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The Manipulations of the Mechanics of the Jacquard Loom to Weave Nigerian Designs

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Abstract

The purpose of this study was to understand the working system of the Jacquard loom and to introduce indigenous Nigerian designs into the Jacquard weaving system, thereby reviving the design qualities of Jacquard materials woven in Nigeria by replacing the stylized floral designs with traditional motifs. The study was limited to the furnishing fabrics produced by Universal Textile Industries Limited, Kano, Nigeria. In studying the problems of Nigerian Jacquard weaving designs, the researchers had to be the Jacquard designers. As designers and researchers, the team centered this study on introducing Nigerian mural and cap designs into the Jacquard weaving system. This study was an experimental study, and participant observation was used for data collection. The population was drawn from the Jacquard-woven furnishing materials produced in the Universal Textiles Industry in Kano, Nigeria. A purposive sample of nine original graph-paper designs with traditional Nigerian motifs was adopted. The researchers experimented with indigenous Nigerian designs woven on a Jacquard loom initially constructed on graph paper and transferred to the weaving cards according to the graph paper design. Holes were punched in cards where the squares on the graph paper were crossed (or marked). Holes were punched in rows of eight to correspond with the block of eight squares on the graph paper design, which represented warp ends on the loom. The results revealed that traditional Nigerian designs could be woven successfully on the Jacquard loom. These traditional designs could not only serve as a substitute for imported designs, but products from such works could also be exported, conveying traditional Nigerian designs in woven Jacquard fabrics to many countries around the world.

Keywords: Traditional, Designs, Jacquard, Weaving, System, Fabrics, Furnishing.

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1|Introduction

Nigeria is well known for its traditions in cloth weaving, wall decoration, cap design, carvings, pottery, and calabash decoration, to mention a few. Nigerians are also known for using Jacquard-woven fabrics in almost all their surroundings. The brocade, for example, is used as dress and furnishing fabrics by its people, but the problem is that its design patterns do not convey Nigerian traditional motifs. The designers of these fabrics do not know Nigeria, nor are they exposed to the aesthetic values of traditional Nigerian designs.

The non-availability of traditional Nigerian motifs on industrial woven materials produced in Nigeria justifies this study. This argument was observed during the researcher's Industrial Attachment Programme at Universal Textiles Mills Limited, Kano, Nigeria. The mill imported Jacquard designs and punched cards for its Jacquard looms. They had no jacquard designer then, and there appeared to be none to employ in the country. As reported by Olayiwola et al. [1], textile graduates hardly get a chance of employment in our textile industries because they have no industrial experience; the few who manage to get employed are never put in decision-making positions. In studying the problems of Nigerian Jacquard weaving designs, the researchers had to be the Jacquard designers. The designers/researchers focused on introducing Nigerian mural and cap designs into the Jacquard weaving system. However, the Jacquard machine is a special mechanism situated over a hand or power loom and is called a Jacquard head motion. The Jacquard head motion is used in the production of figured fabrics. These are fabrics with patterns, motifs, or weaves that exceed the capacity of a harness loom. The designs woven on a Jacquard loom are constructed on graph paper, and the designs are transferred to the weaving cards by punching holes in the cards according to the graph paper pattern.

According to Gale [2], the Jacquard loom allows complex cloths to be woven, as each end in a repeat can be raised individually. The author further observed that many designs originally intended for printed fabrics could be successfully converted into Jacquard designs for weaving on the Jacquard loom. Similarly, Zheng et al. [3] observed that the Jacquard shedding motion is used in weaving designs beyond the scope of dobby shedding; these designs consist of more than 24 different orders of interlacing. In relation to the last assertion about the Jacquard, Nevinson [4] opined that the chief advantage of a Jacquard head-motion lay in its total elimination of the draw-boy, which allows the manipulation of individual warp threads in each repeat of the pattern, making the designer's task much easier, involving the use of curved lines. Thus, the pattern could be changed in a few minutes, provided that the cards are punched.

Grosicki [5] went further to explain Jacquard's head motion as a masterpiece of perfection in the textile world, and could produce practically anything, like a two-dimensional image, into fabric. The author acknowledged the Jacquard machine's ability to handle several hundred or thousands of working independently to weave a repeat of a design, and the comparatively small size of the machine itself is the principal feature of the system. An additional advantage is the simplicity of the draft (drawing through the heddles) of the warp threads, and the fact that it does not, as a rule, require alteration when the design is changed. The author lastly revealed that a preliminary division into ordinary and special Jacquards is frequently made. Ordinary machines are extremely versatile and can be used to produce figured designs in almost any construction. Special Jacquards are designed for specific fabric constructions, which limits their general applicability but provides distinct advantages within their intended areas of use. Beyond the broad categories commonly recognized, Jacquard machines can also be classified according to three key criteria: 1) the type of shed formed, 2) the pitch, and 3) the figuring capacity.

Among the research questions are: What skills are required to become a Jacquard designer, and what are the limitations and freedoms of a Jacquard designer? Secondly, could traditional Nigerian designs be woven on the Jacquard loom?

2|Materials and Methods

This study drew its population from the Jacquard-woven furnishing materials produced in the Universal Textile Mill Limited in Kano, Nigeria. The sample population comprised nine original graph paper designs

with traditional Nigerian motifs, purposively selected. Each design was constructed by the researchers on graph paper, which was then punched into cards using the punching machine.

Practical, participatory observation methods were employed as tools for data collection. The company allowed researchers access to all materials and equipment in exchange for the designs produced during the research work. The company also provided pencils, drawing paper, graph paper, magnifying glasses, pick needles, Jacquard weaving cards, punching machines, and the Picanol looms with Jacquard heads. The Jacquard-head width was 1,344 ends, and the graph paper was 5 x 5 squares, with the loom repeat width taken into account. The woven fabric's thread count was weft-to-pick the same, and because of the selection of weft-colour yarns, 24 ends (12 from each side of the selvage) were removed. The selection of the weft color yarns was made on the cards by punching holes on the right-hand side; in the case of Universal Textiles, their looms were only four-colour weft yarns. The total number of ends left for manipulation was 1,320; this was the limit of the designers' width. The designers had no limit lengthwise. Since 1,320 ends was a large figure for drafting a design when card cutting was done manually, the researchers decided to make designs with sizes 96, 128, and 192 ends, which are multiples of 1,320.

Grosicki [5] observed that the principles of operation of Jacquard systems should be thoroughly understood by the designer to fully exploit their capabilities and comprehend the exact meaning of the terms. For this reason, the researchers worked within the factory and its design office for 8 months, studied the materials/equipment used in the Jacquard cloth production process, and made the following discoveries.

3 | The Jacquard Loom

The Jacquard loom used at Universal Textiles Mills Limited, Kano, Nigeria, where the researchers carried out this study, was a single-lift type; it had only one griff carrying the lifting knives at every weft insertion and only one pattern card. The Jacquard head-motion had a metal plate with 1,344 holes or pegs, representing the number of weft yarns that can be manipulated in a single loom repeat. There were horizontal needles corresponding to the holes on the metal plate, and each needle projected through a needle box facing it. The griff carrying the lifting knives moved up and down with each pick, and when the griff was in its lowest position, all the hooks attached to the needles moved over their respective knives. The designers selected which hook to lift and which to leave on the graph paper. To indicate the hooks that should be lifted in each pick, a cross is marked where a hook is to be lifted.

The weave pattern was copied from the graph paper by punching a series of cards. Each card contained the same number of holes as in the metal plate and controlled the action of each warp thread in each pick. In punching the pattern cards, a hole was punched for every mark on the design paper, and a blank was left for every empty square on the design paper.

To hold the cards above the loom, two small clips are attached at each side, spaced every 20 cards, and the cards are folded into a creel. The card was then placed on top of the metal plate; the needles in the needle board facing the metal plate were held in position by a small spring in a spring box. For each pick, the needles pierce the needle board and enter the holes of the metal plate. Determined to penetrate the holes of the metal plate, the needles met the punched card on their way. The blanks on the punched card push the unwanted needles, and the corresponding hooks are pressed away from their knives. The holes on the card allowed the needles to pass through and thus remained stationary so that the corresponding hooks remained in the path of the lifting griff and caused the corresponding warp thread to be lifted. Instead of a whole group of warp ends being lifted by the harness frame, each warp end was controlled independently.

At the lower end of each hook are the harness cords, and they contain the mails (or heddles) through which the warp threads are drawn. The harness cords are evenly spaced by being passed through holes in a comber board, with one hole for each cord. Connected to the lower end of each harness cord was a small weight called the lingo; this pulled the cord down after the ends had been raised and the weft inserted. After each

pick, the knives are returned, and the next card is moved to the position of the metal plate. For the next pick, the whole process was repeated.

4 | Designing

Universal Textiles Mills Limited, Kano, Nigeria, used a Picanol-mounted Jacquard loom with a Jacquard-head width of 1,344 ends, and the graph paper was 5 x 5 squares, with the loom repeat width taken into consideration. The thread count of the woven fabric was the same for the weft as the pick, and because of the selection of the weft-colour yarns, 24 ends (12 ends from each side of the selvage) were removed. The selection of the weft color yarns was made on the cards by punching holes on the right-hand side; in the company's case, their looms were only four-colour weft yarns. The total number of ends left for manipulation was 1,320; this was the limit of the designers in terms of the width of their designs.

In sketching a Jacquard design, according to Grosicki [5], the width of repeat that is employed should be equal to or a factor of that of the machine in which the design will be woven. Thus, the designers had no limit lengthwise. Since 1,320 ends was a large figure for drafting a design when card cutting was done manually, the designers decided to make designs in sizes 96, 128, and 192 ends, which were multiples of 1,320.

An original design was first made on drawing paper. A unit repeat of the design was enlarged and plotted on graph paper, with the Jacquard loom repeat width and the woven fabric thread count taken into account. Different areas of the motif were filled with different weaves to distinguish the shapes and form the weave pattern of the woven fabric.

5 | Cards and Cards Punching

The cards were made of plastic paper and punched according to the graph paper design. The width of a card was eight holes, and each card was capable of containing 1, 344 holes the same size as the loom capacity for ends. There were many cords, and in one iteration of the design, each pick was represented by a single card. The punching of holes on the card was carried out on a punching machine, which punched a row of eight holes across the width of the card [6]. The punching machine was piano-like and had 16 narrow, black-and-white pressing bars, arranged in two rows of eight holes on the card. The white bars represented even numbers, and the black bars represented the odd numbers on the machine. A hole was punched on the card where a square on the graph paper was crossed (or marked).

The holes were punched in a row of eight to correspond with the block of eight squares on the graph paper design, which represented warp ends on the loom. The row would be the first eight ends, from 1 to 8 squares on the graph paper, reading from left to right [7]. The second row of eight holes corresponded to the second block of eight squares, 9 to 16 on the graph paper design, representing warp ends on the loom. It reached the punching machine's capacity of 16 pressing bars. The paper design was divided into 16 squares to correspond with the capacity of the punching machine. After the first division of 16 holes had been punched, the card was moved to the next punching position [8]. This process continued until the last 16 ends of the design paper were punched, donating one pick across the cloth on the loom. For the next pick, the next card was taken to the first punching position, and the puncher started with the next 16 squares on the design paper. This process continued until the last pick of the design was punched.

6 | Practical Procedure

Having understood the use and limitations of the materials and equipment of the Jacquard weaving industry, the researchers, as designers, began constructing the graph paper designs using indigenous motifs. Thus, the construction of the graph paper, Furnishing Designs (FD) 001, is below.

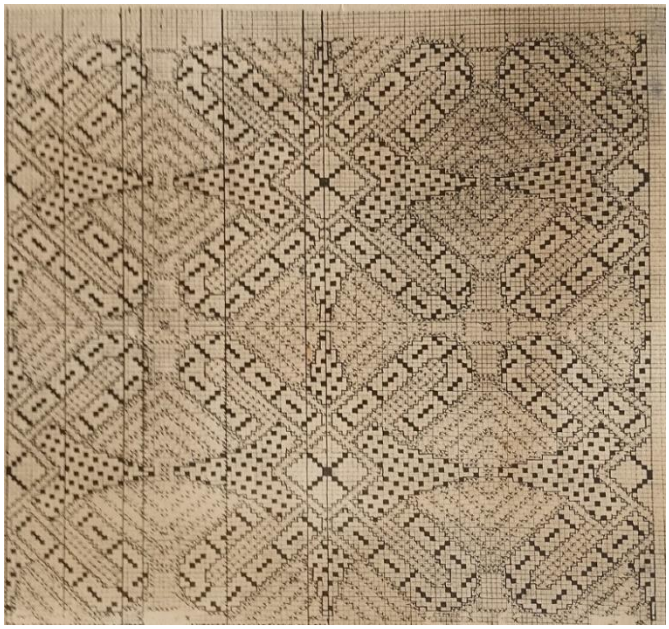

Fig. 1. FD 001 Photograph.

FD 001 was constructed on a graph paper with 5-by-5 squares. The motif is a stylized northern knot found on traditional dress and moral designs, which repeats on 64 ends and 64 picks. 64 cards were punched on the punching machine to correspond to the 64 picks; each pick line was represented by one card, as mentioned earlier.

The motif and its background were well decorated with both warp and weft yarns on the graph paper, but the result on the woven fabric was very disappointing. The woven fabric and the paper design were studied, and the reason the motif and its background were not easily distinguished was the competitive roles played by both the warp and the weft yarns in the two areas [9]. It was also discovered that the motif was broken into smaller shapes because the thread count reached 18 Picks Per Centimeter (PPC); the shapes cannot be easily distinguished. It was then assumed that if a distinction between two shapes close to each other is needed, the weave construction should have either the warp or weft yarns dominating in one area; the other area should have the reverse weave.

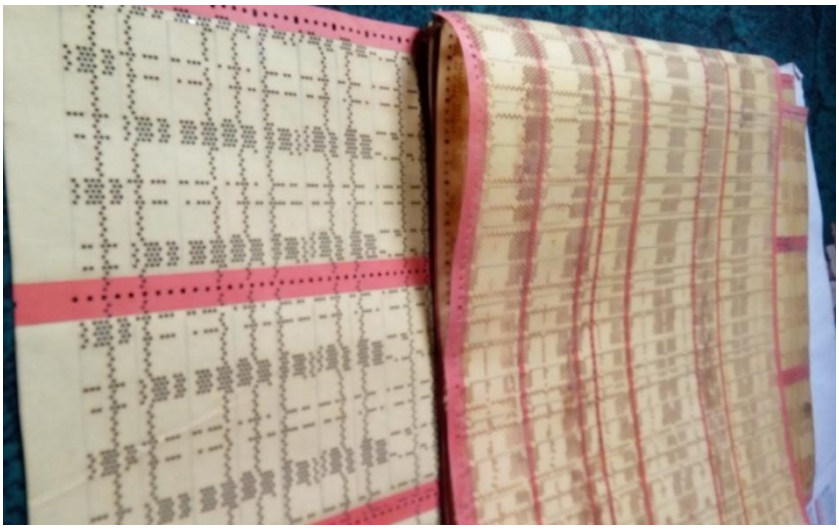

Fig. 2. Punched cards for plate 1, Photograph.

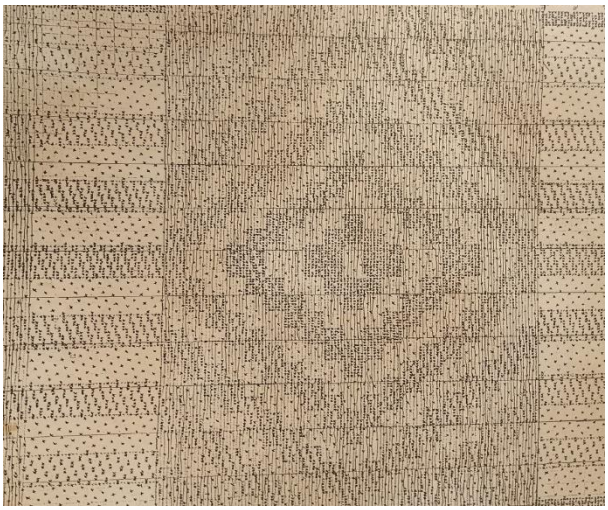

Fig. 3. FD 002 Fabric Photograph.

The sketch of FD 002 in plates 3 and 4 was originally sketched from a mosque in Kano, Nigeria. The motif was then stylized and reproduced on 192 ends and 190 picks, with the effect of light and shade. The light-and-shade effect was applied on an alternative basis. Although the effect was gradual, it was not evident. To achieve a perfect light-and-shade effect with the motif, FD 007 on plate 6 was constructed.

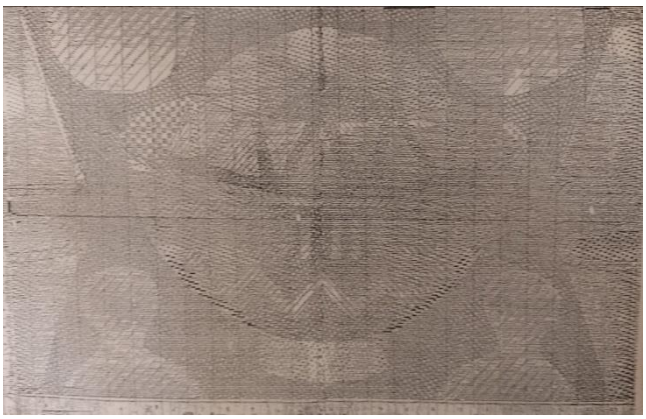

Fig. 4. FD 003; Photograph.

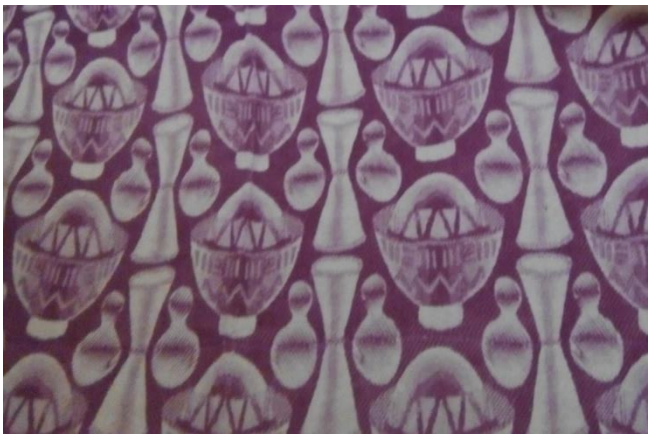

Fig. 5. FD 003 Fabric; Photograph.

This motif was also sketched from a mosque in Kano, Nigeria. It was then stylized and rearranged into an all-over design. The motif size is 192 ends and 190 picks. It took two weeks to reproduce the design, and the woven fabric gave an expected result.

The designers considered the loom repeat capacity, which was the number of warp threads the Jacquard machine could manipulate in a single loom repeat. The designs were drawn on graph paper and then transferred to the weaving cards using a keyed punching machine.

Fig. 6. FD 004 Design; Photograph.

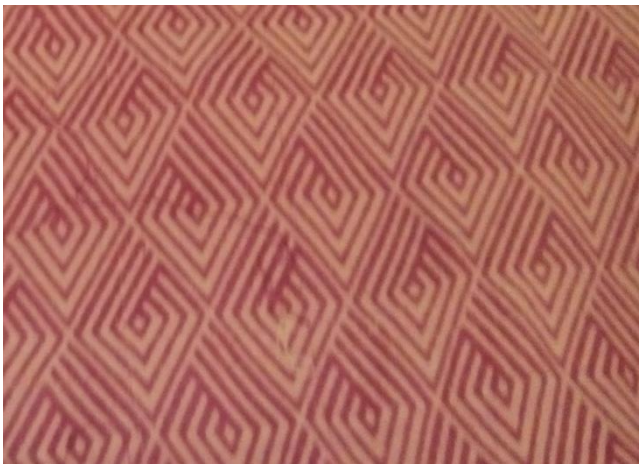

Fig. 7. FD 004 Fabric; Photograph.

The method employed in designing the Jacquard loom in this study was to sketch an original traditional motif onto graph paper and to fill different weave patterns into the figure and its background. The woven fabric turned out very well.

7 | Findings

Two variables, the three-count of the woven fabrics and the dimensions of the motifs in the woven fabrics, were measured for the purpose of determining the freedom available and the desirable appearances of the designs in the woven fabrics. The thread count of the woven fabrics, which was determined by the number of ends and PPC of a woven fabric, was measured with the help of a thread counter and a pick needle. The dimensions of the motif in the woven fabric were measured with a ruler.

The findings of this study were:

I. The two variables measured were found to be affected by 1) the pick-wheel adjustments made on the loom, 2) the weave selections used in considering the motifs, 3) the yarn count of both warp and weft yarns, and 4) the cloth contraction when removed from the loom tension.

II. It was then discovered that the thread count of a woven fabric was inversely proportional to the area of the motifs in the woven fabric. That is, as the thread count of the woven fabrics increases, the area of the motifs decreases, or vice versa.

III. Traditional Nigerian designs can be woven successfully on the Jacquard Loom. Thus, these designs would not only substitute for imported designs but, provided the right machinery is used, could also be exported, conveying traditional Nigerian designs in Jacquard-woven fabrics.

8 | Conclusion

Traditional Nigerian Indigenous designs can be successfully woven on the Jacquard loom; these designs would not only substitute for imported designs but, provided the right machinery is used, could also be exported, conveying traditional Nigerian Indigenous designs in woven Jacquard fabrics.

The two variables, the cover factor of the woven fabrics and the area of the motif in the woven fabrics, were measured for the purpose of determining the freedom available and the desirable appearance of the woven fabrics.

From the results, the following conclusions could be made:

I. The area of a motif is inversely proportional to the cover factor of the woven fabrics. That is, as the area of a motif increases, the cover factor of the woven fabric decreases, vice versa/

II. The size of the design can depend largely on the time required to hand-punch it onto the cards. It can force the designer to reduce the size of his motif so that the design can be punched easily on less sophisticated machinery.

III. The pick-wheel adjustment and the weave selection for the woven fabric determine the Picks Per-Centimeter (PPC).

IV. The shape of the design motif depends on the fabric's thread count. That is, the PPC and the yarn count of the weft yarns and their relationship to the ends per centimeter and their yarn count.

V. Using double-color warp and weft, shades of different colors, or even new colors, can be created on the loom and woven into the fabric.

VI. Traditional Nigerian designs can be successfully woven on a Jacquard loom. These designs would not only substitute for imported designs but, provided the right machinery is used, could also be exported, conveying traditional Nigerian designs in woven fabrics.

8.1 | Recommendations

I. Future research should focus on how the techniques discovered in this paper can be fully utilized with well-developed Nigerian culturally oriented figure designs.

II. Since the Jacquard loom can weave any motif or design into fabric, research should be conducted on consumers' views on the use of Nigerian traditional motifs compared to fabrics with imported designs.

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