

# Ajrak Beyond Borders: Revival and Reinvention of a South Asian Textile Heritage in Europe

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**Abstract**—Ajrak is recognised as a centuries-old block-printed textile tradition from the Indus Valley, representing identity and artistic sustainability, but this article analyses the revival and reinvention of this traditional textile for modern global audiences via experimental design techniques that combine traditional craft with modern technologies. The primary aim of this article is to reposition Ajrak in the sustainable European fashion market; therefore, it explores the development of a prototype winter outerwear line with three-dimensional interpretations of classic patterns supported by 3D printing techniques, adding visual appeal to Ajrak patterns while retaining its traditional integrity. The findings of this article demonstrate that surface design innovation effectively creates new sensory experiences that improve the user-garment relationship and historical appreciation in modern fashion, while this reinvention also meets the European need for sustainable and meaningful fashion by revitalizing traditional craft through adaptable design. The article concludes with the prospect and potential of fusion between the traditional garment product of Ajrak with contemporary technologies to preserve cultural memory, allowing transnational revival and reinvention of Ajrak as a global fashion design language.

**Index Terms**—Ajrak, Textile Heritage, Fashion Innovation, Cultural Revival, European market.

## 1. Introduction

Textiles play a vital role in expressing identity, history, and societal importance because, being a practical product and symbolic in nature, according to Akyuz et al. (2017), they represent “*the fabric of civilization*,” hence South Asian textiles are commodities and cultural archives. In the culture of South Asia, a famous Sindhi textile product, Ajrak, is a Pakistani block-printed cloth, valued as a craft and cultural symbol while surviving for more than a thousand years and still recognised for its deep indigo and madder hues, elaborate geometric and floral motifs with natural dyes (Simair et al., 2023). Vidale (2017) cited that a Priest King sculpture excavated at Mohenjo-Daro wears a patterned shawl with a striking resemblance to Ajrak motifs (Figure 1), linking the textile to early expressions of authority and sacred symbolism. In the modern context, Ajrak is still a recognised persistent tradition within the regions of Sindh and Rajasthan, completing a “*social life of things*” objects that travel, adapt and get new meanings because men of this region wear Ajrak as turbans (pagri), shoulder cloths (chaddar) or waistcoats and women as shawls (Costa and Santos, 2019). However, beyond everyday utilisation as fashion

or essential, Ajrak also symbolises respect and diplomacy as state authorities and ordinary people give guests Ajrak as a sign of respect, the gift of Ajrak and Shawls presented to global celebrities, demonstrated its global status as a cultural ambassador (Spielmann and Minton, 2018).



Fig. 1. A sculpture discovered in Mohenjo-Daro reflects a king wearing an Ajrak Shawl with floral and circular designs (Vidale, 2017)

The production process of Ajrak is resilient and eco-friendly as the washing of cloth in river water, oiling and knotting to soften fibres; block-printing with resist pastes, multiple indigo dye baths and sun-drying take two weeks within traditional production while this historical practice is further confirmed by the archaeological discovery of Indigo dyeing workshops around the Indus River (Neogi et al., 2020). According to Singh et al. (2021), the natural dyes used in Ajrak are mostly eco-friendly, unlike other worldwide dyeing techniques where natural dyes are not always sustainable; hence, this ecological aspect places Ajrak as a “*slow textile*” founded in artisanal labour and environmental care, aligning with worldwide contemporary sustainable fashion discourses (Greco and Cock, 2021). The presentable themes of Ajrak are symbolic as well as decorative because a different Ajrak motive highlights how circular medallions, geometric lattices, and floral repetitions symbolise divinity and protection, as some designs depict Indus Valley gods, while others resemble later Islamic geometric abstraction (Wichmann and Wade, 2017). This resemblance aligns with the concept of material culture, which mediates meaning via forms (Phungsuk et al., 2017), under which the design grammar of Ajrak incorporates cosmological and social

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connections because Bonato (2024) further added that cultural semiotics highlight the potential that motifs can be commoditised as ornament when removed from their natural environment. Besides this, modern Pakistan also adapted Ajrak in several ways, but rural Sindh still uses block printing, as Hirscher et al. (2018) reported that metropolitan designers used Ajrak in household textiles, fashion, and exports. Similarly, Ajrak is reinterpreted in bed linens, tablecloths, and modern apparel, but the shawl and turban are still its most durable and culturally significant forms. Despite that, such reinventions fostered with the concept of invented tradition, confirming the glocalization of this textile tradition.

Moreover, with a prototype winter outerwear line that incorporates three-dimensional themes, this article proposes the reinvention of Ajrak for European fashion markets and by following the recommendations of Chakraborty and Biswas (2020) on craft-technology fusion, the research employs 3D printing, laser cutting, digital stitching, felting and hand embroidery to make Ajrak motifs tactile. This technologically advanced method continues to respect the cultural grammar of Ajrak but creates new sensory sensations by reinventing flat patterns in three dimensions, aligning with the narrative of Alexandre et al. (2017) that craft is a dialogue between material and imagination. The article further links heritage, sustainability, and globalisation because heritage fabrics like Ajrak, with their eco-friendly dyes and handcrafted provenance, are benefiting from growing demand among European customers for sustainable, ethical textile products (Goworek et al., 2018). However, Ross and Saxena (2019) argued that legacy reinvention risked commodification, but the design method in this article ethically respects the symbolic logic of Ajrak by placing motifs on upper garment sections to acknowledge their original placement in shawls and turbans rather than randomly spreading them in the European market. Besides this, Malik et al. (2021) cited that textiles were used to trade across borders, like the Silk Road, making the cultural bridging function of this article even more significant, as the entry of Ajrak in European markets allows South Asian customs and European consumers to communicate. According to Lengen et al. (2019), such reinvention always provides a sense of continuity for diasporic communities, fostering a traveling culture where heritage migrates and shifts across borders; thus, Ajrak has become more than fabric because it connects places via art and sustainability. Collectively, the revival of Ajrak in European fashion shows the conflict between tradition and innovation, local and global, remembrance and reinvention; however, this article highlights the potential of traditional textiles to stay relevant in modern contexts by combining the historical depth of Sindhi craft with cutting-edge design approaches.

## 2. Reinventing Ajrak via Technology

According to Shin et al. (2011) the word “cultural products” includes culture and the culture symbolizes a time and historical customs, making cultural products as artefacts made for a specific culture. However, the modern commercial requirements and needs often imply that different cultural groups can make the artefact while preserving the form and

style because the cultural reinvention model in product design can modify design components, functional usage or traditional features (Figure 2). The technology rooted reinvention of Ajrak combines heritage preservation, material innovation and global fashion as Ajrak traditionally been produced by labour-intensive block-printing techniques employing natural dyes and designs representing cosmology, nature and spirituality (Vidale, 2017; Singh et al., 2021). Traditionally, Ajrak considered a cloth of ritual and identity but Ajrak successful reinvented as an architectural theme, domestic furnishing and symbolic costume but Ami-Williams et al. (2024) argued that modern fashion and textile designers typically use only the original fabric or manufactured replicas, flattening its handcrafted spirit into commercial themes. Therefore; reinvention via technology offers a vital gateway to conserve and recreate Ajrak within contemporary design paradigms, enabling new visual and product qualities while positioning it in global markets like Europe.

The geometric and floral motifs of this textile were engraved on tombs and tiles in the Mughal period, demonstrating its symbolic value (Ross and Saxena, 2021), but Ajrak has evolved to adapt with modern dynamic cultures. According to Akber et al. (2021) evolution of Ajrak into architecture and protective shelters; used as sunshades and insulation reflected its adaptability via effective utilisation in home furnishings while Kashif and Mubarik (2020) further added that modern South Asian fashion designers also used Ajrak in couture designs. These reinventions use industrial printing methods, losing ecological and handcrafted originality of Ajrak because Soukhathammavong and Park (2019) clearly demonstrated that mass-produced symbols erase cultural narratives and make cultural crafts decorative rather than dialogical hence; reinventing Ajrak with new technology transforms the textile from a static cultural item to a dynamic medium of innovation, legacy and sustainability. The current research process focused over reinventing the cultural importance of Ajrak motif and restabilising its contemporary engagement because primarily the sources of appeal for the traditional Ajrak are its geometry and symbolic symmetry (Vidale, 2017). However, the proposed reinvention converts these patterns into tactile, three-dimensional forms so wearers can recognise and feel the design because according to “*Touch: The Science of Hand, Heart, and Mind*” by Kiser (2015) touch is essential to cognition, social connection and memory. Besides this, Bardalai and Underwood (2022) further added that tactility including sensory perception and tangibility in textile design enhances emotional and psychological engagement, strengthening product loyalty and attachment. Following this approach, the reinvention process uses 3D printing, laser cutting, machine embroidery and hand embroidery to transform Ajrak motifs into tangible or layered prototypes that revive cultural heritage and satisfy sensory demands for experiential and differentiated fashion among the consumers of European region (Alexander and Ling, 2023).

The process of reinvention relies on technology as (Tolmaç and İsmal, 2023) cited that 3D printing allows themes to be digitally sculpted, transforming into sculptural geometries and applied to wool and leather. According to Ikram (2022) the

technologically advanced procedure increases durability and adds textures for European winter clothing styles; laser cutting layers fabrics, cuts detailed negative spaces, and adds depth, imitating modernised block-printing while Dombrowski (2024) added that computer-operated embroidery machines allow felting and layering experiments that mimic traditional reversibility of Ajrak following the adaptation to modern aesthetics. The inclusion of hand stitching is significant to connect tradition with technology in European culture because the creation of raised and textured surfaces with threads allows craftspeople to recreate tactile themes without compromising expertise (European Craft Alliance, 2025). Thus; the entire process aligns with the claim of Partarakis et al. (2020) that handicraft and digital techniques generate “hybrid objects” that combine historical continuity and technological innovation while this hybridisation reflected that reinvention of Ajrak enhances its handcrafted roots through technology.

European culture and fashion systems contextualise the reinvention of Ajrak because the historical roots of Greco-Roman, Renaissance, and Enlightenment within EU valued material culture as a symbol of identity and modernity (Borghesi, 2019). Modern European fashion customers, especially the demographics between the age of 14 to 40 years prefer experimental yet culturally authentic apparel that is sustainable and handmade (Moorhouse and Moorhouse, 2017). Thus; by positioning Ajrak as a three-dimensional tactile outerwear textile, the reinvention correlates with European autumn-winter collections which recognised as a prominent fashion cycle in Paris, Milan and London (Pettinari, 2023). However, Karamullaoglu and Sandikci (2019) demonstrated that European fashion stresses on femininity, personalising and formality, aligning well with the symmetry and geometry in structured outerwear of Ajrak fostering the opportunity of cultural translation. The translation is further exemplified by Lamarche-Beauchesne (2025), as the brand like Dolce & Gabbana made localised craft globally relevant by incorporating Pakistani truck art into luxury couture while the western menswear interpretation of the Pakistani “*Peshawari or Kohati chappal*” by Paul Smith reflected how reinvented traditional artefacts can gain international acceptability (Khan et al., 2021); affirming reinvention potential of Ajrak for European markets as inventive heritage.

The process of reinvention is effective but the integration of technology associated with certain risk and challenges because according to Richardson (2019) the inclusion of technology for artefact production led to “*decontextualised global flows*” under which cultural items are commoditised and consumed without acknowledgment; requiring balance between innovation and cultural integrity. Similarly, reinventing Ajrak needs to ensure that local craftsmen and cultural narratives are not neglected for global markets as Sætra and Danaher (2022) cited that ethical reinvention always involves collaborative models where craftspeople benefit economically and culturally from global heritage circulation. Besides this, opportunity lies in placing Ajrak within sustainability discourse as the heritage textiles can promote slow fashion, authenticity and environmental awareness in Europe as fast fashion becomes more

environmentally conscientious (Niinimäki et al., 2020). Ikram (2022) cited that technological reinvention improves durability, visual novelty and relevance; the traditional use of natural dyes and sustainable procedures is strongly aligned with these objectives thus, technological reinvention of Ajrak represents cultural translation with ethical and environmental connection within global fashion prospects. The holistic reinvention of Ajrak via technology restores cultural significance by re-centring the motif, enhances sensory engagement through tactility and places the textile in European markets by aligning with fashion cycles, consumer values and sustainability discourses. However; Ajrak is not just duplicated but reinvented by combining traditional handicraft with new technologies hence, reinvention of Ajrak reflects how technology would revive tradition and integrate it into new cultural economy as global fashion struggles to reconcile heritage and modernity.

### A. Process of Ajrak Reinvention

#### 1) Idea Generation

The idea generation step within the reinvention (redesigning) of Ajrak is driven by the need to maintain cultural authenticity while providing technological and aesthetic advancement for the global European markets but it was difficult to transform the traditional Ajrak motifs that are geometric patterns symbolising harmony and continuity modified to modern European design (Ross and Saxena, 2021). According to Zhang et al. (2024) design-led research ideation must balance history with new ideas because new idea must add something to the cultural meaning instead of undermining it thus the conceptual underpinning was minimalist transformation; motifs and patterns were kept in form while expanding via colour, scale, material and dimensionality to meet contemporary design sensibilities and environmental concern. The new idea initiated with a conscious decision of not disturbing the basic pattern of the Ajrak because as per Zappalà (2021) the traditional patterns have deep cosmological and philosophical meanings while their symmetry illustrated the balance between humanity and nature. The modification in the geometric shapes would lose the cultural relevance under which the reinvention, modified and redesigned the colours as a symbolic and experiential link between South Asian origin and European culture. Ikram (2022) cited that traditional Ajraks use natural dyes like indigo, madder red and white because these colours are beautiful and represent ecological awareness, cleanliness, fertility and living in harmony with nature but the pleasant weather, changing seasons, and symbolic architecture afforded of Europe provided fresh perspectives to artistic narratives (Figure 2).

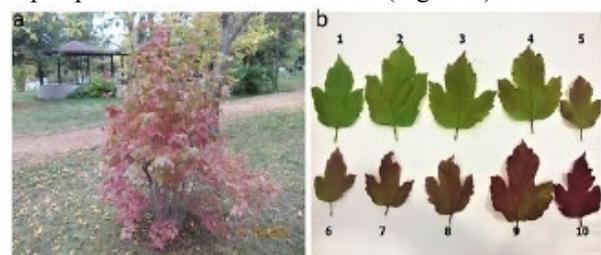


Fig. 2. European autumn cranberry colour pallets (Şahin et al., 2024)

The colour shades that reflect European weather, prominent buildings and cultural events were used to convey local moments and feelings with contextual storytelling as muted grey influenced by London's gloomy skies, deep terracottas inspired by Tuscan architecture and Scandinavian minimalism-inspired winter blues. Corey (2023) established that design should provide "*localised meanings within global frameworks*" combining cultural identity and environmental conscience and following this, the utilisation of colours like indigo, madder, turmeric and pomegranate peel was ethical and ecological as Liu et al. (2025) emphasised that utilisation of sustainable materials indicates a social and environmental awareness with technical expertise of the designer while making the idea more sustainable. The colour also served as the medium of two-way communication between the culture by connecting earthy tones of South Asian natural dyes with modest beauty of European visual culture (Josserand et al., 2021); comparison of traditional Ajrak colours with contemporary European-inspired schemes using digitally reproduced colour palettes ensured that new ideas and ancient traditions integrated with each other. The practical idea generation adopted Adobe Illustrator and CorelDRAW to test the shape, colour and scale of motif as continuous inquiry was possible in the digital environment without damaging physical materials and Loh (2022) recognised modern craft as a "*digital-craft continuum*" because digital tools provide more creative freedom to the designers via simulations. Chromatic reinvention was a key method for the reinvention or redesigning of Ajrak but the tactile metamorphosis associated with the 3D Ajrak patterns still serve as fundamental idea under which the layered colour and resist-dyeing give optical depth to traditional Ajrak. Building on the neuroscience-based claim of Chakraborty and Biswas (2020) that tactile participation improves emotional resonance and cognitive recall, despite the modification the phase of idea generation aims to reintegrate touch as a fundamental sensory dimension thus; the idea was to create surfaces that invite tactile engagement so people could see and feel the motif and contribute to multimodal heritage revival.

Three technologies were identified during 3D ideation which included 3D printing, laser cutting and machine embroidery because all of these identified technologies connected digital design to physical reality differently. According to Yang et al. (2024) 3D printing makes classic patterns precise and reproducible under which it would transform the depth and texture of the prints while making the geometry of Ajrak as sculptural textiles because the principle of "digital ornamentation" by Cudzik et al. (2025) already suggested that craft traditions can be modified through computer fabrication without losing their cultural identity. The other technology of laser cutting revealed negative space and layers as the volumetric shadows created by precise incisions in natural fibres like wool and leather ensure designs depth and contrast between transparency and hardness. Chittenden (2021) established that in the modern craft, the new laser-block printing method recognised as the "*dialogue between hand and machine*" under which the computer-controlled machine embroidery combined tactile density with digital accuracy thus;

modification in stitch depth, layering threads and repeating patterns can make motifs 3D which bring reinvention for the symbolic geometry Ajrak with modern textile technology (Alexander and Ling, 2023). The selection of these technological interventions within the idea generation subjected to their alignment with material logic of Ajrak because traditional Ajrak developed by the repeated process of layering which is similar to the modern technology operations of building or removing layers while Partarakis and Zabulis (2023) already stated that traditional craft and technology are the continuities of each other hence; ideation phase reinvents Ajrak from a design and philosophical perspective while making them a material language for global audiences.

## 2) *Challenges in Designing*

The design development phase of the reinvention process faced many creative and technological challenges that affected the technique and concept within the reinvention process, as the utilisation of modern technology and adaption of ancient Ajrak designing into modern design for the European marketing was the key challenge. According to Richardson (2019), the innovation of any traditional craft needs continuity and development but even the moderate modification could disrupt the symbolic and aesthetic coherence of Ajrak designing because the traditional process is culturally standardised thus; every simulation from changing the colour shade to replacing the material had to continue the cultural standards of the craft while empowering the modern material perspective. The utilisation of the graphics software to digitally reinterpret historic Ajrak motifs and test new colour schemes on software-based simulation generated the primary challenge because the simulations highlighted that adjusting colour relationships kept the design intact but impacted the appearance of the fabric. Heritage-based design research often gets difficult due the complexities between the authenticity and adaptation (Alexopoulos et al., 2025), under which the chromatic reinvention process revealed that signature colour of Ajrak is indigo-red but its shape and symmetry are also important. However, the modifications in the colour did not impact the artistic presentation and instead it provided new design opportunities that align with the modern global fashion tastes because the concept of "adaptive authenticity" by Moorhouse and Moorhouse (2017) established that sustainable and culturally rooted fashion must adapt to new social and material situations.

The transformation to hands-on block printing experiments followed the digital phase led to new technological and material limits under which following the breakthrough documentary "*Sun, Fire, River, Ajrak – From the Soil of Sindh*" by Noorjehan Bilgrami; physical reproduction on digital simulations was used to explore experiential labour and rhythms of traditional printing (Figure 3). Bilgrami illustrated that Ajrak-making is a technical and spiritual process by highlighting its tactile intelligence and integrated understanding which further signified the claim of Jia et al. (2022) that it is very difficult to transfer implicit knowledge into new materials and approaches; replication within the design approach became challenging because the simulations lacked the talent and physical precision

to carve wood for replicating the original wooden blocks.

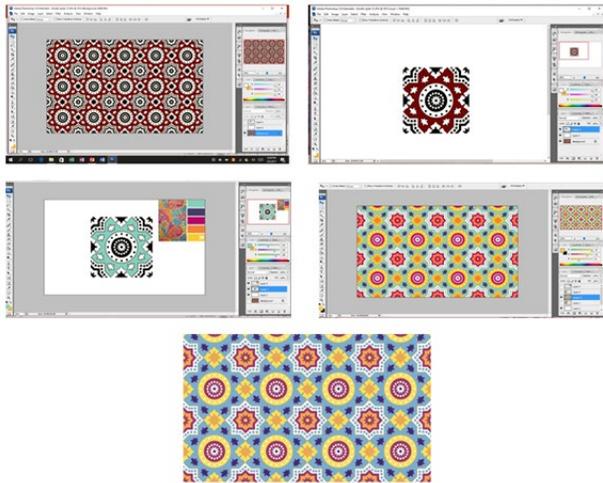


Fig. 3. The journey of developing final look of fabric design after editing on the graphic software and application of European colour palettes (Images by Author)

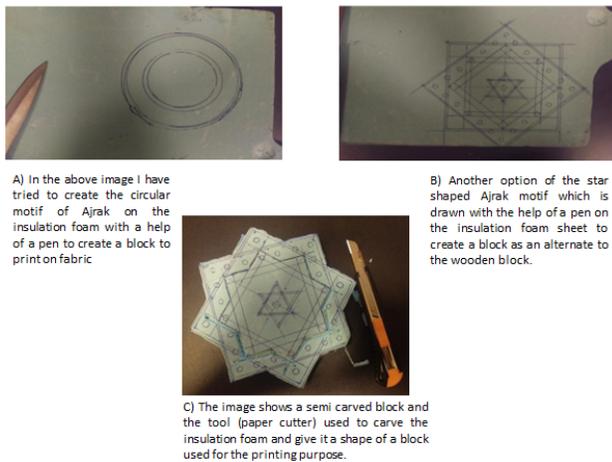


Fig. 4. Process of developing foam motive (Images by Author)

Moreover, wood-like substitutes were investigated for their structural properties under which the food-grade materials like potatoes were easy to carve but in the initial tests they appeared weak and small for larger Ajrak designs. Marzari et al. (2021) cited that attempting new materials in design usually involves failure and adaptation as materials "speak back" to the designer and following the restrictions of potato medium forced the re-evaluation of Ajrak blocks' material logic leading to firm foam as a viable substitute (Figure 4). The innovative decision making is aligned with the Yang et al. (2022) that already recognised these kinds of unique decision-makings as "correspondence in making" where the maker has a dialogic relationship with the material qualities while allowing the process that emerge naturally rather than rigid designs. However, the designing with foam also lead to technological challenges because the dense cellular substance made carving of minute details difficult while the development of clean motif edges required a lot of tools with pressure trial and error. The foam blocks showed potential after annotating the drawing and improving the carving under which the innovative technique

illustrated that non-traditional material can facilitate craft-based experimentation while the adaptability further supported by Zabulis et al. (2023) that craftsmanship depends on the "problem-solving intelligence of the hand" which is developed via experience and error.

The subsequent steps of test printing and surface evaluation were also crucial for understanding the performance of different colours and materials with fabric surfaces; first poster paints were used to see the visual presentation then acrylic paints were tested followed by the fabric paints to have a better idea about the colour functions in textile industry (Figure 5). The continuous experimentation with type of colours highlighted the variable effect pigments on the natural fibres with unconventional application because textile innovation required knowledge of adhesion, absorption and colourfastness as well as visual design due to the range of water-based and fabric-specific paints.



Fig. 5. Final outcome of painting fabric with foam motives (Images by Author)

Contrary to the technological challenges, the designing approaches prompted deep reflection on craft knowledge epistemology including the redevelopment community-based creative processes within an individual design research

framework because Riley (2024) stated that practice-based design research modify the crafts into cognitive and epistemological activity. The reinvented designing of Ajrak with the use of innovative materials and digital mediation exemplified material thinking because each of the technical or conceptual challenge served as the opportunity to create new cultural identity with sensory experience and innovation thus; design challenges like adjusting digital image colours and improvising were chances for creative development by emphasising on continuity and transformation.

### 3) *Ajrak with Modern Technology*

According to Vidale (2017) and Bonato (2024) the Ajrak motifs have been artistically interpreted using resist paste, dye baths and successive layering for rich geometry and colour depth but the design challenge is to provide them tactile appeal so that the users in Europe can feel the form of motif. The researcher utilised modern technologies to revive the Ajrak cloth while keeping the inspiration from thousands year old textile heritage under which the process reinvention utilised 3D printing, laser cutting or engraving and computer-based machine embroidery to modernise the design and texture of Ajrak thus the experimentation is focused on developing unique motifs of the fabric. The process of combining Ajrak with modern technologies aimed of modifying these motifs into tactile and raised forms that could be sensed to improve the viewer-textile interaction while traditionally Simair et al. (2023) reported that Ajrak designs are printed on cotton which is a lightweight, natural fabric having rich visual appeal but limited raised texture. Following the fabric variation, the process employed leather, wool and felt instead of cotton because cotton is unsuitable for colder European countries while the substrate of these fabrics naturally provides structural solidity and 3D textures hence; the method promoted aesthetic and practical capabilities of Ajrak by combining traditional craftsmanship with modern technology.

The primary technology that was examined is 3D Printing as 3D Maya software (Autodesk) was used to model the shapes which extruded the design from the flat geometry into sculptural forms in Rhino to make them more exact. The digital to physical approach aligned with the modern fashion textile trends as Chen et al. (2021) cited that utilisation of 3D printed motifs and parametric design is adopted by many famous garment corporations while the zero-waste printing research by Javaid et al. (2021) further implied that additive manufacturing could reduce material waste in apparel accessory manufacture. The first two samples on the SLA (stereolithography) material were oversimplified and stitching holes are also excessively fine for the needle works however, the designs were later modified make the holes larger and the motif were divided into two sections that needed stitching to combine under which, following the digital-craft continuum of Loh (2022) the stitching holes strategically link the digital and traditional craft by including the handcraft within technological process. Contrary to the benefits, Silvestre et al. (2023) argued that Fabric 3D printing can have flexibility and adhesion issues under which motifs were sewed onto felt substrates and backed with contrasting felt patches to overcome the technological

limitation. The process of blending printed pieces with base materials to make them wearable followed the recommendation of Gorlachova and Mahltig (2021) regarding the composite process making layered composite structures are strong and flexible against the body (Figure 6).



Fig. 6. Images showing 3D printed motives embroidered onto felt fabric to simulate fabric as the Ajrak pattern motifs were redesigned in Maya and printed (Images by Author)

The technology of laser cutting allowed subtractive or differential stacking and additive manufacture as the researcher converted Adobe Illustrator motif line work to laser software (ECP) formats and tried fake leather, real leather and felt (Naresh and Khatak, 2021). Power settings were adjusted to leave raised edges or "burned relief" instead of cutting through the material in some design experimentation under which the "ragged texture" of leather fibres along with the cut edges felt better but the edges of felt were easier to wipe up after initial burns; Figure 7 demonstrated that laser cut felt shapes provided the physical depth after stitching on fabric.



Fig. 7. The laser cutting machine cuts felt cloth into Ajrak motives in the above self-experiment then motifs stitched on the fabric (Images by Author)

The textile-based laser engraving is also a famous technology in the modern fashion and according to Liang et al. (2025) laser systems are fast, accurate and compatible with digital design workflows of the contemporary fashion sector. The research used low-power laser treatment to scorch leather or felt surfaces to create a visual and tactile "self-print" effect in motif studies (Figure 8) because as per Sarkar et al. (2022) the laser-engraved motifs always create more complicated depth gradients while Singh et al. (2021) further established that these hybrid forms better demonstrated the evolution of textile-based laser systems.



Fig. 8. Laser engraving uses a low laser cutting machine intensity to produce depth and a motive in leather but some parts use high intensity to cut leather (Images by Author)

The digital accuracy and textile tradition combined within the computerised felting modes of machine embroidery but the designs were modified improve their readability for the machine; machine vendor constantly engaged to mitigate the challenges in file conversion. The "felting" needlework technique unites a wool or textile top with a felt foundation because the fibres of top material enter the base under which a 3x3 inch 3D pattern was created within few minutes (Figure 9). The efficiency is further discussed by Wu et al. (2022) that technologically advanced needlework become more precise, faster and creative supporting the growth of ready-made garment (RMG) market while Chang et al. (2024) further signified that hinge-like patterns can make machine stitching self-folding structures like OriStitch which became a promising pathway for mechanically responsive motifs.



Fig. 9. Illustrating machine felt embroidery self-experiment as the machine uses felt fabric underneath other fabrics and a computerised design inserted via a USB device attachment- felt colour and threads create a motif on the other cloth with thickness

The technological experimentations adopted research with design approaches like continuous prototyping, reflective evaluation and direct engagement with material constraints because every technology examined against the semantic integrity and sensory effect of Ajrak. The datasets of experimentation classified as 3D printing gives hard texture, laser cutting and engraving allow contouring and shading but embroidered felting softens relief with the textile substrate thus; integration of modern technology advanced fabrication

methods for the reinvention of Ajrak in European market with aesthetic innovation for balancing legacy with modernity.

#### 4) Hand Embroidery

Hand embroidery is one of the oldest and most versatile arts in textile history of Pakistan but the rapid disruption of industrialisation and the technological disruptions like the computerised needlework modified the processes of hand embroidery however, Chen et al. (2022) stated that fundamentals of hand embroidered clothing still hold significant cultural, artistic and symbolic value. The craftsmanship, creative originality and a communication between old and modern designs are represented by hand embroidery methods under which Bose (2024) cited that South Asian hand embroidery plays a vital role in cultural storytelling and identify development by preserving the culture via integration of folklores and community values within the design motifs. Following the cultural importance, the foundation of using hand embroidery in the reinvention of Ajrak for the European market is to redesign the Ajrak patterns while keeping its symbolic geometry and rhythmic symmetry but as per Akyuz et al. (2017) the repetition of block-printed cotton with indigo and madder dyes is the source of attraction in traditional Ajrak but the reinvention process utilised standard thread works with modified density to create a three-dimensional sensory experience.

The tracing procedure which is the foundation for correct embroidery was modified to match local craft methods under which a tiny needle holes were made after sketching the pattern on tracing paper while temporary shoe polish and turpentine oil were put through the holes to outline the fabric pattern. The method is simple but effective transfer approaches that align with the craft epistemology under which Coppola et al. (2023) reported that "*doing things by hand and knowing how to do*" connect the creative imagination with practical realities. The tracing further maintained a tactile link between artist and substance without industrial transfer equipment which also signified the Craft-based innovation of the Global South; handwork is slow but collaborative by using manual tracing for design translation.



Fig. 10. Tracing of Ajrak Motif and needlework starting (Image by Author)

The hand-embroidery process started after the tracing stage by bordering the traced motifs with double-thread cotton that is also known as the "*anchor*" because the bordering ensured the

symmetry of the motifs and guided the filling of pattern (Figure 10). The needle work was performed using silk (Resham), cotton (Anchor thick), wool and soft silk (Kacha Resham) threads as the selection of different threads were employed due to their variable texture and appearance to create three-dimensional pattern while traditional Pakistani stitching methods including "French knots (Ghera), Sundi (rolling stitch), Ari Tanka for outlining, Farsi Tanka for metallic thread filling, and Long Ghera and Pink Star Dedh Tanka" were used for floral details. According to Samizadeh and Samizadeh (2024) the combination of different threads and stitching methods created the dynamic surface texture that transformed visual language of Ajrak from flat geometry to sculpted relief but the overall process is time-taking; one brown wool outerwear piece took three weeks of creative effort (Figure 11). Phillips et al. (2024) already established that artistic handwork needs time and patience because the longer engagement enabled continuous evaluation for research with design approach under which each motif improving the thread stacking and visual density. The focus on the manual processes inclined towards ensuring the human touch within the innovative Ajrak as Hansson and Busch (2022) affirmed that development of any craft by hand is referred as the process of talking to the material hence; unlike digital techniques like 3D printing and laser cutting the hand stitching emphasised on the human touch in material creation.



Fig. 11. Brown wool embroidery piece created in 3 weeks  
(Image by Author)

The experimentation of hand-embroidery used multiple fabrics including cotton and leather to explore the efficiency of thread work but the embroidery on leather appeared difficult which demonstrated the challenges of material translation to innovative substrates (Figure 12). The experimentation of embroidery on cotton and fake leather showed good results which supported the choice of these fabrics as effective substrate but the transformation of the designing on real leather revealed two major challenges: "(1) thin leather, which was chosen because needles were easy to enter, tore when punctured; and (2) thicker leather, which was hard to penetrate, slowed development and made it physically demanding". The challenges demonstrated that fine tensile structure of embroidery threads and dense animal skin have

inadequate interaction because Jiang et al. (2023) found that material density, elasticity and surface grain affect stitch tension and thread performance in experimental textile design thus; material agency was highlighted in this phase of experimentation establishing that not all traditional processes can be applied to modern or alternative materials. The experimentation also provided the comprehensive understanding about the ethics of using faux leather in sustainable textile design by comparing it to real leather as stitching on synthetic leather is feasible because it lacked genuine dense structure and visual depth. The hand-embroidered experimentation of the Ajrak reinvention process emphasised over the Craft-based innovation of the Global South by advocating for slowness and collaboration while the practice based research was used via tracing to stitching for dealing with material resistance thus; the resulted motives revived embroidery skills and added innovation with sensory engagement which made the Ajrak more expressive for the European consumers.



Fig. 12. Different fabrics of cotton and leather used for embroidery  
(Images by Author)

##### 5) Fabric Selection

The fabric selection is an important stage within the process of reinvention of Ajrak under which the historical legitimacy of the clothing product was linked to its modern European redesigning as Vidale (2017) and Singh et al. (2021) cited that traditional Ajrak is developed primarily of hand-woven cotton which is suitable due to its flat surface for block printing and cultural associations to purity and simplicity among the Sindhi and Kutch populations. The transportation or expansion of the traditional craft to the European market required comprehensive evaluation for the adequate material properties due to the exposure with environmental conditions of extreme climates like winter and snowfall while preserving the traditional cultural meanings. Salmi and Kaipia (2022) argued that material selection in design involves cultural and sensory factors that affect aesthetics and user experience under which the reinvention process switched from cotton to warmer and more durable natural fibres like wool and leather, following the Ajrak philosophy of using natural materials and being environmentally conscious thus; the revived fabric was modified to fulfil stylistic and environmental standards for the European fall/winter fashion market.

According to Lin et al. (2022) natural materials aligned with the global trend towards sustainable fashion which integrates environmental protection with cultural preservation under which the wool was chosen for its warmth, comfort and suitability for embroidery and laser cutting. Jamshaid and Mishra (2024) reported that twisted fibre structure of wool makes it elastic and shape-retaining which further made it ideal for outerwear with structure and tactile depth while the property also allowed Ajrak designs to be elevated or textured without impairing fabric flexibility hence; the utilisation of 100% pure wool emphasised natural purity and sustainability following the original Ajrak which was manufactured with hand-dyed organic chemicals and plant-based additives (Hirscher et al., 2018). Contrary to wool, leather was selected because appears rich and has a long history of being utilised in European design to reflect quality and durability while the leather further symbolised the contrast between softness of wool and rigidity of hide (Thomasset and Benayoun, 2024), demonstrating the communication the temporary and the eternal foundation of reinvention. Wu et al. (2025) cited that cultural communication can occur when fashion designers use universally known materials to reinterpret local traditions and following the cultural communication medium, the Ajrak reinvention also selected leather connect South Asian artisan iconography with European material sensibility.

The selection of material is challenging but finding the right material after the selection is even more difficult as the process faced the early challenge of sourcing 100% wool materials in blue and brown colour shades for reflecting water and soil but the challenge in material sourcing highlighted the conflict between design idealism and material reality (Busch, 2022). The selection of colours subjected to the alignment with nature because as per Vidale (2017) the traditional Ajrak also utilise the indigo colour for rivers and madder for earth and vitality however, the procurement challenge represented the engagement of designer with the material as the trail sourcing is essential for long-term design thinking. The search of leather is also challenging because it led to leather plant in Sialkot, Pakistan which is globally famous for leather processing; the designer able to receive the materials needed but also learn modern leather refinement processes including washing, drum-dyeing, painting and pressing. The knowledge acquisition reflected "*thinking through making*," where knowledge comes from working with materials and manufacturing situations that is signified by the direct engagement with material producing sites in Sialkot thus; fabric sourcing experience established that design research connects designers with industrial producers in a creative ecosystem. The selection of Wool and Leather aligned with the functional needs and support the reinvention aim of developing innovative Ajrak for the European market because the process preserve the original natural, sensory and cultural integrity of Ajrak while changing its fabric body to fulfil new environmental and aesthetic environmental needs under which the fabric selection process provides a opportunity for sustainability, heritage and design innovation dialogue.

#### 6) Designing

The process of Ajrak reinvention needed to mix cultural

history with modern design but following Moscatelli (2023) the modern design needs to maintain its cultural use and meaning with positioning into a worldwide design communication that promoted originality and hybrid styles to ensure an innovative design of Ajrak for modern fashion. The designer (researcher) avoided reinterpreting Ajrak as lower wear fabric to preserve its symbolism as the designs were developed on the outerwear like coats and jackets to maintain the visibility and symbolic significance of the fabric.

*a) Argument:* The creative validation procedure comprised of scholarly and professional evaluation at the Estonian Academy of Arts, where a designer displayed the experimental samples of the current reinvention samples using 3D printing, hand embroidery and laser cutting under which the response from the judges demonstrated varied opinions. Some of the members proposed to employ all methods for displaying the versatility of the fabric but some of the jury member suggested focusing on one single method to keep the consistency and efficiency within large scale production process however the class voting peer assessment showed that most students favoured hand embroidery for its tactile and cultural authenticity. According to Greco and Cock (2021) the sustainable fashion associated with the conflict between artistic authenticity with the industrial application, and following the conflict hand embroidery is more expensive and time-consuming than machine embroidery which made it less accessible to mass audiences. The challenge further reflected the element of "*slow fashion*" which values craftsmanship and material creativity over the rapid mass production (West et al., 2021) thus; the decision to merge all three technologies into one prototype was focused to combine handwork and digital fabrication.

*b) Design Sample:* The first design sample of the reinvention combined expertise and technology as the coat had a modified trench construction with a classic bodice and a curved shoulder panels down the front followed by a straight rear panel for stability (Figure 13).



Fig. 13. Model wearing the coat designed sample (Image by the Author)

Strong and laser-friendly feeling fabric was used to make these panels while the wool body of the coat maintained the integrity of fabric as that laser-cut Ajrak geometry motifs were on the felt panels and machine embroidery was conducted with felting on the flared waist to hem. Following the recommendations of Simair et al. (2023), the combination of digitally cut accuracy and hand-crafted details produced an innovative sample which combined the flatness of conventional print with the dimensionality of modern production enhancing the visual language of Ajrak by transforming the sensory feeling of the material.

c) *Prototyping*: The reinvention adopted strategic but continuous design improvements to develop prototypes as the designer started with visual research on several trench and overcoat styles; alternative Ajrak-inspired panel arrangements were initially sketched followed by the subsequent designing draft adding colour and motif arrangement based on symbolic value (Figure 14 and 15). The finished prototypes demonstrated three outerwear items that recognised cultural semiotics of Ajrak differently but the anthropologically sensitive designs featured motifs on the shoulders and chest to honour the dignity and respect of Ajrak traditions (Figure 16).



A) The above picture is the final illustration for the first prototype and it will have colorful embroidery on the collar and detachable panels on the shoulders filled with embroidery.  
 B) The above picture is the 2nd prototype where I plan to keep the blue color as the base to represent water and the fabric will be 100% wool and embroidery on the collar and back panel.  
 C) The above picture is the final illustration for the third prototype and will be in brown colored leather fabric. It also has a detachable panel on the shoulders which will have laser engraving on it with Ajrak motives.

Fig. 16. Final illustrations of prototypes (Images by Author)

d) *Colour and Cuts*: The selection of proper colours is very important for symbolising the old traditions within the reinvention of Ajrak under which the Sindhi cosmology-inspired foundation colours including earth brown, indigo blue and golden represented Earth, River and Sun (Khalid et al., 2024). The colour strategy focused on natural dye history and long-term utilisation to align the reinvention with concept of sustainability while the trench-inspired cuts were used for aesthetic and conceptual reasons. According to Gerz et al. (2021) trench coat symbolised strength, adaptability and beauty throughout European civilisations for over a century under which the addition of panel supported the integration of Ajrak motifs in structured but expressive sections as the 3D motifs covered the upper body.

e) *Linings*: The coat linings were manufactured from linen fabric that was digitally printed with Ajrak designs to preserve the cultural story as the linen was better for lining clothing than cotton since it was softer and draped better. Following the process of lining and finishing, Estonian collaborators Mari Ly Kapp and Elis Jurkatam and Tallinn model Gertrud Kiisa from the EMA modelling agency photographed the prototypes professionally under which the photos revealed the outside and inside lining of fabric from multiple perspectives (Figures 17-22). The professional photos highlighted the integration of history and current design of Ajrak under which the process of reinvention reinterpreted a centuries-old skill in a global fashion setting while as per Ko and Yim (2023) the cultural reinterpretation fostered creative communication on decolonising design via cultural continuity and technology hybridity.



Fig. 14. Rough prototype sketches (Image by Author)



Fig. 15. Prototype with coloured Motifs (Image by Author)



Fig. 17. Professional photo-shoot (Image by Elis Jurkatam)



Fig. 19. Professional photo-shoot (Image by Elis Jurkatam)



Fig. 18. Professional photo-shoot (Image by Elis Jurkatam)



Fig. 20. Professional photo-shoot (Image by Elis Jurkatam)



Fig 21. Professional photo-shoot (Image by Elis Jurkatam)



Fig 22. Professional photo-shoot (Image by Elis Jurkatam)

### B. Accessories-Reinvention beyond Garments

The inclusion of Ajrak inspired accessories take the reinvention of Ajrak beyond the garments under which the reinvention for European market included the accessories like earrings (Figure 23) because accessories acted as aesthetic and cultural signifiers in fashion systems. According to Turunen et al. (2025) identity of the wearer is reinforced by symbolic materiality and following the symbolism of Ajrak, the designer (researcher) copied the geometric patterns of Ajrak via modern fabrication methods to form cultural and aesthetic alignment between the garments and accessories. The earrings are developed by using 3mm plywood sheets and a laser cutter to carve Ajrak-inspired motifs because Chakraborty and Biswas (2020) cited that digital fabrication techniques played a vital role in reviving the ancient craft within the modern fashion apparel while Ikram (2022) added that laser design can mix accuracy of technology with cultural heritage. The utilisation of sustainable and flexible plywood aligned with principle of sustainable fashion because the strength, cheap cost and ease of usage always made the substrate or raw material suitable for producing small, eco-friendly accessories.



Fig. 23. Ajrak inspired earrings (Image by Author)

The laser cutting experimentation already demonstrated the difficulty of converting delicate Ajrak patterns to plywood, which burns easily and requires precise laser power and speed settings; the initial experimentation created uneven edges and unfinished cuts but the failed designing experiments reflected the learning curve of digital craftsmanship (Song, 2021). Following the learning, the double-pass cuts on the same pattern improved the process because it cleaned the edges and smoothed the polish without scorching while the continuous process aligned with principle of "material-led design," which established that designer-material dialogue effects the final product (Hansson and Busch, 2020). The finishing of the surface was achieved by enamel paints (post laser cutting) and two coats of the paint with overnight dyeing, created an attractive yet durable surface that aligned with the embroidery pattern of Ajrak garments; enamel process gave the wooden

pieces a different texture and colour shade while making them a piece of miniature textiles.



Fig. 24. Professional photo-shoot (Image by Elis Jurkatam)

The process of fine metal wiring used to join the earring pieces and the use of fine metal wires kept the accessory light in weight but strongly joint the motif pieces; the earrings communicate the cultural story of Ajrak and also provide an overall attractiveness for the new consumers in UK market (Figure 24). The process of developing matching accessory further aligned with insights of Hanafiah et al. (2025) that cultural reinvention in design should be cohesive rather than fragmented under which the addition of laser cut glasses frame in the future would also integrate Ajrak-inspired motifs into utilitarian objects that combine art, fashion and technology. The integrated approach also followed the principles of sustainable fashion because localised production, material awareness and creative ideas to preserve cultural traditions are the strategic priorities of sustainable fashion hence; the reinvention of Sindhi aesthetics via accessory design established that digital technologies can make craft-based innovation more accessible in the global design market.

### 3. Conclusion

The fashion research on “*Ajrak beyond Borders*” focused on combining South Asian Textile Heritage with modern fashion technology power to reinvent Ajrak for the European market and the practical designing processes improved the overall

design skills and provide comprehensive understanding regarding the progression of historical crafts in the fashion and textile business. Ajrak was traditionally used only for natural dye printing and pattern enhancement in Pakistan and India but its industrial reproduction reduces cultural and artisanal value under which the industrialisation made Ajrak more accessible but it also destroyed its beauty and cultural meaning. The process of reinvention with technology promoted a tactile and sensory renaissance for Ajrak through three-dimensional reinterpretations using 3D printing, laser cutting and digital embroidery hence; the reinvention protected cultural story and heritage-based textile innovation of Ajrak. The design experimentation critically highlighted the technology experimentation while connecting artisan authenticity and modern industrial processes as the utilisation of 3D software to digitally modify Ajrak motifs and then making them practically on the fabric established that computational design can preserve traditional value while creating new patterns and forms. The experimentation with insulating foam, felt and leather illustrated that each material reacts differently to digital procedures and requires a technology-craft communication under which the transformation of Ajrak fabric from cotton to wool and leather was practical and conceptual having alignment with European fashion and climate. The selection of wool fabric met the seasonal needs and changed the image of Ajrak as a rich and warm textile that could be sold across the globe which demonstrated that fashion “glocalization” is adapting local culture for a global audience without losing their cultural significance.

The outcomes of hand embroidery experimentation are also important because hand stitching took time and difficult on variable fabrics like leather but it gave three-dimensional designs depth, texture and authenticity that cannot be achieved by modern technologies. The variable use of fabric as substrate highlighted the technical issues like using imitation leather instead of real leather which further reflected the importance of using pure material and constant improvements of methods; computers performed most task of creative labour but the outcomes suggested that human artistry and handwork is still important in the age of global digitalisation. The mix of human and machine approaches improved the product and developed a sustainable hybrid method for textile creation that acknowledges the past and embraces digital progress but the overall process of reinvention also went beyond experimentation because it inspires other Pakistani designers and craftspeople to combine traditional designs with modern technology. The 3D Ajrak-inspired shawls, coats and accessories like earrings and glasses demonstrated that traditional crafts can be integrated into modern fashion and lifestyle design under which the cross-cultural collaboration between foreign designers and local craftsmen would better combine global styles to create inclusive design languages under which the process of reinvention provides important understanding on adapting to new cultures and employing technology.

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