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Utilising Digital Technology for Garment Longevity

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Abstract: This research explores methods for repurposing both physical resources and contextual specialist knowledge, offering insights that can inspire and enhance future fashion design and re-manufacturing and archival practices within the industry. It questions whether digital fashion design tools, such as CLO3D can expand from facilitating faster production and consumption to enhancing the use and potential longevity of garments. The study employs an ethnographic approach to practice-based research, where the authors focus on the interaction between the physical and digital worlds, to understand the wider application of CLO3D that promotes the value and lifespan of a garment. Two case studies were investigated to explore the impact of CLO3D on longevity: a historical garment archive that examined historic pattern cutting approaches; a contemporary collection of 30 deadstock sportswear garments. This research aims to enhance the designers understanding and accessibility of archival and sustainable practices by exploring ways to expand the use of a garment through existing digital tools.

Introduction

Technology has had a profound influence on fashion over the last two decades. Digital pattern cutting and simulation technologies, such as CLO3D have recently impacted the way that garments can be designed, sampled and produced. This technology has been proven to reduce waste caused by physical sampling and enable adjustments and experimentation in the digital realm (Business of Fashion, 2020). This research aims to understand how this technology can be repurposed to enhance garment longevity of archival fashion and deadstock collections. By adopting creative design tools such as CLO3D, this study uses an ethnographic approach to explore two case studies that address gaps in both past and present fashion practice.

Due to the speed of current trends of fast and instant fashion the time spent considering the fit, cut and manufacturing methods is often vastly reduced. Kent (2024) highlights how recycling isn't keeping up with consumption, with material-to-material recycling accounting for only 2% of recycled fabric used in 2023. This emphasises that the focus on recycling alone will not address environmental degradation. Therefore, it is imperative that we find alternate solutions and use what we have for longer.

Present-day manufacturing often leads to overproduction and large amounts of deadstock (Tonti 2024), creating a waste stream that designers and brands could potentially utilise.

Currently, remanufacturing is viewed as time-consuming and labor-intensive (Stahel 2019), however, earlier research suggests that technology can streamline this process (Wetherell et al. 2023). By examining the current challenges of present-day fashion, this research aims to explore how technology could enhance the efficiency and accessibility of redesigning and remanufacturing, ultimately extending the life of clothing.

New developments in the field of digital archiving have revolutionised the preservation and conservation of valuable historical artefacts. Digital technology affords the researcher opportunities to broaden access to past collections, both historical and contemporary, and its innovative use allows a sharing of previously unmined resources and innovative design solutions, often overlooked in modern-day fashion. However, these artefacts are often inaccessible due to the controlled

environments where the garments are stored, their often-singular geographic locations (Pecorari, 2019) and lack of physical space (McNulty, 2019, p.239). In a generation where knowledge of clothes-making has become lesser known, the fashion industry and fashion design education can benefit from promoting a slower approach to design; pausing to look back, before we move forward.

By exploring new ways to utilise existing technology, we can begin to hypothesize applications that could educate and empower designers to work in a less linear fashion. This approach is aiming to provide tools to encourage slower, thoughtful design elements and create a space to explore alternative starting points, such as deadstock garments. Consequently, two key questions underpin this research: first, how can technology be used to promote garment longevity? Second, how can tools like CLO3D facilitate this process?

Contextual Review

Speed and Environmental degradation

The speed of clothing production and consumption has grown rapidly in recent years, creating billions of excess unworn and unsold items of clothing (WRAP, 2022). Tonti (2024) reveals that the fashion industry is set to double its emissions in the next ten years, highlighting the importance of sustainable change. Niinimäki et al. (2020) notes how our levels of consumption are often outpacing the sustainability efforts undertaken by brands, propelling us towards the 2030 deadline with limited promise. Technology however can pose a threat to such sustainable goals, with fast fashion brands, such as Shien, using technology to accelerate their systems, allowing them to bring new products to their online stores daily. Pucker (2024) demonstrates how Shein are rapidly outpacing the production of brands once considered 'fast', such as H&M, selling over 1.3 million new garment options in 12 months. This significant growth is accompanied by a 52% increase in carbon emissions (Pucker, 2024). This shift to overproduction and underutilisation of garments remains one of the key challenges within fashion:

"The available statistics suggest that between 80bn and 150bn garments are made every year and that between 10% and 40% of these are not sold. So, it could be 8bn or 60bn excess garments a year" (Tonti, 2024).

Fashion brands are predicted to become increasingly dependent on technology, with investments in the tech sector predicted to rise 3-3.5% by 2030 (Business of Fashion, 2022), enabling this problematic shift from fast fashion to instant fashion, causing significant environmental and social impacts (Pucker 2024). It is to be acknowledged that the faster the system of production and consumption, the less consumers use and value each garment in their wardrobes. This increasing volume of garment production is causing widespread environmental damage, especially when garments reach the end of their useful life (Askiner and Gupta 1999).

Digital technology has enabled the fashion industry to reduce waste, particularly during the sampling stages, by utilising digital garment samples created with 3D software (Business of Fashion, 2020). Additionally, it has facilitated automated made-to-order systems. However, these advancements do not appear to be decreasing the production or consumption of garments (Kent, 2024), indicating that there is still significant potential for further improving sustainability.

Today, designers are increasingly incorporating 3D design tools, such as CLO3D, into traditional fashion design processes. This shift creates opportunities to expand these existing 3D skills and transform the linear design process into one that promotes greater longevity by reconsidering how we use the technology that is available to us.

Garment Longevity

In this research, garment longevity refers to the prolonged use and utilisation of existing clothing, which is part of the broader system of circularity and sustainability. As highlighted by the Ellen MacArthur Foundation (2017; 2021) clothing production has surged since the early 2000s, yet the average wear per garment has significantly decreased. This trend underscores the importance of longevity in fostering a more sustainable fashion industry.

The concept of longevity in fashion archives encompasses several key aspects. Access to collections are often limited by geography, restricting the range of garments available for study. Additionally, repeated handling over time

can compromise the condition of fragile artefacts. The opportunities that technology presents could be optimised to create replicas of these garments enabling a greater reach. This potential of online availability beyond the constraints of the object's physical location (Pecorari, 2019) also has the ability to revolutionise access. By uncovering historical pattern cutting and manufacturing techniques, which may otherwise be lost, we can draw from past knowledge to positively impact future approaches to garment sustainability.

Due to present day over-manufacturing there are large number of unused and unsold garments, often referred to as deadstock, that could be reevaluated. Unfortunately, these garments are frequently sent to landfill, shipped to the Global South, or incinerated (Chan 2024). Brands like Patagonia, The North Face, and Nike are exploring creative remanufacturing solutions for their excess stock; however, the current processes remain largely analogue and operate at a micro scale (Patagonia, The North Face, Nike 2025). Due to the scale of deadstock in the fashion industry, there are often multiple garments available in the same size, fabric type, and colour. By leveraging technology, we can identify ways to reduce the challenges associated with redesigning and remanufacturing deadstock, such as time. This approach could help utilise these unused garments, extending their useful life.

Tools for enhancing garment longevity have seen limited development and primarily depend on adaptations of existing technology (Wetherell et al, 2023). 3D fashion design tools, such as CLO3D, are being quickly adopted by university fashion programmes and brands alike to enhance traditional design processes. These tools are now frequently used for production purposes, such as sampling, as well as for commercial applications, including e-commerce and social media (Bain 2022). It is crucial to explore innovative approaches in fashion technology to facilitate garment longevity, with a focus on how current software, such as CLO3D could enable increased lifespans, rather than helping speed up the process of producing and selling new items (Kozlowski et al, 2019). Due to large quantities of resources going into the production of clothing, from the raw materials and manufacturing to the shipping and care (Tonti 2024), exploring ways to enabling garment longevity; extending the time a garment is in use, is crucial to the circular system (Ellen MacArthur Foundation 2021).

Methodology

This research adopted an ethnographic approach to understand how technology can be used to enable garment longevity. Practice-based research was undertaken using two case study examples, the first was looking at the past with garments that are placed in archives that hold information about former design and pattern cutting methods. The second was looking at a present-day challenge, deadstock garments that are produced and remain unused. To understand how technology influenced longevity in these two cases the researchers were emersed in the process, exploring how technology, such as CLO3D could be used to address the longevity of these past and present garments. Both case studies explored the interplay between physical and digital worlds, using traditional physical pattern cutting and manufacturing techniques to inform the digital development. This process is demonstrated in figure 1.

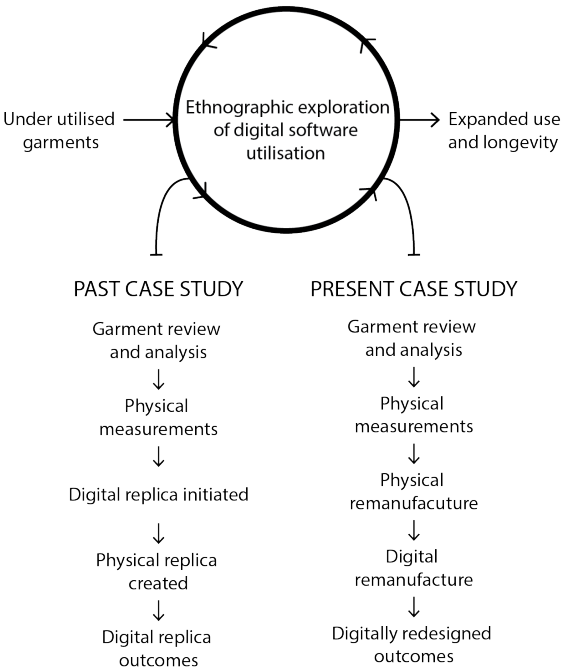

Figure 1. Methodological Diagram

Past

Two garments from UK-based archives were selected for investigation, chosen due to their limited prior research and restricted

accessibility. Object-based analysis methods were implemented to examine and learn from these historical artefacts. Complying with archival handling protocols, a detailed inspection of physical garments, guided by a 'Checklist for observation' (Mida & Kim, 2015, pp. 216–219) to record fundamental data on the garments' key features and construction methods. Additionally, a comprehensive set of measurements were acquired to inform a reinterpretation of the garment patterns.

A combination of manual and digital pattern cutting methods were blended to achieve an accurate pattern replication. Physical prototypes were produced and fitted on a live model, offering the potential to test functionality, crosscheck alongside the original artefacts and refine in response to analysis. Pattern pieces were digitally assembled in CLO3D to create an initial 3D model, with digital textiles carefully selected to replicate the original garment materials. Throughout this phase, software functions were manipulated to refine the digital representation of the original artefacts, with outcomes assessed through an evaluative framework.

Present

A selection of garments donated by a sportswear brand were used, some of which represent best sellers, and others that are no longer in production for reasons such as poor fit, and sizing issues. The aim was to understand how digital technology can be used to redesign these garments, exploring how popular styles could be redesigned and remade from out-of-production garments that represent unsold deadstock bringing longevity to unused and unvalued stock. To gain a better understanding of the garment construction and the challenges associated with unsold items, a physical assessment was conducted. This involved noting the fabric type, construction details, fit (including measurements), and reasons for the garment being out of circulation. Following this, a physical and digital plan was developed to help the researchers comprehend the differences between exploring longevity in a physical context versus a digital one. This plan outlined various remanufacturing ideas aimed at converting unsold stock into popular styles.

The physical space was explored first, enabling a thorough understanding of the construction challenges and opportunities. Some garments only required a light remanufacture, turning trousers into shorts, and others required an overhaul of design, converting t-shirts into shorts for example. The digital space was then explored, using the digitised copy of the garments in CLO3D, mimicking tools used in industry presently. New styles were then rendered through a trail-and-error approach, overlaying patterns and digitally constructing a range of new outcomes based on best selling styles and accessories.

Findings

This research aimed to enhance the designers understanding and accessibility of both archival (past) and contemporary (present) sustainable practices by exploring ways to expand the use of a garment through existing digital tools.

Past

The study of archival dress artefacts presented multiple challenges throughout the research process. For instance, handling protocols significantly restricted direct interaction with the garments; standard archival practices required that garments be handled only with gloved hands and any movement or examination was carefully guided by an archivist. These limitations minimised the researcher's ability to physically touch the materials and was therefore restricted to visual observation and imagination to understand the tactile qualities.

Reverse engineering patterns from archival garments posed additional challenges. Instead of pinning and tracing the pattern directly, the researcher was required to take multiple measurements in order to replot the pattern, an approach that introduced inaccuracies which were presented in the reinterpretation process. This approach was however the most appropriate method in this circumstance and highlighted the importance of accurate measurement records.

Figure 2. Image demonstrating freezing and pinning digital garment panels in CLO3D

The digital reconstruction of the archival garment in CLO3D involved extensive trial and error to accurately replicate and manage the fullness of the skirt. Through experimentation with the software function, a successful outcome was achieved by adjusting the mesh and strategically freezing and pinning parts of the fabric to achieve the desired drape and resolve common collision issues, seen in figure 2. This aspect of the work took significant time to problem solve. However, the process was remarkably quicker when applied to replication of the second archival simulation.

Figure 3. Image illustrates the archival garment in its component parts

During a project evaluation where the digital replicas, such as figure 3, were presented to museum archivists, the research team was encouraged by the positive response to the digital outcomes which communicated the relationship between the archival garment and its component two-dimensional parts. This suggested the work's potential to deepen understanding of historical pattern-cutting techniques and to enrich museum collections.

Present

Working through the physical plan, it became clear that redesigning and remanufacturing the deadstock garments without digital input was time consuming and had the high possibility of errors, such as inaccurate lay plans. When exploring how to redesign a selection of t-shirts into shorts, it was challenging to picture the outcome in advance. As the garments were already constructed, it was difficult to work accurately with the fabric on both the front and backside of the garment in tandem.

Conversely, working with physical samples enhanced the understanding of garment construction factors that may arise during the remanufacturing stages. For instance, while modifying the elasticated waistband on a pair of hiking trousers, simply removing the elastic was not possible. It became evident that additional reinforcement would be necessary to ensure stability in the fabrics, requiring extra fusing and topstitching. The opportunity to physically test and examine samples facilitated more precise digital redesign options, ultimately resulting in more feasible solutions for remanufacturing.

When working with the digital plan, the process was smooth and redesigned ideas were quickly rendered. The deadstock items selected for this experiment had various issues, including poor fit such as a misshapen hood. The deadstock garment fabrics closely matched those of the best-selling garment that served as a template for redesign. Having a digital plan gave focus to the process, enabling multiple ideas to be tested and the outcomes visualised, enhancing the creative impact of the designer.

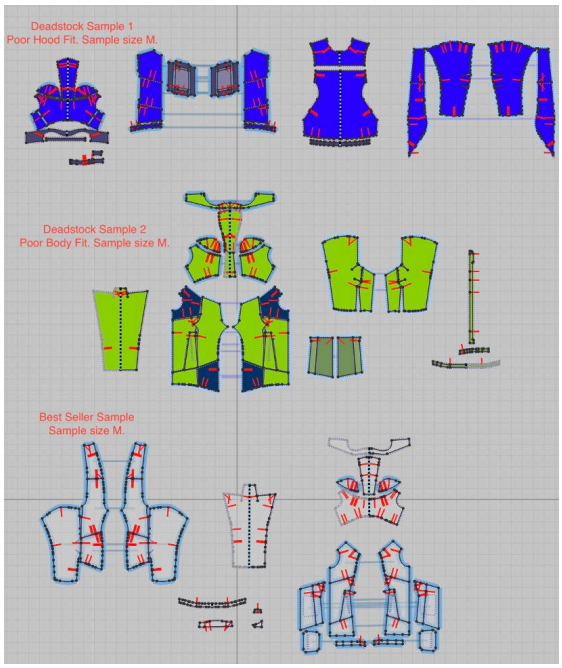

Figure 4. Image showing a digital pattern comparison of a best-selling (white) garment versus two deadstock garments (green and blue).

The digital lay plans were much easier to experiment with, reducing the barrier for designers to reengage with deadstock products and cutting down the time burden when exploring redesign options.

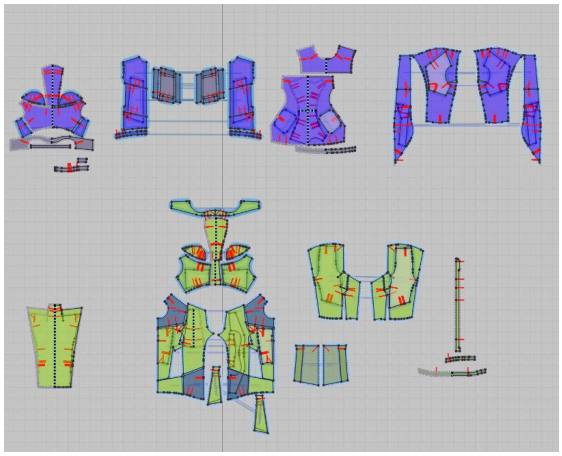

Figure 5. Image showing a digital pattern lay plan ready to digitally recut the deadstock garments into new pattern pieces.

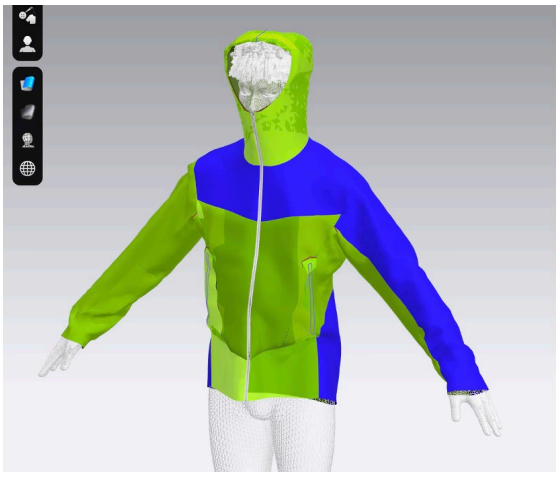

Figure 6. Image showing the final digital outcome of a redesigned jacket made from two deadstock jackets.

Figure 4 and 5 demonstrates how the digital patterns can be easily compared and overlaid, enabling the designers to find new viable solutions for unsold stock. The final redesigned results can be visualised, edited and tested as shown in figure 6. Once the designer is satisfied, the new pattern can then be exported, allowing edits to be applied directly to physical garments for remanufacturing, creating new outcomes. This method could be used for both small edits to garments from rebuilding a waistband, through to a full garment redesign.

In both case studies, it became evident that a solid understanding of garment pattern cutting, and design is essential for effectively engaging in the digitisation process. The feedback loop between digital and physical helps to ground the digital work in realistic and achievable outcomes.

Longevity and Accessibility

Figures 7 and 8 demonstrate how digital technology could be hypothetically utilised to enable longevity in both past and present garments, extending the reach of archival pieces, and diverting garments from deadstock. They explore how both archival and contemporary garments could have their use prolonged.

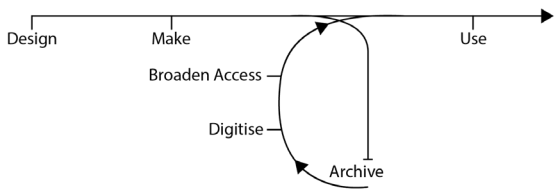

Figure 7. Diagram of Longevity, Past Case Study.

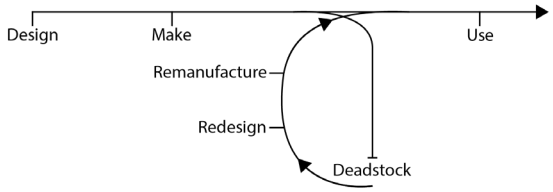

Figure 8. Diagram of Longevity, Present Case Study.

By expanding the use of digital technology, designers can engage with both historical and contemporary garments, offering innovative solutions through familiar tools. Enhancing accessibility to past garments contributes to creating a more circular fashion system. By learning essential skills from history, we can fortify our design foundations. Additionally, developing a process to revisit and redesign garments in ways that align with today's design practices may encourage designers to reconsider items that have not sold.

Conclusion

Re-engaging designers with historical collections and deadstock garments presents valuable opportunities to combine historical insights with contemporary remanufacturing and sustainable practices. By repurposing 3D design technology, we can reverse-engineer both historical and contemporary garments, digitally preserving this knowledge to extend their lifecycle. This approach not only unlocks new educational opportunities but also influences future industry practices.

CLO3D helps to enable access to explore new design options for deadstock items. It could create an environment where redesigns have greater potential for scale and adoption, helping brands transition from micro offerings to more impactful solutions. CLO3D enables the digitisation of archival garments, enriching knowledge of past collections while showcasing historical techniques that inspire new perspectives for future fashion production.

There are areas that warrant further exploration, particularly regarding the long-term storage and accessibility of digital assets such as CLO3D files. Additionally, researching and tracking the usage of both past and present garments would offer valuable insights into how these items have been utilised over time. One limitation is the resource-intensive nature of digitising garment patterns, particularly when there is no original CLO3D file available. However, if the garments did not have an existing digital footprint, the digitisation process is possible but time consuming. Further investigation could help to support garment longevity and promote a more sustainable application of technology in the fashion industry.

References

Gungor, A., & Gupta, S. M. (1999). Issues in environmentally conscious manufacturing and product recovery: a survey. *Computers & Industrial Engineering*, *36* (4), 811-853. https://doi.org/10.1016/S0360-8352(99)00167-9

Bain, M. (2022). *The new technologies fashion schools are teaching students.* The Business of Fashion (BOF). Retrieved October 2024, from https://www.businessoffashion.com/articles/technology/the-new-technologies-fashion-schools-are-teaching-students/

Business of Fashion. (2022). *The state of fashion: technology*. https://cdn.businessoffashion.com/reports/The_State_of_Fashion_Special_Edition_Technology_2022.pdf?int_campaign=sof22_040522&int_content=v1&int_medium=articlezembed_asset&int_source=onsite_marketing

Chan, E. (2024) Why Aren't More Brands Upcycling Their Excess Stock? British Vogue. Retrieved February 2025, from https://www.vogue.co.uk/article/brands-deadstock

Ellen MacArthur Foundation. (2017). A New T*extiles Economy: Redesigning fashion's future.* https://www.ellenmacarthurfoundation.org/a-new-textiles-economy

Ellen MacArthur Foundation. (2021). *Circular business models: redefining growth for a thriving fashion industry.*https://www.ellenmacarthurfoundation.org/fashion-business-models/overview

Kent, S. (2024) *Fashion's Plastic Addiction in Four Charts*. Business of Fashion. Retrieved October 2024, from https://www.businessoffashion.com/articles/sustainability/fashion-polyester-addiction-textile-exchange-recycled-plastic/

Kozlowski, A., Bardecki, M. & Searcy, C. (2019). Tools for sustainable fashion design: An analysis of their fitness for purpose. *Sustainability, 11* (13), 3581. https://doi.org/10.3390/su11133581

Kupresanin, A., & Chen, B. (2019). Fashion beyond physicality. Medium. https://medium.com/@superbureau/fashion-beyond-physicality-486d71b05dae

McNulty, R. (2019). *Future Applications of Digital Clothing for Historical Costume: The past, present and future of fashion.* Proceedings of EVA London 2019. https://doi.org/10.14236/ewic/EVA2019.45

Mida, I., & Kim, A. (2015). *The dress detective: A practical guide to object-based research in fashion*. Society of Antiquaries of London, Bloomsbury Academic, an imprint of Bloomsbury Publishing Plc.

Niinimäki, K., Peters, G., Dahlbo H., Perry P., Rissanen T., & Gwilt A. (2020). The environmental price of fast fashion. *Nature Reviews Earth &* Environment, 1 (4), 189–200. doi: 10.1038/s43017-020-0039-9. DOI: 10.1038/s43017-020-0039-9

Nike (2025). Introducing the Nike Re-Creation Program. Retrieved March 2025, from https://about.nike.com/en/newsroom/releases/nike-re-creation-program

Patagonia (2025) Worn Wear Recrafted. Retrieved March 2025, from https://wornwear.patagonia.com/collections/recrafted

Pecorari, M. (2019). Fashion archives, museums and collections in the age of the digital. *Critical Studies in Fashion & Beauty, 10 (*1), pp.3-29. DOI: 10.1386/csfb.10.1.3_7

Pucker, K. (2024). *Beware the 'Sheinification' of Fashion.* Business of Fashion. Retrieved March 2024, from https://www.businessoffashion.com/opinions/sustainability/shein-fast-fashion-hm-sustainability/

Stahel, W. R. (2019). *The circular economy : a user's guide*.

The North Face (2025) Renewed. Retrieved March 2025, from https://thenorthfacerenewed.co.uk/collections/remade

Tonti, L. (2024). *'It's the industry's dirty secret': why fashion's oversupply problem is an environmental disaster'*. The Guardian. Retrieved January 18, from https://www.theguardian.com/fashion/2024/jan/18/its-the-industrys-dirty-secret-why-fashions-oversupply-problem-is-an-environmental-disaster (Accessed: March 2024).

Wetherell, S., Nicholson, T., & James, A. (2023). 3D Fashion Design Software as a Critical Tool for the Remanufacture of Sportswear. *5th PLATE Conference Espoo, Finland, 31 May - 2 June 2023*.

WRAP (2022). *Nation's wardrobes hold 1.6 billion items of unworn clothes* People open to new ways of shopping* [Press Release].
https://www.wrap.ngo/media-centre/press-releases/nations-wardrobes-hold-16-billion-items-unworn-clothes-people-open-new