

AI-Enhanced Textiles: Preserving Wheel-Assisted Inkle Loom Textile Patterns and Driving Economic Growth.

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Abstract

Every facet of our society is rapidly transformed by technology. A wheel-assisted inkle loom is a modified loom with a wheel mechanism that enhances weaving efficiency and pattern complexity, and fosters an entrepreneurial spirit. Inkle refers to a coloured linen tape. This paper explores the unique intersection of technology and wheel-assisted inkle loom woven fabric production, focusing on how AI tools can support pattern design, pattern preservation, empowerment, and creative innovation. The fusion of artificial intelligence (AI) with wheel-assisted inkle loom textile production presents an opportunity for economic development. However, rapid modernisation and industrialised production threaten the continuity of this rich Nigerian tradition. The study aims to encourage pattern design by integrating technology with inkle loom woven textile designs in an era of artificial intelligence. AI-driven tools can help catalogue endangered patterns, predict market trends, and customise products for contemporary fashion. The conceptual theory of Diane and the modern creativity theory of Kanematsu will be adopted as indicators to guide the execution of this study. The study is studio-based and uses qualitative and descriptive research methods within an exploratory framework. These

methodologies facilitate data acquisition through in-depth observation and interviews with art practitioners who possess specialised knowledge in weaving and pattern creation. This study will contribute to sustaining cultural identities and generating economic opportunities.

Keywords: artificial intelligence, textiles, wheel-assisted inkle loom, cultural preservation, economic growth, pattern recognition

Introduction

The intersection of artificial intelligence (AI) and traditional textile practices offers opportunities for cultural preservation and economic revitalization. Textile production in Africa has long served not only utilitarian purposes but also as a profound medium of artistic expression. Textile traditions are essential carriers of cultural identity, reflecting the aesthetic, social, and spiritual values of communities Arthur, (2021). Among these traditions, wheel-assisted inkle loom weaving stands out for its intricate patterns and historical significance in various cultures. However, with the encroachment of mass production and digital printing technologies, many traditional textile practices face the threat of extinction. Recent advances in artificial intelligence (AI) offer promising tools for the documentation, preservation, and revitalisation of these endangered crafts (Xu et al., 2022). The ability of AI to process vast amounts of data and make informed judgments that optimise various production and design stages is a key factor driving its adoption in the textile industry. In addition to simplifying processes like fabric inspection, pattern identification, and defect detection, this technology is making it possible to estimate customer demand and supply chain management with greater accuracy. In the textile business, artificial intelligence is also playing a significant role in sustainability initiatives. Manufacturers can reduce waste, maximize resource use, and investigate new recycling and circular fashion opportunities by employing predictive models. Diane conceptual approach to pattern design, emphasizing the fusion of traditional techniques with modern technologies. Her teachings on advanced Photoshop techniques complement the capabilities of AI tools, enabling designers to explore new realms of creativity and innovation in pattern drafting. Modern Creativity theory by Kanematsu, H (2016) is a theory adopted and built into the structural drafting of wheel-assisted loom fabric patterns.

This theory underscores creativity as the ability to produce original ideas and items. It also includes the combining of existing work and objects in different ways for new purposes. Creativity involves higher levels of thinking and is very important for all areas of education. This paper investigates how AI can be harnessed to preserve the unique patterns of wheel-assisted inkle loom textiles and how such integration can drive economic growth through heritage tourism, niche markets, and collaborations in contemporary fashion.

Pattern Drafting and Structural Draft in Textiles.

A draft in textiles is a plan or diagram that outlines how threads are arranged and interlaced in fabric production, serving as a blueprint for creating specific weave patterns. Textile patterns are repeated designs applied to fabric surfaces, consisting of geometric, floral, abstract, or figurative elements. Pattern drafting according to Black et al., (1980) is a set of mark or characters used to designate the order in which the threads are drawn into the heddle to form the weave. It can also be referred to as the process of creating templates or blueprints for different parts of a garment based on specific body measurements, used to cut fabric for sewing, and is crucial in garment construction. In textiles, particularly in weaving, a structural draft refers to the plan or diagram that shows how threads are to be arranged and interlaced on a loom. This draft guides the weaving process and determines the fabric's texture, strength, and appearance. Integrating structural drafting with Artificial Intelligence (AI) can significantly enhance the textile industry's efficiency and innovation, driving economic growth. This paper focuses on the structural draft in relation to wheel-assisted loom weaving. The structural draft also helps the weaver develop a deep understanding of the weaving process and ultimately enables them to produce entirely original designs. With this procedure, the weaver will keep a record of all their works. It has been observed that a careful study of structural drafting enables the weaver to understand and develop new, original designs for different productions, thereby facilitating the analysis of weave structures. Oghale and Oluwafunmilayo (2020).

AI can analyse structural drafts to optimise weaving patterns, thereby reducing material waste and enhancing productivity. AI algorithms can also predict consumer preferences and market trends, enabling accurate

demand forecasting and customized designs. AI can optimise resource use in the drafting process, thereby supporting sustainable practices and cost savings. Additionally, AI can assist in creating innovative structural drafts by exploring new patterns and enhancing creativity. Integrating structural drafting with AI in the textile industry enhances efficiency, sustainability, and innovation, contributing to economic growth in the textile sector. Although Structural drafting is regarded as a system of notation used to represent the appearance and mechanics of a weave graphically, a weaver should be able to decode and understand the signs embedded in the drafting system; this is a solemn and tedious exercise if a weaver wants to be creative and innovative. Originally, structural drafts are plotted on graph paper so that the design appears as it would on the fabric surface. Still, with innovations and technological computer-aided devices and AI, it is much simpler, faster, and easier for art practitioners.

The Wheel-Assisted Inkle Loom: Cultural and Economic Significance

The inkle loom is a narrow-band loom used historically for weaving belts, sashes, and decorative bands. The wheel-assisted variant, equipped with a rotating mechanism, enables more complex pattern generation and faster weaving Osei-Tutu, (2020). In the textile business, a loom is an essential equipment that promotes economic growth, effective production, and high-quality fabrics. Looms have been around since the prehistoric era and are used to make a variety of basic materials, including clothing, bedding, mats, rugs, tents, harnesses, and straps. Weaving machinery called looms can be used to make woven fabric mechanically or by hand. These tools allow the weft to pass over or beneath the warp threads by stretching the warp threads.

One of the earliest techniques for creating fabric from plant or animal fibres is weaving, which has developed from basic hand-woven frames to intricate, machine-driven ones. The fifth millennium BCE saw the invention of the first looms. With automated weaving procedures and thread tension management, modern looms are frequently complex and mechanized. In Nigerian culture, looms have become indispensable, especially for ethnic groups with a long history of weaving. They are used to make different kinds of cloth and range in complexity from basic hand-manipulated looms to intricate ones driven by foot pedals. The Egyptians, Chinese, Greeks, and Romans were among the civilisations that used

looms to produce linen garments. African woven textiles are a wide variety of fabrics with unique artistry, cultural value, and visual appeal. With the help of these intriguing tools, weaving is fun and has countless applications. Many loom varieties, such as floor, table, stiff-heddle, inkle, two-shaft, and tapestry looms, as well as the wheel-assisted inkle loom, are used in weaving techniques worldwide. In several indigenous and artisanal communities, these textiles are more than utilitarian objects; they represent lineage, social status, and ceremonial traditions. Economically, textiles woven on wheel-assisted inkle looms have served as significant trade goods, contributing to local markets and cross-cultural exchanges Ajayi, (2019). However, diminishing interest among younger generations and limited digital documentation threaten the continuity of this tradition.

The Wheel-Assisted Inkle Loom Concept



Title: Warping of the Wheel-assisted Inkle Loom.

Medium: Weaving Technique

Source: Jonathan, Peace E

Year: 2024

Wheel-assisted inkle weaving entails turning the loom over before attaching it to a 12-inch table runner. The loom is held in place during rotation by the iron runner that is fastened to the table. Two bearings support the turner's rotation. After being connected to the loom's first dowel, the warp yarn is twisted around the warping dowels. Maintaining warp threads under constant tension prevents weaving problems. Use a strong thread or string and alternate the heddles to make a shed. Secure

the warp by tying the end of the final thread to the final dowel or peg. Use the loom's tensioning mechanism to change the tension. Build the first shed to begin weaving, then fill it with weft yarn and beat it into position.



Title: Wheel-assisted inkle Loom with woven fabric.

Medium: Weaving Technique

Source: Jonathan, Peace E

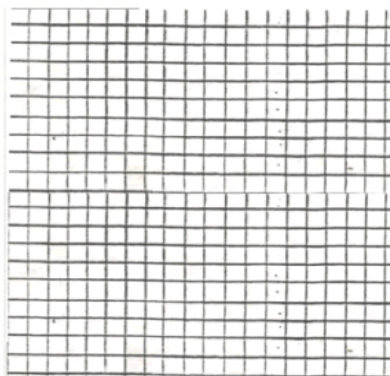
Year: 2024

This loom is traditionally used for producing decorative woven fabrics and is associated with historical textile traditions. It contributes to cottage industries, small-scale weaving enterprises, the weaving market, the sustainable fashion movement, and cultural tourism and craft education, as woven fabrics are often featured in workshops and heritage centres.

Originally used the Point Paper (Design Paper) and an AI-Generated Design.

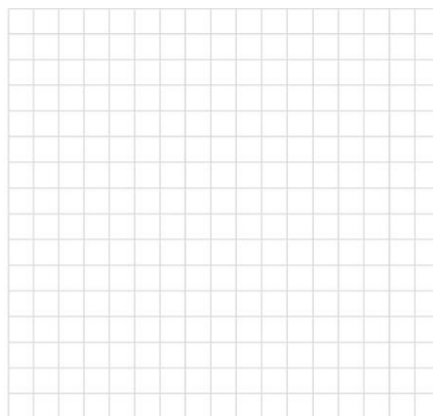
In mathematical computation, it is comparable to standard graph paper. It is characterised by vertical and horizontal lines, making it appropriate for displaying weaving and designs. The weft yarn, or pick, is typically indicated by horizontal spaces/lines, while each vertical line typically represents one warp yarn or end. It should be noted that structural drafting, or pattern drafting, is primarily performed using point or design

papers. A pen, pencil, ruler, and eraser are additional tools used to develop, draw, and arrange the draft's signs in accordance with the design formulation.



Sample of Design / Graph Paper

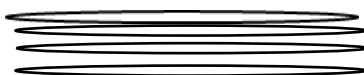
Title: Point paper design
Medium: Weaving technique
Source: scitechnol.com
Year: 2020



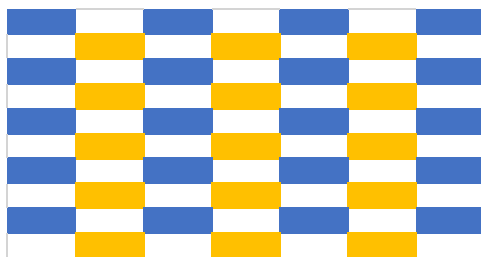
Title: AI-generated design
Medium: Weaving technique
Source: chatgpt.com
Year: 2025

Whether a house is market-based, commercial, residential, or recreational, its architectural planning differs. The type of loom used in formulation affects the woven fabrics used for office wear, furniture, and clothing. The manual wheel-assisted inkle loom patterns, which are controlled by the hands at the top using a rotating built-in mechanism, are the focus of this paper's structural draft. Sectional diagrams are separated into two categories: warp and weft.

The weaver should first choose the weave pattern to be used before beginning drafting. For example, twill weave 2/2 or 2/3, pickup techniques, or plain weave 1/1. Now, visualize the top of a wheel-assisted inkle loom, you will be looking at the warp dowel in which the heddles are tied for the warp thread to pass through.



Title: Warp heddles
Medium: Weaving technique
Source: Jonathan, Peace E
Year: 2025



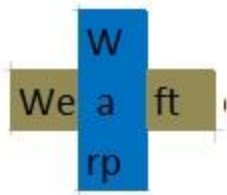
Title: Plain weave
Medium: Weaving technique
Source: Jonathan, Peace E
Year: 2025

Applications of Artificial Intelligence in Textile Pattern Preservation

AI technologies, particularly machine learning and computer vision, have been increasingly applied to heritage preservation (Li et al., 2023). The art of woven fabric design has undergone a significant transformation with the advent of artificial intelligence (AI), enabling the creation of sophisticated, time-consuming structural patterns. In woven fabric design, a structural draft is a visual representation of how warp and weft threads interlace to create a particular weave pattern. It serves as a guide for weavers to understand thread placement and the sequence of motions required on the loom. The creation, analysis, and visualisation of woven patterns are now facilitated by AI-driven tools, which improve understanding of textile structures and the design process.

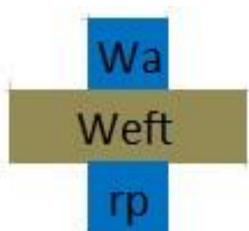
Methods of fabric representation

A weave can be defined as the interlacing pattern of the warp and weft. There are two ways of interlacing.
Warp overlap in which warp is above 101meds weft



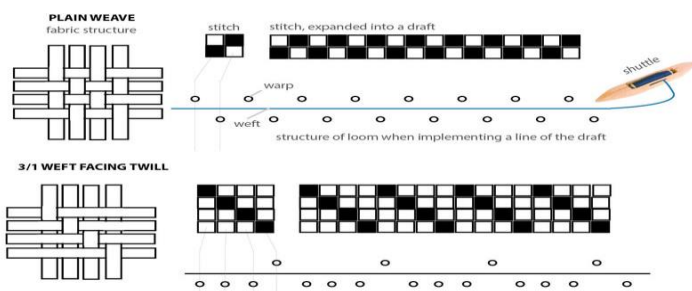
Title: Warp
Medium: Weaving technique
Source: textilestudycenter.com
Year: 2015

Weft overlap in which the weft is above the warp



Title: Weft
Medium: Weaving technique
Source: textilestudycenter.com
Year: 2015

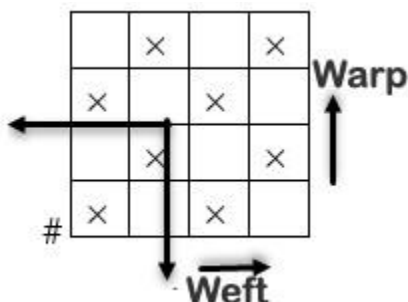
When the warp is lifted above the inserted weft, warp overlap results. When the warp thread is lowered, the weft thread is inserted above the warp thread, and the weft overlap is obtained. Sobuj (2015).



Title: Fabric Structure
Medium: Weaving technique
Source: researchgate.net
Year: 2025

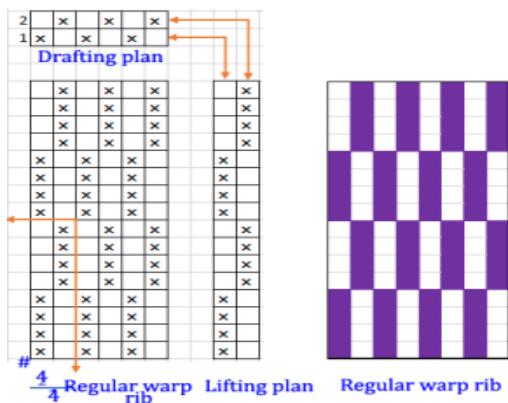
Structural drafts are essential components in fabric design, defining the weave structure, such as plain weave, twill, or satin. They consist of a Threading Plan, which indicates how warp threads are threaded through the heddles; a Tie-Up or Lifting Plan; and a Treading Plan, which depicts the sequence in which the treadles are pressed to control the lifting. Various draft plans are employed to achieve different weaving effects, including Straight Draft, Pointed (V-) Draft, Skip Draft, Broken Draft, Grouped Draft, Curved Draft, and Combined Draft. Each draft type serves a specific purpose and is chosen based on the desired fabric characteristics.

A typical example of a structural draft is the 2/2 twill weave, in which each weft thread passes over two warp threads and then under two, producing a diagonal pattern with threading and lifting plans arranged to produce characteristic twill lines. Visual resources such as ResearchGate and Textile Details offer detailed illustrations of how weave drafts represent woven structures and how looms implement these drafts. In a weave plan, a blank in a square indicates that a warp goes below the corresponding weft and any color or 'X' mark in the square indicates that the warp floats above the weft.

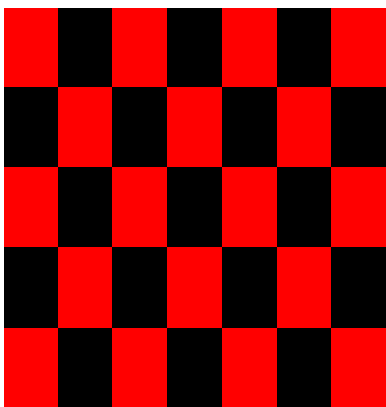


Title: Warp
Medium: Weaving technique
Source: textilestudycenter.com
Year: 2015

Vertical lines are represented as warps and horizontal lines as wefts. A complete repeat should be displayed on design paper, with squares indicating intersections. 'X' marks indicate warp over weft, while blank squares represent weft over warp. symbols indicate repeat unit. These can be achieved with the use of AI tool to make it fast, easier and very simple for art practitioners.



Title: Drafting
Medium: Weaving technique
Source: textilestudycenter.com
Year: 2015



Title: Twill weave draft 2/2.
Medium: Weaving technique
Source: Jonathan, Peace E
Year: 2025



Title: Twill weave
Medium: Weaving technique
Source: freepik.com
Year: 2025

1. Jamdani Motif Generation Using Conditional GAN

A notable advancement in AI-driven textile design is the development of a Generative Adversarial Network (GAN) model for generating Jamdani motifs. This model is trained on a dataset of traditional Jamdani patterns and can develop new motifs from user input. The system allows users to input rough sketches, which are then refined into complete motifs that adhere to the geometric structures of authentic Jamdani designs. This

approach not only preserves traditional aesthetics but also introduces innovative variations in motif design.

2. Textile Pattern Generation Using Diffusion Models

Another significant development is the use of fine-tuned diffusion models for generating textile patterns. These models are trained on extensive datasets of textile patterns and can generate new designs from textual descriptions. The AI system interprets the input text and produces visual patterns that match the described characteristics, such as colour schemes, textures, and weave structures. This method streamlines the design process, enabling rapid prototyping and customisation of woven patterns.

In the context of wheel-assisted inkle loom textiles, AI can contribute through:

Pattern Recognition and Digital Archiving

AI-driven image recognition systems can analyse existing textile samples, identifying recurring motifs, colour schemes, and weaving techniques. By digitising these patterns, researchers and artisans can access, study, and replicate traditional designs without the risk of physical degradation. (Kumar & Bansal, 2021).

Design Augmentation and Innovation

Generative AI models, such as generative adversarial networks (GANs), can synthesise new patterns inspired by traditional motifs, facilitating the fusion of heritage designs with contemporary aesthetics (Zhang et al., 2022). This approach not only preserves cultural identity but also attracts younger designers and markets interested in culturally-rooted, AI-enhanced textiles.

Virtual Education and Skills Transfer

AI-powered virtual simulations and tutorials can support the training of new weavers, especially in remote areas. By recreating the mechanics of wheel-assisted inkle looms in virtual environments, these tools make traditional knowledge more accessible (Li et al., 2023).

Economic Growth through AI-Enhanced Textile Production

The integration of AI into textile heritage practices offers tangible economic benefits, including:

1. Product Diversification and Market Expansion

By using AI to reinterpret traditional patterns for modern markets—such as fashion accessories, home décor, and digital prints—artisans can diversify their product lines and reach global audiences through e-commerce platforms (Arthur, 2021). AI is transforming the textile industry by increasing productivity, innovation, and market penetration. Textile manufacturers can increase productivity, reduce waste, and enhance product quality by combining AI-driven automation with predictive analytics. As a result, businesses can experiment with creative designs, innovative textiles, and customised clothing based on customer preferences, leading to product diversification. Another important advantage is market expansion. Businesses may streamline supply chains and reach new markets worldwide by using AI to spot new trends and demand patterns. In an industry that is evolving rapidly, machine learning models help organisations remain competitive by supporting pricing strategies and customer engagement.

Heritage Tourism and Cultural Experiences

AI-enhanced textile workshops and exhibitions can be integrated into cultural tourism packages. Interactive AI applications, such as augmented reality (AR) presentations of traditional weaving techniques, can enrich visitor experiences and generate additional income streams (Osei-Tutu, 2020). AI-enhanced textile production can significantly contribute to heritage tourism and cultural experiences by preserving traditional craftsmanship while leveraging modern technologies. Machine learning and generative design tools enable artisans and manufacturers to recreate historical textile patterns, weaving methods, and culturally significant fabrics at scale. These innovations benefit tourism by allowing AI-powered customisation, enabling visitors to engage with textile heritage through interactive experiences such as virtual fabric design workshops, augmented reality (AR) demonstrations of weaving techniques, or AI-assisted cultural storytelling embedded in garments. This fusion of tradition and technology attracts global markets seeking authentic yet innovative textiles, thereby driving economic growth and fostering cultural appreciation.

1. Sustainable and Inclusive Economic Models

Digital documentation and AI-driven design democratize access to cultural resources, enabling marginalised communities, particularly

women and youth, to participate in the creative economy. This fosters inclusive growth while maintaining cultural integrity (Ajayi, 2019). AI-enhanced textile manufacturing is supporting inclusive and sustainable economic models, guaranteeing equitable opportunities for a range of groups. This is accomplished by the development of novel materials, the enhancement of environmentally friendly textiles, waste reduction, and energy efficiency. Demand is predicted using machine learning, thereby reducing overproduction and surplus stock. AI also improves recycling procedures, enabling the reuse of textiles. Accessibility driven by AI allows craftspeople from underrepresented groups to engage in international markets. Automated design platforms enable people with disabilities to participate in textile crafting, while translation tools support worldwide collaboration. Adaptive AI algorithms promote equity in fashion by ensuring that a variety of body shapes and cultural preferences are accounted for in the production process.

While AI offers numerous benefits, challenges remain regarding data ownership, cultural appropriation, and the potential homogenization of diverse textile traditions. Ensuring that AI applications respect cultural intellectual property and involve community consent is essential for ethical practice (Kumar & Bansal, 2021).

Conclusion

The textile industry is undergoing transformation thanks to artificial intelligence (AI), which is improving sustainability, accuracy, and efficiency. By automating processes, enhancing quality control, and optimising resource use, AI reduces waste and boosts output. AI-enhanced textiles represent a dynamic intersection of tradition and technology, offering pathways to preserve wheel-assisted inkle loom patterns and stimulate local economies. Through pattern recognition, design innovation, and virtual education, AI technologies can safeguard cultural heritage while promoting sustainable economic development. Textile pattern drafting is a creative and innovative endeavour deserving of recognition. It is a cognitive endeavour that cannot be managed by just anyone. It is primarily intended for skilled professionals or weavers. Individuals who are eager to learn, innovate, and refine the threading draft using the standard Basic Unit of Bottom shad can achieve significant proficiency after numerous attempts at pattern drafting using AI tools.

However, careful consideration of ethical implications and community involvement remains crucial for responsible integration.

The use of AI in wearable technology and smart fabrics is opening up new possibilities for creative applications that adapt to physiological and environmental factors. Data management, integrating legacy processes, and ethical frameworks are some of the obstacles that AI implementation must overcome. Adoption of AI will spur innovation, encourage sustainable practices, and satisfy customer demands as the industry develops. In an increasingly digitised and environmentally sensitive world, the textile industry's competitiveness depends on ongoing research, cooperation, and investment in AI technology.

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