate in his certainty that haptic technologies would not be something which would be integrated into fashion in our lifetime, due to the lack of need and the difficulty of replication (Grant & others 2024). These discussions allow insight into where the integration of 3D modelling is currently, and where it is likely to go in the future.

**Paul Bratcher** (Bratcher, 2024)

### **Bias in AI**

In our interview, Paul Bratcher explored the issues of bias within AI systems, especially those utilizing image generation within the fashion industry. He elaborated on how AI

models are typically trained on extensive datasets, which often include publicly accessible images from platforms such as Flickr and Instagram. These platforms present a curated and often idealized view of life, where users predominantly share aesthetically pleasing and aspirational content, however, this data does not realistically reflect the lives lead behind the scenes. Consequently, the data that AI systems are trained on inherently possesses cognitive bias. For instance, Instagram images frequently feature attractive individuals in picturesque locations, contributing to a skewed representation of reality. Bratcher pointed out that this bias is not only a reflection of individual preferences but is embedded in the larger cultural narrative which favors certain aesthetics over others.

Bratcher goes on to mention how moving away from bias is something that we will never be able to do, as it is impossible to eradicate it completely. Bias is something that we couldn't fix in the real world, it is ingrained in every part of data and in every human being. Additionally, bias is not universal: it will change with each person, and is deeply entrenched and multifaceted, furthermore it is also shaped by diverse cultural, societal, and generational perspectives. The inherent biases in data collection—such as the tendency for users to post only the most flattering images—combined with the biases in algorithm design, create a compounded effect that is difficult to neutralize entirely. These factors mean that the virtual world is incredibly interlinked with the real world, bias cannot be negated in one without it being negated in the other, and trying to gather a universal moral compass is near impossible.

Following on from this, companies are trying to introduce methods of removing bias in their use of AI. However, the algorithms designed to mitigate these biases often introduce their own set of biases. For example, when AI attempts to balance gender or ethnic representation in generated images, it relies on the preconceptions of the engineers who created the bias-correcting algorithms. This can lead to unexpected and sometimes absurd results, such as generating inappropriate or historically inaccurate images. A notable instance Bratcher mentioned was Google's image generation system producing images of African American members of the Ku Klux Klan due to an overzealous attempt to remove bias.

Looking forward, Bratcher speculated that as AI becomes more integrated into our daily lives, the manifestations of bias will likely mirror the biases present in society. In the fashion industry, this could mean AI-generated content will continue to uphold idealized beauty standards unless there are deliberate efforts in place from brands to diversify the data, which the smartest companies will always try to work around. He mentioned how you will have a spectrum, with some firms attempting to be as representative as they can,

some being conformist with only visual representation, many firms in the middle playing it safe, often with one standout diversity hire, and on the far end of the spectrum, there will be brands who don't care, and will be using whatever the technology produces, being the equivalent of fast fashion.

Bratcher suggested that the solution does not lie in attempting to eliminate bias entirely but in managing and understanding it better. He emphasized that bias in AI reflects broader societal issues and that addressing these requires a holistic approach. For instance, improving diversity in the teams that develop these AI systems and being more conscientious about the data used for training can help mitigate some bias. However, he acknowledged that this is an ongoing challenge, as societal norms and values are continuously evolving.

Bratcher also mentions how he does not think bias is always necessarily a bad thing. He mentions how he doesn't think it would be harmful to get rid of extremes of either end of bias, and goes on to express that extremist viewpoints should not be weighted with equal respects to viewpoints with mass position. Bratcher discusses how a dangerous side effect of bias is trying to flatten the curve so that every opinion has equal merit, whereas it should instead be weighted by some form of consensus.

## **The Role of Prompts**

Paul Bratcher discussed the role that user prompts play in generative AI, particularly within the context of applications in the fashion industry. He stressed the importance of involving AI actively in each step of the creative process, advocating for a practice where AI is regularly invited to contribute to tasks ranging from ideation to problem-solving. The aim becomes to invoke a chain of thought with the AI, not stopping at the first prompt, but instead pushing beyond the initial moment. Bratcher's advice is to integrate AI into daily activities, encouraging users to spend at least ten minutes a day interacting with AI tools, building it into your daily habits. This regular engagement helps users become more adept at crafting effective prompts and understanding AI's capabilities and limitations.

Bratcher emphasized that the quality of AI output is heavily dependent on the prompts provided. He advised prompts to be detailed and contextualized, like giving instructions to a less experienced individual. For example, rather than asking a vague question like "What are the benefits of AI in fashion?" A more effective approach would be to break down the question into specific aspects: this involves providing a large amount of context prior to



asking the question, either starting with a large prompt setting up lots of detail or starting a discussion as if the AI was a real person. This structured approach allows the AI to understand the context of the question better and hence provide more nuanced responses. He also mentions how LLMs such as perplexity have behind the scenes prompts which generate the steps to do the research prior to doing the users prompt, but getting into the habit of breaking it down further will work better for long term prompt efficiency.

He highlighted the nature of working with AI, where users can refine and build upon the AI's responses with more prompts, as if having a conversation. This iterative process is crucial for complex and creative projects, where the initial output might not be perfect but can be improved through successive interactions. Bratcher noted that while concise prompts can be effective for straightforward tasks, more intricate and creative endeavors benefit from longer, more detailed prompts that provide comprehensive context and clear instructions. He mentions how longer prompts are useful when the query is more research and factor oriented, and when his thoughts are already well formed, allowing him to pre-scaffold the points he wants to be considered.

Contrastingly, he mentions how shorter prompts are effective when you want unbounded creativity and aren't quite sure where the discussion is aiming to go. Short prompts are also useful when you can do several short prompts in a row, this builds a context scaffold as the interaction progresses.

Additionally, building on the idea of using many short prompts, Bratcher discussed the concept of prompt chaining, where a sequence of prompts is used to guide the AI through a complex task. This involves starting with a broad prompt and gradually narrowing down the focus based on the AI's responses. For instance, in fashion design, one might begin with a general prompt about creating a summer dress, followed by more specific prompts about the desired fabric, color palette, and stylistic elements. This method makes use of the context scaffold discussed previously, and maintains a coherent flow of ideas, resulting in a more refined final output.

Using a large prompt would be useful, for example, when seeking to compare two skincare products, a prompt could be structured to first ask the AI to list the criteria for comparison, followed by another prompt to apply these criteria to the specific products. This step-by-step approach helps in building a comprehensive response.

Bratcher mentions how expanded prompts will become ubiquitously everywhere in the future, with every company using them, and AI becoming another interface in their devices.

He mentions how the future will involve many more people speaking to their phones and won't even realize that they are prompting it as they do this. As this evolves, prompting will become progressively easier. He also discusses that there will be a spectrum of skills, as with everything, where most people will be able to use AI averagely and there will be the odd person who will be able to use it to produce excellent results.

Diving further into the world of generative AI, Bratcher mentions how the tools are currently not good enough to generate a finalized product in one prompt, and how you iterate through many different prompts to generate the final design. This process becomes an AI scrapbook, with scrapbooking in the past having been done manually with scissors and glue, followed by the age of photoshop. Bratcher mentions how he believes us to be near AI becoming integrated into this process, with some refinements being needed for logo swapping using AI, which is nearly there, and adjusting specific details on a design without the whole design changing as a result. He goes on to mention how this future is only so far away as there is such a large use case for this.

Furthermore, Bratcher discusses how generative AI is driven by probability, and when using GenAI to produce images, it is likely that 6 out of 10 of them will be incredibly similar. He mentions how, when looking for innovation ideas, users need to find a way to filter out the results which everyone will get, and to build the skills for AI to produce more diverse ideas and thoughts. With AI being used as a tool to do the dull data grinding research, it allows for a human touch with humans overseeing the driving process.

In terms of augmented reality, Bratcher mentions how companies such as Nvidia are using AI for asset creation, such as scene generation: where it is being used in set dressing. This allows for an entire 3D model for metahumans to interact with, in a gamified reality where a user can walk around the different biomes. Building these graphics is originally a very time consuming and tedious task. Recent developments are looking to provide tools which make this much easier for the designer to do, it does this by using AI controls to generate all the various scene, and then algorithmically generates everything else. When using AR in a fashion context, I asked Bratcher on his thoughts of using prompts to design an article of clothing before putting it on an image of the user. Bratcher explained how this is 3 different systems, with the first being modelling the user using body scans to create a body map, which is currently already in development in luxury beauty brands such as Chanel. During this process, you would be scanned and essentially have a virtual version of yourself, for the exact purpose of modelling the clothes on a user. Whilst this currently requires the user to be wearing close fitting clothes, it is likely that as more data is collected, accurate scans will eventually be developed which aren't dependent on the fit of the users clothing.

The second problem includes the virtual design of the product which would be mirrored onto the user, and the third problem would involve merging the two together. The second problem proves the most challenging as garments are incredibly complicated due to their various textures and properties.

## **Haptic Technologies**

Haptic technology in fashion, while innovative, faces significant challenges in terms of widespread adoption. Bratcher mentions how haptic feedback, which provides tactile sensations, is already utilized in specific applications such as wearable technology. However, integrating this technology into everyday fashion remains complex due to the nuanced nature of fabric textures and the detailed sensory feedback required. While there are advancements in interactive fashion, such as garments with LED displays and changing patterns, as seen in Adobe's Project Primrose, full-scale haptic integration is still a distant reality. The primary hurdle is replicating the intricate feel of different materials in a cost-effective and practical manner. Despite these challenges, there is potential for haptic technology in niche markets and high-end fashion, particularly in products that combine fashion with health and fitness tracking, and integrations with medical applications. For example, thinking about clothing which tracks diabetes and blood pressure would be an entire market once the technology is there. The largest challenge currently is that there is not yet a complete interconnection of these fields. The goal would be to ensure aesthetics and certain achievable looks are still wearable, and have technology integrated, instead of having to sacrifice aesthetics for functionality. Bratcher mentions how we will move towards having more interactions between fashion and technology, for example, rings which have your wallet on them and provide haptic feedback when a transaction is processed, or gym and workout wear which coordinate with a workout routine. Whereas there isn't a need for generic implications. The future may see more sophisticated applications, but widespread consumer use is still a long way off due to the challenges associated with replicating haptic feedback corresponding to the properties of fabrics, and the lack of a requirement for this.

**Damara Yolanda Inglês** (Inglês, 2024)

## **Augmented Reality (AR)**

AR has the potential to revolutionize how we interact with the digital and physical worlds. Damara Yolanda Inglês elaborates on how AR serves as a bridge, with the power to integrate digital enhancements with our reality, using it to create more immersive and empathetic experiences. The pandemic significantly accelerated the shift from basic digital overlays to hyper-realistic interactions, from which we went from posing with interactive filters, to the other extreme where our avatars are now in the metaverse. In digital fashion, AR has evolved from simple avatars wearing virtual clothes, to detailed lifelike simulations which mirror the nuances of physical fabrics and designs.

Inglês discusses how LLMs which can produce a scene or image, and regardless of machines such as DALL-E and Midjourney being the same species, the results they produce for each generation would be wildly different. This also, however, allows for a large degree of personalization. If we imagine template creation when it comes to experiences with augmented reality in relation to prompting the model, since not everybody would have the exact same filter, it will allow for a more unique filter being generated. This allows for the consumer experience to be far more unique as there will be hundreds of versions of products to be created, this allows for technology to make use of its creative power, decreasing predictability and allowing for products to be less sterile.

Inglês points out that AI's role in AR is crucial in enhancing human connections through gestures and imagery, which are fundamental modes of communication that we see physically. She mentions how having experiences designed by other people projected into your body is 'such an amazing tool of empathy'. She expresses how much she wishes that AI would explore this more, and how guidelines on different platforms don't allow for a certain level of dialogue and visual connection, that she hopes to see in the future.

This shift towards more human-centric AR experiences allows for a deepening of our interactions, making digital engagements more meaningful and reflective of real-world emotions and situations. For instance, wearable AR devices could allow users to experience the emotions or conditions of others, this would foster a greater sense of empathy and understanding in individuals that we seem to lack in social media currently. Inglês and I imagined a scenario of walking down the street and receiving real-time information about the people around you, such as a notification that someone is feeling sad, prompting a supportive gesture from you. This kind of interaction can transform social dynamics, making us more aware and responsive to the emotions of those around us. This could be heavily influential since it allows us to move away from a digital world which views reality through rose tinted glasses, and towards a digital world which builds in the realities of human experience and emotion into it.

Inglês goes on to highlight the creative potential of AR in storytelling and artistic expression. AR can project experiences designed by others onto our own bodies, serving as a powerful tool for empathy. She mentions how mainstream platforms such as Snapchat's Lens Studio and Meta's Spark AR have begun integrating AI and AR to enhance user experiences. However, these platforms often impose guidelines that limit the depth of emotional and visual connection. Inglês advocates for a more open approach, where AR can be used to explore a broader range of human emotions, including those that are often considered negative or uncomfortable. This would allow for a more honest representation of our reality, capturing the full spectrum of human experiences. She mentions how she loves to imagine digital and virtual archaeologists looking back to find rare data and connections, she goes on to say if that these archeologists looked to the state we are in today, they would instead be disappointed to see only beautiful makeup and flowers.

Inglês discusses how she doesn't believe that platforms will soon operate in a way which allows for more raw human emotion to happen in an authentic way due to user guidelines based on the diversities of users existing in that space, the first AR platform doing this, she says, would need to be willing to be offended, with users understanding and expecting there to be tension in the space. Inglês says how currently, even language is sanitized, and of course you can go about by sanitizing human nature, however that would lead to a boring experience due to the human experience being unsanitized in real life. She emphasizes the need for contemporary representation of the times we are living in, reflected in AR. The process is substandard due to these guidelines and prevents a certain level of meaning due to it existing within a box. Inglês mentions how emotions involving anger and sadness and depression are all completely natural existing processes of our brains, that technologies which we interact with must have the ability to mirror: lack of doing this would promote a feeling of guilt for not replicating these processes. Inglês discusses how currently we're in a space which makes you feel bad about your features, and to imagine the idea of feeling bad about your emotions too.

In terms of addressing these issues, and moving forward to find a representative solution, Inglês thinks that the notion of safety which we have currently should be challenged. She mentions how going into an eco-chamber and thinking that everybody thinks like her, is in fact the opposite of safety and can become quite dangerous. She discusses how for her, finding an accurate representation of AR in a safe space would actually include having an unsafe space to express diverse perspectives. Additionally, she talks about how these issues are filtered out by awareness and experience, one thing which would be important to have would be digital platforms for different age groups, children growing up watching

identity shifts online would be damaging for a sense of self and identity. Inglês thinks it's important to use these technologies to have honest dialogues about history and reality, rather than to use these technologies to escape reality.

The future of AR, as envisioned by Inglês, involves more niche platforms who break away from the sanitized, mainstream narratives. She discusses wanting to see a "punk movement" in AR, where platforms allow for these raw and unfiltered expressions of human emotion. She touches on how it would be interesting to see filters which allow for seeing people on fire and mentions the irony of these videos existing in real life, but not being compensated for on digital platforms. This could involve creating AR experiences that reflect the harsh realities of the world, such as the impact of war or social injustice, rather than just projecting an idealized version of life. She goes on to discuss how existing in a beautified world where we see filters engaging in cute freckles and pink blush, and distorting faces to give someone white skin, caucasian noses, asian eyes and african lips, is not something which is representative of the real world, but instead is an extension of certain vanities, Inglês mentions how she would instead love for it to be an extension of securities and vulnerabilities.

Inglês mentions how a change to raw and unfiltered human emotions being seen digitally is extremely important if we wish to see an augmented or virtual reality. If we simply project an idealized version of reality, then we are instead projecting a distorted reality and will not be able to achieve a full representation of humanity. AR has the potential to make use of an accurate reality and become a powerful medium for social commentary and change, helping to raise awareness and provoke thought about critical issues.

### **GenAI and spatial computing with AR**

Inglês mentions how using GenAI and AR together allows for limitless possibilities, she discusses how some possibilities would involve people with different impairments and disabilities being able to connect with people in a different way. She discusses a scenario of trying on clothes in a virtual fitting room, but as well as the clothes being worn, one of your legs is prosthetic, she mentions how this would prompt an emotional response at a much higher level than what we are seeing right now. She talks about the possibilities of people with neurodivergences having access to meta glasses, which can better read facial expressions, it also gives people better ways to verbalize emotions. Inglês mentions the project she had taken part in, in collaboration with snapchat, about their spectacles which grow with you, and each time you turn it on they grow a little more and change color. This

wearable technology creates a bond, knowing who you are and creating an identity specific to you. For Inglês, the direction of AI is about creating an augmented reality wearable, where each person who downloads it has a completely different experience, even if an item is trending and would originally have been the same for each person. This could involve them having different patterns or growing in different directions, it could also depend on the facial expressions of the person wearing the item, with different facial expressions reflecting different colors of the garment and different emoticons.

She also discusses how the use of spatial computing could allow for human interactions, for example, if somebody had a deep blue garment to reflect their sadness, then another user could show them a positive interaction such as a smile to try to make the blue garment a little bit greener. Additionally, it would allow for AR device enabled experiences, such as your garment overlapping with someone else's, allowing for changing colors and graphics around it. Inglês describes this emotional connectivity as a spontaneous moment of serendipity and describes how genAI can really allow the ability to create a single experience which is 100% different for each of its users. Furthermore, currently we are limited by linear lists on social media profiles, for example, however in the future we could all have glasses which prompt notifications, allowing you to share music to make somebody happy, allowing for a much more fluid experience. This is simply something which is not happening now. Spatial computing would also allow for interaction with people as they come, for more raw connections with people on the train or in the supermarket, rather than rigid following lists.

Inglês discusses how this platform will likely be similar to IOS and android devices, where each device will have the same apps in both stores available, therefore giving people the ability to access this space from different devices. She also thinks that much smaller communities will come from this space, and every now and again users will encounter people from specific groups they are a part of. She especially thinks that smaller language models would be seen rising in this space as it allows for more individuality.

### **Small Language Models (SLMs)**

Inglês explains that SLMs are increasingly being recognized for their potential to create more personalized and adaptive user experiences, for example, when integrated into platforms such as Snapchat's Lens Studio, they allow for highly personalized and customizable digital interactions. These advancements can significantly increase user engagement. Unlike larger models, SLMs can be tailored to specific brands or

communities, ensuring unique outputs that reflect individual preferences and histories. This level of granularity allows SLMs to generate content that feels unique to each user, thereby enhancing their sense of ownership and connection.

Inglês notes that SLMs can revolutionize the consumer experience in digital fashion and retail. For instance, a fashion brand could use a SLM to design garments which adapt based on a customer's personal data, such as their favorite colors, styles, and past purchase behaviors. Currently, our social interactions are mediated by a flat screen where people are in little squares and all appear at once, once you remove this space and have it integrated onto the street, it will create a different space where people will stop trying to be the same as each other, as they are online, and they will instead try to be unique to themselves. Inglês goes on to talk about how online, people will post for likes and shares and don't want to stand out, but in real life people want to be unique and have individuality, inglês states that the only conclusion she can draw is that people online are currently all looking the same due to the state of these platforms being one of conforming and unifying identity.

The integration of SLMs into creative workflows also holds significant promise. Inglês describes how SLMs can be used to assist designers in generating ideas and refining their work. For example, a SLM could help a designer create a variety of garment patterns or suggest modifications based on current fashion trends. Inglês thinks it's important to continue the bond we experience with our physical objects, into a virtual space with our digital objects too, even when a million people own the same product, you still feel a sense of connection with an object that you own. This collaborative approach between human creativity and machine learning can lead to more innovative and diverse designs. She talks about how these brands can make use of genAI to generate colors and patterns for the buyer, going on to say that the digital counterpart would include interacting with a LLM, to ensure that a digital wearable must be worn for a week to establish a connection before generating things to do with the specific user. There is even the possibility of prompting a brands genAI, or creating your own and selling this, enabling for hyper personalization.

Inglês discusses how the future would look, with mention of it likely being a freemium model, where everybody is able to prompt a LLM and your prompting identity would be being fed into a larger machine, this could even result in people down the street wearing t-shirts with your grandparents faces on, since they would be part of the network. It would also give the opportunity to pay more and use a SLM for couture wearables. This would lead to brands wanting to keep their knowledge exclusive and private, along with their prompting mechanisms, eventually leading to brands having their own SLMs which are



based on the archives of previous designers and sustainability goals from the company. The machine would become a collective brain of everybody in development in the brand, essentially making the model the brand itself. By being a smaller language model, then there is a bias created towards the brand identity, and complete control from the brand itself. SLMs also can mitigate some biases inherent in larger models. By focusing on more specific datasets relevant to their application, SLMs can provide outputs that are less likely to perpetuate harmful stereotypes or inaccuracies. Brands can also work on the values they wish to include, and create more diverse and representative designs, thereby better catering to a wider range of customers and promoting a more inclusive market.

**Costas Kazantzis** (Kazantzis , 2024)

### **Intersections and Challenges of AR and Fashion**

In our interview, Costas Kazantzis and I discussed the integration of AR and the fashion industry. Kazantzis, with a background in computer engineering and visual communication, has been using AR to create interactive and immersive experiences that blend the physical and digital realms, alongside using technological means to identify new ways of disseminating visual content in ways which are more interactive. He emphasized that AR, as opposed to purely virtual environments, offers a more seamless and realistic integration into daily life, especially post-COVID, when digital fatigue has become a significant concern.

Kazantzis explained that AR enhances the physical world by using it as a canvas to project digital visuals, thus making digital experiences more spatial and immersive. He mentions how this allows for the physical world to become digitally aware. He goes on to say how for a long time, we have been consuming the digital as a separate entity using screens, but with AR and other advancements, this won't be necessary anymore, making it more logical to consume both the digital and physical together. In fashion, AR is often used for virtual try-ons and to extend the lifecycle of physical garments by allowing users to change textures and styles digitally. However, he noted that achieving photo-realistic AR outputs, which meet the high standards of luxury fashion brands, remains a significant challenge. Kazantzis also mentions how he is interested in connecting physical products to digital experiences to create more interesting relationships between fashion brands, designers and the audience. His aims include focusing on identifying ways where digital experiences can enhance what we already have physically, rather than completely replacing them,

emphasizing how continuing to perceive the two realms as distinct entities will not take us anywhere.

There is also a large amount of room for development of 3D modelling, Kazantzis mentions how you can map digital effects in specific places in the physical world, allowing for more responsive digital augmentations which seem more realistic. This allows them to identify real world barriers, which can be possible by considering digital layering, in which the physical world becomes the canvas for these creations

There are still a lot of limitations in current hardware. One of these include the number of graphics which can be streamed, due to AR being experiences through a mobile or headset, and since the processing power is limited, it cannot serve as well as a gaming laptop, for example, where the graphics are very enhanced. Kazantzis goes on to say that photo realism in AR is very challenging, with luxury fashion requiring a perfect output, where big brands need to see the output to believe that it is possible. Over the last 5 years these challenges have been being reduced, and the implementation of AI allows for algorithms to create more seamless integrations. For instance, AI can be used to create realistic cloth simulations for virtual try-ons, where digital garments need to behave realistically in response to a person's movements, creating creases and folds accurately. This involves training AI models with your outputs to understand and replicate the behavior of different fabrics, which is currently a complex and time-consuming process. Currently, AR would allow you to scan something, pre-render it, process it and create the output. However, this process would not account for the experience to run with real-time processing, which adds another layer of complexity, and significant computational power to deliver these seamless AR experiences.

Kazantzis also mentions how we are experiencing a very different phenomena from when the iPhones were released, as these were created prior to the needs. However, this time, the world is already so integrated with digital industries, hence the needs for immersive experiences have already been created, and it is a matter of time until the corresponding hardware is produced. Furthermore, he mentions how a lot of his views are future-facing, and therefore it is a lot easier to collaborate with newly emerging designers who are willing to take risks and experiment with this technology rather than bigger brands who are more hesitant.

Generative AI, which has grown largely recent years, has possibilities in fashion design. Kazantzis believes that generative AI will continue to be used at a larger amount in the industry and mentions how it is being used as a design tool to create mood boards and

iterate on design concepts. He emphasizes that generative AI cannot replace the nuanced skills of a fashion designer, it instead serves as a valuable collaborative tool, enabling designers to co-create with AI and explore new creative possibilities. He highlighted the importance of spending time with AI models to understand their limits and strengths, this ensures that the outputs are unique and reflective of the designer's style. He would also like to see genAI being used to create 3D worlds and assets.

## **Future of Fashion Tech, Social Media and Digital Integration**

Kazantzis envisioned a future in which AR becomes an integral part of everyday shopping experiences, this would allow consumers to virtually try on clothes and visualize outfits in real-time. This technology offers the convenience of e-commerce alongside the experience of physical stores.

Individual brands in the future, may move towards customizing their own AI models, or training existing ones to do so, based on previous work. This would be an interesting use case of SLMs and agrees with Inglês's vision (Inglês, 2024) of how small language models will allow for a brand's identity to be represented independent from an overarching system. Kazantzis emphasizes how he feels this would make a large amount of sense for where brands should go. In terms of where they are being used now, there are young designers using smaller models which they have trained themselves, however Kazantzis hasn't heard of big brands using these models. In the future, brands will move towards implementing smaller models dependent on the size of the brand and their financial status, and if the brand was willing to employ people working with AI.

Kazantzis and I discussed the current states of social media, and its relation to the fashion industry, individuality and microtrends. He discusses how the current platforms are heavily focused on individualism and consumption, often leading to feelings of alienation and depression. By taking inspiration from more interactive use cases of 3D which could be applied to social media, we could move away from the dry feeling currently perpetuated from these platforms. Kazantzis advocates for a move towards community-centric platforms which prioritize collective well-being and problem-solving over individual metrics such as likes and followers.

Kazantzis also touched on the future of social media, believing it will also be shaped by AR and AI. He does think that they could have more 3D integrations however also expresses

the importance of the mindset being the social media platform created. He speculated about the possibility of social media becoming more immersive and interactive, becoming a space where users could engage with digital overlays in their physical environment. For example, walking down the street and seeing interactive digital elements through AR glasses could become a reality. He goes on to say that if we completely eradicate the individual from our brain and shift away from having a profile with picture perfect images and a platform where you count your likes and followers, then social media could be used to solve action problems and to help in well-being.

In terms of fashion shows, Kazantzis mentions his excitement about the potential for hybrid events that combine physical and digital elements. He envisions fashion shows where physical models' movements are translated into digital avatars, allowing audiences in both physical and digital spaces to experience the event simultaneously. This would allow for everyday users to enter a gamified experience and view a fashion show in this way, as well as the real time fashion show which would be happening exclusively. This approach extends the reach of fashion shows and introduces new creative possibilities, such as digital-only catwalks in fantastical environments. These hybrid events can democratize access to high fashion, making it accessible to a broader audience while maintaining the exclusivity and glamour of traditional fashion shows. He continues to explain how the idea of a real time live hybrid fashion event would allow for people to gather at a physical location, emphasizing how technology has the potential to connect us rather than alienate us.

Kazantzis describes the body as a territory, where there are limits that need to be considered in real spaces. However digitally, these restrictions are shifting away since the body can be a starting point for creating experiences for creative experimentation. This poses a question of how to define the body in between material and immaterial spaces, with a lot of conceptual interest surrounding.

Looking ahead, Kazantzis envisions a future where fashion technology is more integrated and immersive, where the everyday person can gain access to these devices. He anticipates that AR and AI will play significant roles, and additionally there will be significant advancements in hardware, such as lighter and more affordable AR headsets, which is something we do not see currently as hardware is very expensive and heavy, and often causes strain on the eyes. He also believes that fashion brands will continue to increase their use of AI to create more personalized and engaging experiences for consumers, both online and offline.

## **Ethical and Practical Considerations, Queer and Diverse Spaces in Fashion**

Kazantzis emphasizes the need for responsible and ethical use of AI and AR technologies. He criticized instances where brands have used AI for the sake of using technology, without considering the broader implications. He discussed Levi's facing large backlash for using AI-generated models to promote diversity, inside their Lalaland.ai project, instead of supporting marginalized communities directly. He states how in his opinion, the most problematic part of this project was the fact that they used the AI and labelled it as a diversity story. He found it startling that such a large and old brand didn't have anybody in the marketing team have a second thought about this potentially being problematic. This highlights the importance of thoughtful and inclusive implementation of AI in the fashion industry, as it was not the technology which was the most problematic but instead the way it was represented.

Kazantzis talks about his views on this technology needing to change, technologies which are human made cannot always be trustworthy, additionally, technology can fail and glitch. His view is that we need more examples of technology being used for radical purposes. Kazantzis mentions how the benefit of the controversial Levi's project is that the criticisms around it will build the framework of where AI is going. He still thinks there will be applications of GenAI in fashion, but they will be more mundane jobs rather than taking over marketing, especially in the creative sector.

Fashion is often something used for identity expression, something which Kazantzis wishes to see translate to AR. He mentions how anonymity has been very important for underrepresented and marginalized groups, and how these groups are finding it easier to express themselves in the digital space rather than the physical world. He goes on to say how the human experience is unfolding into a discussion about what it means to be human, where it isn't just existing in a physical world where we acquire a finite space, anymore. Kazantzis agrees with Inglês view (Inglês, 2024) on a need for a decentralized space, this allows for people to gather and exist beyond moderation algorithms and control from major tech organizations. This allows for voices to have representation when they didn't in mainstream. He mentions how he believes 3D can be used together with decentralization to create these interactive spaces.

**ALEX KARIM** (Karim, 2024)

## **Bias in AI Systems and Their Applications**

Bias, being inherently tied to the data AI systems are trained on, poses a significant problem in ensuring that these systems are culturally sensitive and inclusive. As discussed by Alex Karim, the responsible use of AI involves using a robust framework where bias is one of the cornerstones, along with transparency and trustworthiness. The complexity of bias mitigation stems from the fact that LLMs rely heavily on large datasets which reflect the biases present in the real world, as discussed previously by Bratcher (Bratcher, 2024). These models, such as those developed by OpenAI, effectively use a large chunk of data—almost a condensed version of the internet—to predict responses. Consequently, any inherent bias in this data inevitably influences the AI's output. This results in it being difficult for the data to be unique, as they are trained on past events. Combating bias in AI becomes a challenge not because of the AI, but because of the data that we are feeding it, Karim says. For instance, in a recruitment scenario, if historical data predominantly features successful candidates from a particular demographic, the AI system might inadvertently favor similar profiles, perpetuating existing biases.

Karim discussed how we go about handling these biases, mentioning how the iterative process of refining AI systems, which is often termed "red teaming," involves rigorous testing to identify and correct biases. This process includes feeding the AI various prompts designed to elicit potentially biased responses; by doing this it allows developers to adjust the model accordingly. Karim also explains the concept of temperature: this is how random the next choice of word would be, at one end it would be the highest percentage to reproduce the most likely word, this would result in many similar responses. If, however, the temperature was at the other end of the spectrum it would allow for a large amount of randomness, resulting in much more creative and different answers with the same prompt applied. This essentially allows the user to toggle the type of content desired. Karim goes on to say that while smaller language models can be useful in specific scenarios, such as on devices with limited computing power, they are not necessarily the solution to bias. He believes that larger models are likely to be more effective due to their more comprehensive training on diverse data.

Furthermore, the concept of decentralized spaces has been suggested as a potential solution to reduce bias. In these spaces, individuals can express themselves freely without the constraints of traditional content filters. However, Karim expresses that this approach comes with its own set of challenges, particularly when it comes to training AI systems on such unfiltered data. While it might provide a more authentic representation of diverse

viewpoints, it also risks incorporating offensive or inappropriate content into the AI's training dataset. He mentioned that there have been successful decentralized platforms such as web three and the use of non-fungible tokens, or NFTs, with some of these platforms being more successful than others. Therefore, a balance must be struck between ensuring diversity and maintaining a standard of decency and respect in the data used for training AI systems. Karim discusses how there will be newer forms of AI which present themselves in the future, where we currently have LLMs, ML and deep learning for example, we are going to see new forms emerge. He mentions how there are researchers and scientists exploring these options, as well as how to produce LLMs which are more effective, performant and accurate, with less bias.

In the fashion industry specifically, the use of AI spans various stages from design to manufacturing and retail. Karim mentions how AI tools are increasingly being used to create innovative designs, such as allowing for creatives to test different patterns and brainstorm different designs, enhance manufacturing processes, and provide personalized shopping experiences. AI stylists, for instance, can offer recommendations based on individual preferences and historical data, significantly enhancing the customer experience. He discusses how he thinks that there will be a large amount of collaborative work between the AI and humans, such as revolutionizing the shopping experience, allowing you to have tools accessible on your device to gain information about a product which was previously not accessible in-store. The future of AI in the fashion industry looks promising, with recent advancements, such as the release of GPT-4, demonstrating significant improvements in response time and interaction capabilities. These developments suggest that AI will play an increasingly large role in various aspects of fashion, from design to customer service.

### **Augmented Reality, AI, and Societal Impact**

The integration of AR with AI is set to revolutionize the retail and fashion industries. Karim talked about AR headsets and glasses, such as Meta Quest and Apple Vision Pro, which are paving the way for immersive shopping experiences which blend the physical and digital worlds. These devices, though currently at varying price points, he expects to become more accessible over time, potentially transforming how consumers interact with brands and products. Karim points out that while current headsets like the Meta Quest 3 are relatively affordable, high-end options like the Apple Vision Pro offer a premium experience that could redefine retail. The anticipated advancements in AR glasses, including AI capabilities, will likely make these technologies indispensable in everyday life.

He discusses the possibilities of existing in a 3D space and bring a product into your room, or to be able to have an AI stylist which would be able to provide recommendations on products and give you advice based on what data it is able to interpret visually.

One of the most exciting prospects of AR and AI integration is the enhanced shopping experience it offers. Karim Imagines a scenario of walking into a store with AI-enabled glasses which can provide real-time information about products, such as price trends, customer reviews, and personalized recommendations based on your past purchases. This level of interaction, facilitated by AI companions or "co-pilots," can bring the rich data of e-commerce into the physical retail space, creating a seamless shopping experience. However, the widespread adoption of these technologies will depend on overcoming certain limitations. Current AR headsets are often bulky and expensive, limiting their appeal to a broader audience. For AR and AI technologies to become available to the average person, they need to be more user-friendly and affordable. Karim discusses how once these technologies reach these goals, they are likely to become another integral part of technology, such as smart phones which are owned ubiquitously. Companies like Meta and Apple are already working on making these devices more accessible, with future iterations expected to be lighter, more comfortable, and more affordable. Additionally, the software ecosystem for these devices will play a crucial role in their adoption. Whether brands will develop their own dedicated apps or integrate into larger platforms such as Fortnite or Roblox remains to be seen.

Karim goes on to discuss how the cultural acceptance of AI and AR technologies also raises important questions about privacy and societal impact. Devices such as Meta's Ray-Ban glasses, which include AI capabilities and cameras, bring up concerns about constant surveillance and data privacy. While these glasses are equipped with indicators to show when recording is active, society will need to navigate the balance between convenience and privacy. The acceptance of these technologies will likely mirror the adoption of smartphones, where users have concerns for their privacy. However, users ultimately think that the pay-off from using these devices is worth it. As society becomes more accustomed to these new form factors, the trade-offs between privacy and functionality will continue to be a topic of discussion.

From a community perspective, AR and AI have the potential to foster greater connectivity and interaction. Karim envisions that they could even bring holographic representations of friends and family into one's environment that can significantly enhance social interactions, especially for those separated by long distances. He hopes to see technologies that allow for multi-user experiences, rather than isolating individual users, and believes that this will be crucial in ensuring that AR and AI contribute to a more



connected society. The development of these technologies with a focus on enhancing communal experiences, rather than just individual ones, will be important in preventing a dystopian future that seems to be universally unwanted, in which technology isolates rather than connects us.

## **CONCLUSION**

The integration of AI, haptics, and 3D modelling in the fashion industry represents a significant evolution in how fashion is designed, produced, and consumed. This review has illuminated the diverse applications of AI, from generative AI's role in creating innovative designs and optimizing supply chains to machine learning's predictive capabilities for trend forecasting and production efficiency. AI's ability to hyper-personalize products and improve sustainability practices has also been highlighted, showcasing its transformative potential.

One of the key insights from this review is the growing importance of SLMs in the fashion industry. Unlike larger language models (LLMs), SLMs offer a more streamlined and efficient approach, tailored to specific brand needs and requiring less computational power. This shift towards SLMs aligns with the industry's push for sustainability, as these models are not only more energy-efficient but also allow for more targeted and specialized applications. However, the literature reveals a gap in understanding how these models can be effectively implemented and utilized within the fashion context. Further research is needed to explore the practical applications of SLMs, particularly how they can be trained on filtered, bias-free data to enhance inclusivity and ethical practices.

Ethical considerations are essential to consider as AI becomes implemented within fashion. The review underscores the necessity for companies to ensure that AI systems are trained on diverse and inclusive datasets to prevent the perpetuation of harmful biases. This is crucial not only for maintaining ethical standards but also for fostering a more inclusive industry that reflects the diverse demographics of consumers. This would particularly need to involve having a human touch to ensure that if an AI produced an output which contained biases, that there would be a team devoted to ensuring it was adjusted accordingly. The case studies of Levi's and Reebok illustrate the public and industry responses to AI-driven initiatives, highlighting the delicate balance between innovation and ethical responsibility. Levi's use of AI-generated models to promote

diversity, despite its good intentions, faced backlash for not directly supporting marginalized communities, demonstrating the need for thoughtful and inclusive implementation of AI technologies.

The review also delves into the exciting possibilities presented by augmented reality (AR) and haptics in fashion. AR, particularly through virtual fitting rooms, offers consumers a convenient and immersive shopping experience, allowing them to visualize products on their own bodies in real-time. This technology not only enhances the consumer experience but also contributes to sustainability by reducing return rates. Furthermore, AR would align with future visions including 3D modelling, such as integration with virtual spaces where users at home can access, and use of headsets to engage with online experiences in person. However, the high costs and technical limitations associated with AR, such as the need for advanced hardware and accurate simulations, present challenges that need to be addressed for wider adoption.

Haptics, while still in the early stages of integration into fashion, hold potential for enhancing user interaction and providing feedback which can improve the consumer experience. The French brand Volrose and CuteCircuit's development of wearable music garments are examples of innovative applications of haptics in fashion. However, replicating the intricate feel of different materials in a cost-effective manner remains a significant challenge, one which we are unlikely to see for a long time.

The review emphasizes the importance of user prompts in navigating interactions with AI. Effective prompts are crucial for generating accurate and useful outputs from AI systems, particularly in creative and complex tasks. The concept of prompt chaining, where a sequence of prompts guides the AI through a task, is highlighted as a method to enhance the quality of AI-generated content. This iterative process allows for refining outputs and ensuring they meet the desired standards. Furthermore, the ability to build a framework before inputting a prompt to a LLM is essential for retrieving the best possible output, as you can provide it with a context scaffold prior to asking for the information.

The integration of these technologies represents a significant movement towards a more technologically advanced and consumer-centric industry. AI's diverse applications in trend forecasting, design automation, and personalized consumer interactions highlight its potential to transform the fashion industry. The use of Small Language Models (SLMs) aligns with sustainability goals, offering energy-efficient and tailored solutions, with ethical considerations about data bias and inclusivity needing to be addressed to ensure responsible AI deployment. The use of decentralized spaces is also a large topic of discussion, with industry experts agreeing that this could be a place to embrace problems

of bias with the opportunity to be completely individual. Augmented reality (AR) and haptics present exciting possibilities for enhancing consumer experiences, despite the challenges of cost and technical limitations. Case studies of industry leaders like Levi's and Reebok highlight the practical applications and public reception of AI-driven innovations, emphasizing the need for thoughtful and inclusive implementation. However, criticisms of the public voice allow for the trajectory of AI to be shaped into the direction which the consumers wish for it to progress. Ongoing research, industry collaboration, and a commitment to ethical practices will shape the future of fashion, creating a more inclusive, sustainable, and engaging industry landscape.

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