

DENIM UPCYCLING AND THE REVIVAL OF CRAFT TECHNIQUES: A SUSTAINABLE APPROACH TO CONTEMPORARY FASHION

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Abstract:

The textile industry has a significant negative impact on the environment, as exemplified by the production of a single pair of jeans, which requires approximately 3,500 liters of water and releases around 33.4 kg of CO₂ into the atmosphere—contributing to the acceleration of climate change in the long term. Moreover, this type of production relies heavily on the use of harmful chemical substances, which can cause various health problems for workers who are directly exposed to them. Improper disposal of these chemicals into the environment can lead to the pollution of waterways and ecosystems. In a world increasingly confronted with the consequences of overconsumption and environmental degradation, unique, handcrafted clothing is emerging as an important factor in sustainable development, standing in contrast to the widespread influence of fast fashion. Such garments are not merely an aesthetic choice, but also a profound ethical and ecological decision made by the individual. The aim of this paper is to present the process of creating garments using traditional textile enhancement techniques such as patchwork, macramé, smocking, natural fabric dyeing, and redesign.

Keywords: denim, sustainable practices, upcycling, textile waste, fabric enhancement techniques

1. INTRODUCTION

Over the past nearly half-century, the way fashion is produced and consumed has drastically changed. The growth of the world population and its needs has led to a threefold increase in textile production volume, resulting in the phenomenon known as "fast fashion." Excessive seasonal collections, low prices, discounts and promotional campaigns, the ease of one-click online shopping, and the influence of social media have all contributed to individual consumption reaching levels where as much as 85% of textile items are discarded annually into landfills and illegal dumpsites instead of being sent to recycling centres and further degraded back into the environment. [1]

Denim is a durable twill-woven fabric characterized by dyed warp and undyed weft yarns. It is estimated that a single pair of jeans consumes over 3,500 liters of water throughout its entire production chain—from cotton cultivation, through dyeing, to washing processes used to achieve desired colors and patterns [2]. An environmentally sustainable value chain in the fashion industry involves the rapid adoption of high-performance innovative technologies, equipment, and materials that lead to reduced consumption of energy, water, and resources, as well as improved health, safety, and environmental standards for workers in the textile industry [3, 4]

This paper explores sustainable denim transformation through recycling and upcycling processes, emphasizing the artistic and educational aspects of creating unique garments from discarded materials.

2. PRODUCTION PROCESS AND ENVIRONMENTAL IMPACT OF DENIM

The most common twill weave used in denim involves passing the weft yarn over two and under two warp yarns, although it can also be formed by passing the weft over one and under two warps, or over one and under three warps. This weaving method is responsible for the characteristic appearance of denim fabric: the warp yarns are dyed with indigo, while the undyed weft yarns give the fabric its recognizable blue face and lighter reverse side. This material is flexible, elastic, and strong due to the

higher number of threads per inch. The yarn fineness ranges from 30 to 125 tex, depending on the desired outcome of the finished denim. For heavier denim, yarns with a fineness of 50–150 tex are typically used in twill weave, while lighter denim is made using finer yarns of 20–50 tex, sometimes woven in plain weave [1-3].

The denim garment production process consists of four main stages: cutting, sewing, washing, and finishing. To meet environmental standards, washing is performed using machines that utilize ozone and water vapor extracted from the air to clean the garments. This method reduces water consumption by up to 50%, which is equivalent to saving approximately 60 liters of water per garment. The faded appearance of denim is traditionally achieved through sanding, which poses serious health and safety risks to workers due to the inhalation of fine dust particles. A potential solution to this problem is the introduction of laser technology, which lightens the denim without the use of water, sandblasting, or other harmful substances and methods [3].

Billions of denim garments are produced each year. Denim manufacturing methods have a negative environmental impact due to the discharge of dyed wastewater, heavy metals, acids, bases, enzymes, and other pollutants into the environment. Textile workers are exposed to these chemicals, which can be toxic and carcinogenic. For dyeing, manufacturers traditionally rely on indigo pigment, which is naturally derived from plants of the *Indigofera* genus. Indican, a β -O-glucoside of indoxyl (the precursor of indigo), is the natural storage form of indigo in indigo-producing plants. The growing demand for jeans throughout the 20th century led to the development of synthetic indigo, considered a more environmentally friendly option for denim dyeing. The use of artificially engineered enzymes for dye production—such as indican—has eliminated the need for reducing agents and reduced annual carbon dioxide emissions by more than three million tons. Emerging trends in denim dyeing technology include the synthesis of bioindigo, waterless indigo dyeing using supercritical carbon dioxide, digital printing, and other innovative techniques. Traditional desizing processes have limitations that can be overcome through enzymatic desizing; α -amylase can remove insoluble starches from denim using simple hydrolysis methods [4-5].

3. SUSTAINABLE PRACTICES THROUGH RECYCLING AND UPCYCLING

Recycling represents a method of creatively utilizing textile materials of any kind or finished garments that would otherwise end up in landfills or be incinerated, serving as starting points for various fashion products with high artistic value. This process is one of the ways to reduce the negative environmental impact of the fashion industry. Traditionally, textile waste recycling involves its reprocessing through mechanical or chemical means, preparing it for reuse as part of new textile and non-textile products. Adapting one's own clothing means creating a unique style that reflects the taste and lifestyle of each individual, fostering a sense of diversity and individuality in contrast to the modern look shaped by mass media. [4-7]

Upcycling represents a circular fashion approach based on design, where textile waste generated during the production process or after a period of use and wear is reused to create new garments. This method involves the practice of creating new products from old items, components, or materials that have reached the end of their life cycle. The process enables the extension of a product's lifespan, which contributes to reducing the overall demand for newly manufactured products, resources, and energy. By adopting upcycling on a larger scale, industries could significantly reduce environmental harm by lowering emissions associated with the production of new products and materials. Considering these theoretical advantages, upcycling has increasingly been recognized in recent years as a sustainable alternative to traditional manufacturing. [4-7]

Overview of Fabric Enhancement Techniques Applied to the Unique Model

Although modern technology enables mass and rapid processing of textiles, hand finishing still holds a special place, especially in the creation of unique clothing pieces. Aesthetic enhancement methods improve the visual appearance and texture of materials, such as embroidery, braiding, painting, fraying

(leaving raw edges), and similar techniques. These methods not only contribute to the aesthetic value of the garment but also tell a story — about the work process, the designer's inspiration, and even a sustainable approach to production. In an era where mass production often overlooks individuality and creativity, hand-finishing denim brings the focus back to craftsmanship, precision, and personal touch. By using existing garments and various techniques such as patchwork and deconstruction, a completely new and unique clothing piece with a nostalgic flair was created [5].

4. EXPERIMENTAL PART

The experimental part involved redesigning an old denim garment using traditional hand-finishing and embellishment techniques, to demonstrate the creative potential of textile reuse. Inspiration and fashion illustration of the model is shown in the figure 1.



Figure 1: Fashion illustration and technical sketches of the unique garment model (Illustration made by authors)



Figure 2: Bleaching of blue denim by stamping crochet coated with bleach (Photos made by authors)

Sodium hypochlorite (NaOCl), a chemical compound widely used as a disinfectant and bleaching agent due to its strong oxidative potential, was applied in the experimental process for controlled colour removal on denim fabric. In this study, a commercially available household bleach (Domestos, containing approximately 4.5% sodium hypochlorite, <5% chlorine-based bleach, <5% non-ionic and cationic surfactants, soap, and fragrance) was used as the bleaching medium [9]. The solution was applied manually by stamping a crochet tool previously coated with the bleach to achieve localized fading effects on the denim surface. This approach allowed for partial decolorization without significant damage to the fabric structure, simulating sustainable and low-cost surface modification techniques under household conditions. In Figure 2 it is shown the bleaching technique with the crochet.

The **tie-dye** or **shibori** method is one of the physical dyeing techniques that utilizes binding and compression to create patterns on fabric [2] and it is used for light denim for model creation. This manual process involves tying the twisted or gathered sections of the fabric with thread, cord, or rubber bands to protect certain areas from dye penetration. After dyeing, once the ties are removed, the pattern is formed from the original fabric colour—usually white—in contrast to the dyed sections. Typically, the most basic patterns include circles, dots, squares, diamond shapes, or “spider webs,” which repeat in various sizes and proportions [8,10].



Figure 3: Dyeing light fabric using the shibori method (tying with cord + needle/thread) (Photos made by authors)

In the creation of the unique garment, several traditional textile enhancement techniques were applied to achieve both aesthetic and conceptual effects. Illustrations on denim are created using the technique of hand-painting denim fabric with textile paint, which represents a form of visual art depicting human figures or motifs from nature. This method simultaneously adds functional value when the artwork is transferred onto wearable clothing items. Denim as a base is directly painted using a brush and paint over a previously drawn sketch (made with white wax pencil, chalk, or pastel pencil) (Figure 3).

Patchwork is involved as a sewing technique to join a small piece of fabric to create a larger design. The patchwork process requires creativity and precision, as different fabric pieces must be carefully arranged and sewn together to form a harmonious whole. It can be said that patchwork represents a blend of tradition, creativity, and sustainability. This technique remains valued for its beauty, versatility, and timeless charm and this technique is used for model making [10].

Additional decorative techniques included hand embroidery, used to enhance selected areas of the garment with ornamental stitches that added visual and textural richness. Embroidery involves creating stitches on fabric with a hand needle and thread, and decorative stitches are used to make textile items (whether clothing or utility objects) more beautiful and valuable.

Canadian smocking is applied as a method of fabric manipulation creating the three-dimensional texture by stitching with a needle and sewing along a drawn grid of squares, diamonds, or dots on the reverse side of the fabric, forming a textured 3D pattern on the front (right side) of the material [11].

Finally, the macramé technique—hand-knotting cotton yarns into ornamental forms—was incorporated as a decorative element. Originating from the 13th century, this method was historically used by Arab weavers to protect tapestry edges from fraying and was here reinterpreted to add structure and artisanal detail to the final design [12].

5. RESULTS: PRESENTATION OF THE FINISHED UNIQUE MODEL

The crafted model revives memories and tradition by combining rustic aesthetics with contemporary forms. The use of old denim paired with sentimental motifs, such as *grandmother's lace doilies*, creates a unique blend of past and present. Lace details are carefully placed to fill the slits on the knees of the pants. They gently extend over the upper edge of the corset, softly framing its cups. Through the patchwork technique, smaller pieces of denim are carefully joined into a harmonious whole, transforming into large floral shapes that adorn the sides of the women's jeans. A short crinoline, barely covering the hips, is richly decorated with flowers made from thinly cut denim strips, creating a sense of movement and playfulness. The macramé technique of hand-knotting cotton thread, as another decorative element, adds an additional layer of texture, complementing the back of the vest where sparkling white flower stems are painted with a brush. The front of the vest stands out with three-dimensional textured floral patterns created by the fabric manipulation technique known as canadian smocking. This technique uses precise stitching along a predefined grid of squares, diamonds, and dots to achieve depth and tactile dynamism on the surface. The pants gradually widen from the knees downward, forming voluminous bell bottoms made from four panels. Half of these panels are created using the shibori technique of physical dyeing, where tying and compressing or stitching with needle and thread creates patterns—such as scattered concentric circles with soft edges or floral motifs. The other half of the bell-shaped legs is adorned with faded traces of floral prints. A winding botanical embroidery, made from threads of varying fineness, composition, and gloss, decorates the lower part of the corset, uniting all the clothing pieces into a poetic expression of nature, recycling, and handmade craftsmanship.



a)



b)

Presentation of the finished model obtained by recycling old denim:

a) Front view and b) Back view

6. DISCUSSION

By observing various sustainable practices, including the field of redesign, it becomes clear that education—specifically raising environmental awareness among younger generations—is essential as the one of the numerous solutions to the problem of excessive fast fashion consumption, whose impact grows alongside the rise of social media. Instead of merely connecting through the Internet, there is a need to reconnect with roots and artisan workshops, that nurture and study traditional fabric manipulation techniques such as patchwork, embroidery, and various dyeing methods, thereby transforming garments into unique carriers of cultural value.

It is necessary to empower young designers to begin applying traditional methods of aesthetic embellishment and encourage them to further explore the potentials of sustainable fashion through creative reinterpretation of existing resources. As a result of this manual work process, a garment that combines sustainability and artistic authenticity, while simultaneously highlighting awareness of the importance of responsible approaches in fashion, was created. Unique pieces, therefore, can play a key role in shaping a market that values ethical, aesthetic, and ecological practices in the future.

7. CONCLUSION

In today's world, increasingly faced with the consequences of overconsumption and environmental pollution, unique clothing is becoming an increasingly important factor in sustainable development, as opposed to the pervasive fast fashion. As such, it is not merely an aesthetic choice, but a profound ethical and ecological decision for each individual. Unique pieces symbolize the slow fashion philosophy, custom-made for the wearer, produced in small quantities. They are created in artisan workshops, mostly by hand, using embroidery, lace, crochet, various dyeing techniques such as shibori, and patchwork methods to join discarded fabric scraps, with hand-finished edges and macramé details. The materials used are of higher quality, and the lifespan of unique items is longer, so they won't end up in landfills after just one season. Today, vintage clothing and retro styles are everywhere, designers find inspiration for their new models in traces of the past. By reconstructing those old pieces, fresh designs are born. Without producing new materials, using natural dyes, and handmade techniques, unique clothing positively impacts the reduction of environmental pollution, supporting sustainability and the circular economy. Unique and sustainable clothing, therefore, is not just a passing trend, but part of a much broader shift in how fashion is consumed, emphasizing the awakening of ecological awareness when making decisions that will ensure a "greener" future.

8. REFERENCES

- [1] Manaian A.P., Mueller S., Bechtold T., Pham T., Quantification of indigo on denim textiles as basis for jeans recycling, *Dyes and Pigments* 2016 (2023)
- [2] *Denim Focus. Levi's CEO Settles the Debate on Just How Often You Should Wash Your Jeans.* Available at: <https://denimfocus.net/levis-ceo-settles-the-debate-on-just-how-often-you-should-wash-your-jeans/>
- [3] PubMed Central. *Sustainability and Denim Production.* Available at: <https://pmc.ncbi.nlm.nih.gov/articles/pmc9909807/>
- [4] Lehtinen, A. (2021). Upcycling: An Analysis of Opinions within the Fashion Industry.
- [5] Stenton, M. (2021). From Clothing Rations to Fast Fashion: Utilising Regenerated Protein Fibres to Alleviate Pressures on Mass Production. *Energies*, 14(5654). London College of Fashion, University of the Arts London.
- [6] Reet, A., et al. (2021). Designing for Circular Fashion: Integrating Upcycling into Conventional Garment. *Fashion and Textiles*, 8(34).

- [7] Rahmanita, N., et al. (2025). Upcycling Denim as an Eco-Friendly Fashion Solution. Journal of Scientific Research, Education and Technology (JSRET), 4(3). ISSN: 2962-6110.
- [8] Kapetanović, A. E. (2022). *Odabir i realizacija motiva na džinsu po preporuci generacije Z*. University of Zagreb, Faculty of Textile Technology.
- [9] Europlast. *PVC Folija – Tehnički list proizvoda*. Available at: https://europlast.co.rs/index.php?tmpl=component&option=com_virtuemart&view=productdetails&virtuemart_product_id=1953&format=pdf
- [10] *Vogue Adria. Upcycling i Patchwork trendovi*. Available at: <https://vogueadria.com/sr/upcycling-i-patchwork-trendovi/>
- [11] *Canadian Smocking: A Fabric Manipulation Technique*. Quilts Kingston, 2020. Available at: http://quiltskingston.org/cgna/indexlearn_files/2020-11-02%20canadian%20smocking%20nov%202%202020.pdf
- [12] *Ancient Earth Healing. History of Macramé*. Available at: <https://ancienteearthhealing.com/history-of-macrame/>

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