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Innovative Use of Woven Textile Technology in the Production of Beachwear Designs Inspired by African Art

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Abstract

Experimentation in the field of textiles, like in other fields, tends towards introducing a set of changes and formulations that contribute to enriching the artistic textile product. The importance of this research becomes evident in its contribution to the production of beachwear with innovative textile compositions and creative designs inspired by African art, establishing the foundations for their execution.Various textile structures (Honeycomb, Atlas, Beeka, Twill, Extended weft) were integrated with the warp structure to create innovative compositions using modern textile programs. These programs enable control over the movement of the weft after various configurations of heddles. Functional tests were conducted on the produced fabrics to verify their suitability for the intended functional product. The results were then statistically analyzed, demonstrating the functional success of the innovative textile structure and the product resulting from the integration of Honeycomb textile structure with the warp structure as beachwear.

Keywords: *Textile Technology- Beachwear- African Art*

Introduction

In the modern era, artists have been inclined towards experimentation, introducing innovative artistic forms that contribute to enhancing the aesthetic appeal of woven textiles. These forms take various artistic shapes, including three-dimensional or multidimensional ones. The search for new sources of inspiration is a key motivator for innovation among designers, leading to the development of distinctive and unique creative approaches based on a scientific methodology. Creative and innovative capabilities are realized when designers comprehend the tools, artistic techniques, materials, and previous experiences available to them, aiming to achieve a unified aesthetic integration that combines diverse elements of intellectual visions manifested in distinctive compositions (Salem, Dina ,2021)

This current research explores the effectiveness of utilizing woven textile technology, including the production of woven textiles with a woven appearance that combines the characteristics of woven textiles with high-resolution designs. These designs showcase a distinctive aesthetic by drawing inspiration from African art.

Research Problem

What is the contribution of technological advancement in the textile industry to the creation of innovative woven designs?

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How can the aesthetics of African art designs enrich the textile industry?

Research Objectives

Identify weaving trends for developing woven fabric bearing African characteristics.

Research Significance

Support creative practices in the field of woven textile manufacturing.

Contribute to enriching the design of woven artifacts and accessories.

Research Hypotheses

Are there statistically significant differences in the artistic formations of executed designs?

Research Methodology

The research relies on an experimental approach to design a collection of artifacts with innovative woven structures and designs inspired by African art.

Research Scope

Create innovative woven structures by integrating woven fabric with various basic structures using modern textile technology.

Design and execute a collection of woven artifacts inspired by Pharaonic designs.

Spatial Scope: Saheli Textile and Dyeing Company in Mahalla El Kubra.

Temporal Scope: May 2023 for a duration of six months.

Research Tools

Sulzer Ruti textile machines (Binary system).

Penelope textile software – Nedgraphic – 3D attrezzo.

Research Terms

Textile Technology – Woven Fabrics – African Art

Woven Textile Industry:

The woven fabric industry has transcended its functional value, evolving to play an aesthetic role integrated with the overall visual appeal. Initially, power looms were used in the weaving process, but since the beginning of the twentieth century, shuttleless looms have become prevalent due to their increased speed and efficiency. This led to an increase in weft insertion speed, reduced noise, and the introduction of computerization in the operation of textile machines, making them easier to use. The aim of advancing the textile industry is to increase production and quality by reducing the time spent on weft insertion and the need for shuttle speed increase. Modern textile machine features also include:

- Increased machine speed.
- Easy use for wide fabrics.
- Elimination of the weft rotation unit.
- Reduction of stress on warp and weft threads by minimizing their friction during shuttle passage.

- Reduced maintenance and noise.
- Reduced consumption of spare parts.
- Lower percentages of warp and weft breakage.
- Elimination of fast-consuming weft insertion unit.
- Improvement of product quality by avoiding common errors (Mohamed ,2006)
- Contemporary Trends in Textile Formation:

Since the mid-twentieth century, the art of hand weaving has evolved, gradually shifting from the patterned side to the creative side. Like other art forms, it has been influenced by intellectual changes that led to various modern artistic movements and diverse perspectives. There is a general artistic trend opposite to academic artistic thought, which relies on fixed rules and reality as its criteria. Artists have started to move beyond traditional frameworks and usage limitations. In these artistic trends, the artist found an opportunity for formal and artistic definition in the textile plane (Anna Kamneva ,2023)

- The trend towards expressive and aesthetic function of weaving, liberating itself from the constraints of traditional functions, such as textile hangings. It is a move towards breaking the boundaries of a fixed frame to the freedom of expression using the capabilities of modern textiles for self-expression by the artist.

- The trend towards direct expression with threads on the loom, unleashing the artist's imagination and creative expression to draw their design with threads without the need for a pre-designed pattern on paper.

- The trend towards realizing modern concepts in woven artifact design, moving away from diagnostic and representational forms to abstract and free forms according to the artist's unique vision and idea.

In order to analyze the role of information and knowledge needed by a designer working for a manufacturer who caters to European fashion markets, we must look at the production process of the industry and the conditions facing manufacturers and their designers in developing countries. There are several studies that cover the field of fashion production (Weller, 2007, 40), but few focus on design or the consumer market. The garment industry is tied up in global production chains(Patrik Aspers,2009)

The trend towards breaking free from familiar forms and traditional general structures of weaving by creating new structures such as hanging and dangling forms, free irregular shapes instead of the rectangular loom. Modern frames that do not detach from the woven structure shape, such as metal frames, have been used as an alternative to traditional frame looms after being stretched to achieve advanced woven works with the evolution of the era.

The trend towards achieving true third-dimensional perspective and complete embodiment of woven artifacts.

The trend towards using new non-traditional materials in the field of hand weaving, whether woven materials (natural or synthetic), manufactured or non-manufactured, or fully processed (ready-made items) to execute works characterized by a spirit of uniqueness and departure in expressing the spirit of the era. The trend towards achieving void as a formative and aesthetic value in woven artifacts (flat or multi-level or fully embodied). The trend towards using new weaving technology methods in shaping woven artifacts (El-Sayyad, Ghada ,2020)

Quotation

One of the fundamental pillars in product design and its formative and functional nature relies on innovation, creativity, and evolution in the design field. Nature is considered one of the most important sources of inspiration for designers. Nature is not an end in itself but a means to discover the new in the world of design. It inspires the artist with a sense of uniqueness and the exploration of new ideas (El- Sawy,2019)

Stages of Quotation

Identifying the Source of Quotation: Various sources can be quoted, such as nature, historical and environmental arts, general influences, or intellectual (analytical) sources such as intellectual stimuli, analytical systems, and philosophical theorizing.

1- Analyzing the Source of Quotation and Inspiration: In this stage, the designer reveals the artistic truth of the source of the quotation by analyzing its design elements, principles, and formative relationships, leading to an innovative design (El-Sawy,2023)

Textile Design Technology:

Textile Design

It is the process of creating designs for woven and non-woven fabrics, including clothing, household textiles, and decorative textiles such as carpets and knitted fabrics (K-green,2004) Textile design has witnessed tremendous progress and sophistication recently after technological advancements in all areas of life. Using computers in design, designers shifted their focus from traditional design processes involving drawing, coloring, preparing weaving structures, and transferring the design onto them – a laborious process – to creating woven structures that add beauty and extreme precision using specialized textile design software (Al-Samadisi,2018)

A textile designer needs to understand how to design a specific type of fabric, and they must be able to develop woven designs to suit a particular purpose. Designers require a good understanding of current trends, color awareness, and contemporary design issues to ensure their designs reach the final relevant purpose. (El-Sayyad,2020)

The clothing practices of present vestimentary cultures can be observed daily on the street and have the reputation of not following guidelines, being irreducibly complex and diverse. The postmodern era, particularly the digital age, has, analogous to the overused term "image flood" in everyday life, produced a kind of fashion flood. As a system of endlessly and paradoxically changing surfaces, this flood seems describable, but as a structure, it is hardly graspable. Indeed, spontaneity and irrationality are defining characteristics of fashion, setting it apart from other cultural phenomena—not only since the postmodern democratization or the digital revolution.(Mohamed ,2006)

The design is influenced by several factors, and this is evident through the materials that contribute to enriching the functional and aesthetic aspects of the textile product. The structural composition of both the warp and weft threads, as well as the execution method, impact the design. For each functional design, the execution method varies. Different functions entail different materials, functional shapes, and aesthetic qualities for the final product. The subject of the artistic work also affects the design, inspiring the designer with shapes, colors, materials, and surface values that are analyzed to express their emotions and goals (. Hind Saleh,2017)

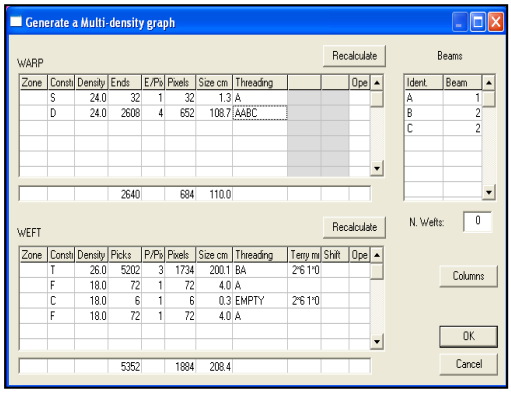
The textile industry sector has been profoundly affected by the remarkable development in computer technology, the digital era, and specialized software in various fields. Textile machines evolved from manual looms to the emergence of digital Jacquard. Similarly, textile design software has progressed from using ordinary drawing programs to specialized textile design programs such as Ned Graphics and Penelope Textile.

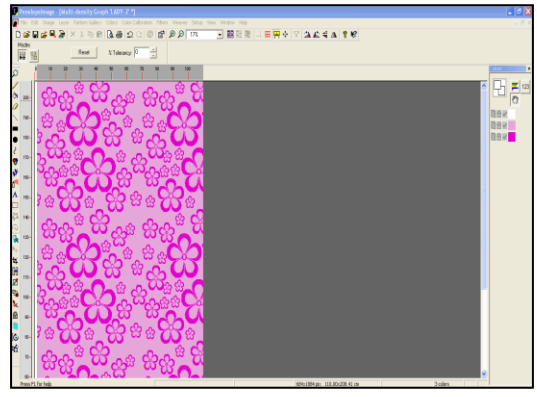
Features of using various design programs include saving designer energy and time, the ability to modify and change, conducting various color experiments while visualizing the design in a form similar to the final product's use, high precision and speed in responding to variables, assisting in increasing and developing the designer's innovative capacity, and benefiting from new non-traditional techniques (Salem,2021)

The design stage specializes in transforming colors, lines, and shapes into woven fabrics that adapt to machines and weaving threads. The computer is used primarily to output the final design to the weaving machine in the form of a disk or flash memory. Several textile design programs are used in this field, such as Penelope Textile and Nedgraphics.(Sayed,2017)

Firstly, Penelope Textile includes:

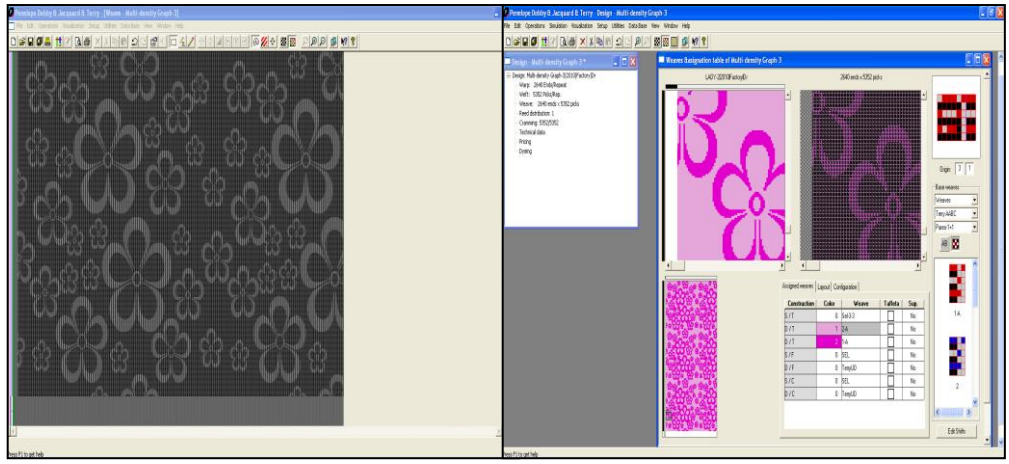
1. Penelope Image: This program draws and designs the product, specifying all required execution specifications such as length, width, warp density, number of picks, and details of the weft fingers. It is a comprehensive program for executing the design before preparing it for weaving machine output.





Starting from the design drawing and preparation stage, where the design specifications are determined in terms of width and length, the design is then drawn, and any excess is removed using the toolbar on the left side of the design. The colors of the design are then chosen. This is followed by the stage of specifying the product's specifications, where the coordinates of the product are determined, such as the number of warp threads per centimeter, the number of picks per centimeter, the required warp width, the number of picks per centimeter, the length of the product, and the spacer, separator, and cutting intervals.

In this program, the required woven structures are placed on the design, and these structures are saved within the program's dedicated database. Additionally, machine-specific data, such as the required number of rows to be operated in the Jacquard device and the type of Jacquard device, is input. After the structure stage, the design is loaded onto the Jacquard device data to be output in its final form, which is then loaded onto the weaving machine to produce the final product.

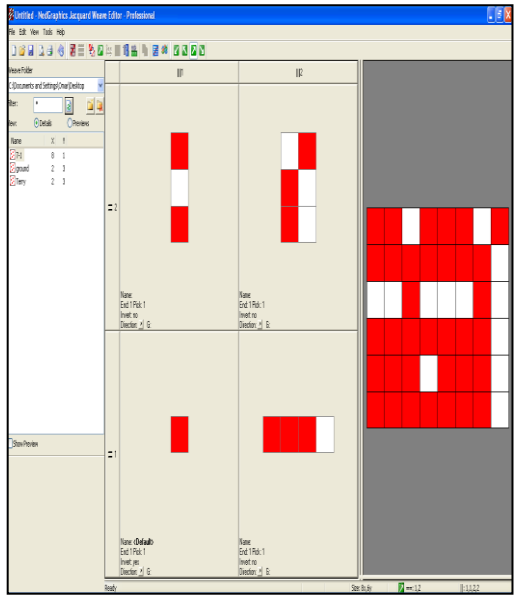


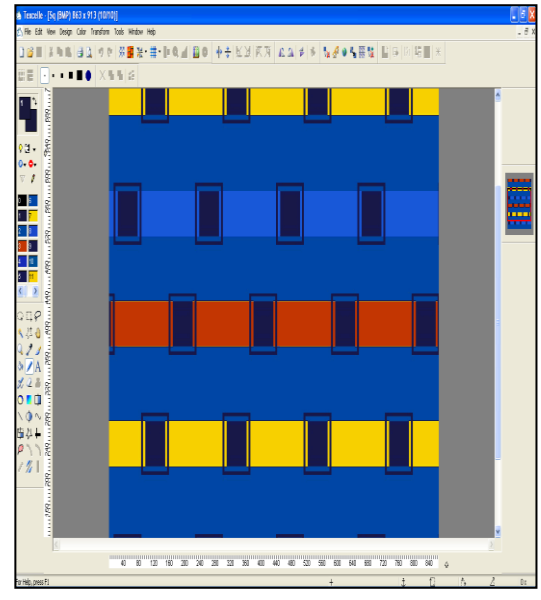
Secondary: NedGraphics

This program includes five applications:

1. Texcelle: Coordinates are placed, and the drawing is cleaned, specifying the width and length of the design. The design is then converted to a new extension, which is "des." The role of the first program ends here.

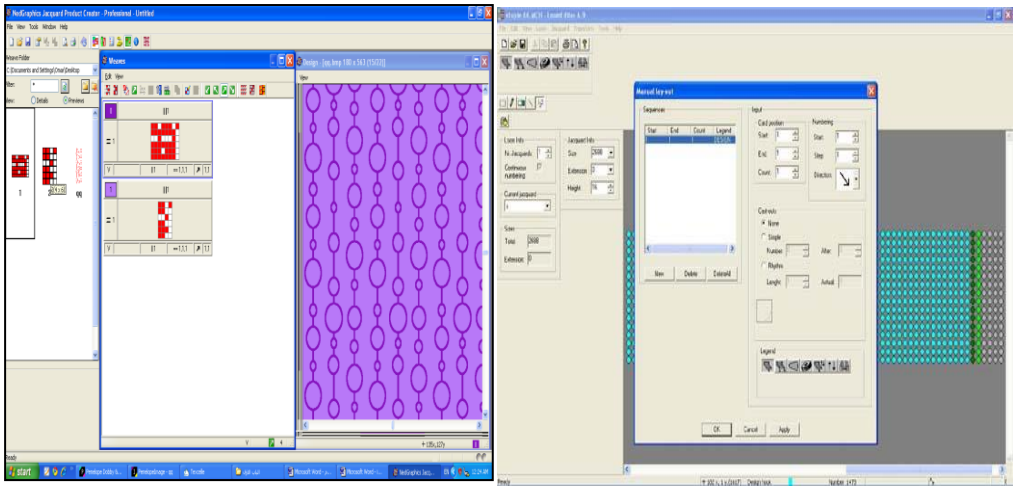
2. Weave Editor: This program is dedicated to creating and implementing the woven structures intended for execution on the design. This is done by specifying the warp and weft repeats and merging them based on the coordinates of the desired woven structure.



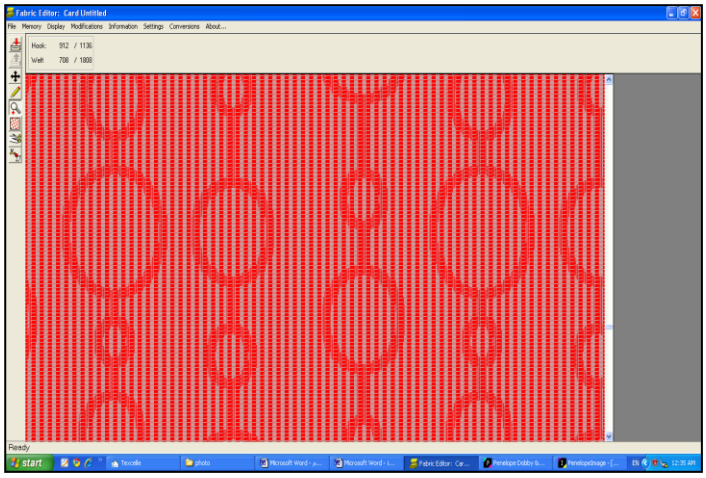


3. Loom Editor: A program for placing thread coordinates, which are determined based on the width of the desired product to be executed and the width of the used machine.

4.Product Creator: This program links the design with the woven structure, incorporating thread coordinates and sending them in a single extension, which is BMP.



5.Card Editor: This program is used to convert the design into a format compatible with weaving machines. In this stage, the design is transformed into pixels, and it is converted into a textile extension specific to the machine.



Practical Experiments

Preparing and executing woven products inspired by African designs.

The practical aspect addresses the experimental experience in designing beachwear. The researcher found that modern textile shaping techniques provided the freedom for creativity without restrictions, using Jacquard fabric. The integrated textile structure, combined with the warp structure, was identified as a variable. Eight designs for a complete set of beachwear were selected, and computer programs were used for design execution and structure preparation.

Machine Specifications

Type of Loom Used: Smit G6200

Jacquard Device Type: Stauble

Woven Fabric Width: 100 cm

Density of Warp Yarn per 1 cm: 24 threads/cm

Warp Yarn Number Used: 24/2

Number of Fabric Threads in the Reed: 1248 threads

Weft Density: 36 picks/cm

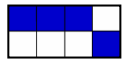
Warp Height: 6 mm

Thread Type: 100% Cotton

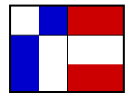
Execution of the Fabrics Under Study:

The fabrics were produced by integrating different weaving structures with the warp structure to choose the best and most suitable structures for the research topic:

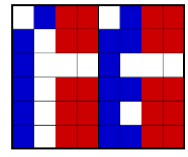
Extended weft weave structure with warp structure:



Plain extended weft weave 3/1

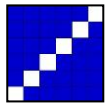
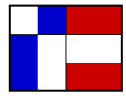
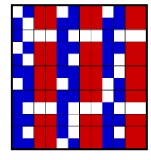


Warp structure

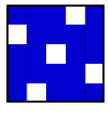
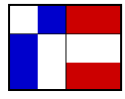
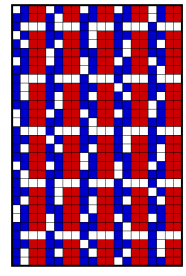


Weave structure after merging

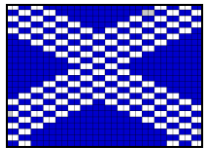
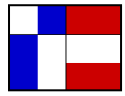
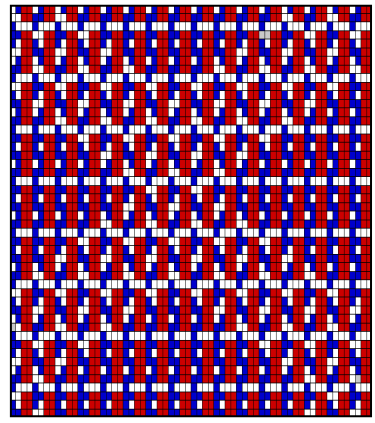
Twill weave with warp structure:

		
will weave 1/5	Warp Structure	Woven Structure After Integration

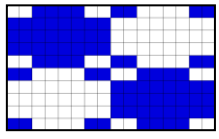
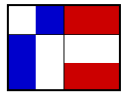
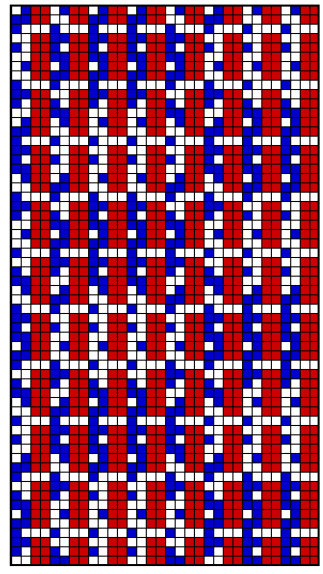
Satin Weave with Velour Texture:

		
Atlas Weave 5	Warp Structure	Woven Structure After Integration

Honeycomb Weave with Warp Structure:

		
Honeycomb Weave	Warp Structure	The woven structure after integration

Textile wave (Beka):

		
"Beka" Weave	Warp structure	The woven structure after integration

Laboratory tests conducted on the fabrics produced in the research include:

Fabric tensile strength in both the warp and weft directions (kg).

Fabric elongation percentage in both the warp and weft directions (%).

Air permeability test of the fabric (cm3/cm2/s).

Water permeability test of the fabric (cm3/cm2/s).

Absorption time test (s).

Roughness degree test (°).

Color fastness to perspiration test (°).

Color fastness to washing test (°).

1 - Change in textile product design.

Five designs suitable for implementation as beachwear.

A survey questionnaire was created to choose the best design suitable for implementation as beachwear for young ladies, and based on the survey results, the following steps and stages for implementing the design were established:
1 - Product Design Stage:

This is implemented in two stages:

Design sketch stage, done using the Penelope Textile program.

Product design stage:

The design, as illustrated in the figure, is placed on

the model using the Attrezo 3D program. In this stage,

the external appearance of the desired apparel

product is determined, specifying its parts and components.

2 - Pattern Design Stage:

The pattern is designed in size 36 according to the attached size chart.

3 - Pre-production Preparation Stage:

• Placing the pattern on the fabric.

• Cutting all pieces of the apparel.

4 - Production and Finishing Stage:

The apparel pieces are sewn, taking into consideration that the woven fabric used is a combination of textiles and fur. Then, any excess threads are removed, and any dirt or dust generated during production is cleaned. Finally, the product is steamed and displayed on a mannequin or stored for final presentation.

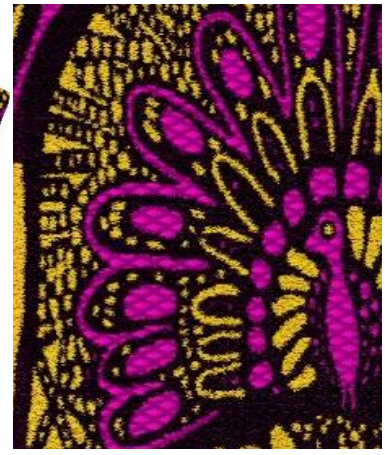
Visual tests were conducted on the produced samples to ensure their suitability for use as beachwear products. This assessment was done through a questionnaire, judging the product based on three criteria (functionality, aesthetics, and economics).

Implementation of Selected textile structures under study.

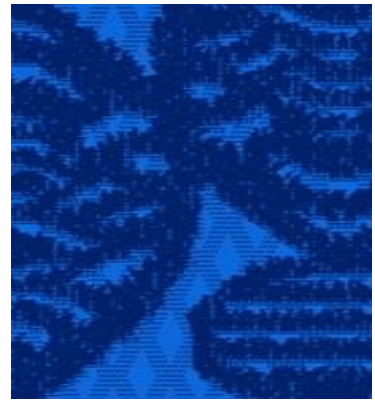
The selected textile structure with design No. (1)

The selected textile structure with design No. (2)

The selected textile structure with design No. (3



The selected textile structure with design No. (4)



The selected textile structure with design No. (5)

Results and Discussion

The study addressed the research results and discussed them. The analysis of variance was employed to study and understand the impact of various study factors on the natural and mechanical properties, specifically the effect of variations in textile composition.

Impact of Variations in Textile Composition on the Natural and Mechanical Properties of Fabrics:

Table (1) Presents the Results of Tests for the Natural and Mechanical Properties, Indicating the Influence of Variations in Textile Composition on the Produced Fabrics.

Sample	Colorfastness to washing	Sweat resistance	Degree of roughness	Absorption time/s	Water permeability ($cm^3/cm^2/sec$)	Air permeability ($cm^3/cm^2/sec$)	Elongation(%)	Tensile strength (kg/5cm)
Honeycomb	4	4	39	3	0.689	70.8	10	48
twill	4	4	40.2	5	0.625	70.4	12	48
Atlas	4	4	40.7	3	0.666	53.9	15	48
Beka	4	3	39.6	11	0.555	60.4	15	45
Extended weave	3	4	40.6	15	0.588	62.6	15	45

The impact of variations in textile composition on the tensile strength of the fabric in the warp direction.

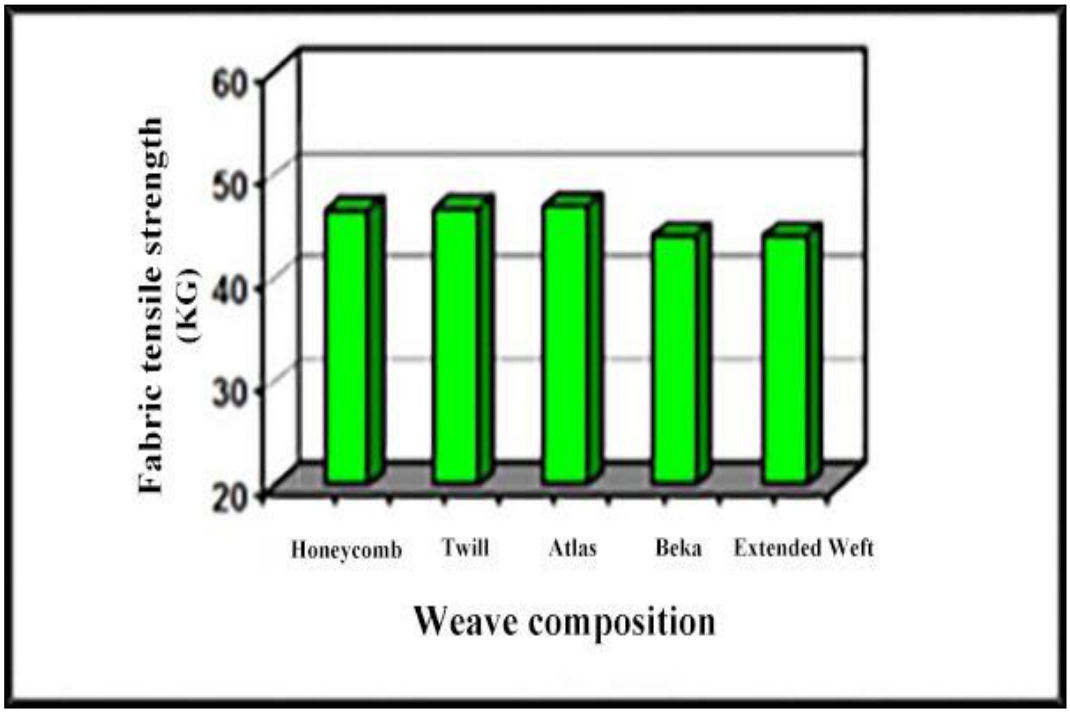


Figure (1): The Relationship Between Textile Composition and Fabric Tensile Strength in the Warp Direction.

From Table (1) and Figure (1), it is evident that fabric samples with a honeycomb weave show the highest impact on tensile strength, Twill, and atlas weave in their effect on fabric tensile strength. Meanwhile, fabric samples with the lowest tensile strength are those made with a Beka and extended weave, alike.

Table (2): Analysis of Variance for the Effect of Textile Composition on Fabric Tensile Strength in the Warp Direction.

Source of variation	Tabulated value	Significance level	Computed value	Mean of squares	Degrees of freedom	Sum of squares
Between groups	2.621	0.0000	6,870	37.500	5	187.5
Within groups				5.458	24	131
Total					29	318.5

From Table (3), the significant effect of the textile composition type on the fabric elongation is evident at a significance level of 0.01 for various textile structures used.

The impact of variations in textile composition on the air permeability of the fabric:

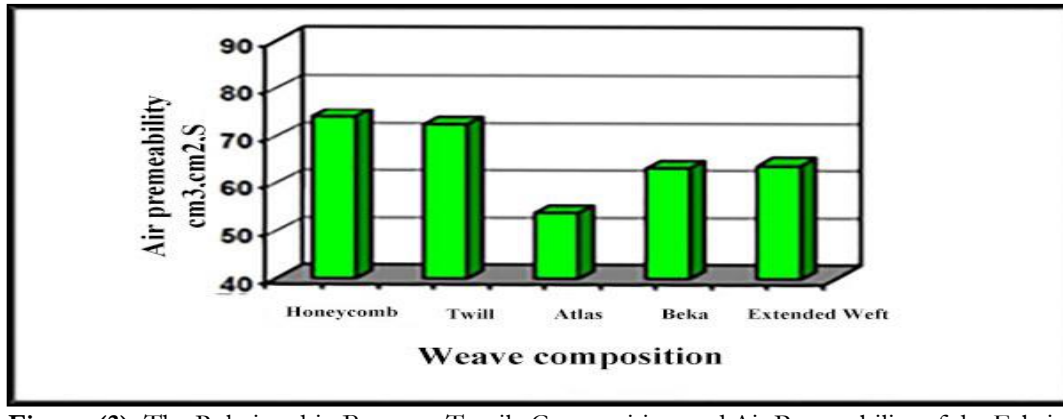


Figure (3): The Relationship Between Textile Composition and Air Permeability of the Fabric.

From Figure (3), it is evident that fabric samples with a honeycomb weave exhibit the highest impact on air permeability, followed by the Twill weave in their effect on air permeability. Meanwhile, the fabric structure with the least air permeability is the atlas weave.

Table (4): Analysis of Variance for the Effect of Textile Composition on Air Permeability of the Fabric.

Source of variation	Tabulated value	Significance level	Computed value	Mean of squares	Degrees of freedom	Sum of squares
Between groups	2.6207	0.0000	223,0528	472,1283	5	2360.642
Within groups				2,1167	24	50.8
Total					29	2411,442

From Table (4), the significant effect of the textile composition type on the air permeability of the fabric is evident at a significance level of 0.01 for various textile structures used.

The impact of variations in textile composition on the water permeability of the fabric:

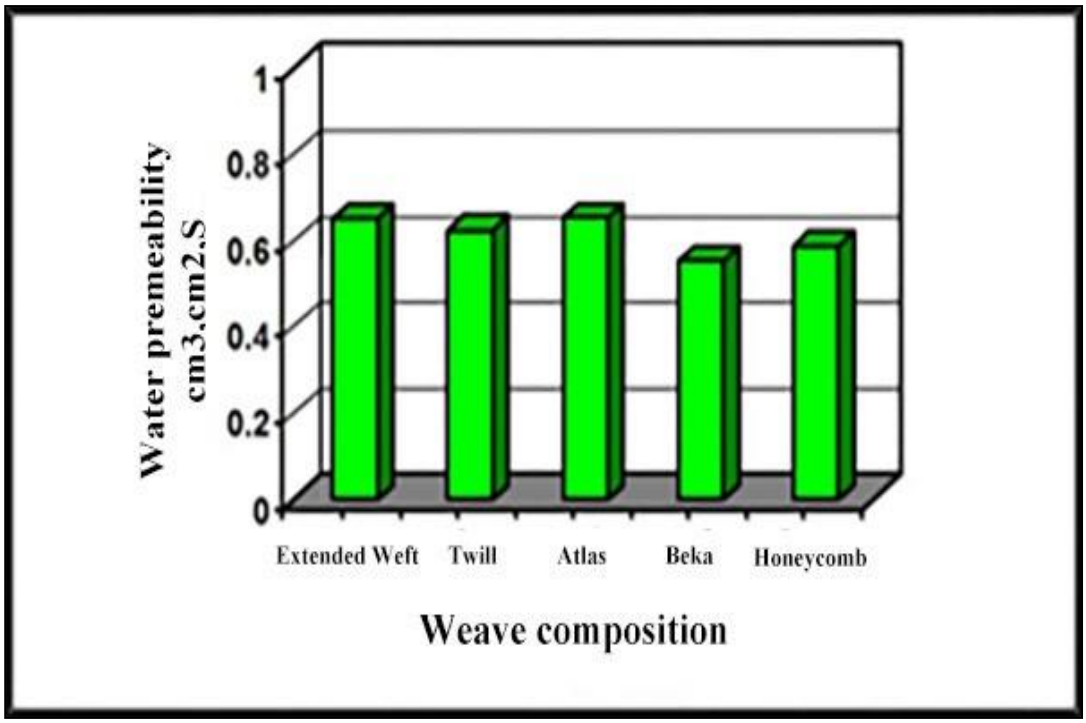


Figure (4): The Relationship Between Textile Composition and Water Permeability of the Fabric.

From Figure (4), it is evident that fabric samples with an extended Weft weave exhibit the highest impact on water permeability, followed by the honeycomb weave ,atlas weave in their effect on water permeability. It is also noted that the Beka weave show the least water permeability.

Table (5): Analysis of Variance for the Effect of Textile Composition on Water Permeability of the Fabric.

Source of variation	Tabulated value	Significance level	Computed value	Mean squares	Degrees of freedom	Sum of squares
Between groups	2.6207	0.0000	175.8395	0.0123	5	0.0613
Within groups				0.0001	24	0.0017
Total					29	0.0630

From Table (5), the significant effect of the textile composition type on the water permeability of the fabric is evident at a significance level of 0.01 for various textile structures used.

The impact of variations in textile composition on the fabric's water absorption time:

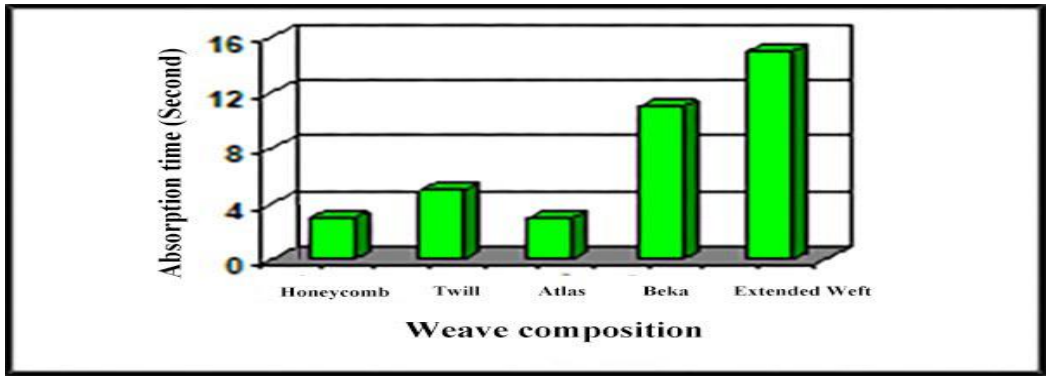


Figure (5): The Relationship Between Textile Composition and Water Absorption Time of the Fabric.

From Figure (5), it is clear that fabric samples with honeycomb weave and an atlas weave have the least time for water absorption, while the Beka weave, extended weaves exhibits the highest water absorption time.

Table (6): Analysis of Variance for the Effect of Textile Composition on Water Absorption Time of the Fabric.

Source of variation	Tabulated value	Significance level	Computed value	Mean of squares	Degrees of freedom	Sum of squares
Between groups	2.6207	0.0000	249.6667	124.8333	5	624.1667
Within groups				0.5000	24	12.0000
Total					29	636.1667

From Table (6), the significant effect of the textile composition type on the water absorption time of the fabric is evident at a significance level of 0.01 for various textile structures used.

The impact of variations in textile composition on the fabric's roughness:

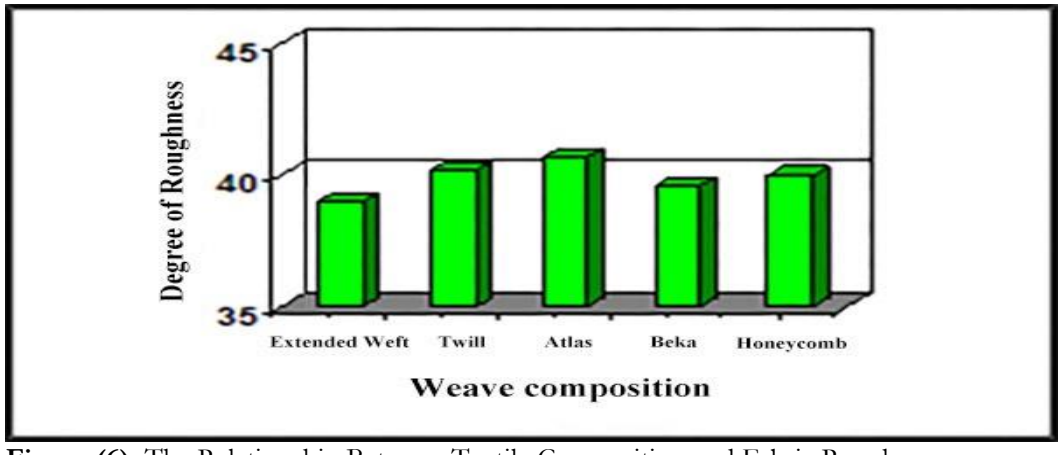


Figure (6): The Relationship Between Textile Composition and Fabric Roughness.

From Figure (6), it is evident that fabric samples made from an extended Weft weave exhibit

the least roughness, followed by a honeycomb weave, while the atlas weave shows the highest roughness.

Table (7): Analysis of Variance for the Effect of Textile Composition on Fabric Roughness.

Source of variation	Tabulated value	Significance level	Computed value	Mean of squares	Degrees of freedom	Sum of squares
Between groups	2.6207	0.9593	0.1994	1.2104	5	6.0519
Within groups				6.0712	24	133.5667
Total					29	139.6186

From Table (7), there is no significant difference in the effect of textile composition on the fabric's roughness.

The impact of variations in textile composition on colorfastness to perspiration:

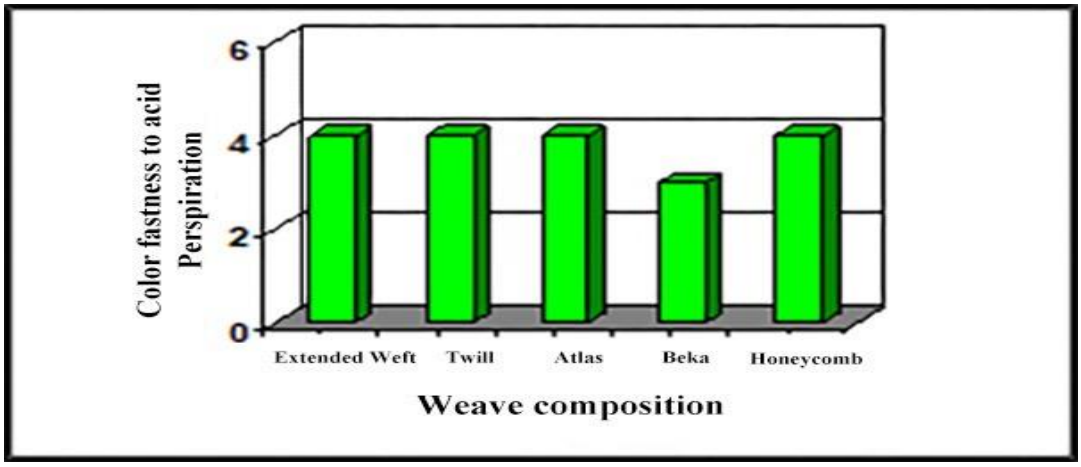


Figure (7): The Relationship Between Textile Composition and Color fastness to Perspiration.

From Figure (7), it is clear that fabric samples produced with extended Weft, Twill , atlas, and honeycomb weaves exhibit similar colorfastness to perspiration. However, the Beka weave shows the least colorfastness.

Table (8): Analysis of Variance for the Effect of Textile Composition on Colorfastness to Perspiration.

Source of variation	Tabulated value	Significance level	Computed value	Mean of squares	Degrees of freedom	Sum of squares
Between groups	2.6207	0.4916	0.9091	0.8333	5	4.1667
Within groups				0,9167	24	22.00
Total					29	26.1667

From Table (8), there is no significant difference in the effect of textile composition on colorfastness to perspiration.

The impact of variations in textile composition on colorfastness to washing:

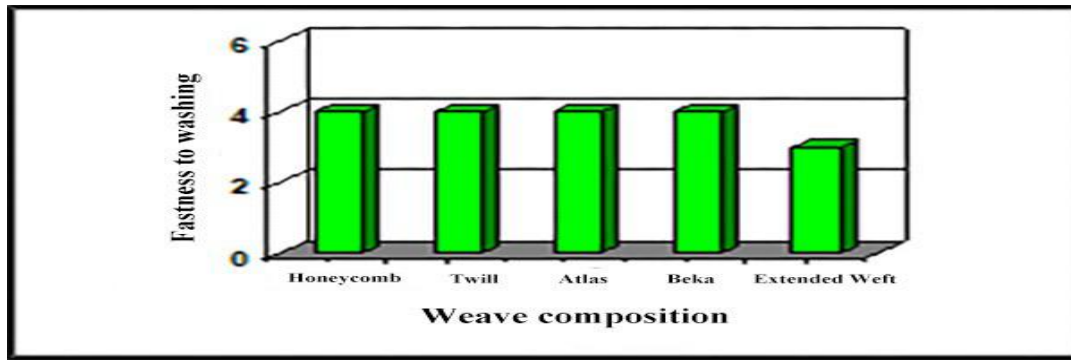


Figure (8): The Relationship Between Textile Composition and Colorfastness to Washing.

From Figure (8), it is evident that fabric samples produced with honeycomb, and atlas weaves exhibit the same effect on colorfastness to washing. However, the samples produced with a extended weft weave show lower colorfastness.

Table (9): Analysis of Variance for the Effect of Textile Composition on Colorfastness to Washing.

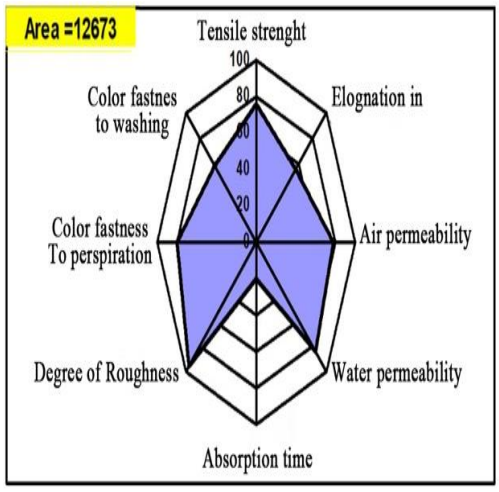
Source of variation	Tabulated value	Significance level	Computed value	Mean of squares	Degrees of freedom	Sum of squares
Between groups	2.6207	0.4916	0.9091	0.8333	5	4.1667
Within groups				0,9167	24	22.00
Total					29	26.1667

From Table (9), it is evident that there is no significant difference in the effect of textile composition on colorfastness to washing.

Evaluation of the quality of fabrics produced with different textile structures:

Table (10): Evaluation of the natural and mechanical properties of different textile structures.

Sample type	AREA	Ideal Results						
		Tensile Strength	Air Permeability	Water Permeability	Absorption Time	Roughness Degree	Color fastness to Perspiration	Color fastness to Washing
Honeycomb	18794.46	64.28571	80.27211	87.95356	100	96.20253	80	80
twill	15893.27	68.57143	82.08617	90.71118	60	96.20253	80	80
Atlas	17707.62	77.14286	61.11111	96.66183	100	96.20253	80	80
Beka	14070.77	71.42875	91.15646	100	27.27273	96.20253	80	80
Extended weaves	12673.56	0.7142917	77.77778	85.34107	20	96.20253	80	80



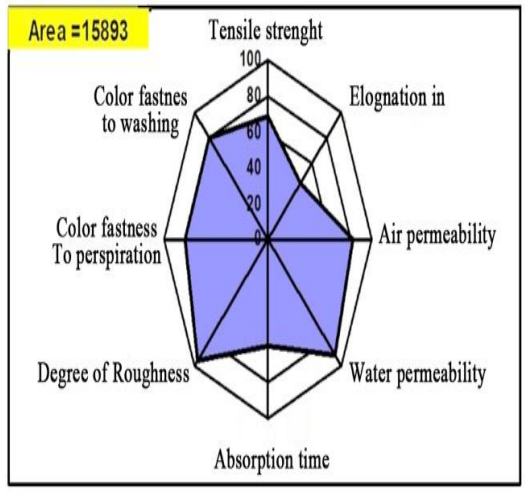
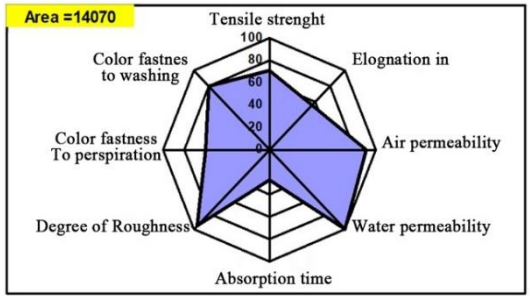


Figure (11): Quality Evaluation for Honeycomb Weave. **Figure (12):** Quality Evaluation for Twill Weave.



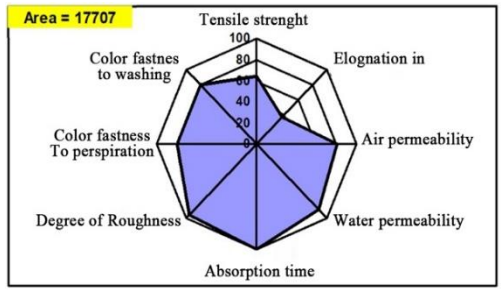


Figure (13): Quality Evaluation for Atlas Weave. Figure (14): Quality Evaluation for Beka Weave.

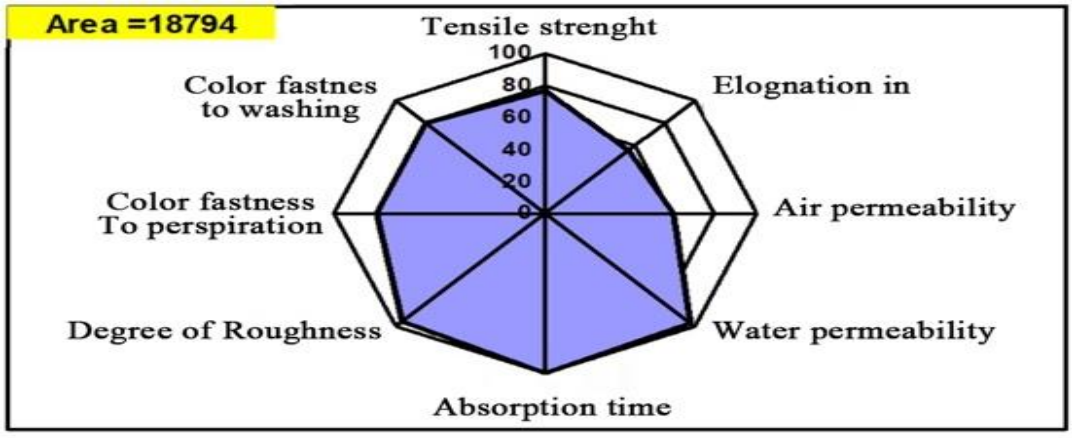


Figure (15): Quality Evaluation for extended Weave.

From Table (10) and the radar charts (15, 14, 13, 12, 11, 10), it is evident that the fabric produced with a honeycomb weave is the best for most natural and mechanical properties, with an ideal area of 18794.46. Meanwhile, the fabric produced with a honeycomb weave

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