FASHION ARCHIVE AS METAMEDIUM unfolding design knowledge through digital technologies

Federica Vacca[2], Angelica Vandi[2]

[1]Politecnico di Milano, Design Department
federica.vacca@polimi.it
[2]Politecnico di Milano, Design Department
angelica.vandi@polimi.it

Abstract

Currently, the issue of archival fashion is mainly to explore emergent methods and digital technologies' application to foster innovation in terms of activation, knowledge-sharing and knowledge-generation related to archival artefacts. The complex archival collections consist of a plurality of artefacts, meanings, and practices interconnected through technologies that make the archive a knowledge-generating process.

Narrowing the study on fashion archives, these are characterised by a significant heterogeneity of materials preserved by companies, private collectors and cultural institutions as evidence of heritage values, design activities, manufacturing culture, and creative processes embedded in artefacts and intangible know-how.

This inner knowledge inherently linked to archival fashion stays permanently implicit in the artefact and usually cannot be accessed by public audiences. Even though Cultural Institutions currently deploy technologies to democratise three-dimensional garment explorations, there are still rare attempts that operate with digital technologies to allow an in-depth study of the creative process and technical know-how lying behind fashion heritage.

In light of this, the paper explores the Reverse Engineering (RE) methods applied to fashion archives to access and unlock the implicit features and techniques embedded in archival fashion to facilitate knowledge-sharing and knowledge-generation processes in exploring culture-intensive artefacts through digital technology application.

Through the explorations of case studies in the fashion archival context, the paper will focus on augmented fruition practices to derive knowledge from the reading of the archive itself, starting with RE and reflecting on virtual and augmented integration to represent and disseminate fashion culture with the final aim of activating the vast inner fashion knowledge patrimony.

Specific considerations will regard the potentialities of digital integration in fashion archives in terms of (1) the different nature of the knowledge unfolded through RE depending on peculiar aspects of archival artefacts; (2) technologies used to encode/decode inner knowledge; (3) the future digital directions related to archival practices and experiences derived from them, also in light of the changes in design languages when technological approaches hybridise those of humans.

Author keywords

Reverse Engineering; Fashion Archive; Digital Technology; Augmented Heritage

Introduction

Immersed in the knowledge economy paradigm, where the intangible assets related to fashion and cultural-intensive contexts have a predominant value (Bertola et al., 2016), the heritage capital preserved in cultural institutions, historical archives and foundations became a competitive tool contributing to the definition of a stratified and transdisciplinary fashion cultural identity that embraces different components: creative, design, material, manufacturing, historical, cultural, social, etc. In the fashion industry, this archival heritage has always been jealously preserved and has contributed, season after season, as an active resource in the design profession because it allows cultural capital and intangible values to be translated into symbolic codes and languages (Martin & Vacca, 2018). In curatorial and museum practices, archival heritage has traditionally been activated by strategies of conservation, enhancement, and promotion of its tangible components through processes that appear more conservative and traditional in the ways of exhibiting. At the same time, the intangible dimension preserved within archives and collections often remains *ephemeral* because it is challenging to display and disseminate. However, as pointed out by recent academic studies (Clark & de la Haye, 2014; Pecorari, 2017; Rocamora, 2012), the potential offered by digital technologies provide cultural institutions and archives with new opportunities to explore their collections beyond the constraints of their physical form and to contribute to disseminating culture linked to fashion heritage to a broader audience.

In particular, the digitisation of collections and the necessary redefinition of archives into digital repositories to preserve digital-born material (such as podcasts, audio, video, photographs and documents) has led (1) to a reorganisation of archival methods and practices by integrating technological solutions, (2) to a redesign of museum spaces that stage artefacts of a heterogeneous and ephemeral nature through the

introduction of apparatus and devices aimed at creating an immersive experience for the visitor and (3) to a rethinking of fashion curatorial practices with new modes that extend and hybridise the physical and digital dimensions of fashion cultural reservoir (Pecorari, 2019).

To date, the most explored experiments in Fashion Curation are linked to AR, which –by integrating the use of QR codes and digital devices in the exhibition– can create a continuous connection with the archive contents allowing the visitor to deepen meanings, themes and relationships. However, the possibilities offered by the new digital technologies can considerably increase the immersion experience and the continuous fruition of artefacts in more sophisticated manners.

For instance, the tangible and motion dimension in fashion is a primary form of knowledge that is difficult to replace by simply observing a garment on display. Therefore, the implementation of VR can unravel innovation scenarios by providing users with an out-of-the-ordinary experience in perceiving materiality, motion, interaction, and manufacturing insights, often invisible in fashion exhibitions. Moreover, multiple transmedia narratives can reach vast and diverse fashion communities by exploiting media integration and hybridisation in terms of diffusion through new social platforms and media legacy and user engagement through empowered interaction with cultural fashion meanings, techniques, processes and relationships.

Coherently with what has been stated so far, the paper explores some of the possibilities offered by digital technologies to identify common research directions related to fashion cultural artefacts that can support the implementation of an augmented archive and constitute a transferable reference standard in the context of fashion cultural heritage. Specifically, the paper aims to codify Reverse Engineering (RE) practices applied to fashion repertoires to enhance the research methodology of archival fashion and develop a technology-enhanced approach favouring knowledge-sharing and knowledge-generation processes in Fashion Archives.

Reverse Engineering for fashion heritage

Fashion, over time, has undergone profound transformations in terms of creative, productive and distribution processes, being a highly multidisciplinary system made of humanistic and scientific disciplines, a cultural-historical dimension and one always in search of change and innovation (Bertola, Teunissen, 2018). Transdisciplinary and hybridisation of knowledge and approaches belonging to different industries and domains (Bertola et al., 2007) have always been at the core of the Fashion System that has always looked towards other industries to learn and combine different methods and methodology through the interaction and connectivity among multiple actors (Gonzalez-Piñero et al., 2021). In particular, this article aims to explore how the practice of Reverse Engineering has been appropriated by fashion in the context of fashion cultural heritage through the discussion of some case studies that have translated this practice into the field of studies on archival fashion.

For the first time, RE was mentioned in the automotive sector and, in particular, to describe the very first design method of eastern car manufacturers such as Toyota, which consisted of simply taking American cars apart piece by piece, learning how they were designed rather than manufactured and replicating them cheaply. More generally, RE techniques can be broadly defined as "the process of analysing a subject system to identify the system's components and their interrelationships and create representations of the system in another form or at a higher level of abstraction" (Chikofsky and Cross 1990, 15).

The introduction of the RE into practices related to fashion archives codifies an approach oriented towards the study, understanding and re-elaboration/restitution of an archival fashion which has always been implicitly carried forward in archival practices. Even if fashion archives have always been reluctant to disclose information related to their collection (Vacca, 2014), they have always documented archiving practices of historical garments and accessories, which mainly consist of an in-depth description of all the material components, techniques, and features of that very artefact. Each aspect is then put in relation with the other archival documentation that – in the form of drawings, technical sheets, and fabric samples – allows deepening every aspect of that given object. This coding process seldom exits the walls of the archive for dissemination or collaboration purposes, with the sole objective of conserving, preserving, and valorising the object, keeping knowledge transferral actions as implicit learning processes, not evident and shared but tacit and concealed. What RE can add to this meticulous archival study is the ability to activate the archive contents to produce new knowledge or share it with different actors. For example, knowing how an item was historically crafted allows an understanding of materials, techniques and technologies employed, the problems related to conservation and restoration, and the shortcomings in the documentation (Fondevilla, 2019).

Moreover, RE methodologies applied to a historical fashion garment have the potential to involve multidisciplinary teams of experts in the "inductive" coding process of "visualising the thinking through things" typical of the fashion design process (O'Neill, 2020, Riello, 2011). The patternmaker and the archivist have the capabilities to acquire the archival garment understanding and reconstruct the technical parameters and material knowledge behind it, while historians and experts in the arts and humanities outline the object's history and context (O'Neill, 2020). Digital specialists and engineers, together with curators, collaborate using transmedia technologies to overcome the pitfalls of materiality when dealing with visualising and explicating the processes behind an exhibited garment, using transmedia technologies such as 3D scanning and virtual prototyping to describe and narrate the knowledge gathered from the analysed object. In this context, the transdisciplinary competencies belonging to fashion designers are conceived as strategic and inventive to transfer, connect, and communicate fashion cultural heritage through novel solutions (Banerjee & Ceri, 2015), having the historical object presented and showcased as a trigger for boosting creativity and fostering cultural literacy within the fashion system.

Following and implementing these approaches facilitates the transfer of culture-intensive knowledge to new generations. It also fosters sharing processes and promotes activities for the implementation of new technologies in fashion design and high manufacturing processes, favouring attention to detail, error corrections, and quality improvement. (Cianfanelli et al. 2019)

Advanced technologies to unfold knowledge inside a fashion artefact

RE's methodologies applied to fashion artefacts mean trac-

ing fashion archival design history and cultural influences (Riello, 2011). Moreover, through new digital technologies, RE accesses more knowledge than one would acquire by looking at a garment on display at an exhibition promoting an augmented and immersive dimension (Martin, Vacca 2018). Therefore, digital technologies intervene in processes of RE in what can be clusterised as *acquisition*, *simulation* and *restitution* phases of the object, encompassing a variety of approaches aimed at reproducing and analysing a physical thing taking advantage of the opportunities derived from digital technologies.

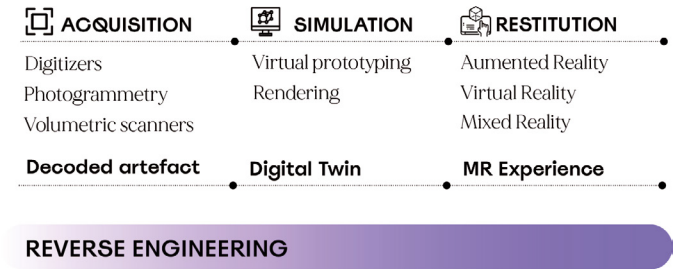

Figure 1. RE and digital technologies implementation in Fashion Cultural Heritage. Source: Authors

The acquisition phase starts with the artefact and its related documentation and implies the access and deepening of the technical documentation available within the archive to start digital explorations to trigger the complete understanding of the artefact's creative processes. Patternmaking and archivist/historical competencies, as well as fashion design and curatorial ones, are involved in the RE acquisition phase, providing culture-intensive insight and appropriating the intrinsic value and techniques inherent in the object. The study of sketches, technical drawings and related paper patterns are verified and validated by directly acquiring dimensions and specifications from the object itself. The digitisation process is crucial at this stage to inform the next steps. Paper patterns are designed from scratch, acquired manually or through automatic digitisers in order to be translated from physical to digital shapes. Shapes of the artefact are captured involving photogrammetry and 360° product photography, which leads to the creation of a wireframe, providing a complete view and greater insight into the garment. Volumes are then scanned – albeit still with limitations in reading textures and fabric processing – to recreate a point cloud from which a 3D model is derived.

A virtuous case in the field is the *Virtual Fashion Archive* (VFA) (https://virtualfashionarchive.com/), an online platform designed by the creative studio Superficial in collaboration with The Museum at FIT aimed at exploring how to combine 3D computer graphics and simulation to examine, measure and study the garments to make users see them in motion through interactive touchpoints (Figure 2).

The *simulation* phase allows the product to transition from 2D to 3D through processes of virtual prototyping (Santos et al. 2020) aided by 3D modelling software, like CLO3D (https://www.clo3d.com), initially programmed following cognitive models dedicated to industrial product innovation, aimed at digitally design a three-dimensional, fashion garment from scratch. Following transdisciplinarity and hybridisation of knowledge during the simulation phase, the RE process appropriates the industrial software to transform archival materials acquired digitally in the design of a digital twin (DT) that closely mirrors the original form, inside and out (Wagner & Kalbaska, 2022). DT simulation allows for in-depth analysis of the fundamentals of pattern making and construction geometries related to a fashion artefact and in-depth visualisation of materials regarding fabrics and textiles, embellishments and embroidery techniques. In this phase, rendering software, such as TwinOne SEE (https://twinone.eu/), allows the creation of photorealistic visual content through textures customisation and material libraries. During simulation, the competencies involved in the capturing phase merge with virtual prototyping, digital visualisation and rendering to digitally represent "the complex of knowledge about such heritage assets, organised to describe the details of which that object is composed" (Niccolucci et al., 2022).

A best practice in this field was the exhibition *From Pattern to Polygon* (https://www.centraalmuseum.nl/en/exhibitions/utrecht-lokaal-from-form-to-polygon) at Utrecht Centraal Museum – coordinated by Studio PMS and several young Belgian designers – that uses RE to stage the kinetic dimension of digital archival fashion through virtual catwalks while study and reinterpreting the object itself (Figure 3).

Figure 2. The Virtual Fashion Archive acquisition and simulation phase. Source: Virtual Fashion Archive https://virtualfashionarchive.com

Figure 3. Digital Twins simulated for the "From Pattern to Polygon" exhibition. Source: Studio PMS, Centraal Museum https://www.centraalmuseum.nl/en/exhibitions/utrecht-lokaal-from-form-to-polygon; EFHA https://fashionheritage.eu/from-pattern-to-polygon-at-centraal-museum-utrecht/

The *restitution* phase of the RE process is used to transmit, communicate and disseminate the fashion artefact's tacit, intangible, embodied knowledge (Casciani, Vandi, 2023). VR technologies are able to provide an in-depth study of the kinetic dimension of the DT garment, digitally reanimating museum objects as moving images. Even though the research area of Cultural Heritage demonstrates great interest and willingness to deploy Virtual Reality (VR), Augmented Reality (AR), or 3D scanning to visualise, animate and disseminate culture-intensive objects, architectures and sites (Cameron e Kenderdine, 2007, p. 51), there are still only rare attempts applied to fashion heritage both in terms of exhibition making and in digital archival platforms that apply these technologies to unfold the related design process and make the knowledge within the object accessible to the wider public. Moreover, technologies acting along the "virtuality continuum" (Milgram, Kishino, 1994) intervene to connect real environments to completely virtual ones resulting in Mixed Reality (MR) tools that potentially transmit inputs synesthetically through audio, visual, haptic and olfactory interfaces (Raisamo et al., 2019; Giannachi, 2020). In this context, competencies related to interaction design are fundamental to structuring relationships between the physical and digital object, generating a cyber-physical continuum where implicit and explicit characteristics are acknowledged and experienced by experts in the RE process and broader audiences. Indeed, users interact with and immerse in the object's unfolded knowledge while staying aware of the physical archival context.

A remarkable, multidisciplinary study and exhibition on archival fashion using RE is 'Exploding Fashion', conducted by Oneill et al. (2021) (https://www.momu.be/en/exhibitions/exploding-fashion) at Central Saint Martin. Here, RE practices are aimed to 'explode' the fashion design process, quickly understanding the interconnection between 2D and 3D clothing, the final garment design and related patternmaking process, highlighting movement and animation dimensions through digital capture. The project clarifies that there is a need for greater articulation of the forms of fashion knowledge produced during design processes and that blended experiences combining the physical and the digital increasingly inform established showcase formats such as the fashion exhibition and the fashion show (Figure 4).

Conclusions and discussion

Following what Muzzarelli et al. (2010, p.10) state: "A dress is not just a dress but the intersection of a series of trajectories, just like a historical event, small or big. [...] It is a matter of reconstructing as much as possible using different methodologies of sources and under the grazing fire of numerous questions. It is a matter of overcoming descriptivism and giving the idea of perspective and context. It is a matter of inserting fashion into history, of using fashion to capture changes, to use it as a mirror reflecting social, economic and political conditions."

In light of the changes in design languages facilitated by the digital turn (Runner et al., 2013) and the ever-increasing integration and pervasiveness of digital tools into curatorial and museum practices discussed in the contribution, major cultural institutions are moving from a traditional curatorship format towards "conversational learning" (Baker, 2002) and "continuous dialogical engagement" (Tchen, 1992) of different publics. Therefore, fashion archives become what Giannachi (2016) defines as Archive 4.0: an augmented repository that transforms from "situated cultural production" into "immersive and augmented environments" in which each component of the physical/tangible collection is equipped with virtual insights guiding the involvement of users in a participatory, interactive and inclusive experience.

Future directions are outlined here regarding the application of digital technologies to archival practices based on the many realities that are currently moving to codify new systems of dissemination of cultural heritage. On the one hand, there is a need to explore new ways of using archival artefacts through digital technology, allowing users to dig into the design knowledge of an object through an immersive analytical approach. This is the case of VFA, which designs DT to show close-ups of specific construction details, seams, textures, and particularly relevant embroideries, as in Thierry Mugler's designs or the animations of the pleated volumes of Issey Miyake's dresses (Figure 2) kept at the Museum at FIT. Alternatively, as expressed by the exhibition at the Centraal Museum in Utrecht (Figure 3), digital practices start from the selection of archival pieces in order to create and animate DT fashion shows to restore those characteristics of dynamism and movement a garment displayed in an exhibition would not be able to transfer. Finally, disseminating knowledge not only on archival fashion but also on the practices and study approaches related to it opens up new opportunities for hybridisation with new professionals to generate new narratives, as in the case of Exploding Fashion.

All these approaches, focused on the preservation and enhancement of cultural heritage in the fashion field, start from RE practices in order to access and unlock the implicit features and techniques embedded in archival fashion. Because archives nowadays are complex assemblages consisting of a plurality of meanings interconnected through technologies, practices, and media (Giannachi, 2020), these approaches could overlay depending on the nature of the contextual archive and the technological apparatus deployed. In conclusion, the RE methodology with digital technologies' applications is essential to multiply the narrative levels of the cultural experience hybridising the boundaries between the implicit and explicit meanings, tangible and intangible dimensions, physical and digital space, and durable and ephemeral components. In fact, RE practices applied to fashion culture are definitely a valuable resource for students, designers, researchers and fashion professionals to discover the beauty and innovation of these designs, enabling curators to show a fashion artefact from different angles and get a sense of the dynamics and know-how behind that creation (Vandi, 2022).

Figure 4. Highlights from physical and digital restitution formats of the "Exploding Fashion" exhibition. Source: MoMu Antwerp, https://www.momu.be/en/exhibitions/exploding-fashion

References

Baker, A. C., Jensen, P. J., & Kolb, D. A. (2002). Learning and Conversation. *Conversational Learning*, Greenwood Publishing Group, 1–14.

Banerjee, B., & Ceri, S. (2016). *Creating Innovation Leaders*. Springer. https://link.springer.com/book/10.1007/978-3-319-20520-5

Bertola, P., Vacca, F., Colombi, C., Iannilli, V. M., & Augello, M. (2016). The Cultural Dimension of Design Driven Innovation. A Perspective from the Fashion Industry. *The Design Journal, 19*(2), 237–251. https://doi.org/10.1080/14606925.2016.1129174

Bertola, P., & Conti, G. M. (2007). *La Moda E Il Design* (1st ed.). POLI.Design. https://www.hoepli.it/libro/la-moda-e-il-design/9788887981926.html

Bertola, P., & Teunissen, J. (2018). Fashion 4.0. Innovating fashion industry through digital transformation. *Research Journal of Textile and Apparel, 22*(4), 352–369. https://doi.org/10.1108/RJTA-03-2018-0023

Cameron, F., & Kenderdine, S. (2007). *Theorising digital cultural heritage: A critical discourse*. MIT.

Casciani, D., & Vandi, A. (2022). Hyper-Sensing Creative Acts The Role of Design in Transmitting Intangible Cultural Heritage through Digital Tools. *Digital Memories, 23*, 227–252.

Chikofsky, E. J., & Cross, J. H. (1990). Reverse engineering and design recovery: A taxonomy. *IEEE Software, 7*(1), 13–17. https://doi.org/10.1109/52.43044

Cianfanelli, E., Goretti, G., & Tufarelli, M. (2019). Reverse Engineering and Digital Archives as a Resource for Practical Craft-Based Manufacturing Process. In W. Karwowski, S. Trzcielinski, B. Mrugalska, M. Di Nicolantonio, & E. Rossi (Eds.), *Advances in Manufacturing, Production Management and Process Control* (Vol. 793, pp. 280–289). Springer International Publishing. https://doi.org/10.1007/978-3-319-94196-7_26

Clark, J., & de la Haye A., (2014). *Exhibiting Fashion: Before and After 1971* (1st ed.). University Press.

Fondevilla, A. (2019). Reverse-Engineering Fashion Products: From a single-view Sketch to a 3D Model, Université Grenoble Alpes. https://tel.archives-ouvertes.fr/tel-02908437

Giannachi, G. (2016). *Archive everything: Mapping the everyday*. The MIT Press.

Giannachi, G. (2020). Imagining the Future of a Complex Mixed-media Work: The Case of Lynn Hershman Leeson's The Floating Museum. *Stedelijk Studies Journal, 1*. https://doi.org/10.54533/StedStud.vol010.art06

Martin, M., & Vacca, F. (2018). Heritage narratives in the digital era: How digital technologies have improved approaches and tools for fashion know-how, traditions, and memories. *Research Journal of Textile and Apparel, 22*(4), 335–351. https://doi.org/10.1108/RJTA-02-2018-0015

Milgram, P., & Kishino, F. (1994). A Taxonomy of Mixed Reality Visual Displays. *IEICE Trans. Information Systems, E77-D, no. 12*, 1321–1329.

Muzzarelli, M. G., Riello, G., & Tosi Brandi, E. (2010). *Moda. Storia E Storie*. Bruno Mondadori. https://www.hoepli.it/libro/moda-storia-e-storie/9788861594906.html

Niccolucci, F., Felicetti, A., & Hermon, S. (2022). Populating the Data Space for Cultural Heritage with Heritage Digital Twins. *Data, 7*(8), 1–28.

O'Neill, A. (2021). *Exploding Fashion: Making, Unmaking, and Remaking Twentieth Century Fashion* (1st ed.). Lannoo.

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

Raisamo, R., Rakkolainen, I., Majaranta, P., Salminen, K., Rantala, J., & Farooq, A. (2019). Human augmentation_ Past, present and future, *Elsevier Enhanced Reader*. https://doi.org/10.1016/j.ijhcs.2019.05.008

Riello, G. (2011). The object of fashion: Methodological approaches to the history of fashion. *Journal of Aesthetics & Culture, 3*(1), 8865. https://doi.org/10.3402/jac.v3i0.8865

Rocamora, A. (2012). Hypertextuality and Remediation in the Fashion Media. *Journalism Practice, 6*(1), 92–106. https://doi.org/10.1080/17512786.2011.622914

Santos, L., Montagna, G., & Pereira Neto, M. (2020). *The Virtualization of the Fashion Product* (pp. 820–830). https://doi.org/10.1007/978-3-030-51194-4_106

Tchen, J. K. W. (1992). Creating a Dialogic Museum. In I. Karp et al. (eds.), *Museums and Communities*, Washington, Smithsonian Institution Press.

Vacca, F. (2014). Knowledge in Memory: Corporate and Museum Archives. *Fashion Practice, 6*(2), 273–288.

Vandi, A. (2022). Digitalising Fashion Culture: Impacts on Historicised and Contemporary Production and Consumption Practices. In *Storytelling. Esperienze e comunicazione del Cultural Heritage* (1st ed., pp. 309–319). Bologna University Press.

Wagner, R., & Kabalska, A. (2022). Sustainable value in the fashion industry: A case study of value construction/destruction using digital twins. *Sustainable Development, n/a*(n/a). https://doi.org/10.1002/sd.2474

Sitography

CLO3D (2018), https://www.clo3d.com/en/

MoMu Antwerp (2022), Exploding fashion, https://www.momu.be/en/exhibitions/exploding-fashion

TwinOne SEE (2022), TwinOne, https://twinone.eu/

Superficial studio (2020), The Virtual Fashion Archive, https://virtualfashionarchive.com/

Utrecht Lokaal (2022), From Pattern to Polyghon, https://www.centraalmuseum.nl/en/exhibitions/utrecht-lokaal-from-form-to-polygon