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Wire Weaving for the Production of Light Fittings

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Abstract:- The main objective of this paper was to explore in a studio setting, the application of wire weaving technique for the production of light fittings. This study was deemed necessary because it was observed by the researchers that much attention has not been given to the technique by fellow craftsmen over the years due to the claim by some that, they are difficult, time demanding and can also be frustrating. The research employed studio based research methodology to execute the project. Under this study primary data from studio experiments as well as secondary data from literature and existing practices were collected and analyzed for the project. In this regard, the study explored various weaving types at the studio in order to select appropriate weaves that were suitable for the wire weaving projects. After the exploration of the weaves, the plain weave, diamond twill weave and twinning technique of basketry were selected and used to design and produce three the light fittings. These are a pendant lamp, a scone and Table lamp. The result of the study revealed that wire weaving technique can be used in the production of light fittings and metal artefacts with less difficulty within a considerable length of time. It was also realized that the wire weaving techniques can be made easy with good workshop procedures. This notwithstanding, it is a worthwhile endeavors because the outcomes can be rewarding.

Keywords:- *Wire weaving, light Fittings, Basketry, Wire Twisting, Jewellery Techniques, and Metalsmithing Techniques.*

I. INTRODUCTION

The jewellery and metalsmithing abounds in a variety of techniques which have been used over centuries in the production of metal products and artefacts for both utilitarian and decorative purposes. The techniques range from complex industrial processes such as metal stamping, spinning, casting, and extrusion to simple but intricate studio based metal techniques such as chasing, repoussé and some forms of wire work. Though most of these techniques are being used widely by jewellers and other metal artists, the use of a technique like wire weaving has not been a common practice among metal artist in the production of artworks. However, this technique has boundless possibilities: easy manipulation to create intricate objects of art that are light in weight and also aesthetically pleasing to the eye. This is realized due to the rich textures created by the variety of possible weaves. Also, wire woven objects tend to produce elastic properties and are also non susceptible to dents to a great extent.

This project was motivated by a visit to the market one sunny day. It was observed that the woven straw hats worn by the market women against the sun created very fascinating shadow impressions on their bodies and immediate surroundings. Figure one presents an example of a market women in their usual sun hat in a shining afternoon shown the impressions on her body as can be seen on the face and arm. A later contemplation on the sight of these beautiful impressions created as a result of the sunlight passing through the woven strands gave rise to the idea of passing light rays through woven wires hence: the application of wire weaving technique in the production of light fittings. However, this project sorts to explore the technique in the production of light fittings that will reflect African design concept and motifs.

Fig. 1: Market woman (source: www.eyeem.com, 2018)

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II. REVIEW OF RELATED LITERATURE

This projects made use of information related to weaving and light fittings, as well as relevant history. It also examines the various extents to which artists have explored weaving in the field of light fittings. Oddy (1977) has it that, wire is something we underestimate in the twentieth century. The system of production includes the slow lessening of the thickness of a metal bar by drawing it through a progression of holes of consistently diminishing measurement, so that the subsequent wire increases in length but decreases in diameter with every pass. According to Cusick (2000), wire is available in different gauges and shapes as well as in different metals. Wire made from alloys (blends of less expensive metals) is an acceptable choice, especially for jewellery for everyday wear or for working a new design. In art production, Firor (2014) asserts that wire is the component that will have the greatest impact on an art piece. He further stated that, even though everyone is most familiar with round wire, wire is also available in several other cross-sectional shapes: square, half-round, domed, rectangular, and triangular wires are often used in wire wrapping and other jewellery-making techniques. This review three main headings. Light fitting, Basketry and Weaving as outlined in the following paragraphs.

- *Weaving*

Adanur (2001) expressed that, weaving is most likely as old as human civilization. This ancient craft however, was not limited to organic garments only. Fisch (2003) took us back to biblical origins of wire weaving, as he quoted, "…and made the holy garments for Aaron, as the Lord command Moses… and they did beat the gold into thin plates and cut it into wires, to work it in the blue, and in the purple, and in the scarlet, and in the fine linen, with cunning work…. Chain of pure gold, twisted like cords, were made for the breast piece…" Exodus 39:1-15. Moreover, archaeological findings of the origin of weaving have been dated to more than 24,850 years (Riggs, 2004). Albers (1974) describes weaving as a popular ancient craft. She further explained that hand weaving is a method of forming pliable threads by interlacing them rectangularly. She added that it was developed in the pre-ceramic age and that it has remained essentially the same till now, even by the modern production methods of the craft through the introduction of power machinery.

Untracht (1985) asserts that there are four main basic weave systems employed in weaving; plain weave, twill weave, satin weave and open weave. He continued that, it was based on these that many derivative weaves came. Furthermore, he is of the view that, weaving is the most important of the hand or mechanism work process that can be used to interwork wire and strip element. In all weaving, the basic concept involves the insertion and interlacing of a set of horizontal (width) elements called the weft through a set of vertical, (length) elements called the warp. He further stated that wire and metal strips weaving can be done without the use of a loom. This he stated was so because of the scale and size range of metal fabric woven for use in jewellery and also the stiffness of wire that makes it stand when weaving without any structural support. This notwithstanding, Gokarneshan (2004) states that a woven material is one created by the interlacing of two arrangements of yarns, to be specific, warp and weft yarns as illustrated in Fig. 2. These yarns are joined with each other as indicated by the kind of weave or plan.

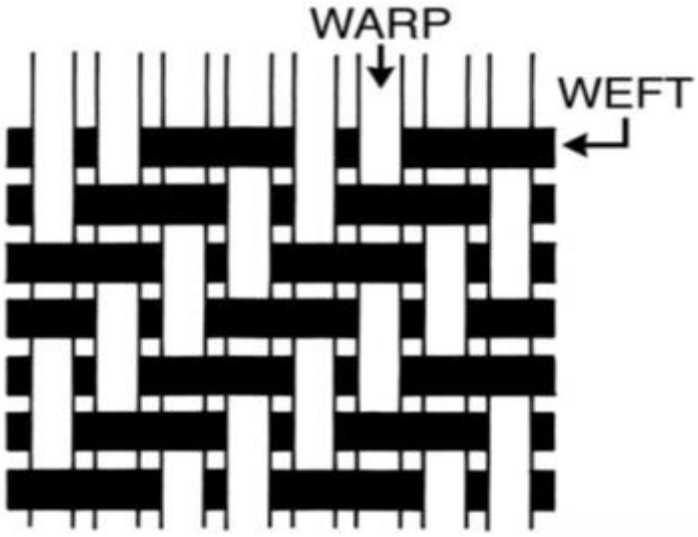

Fig. 2: Weave pattern showing warp and weft

- *Basketry*

Holmes (2015) has it that, basket is one of mankind's most established works of art, and it is positively an ethnic and social symbol loaded with myth and theme, religion and imagery, and adornment in addition usefulness. According to the Anthromuseum (2015) there are four essential systems used to weave a basket: twining, coiling, plaiting, and stake and strand. Any of these systems can be utilised to make an assortment of various sorts of containers, from a small basket for jewels to an enormous one for storing grain. Basic materials utilized in this type of art work include roots, grasses, wood, and tree barks.

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Coiling as shown in fig. 4, comprises of sewing a stationary horizontal component also known as the foundation with moving vertical components also known as the stitches. The stitching and bindings on a coiled basket can be decorative, purely functional or both. Twining is another technique which comprises of passing horizontal components (weft or weaver) around stationary vertical components (warp or stake). It can also be said that twinning is a technique in which two wefts or weavers cross over one another between the stakes or warps as illustrated in fig. 4. Moreover, plaiting involves passing strips of fibre over and under each other at a fixed angle. It produces a checked pattern as illustrated in fig. 5. Untracht (1985) explain plating as a method of forming a fabric with the fingers by diagonally interweaving or inter linking any number of elements, usually strips of the same width or multiple strands of wire. In plating variety of fabric types and structures can be made including the plain weave and twill weave variations. Stake and strand however, consists of two sets of interlaced elements; one set is stable, while the other is moved in and out to alternate the stakes.

Fig. 3: Coiling by Connor O'Malley (Source: http://www.wildernesscollege.com/native-american-basket-weaving.html)

Twining on another hand consists of passing horizontal elements (weft) around stationary vertical elements (warp). It also be said that twinning is a technique in which two wefts cross over each other between warps.

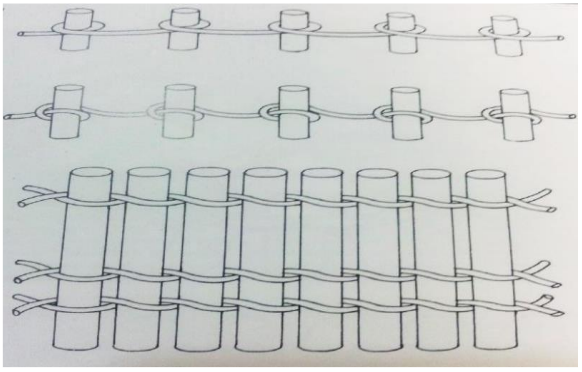

Fig. 4: Twinning by Untracht Oppi (Source: Jewelry Concepts and Technology, 1985)

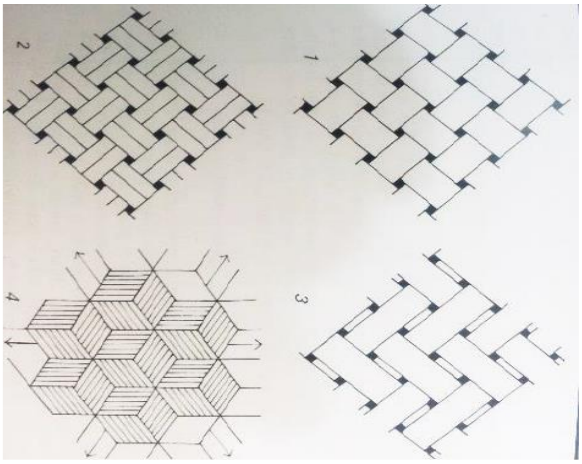

Fig. 5: Plaiting by Untracht Oppi (Source: Jewelry Concepts and Technology,1985)

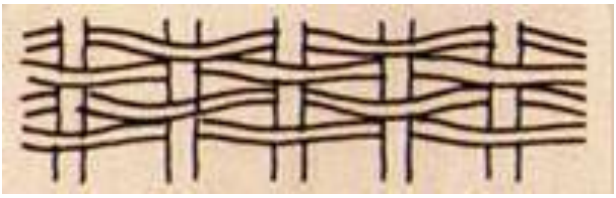

Fig. 6: Stake and strands (Source: https://anthromuseum.missouri.edu/minigalleries/baskets/intro.shtml)

➢ *Light fitting*

William (1999) asserts that a light fitting is known as a 'Fixture' or as an 'Instrument' in America, as a 'Light Fitting' or a 'Lantern' in Britain and as a Luminaire, in other parts of the world and by the engineering community. According to Yee (2008), for centuries the utilization of beeswax candles remained the privilege of the church, the crown and the nobility. Also, Bellis (2013) asserts that, the first light as created around 70,000 BC. He further explains that hollow rock, shell or other natural discovered items were loaded with moss or a similar material that was soaked with animal fat and lit. People started creating similar shapes with synthetic ceramics, alabaster, and metal. These were believed to enhance the appearance of the lights.

Moreover, Wisegeek (2015) illustrate the pendant light by relating it to the pendant that hangs on jewelry chains. Examples are shown in fig. 7, 8 and 9.

Fig. 7: Fine wire table lamp
(Source: http://www.sahm-one.net/lamp-with-table/13/wire-table-lamp)

Fig. 8: Light – Wall Sconce
Source: http://www.turbosquid.com/FullPreview/Index.cfm/ID/526412 31

Fig. 9: Laura Kirar Three Light
(Source: http://www.blisshomeanddesign.com/Laura-Kirar-Three-Light-Chainmail-Pendant)

III. MATERIALS AND METHODS

The project made use of brass and copper as the main materials. These were supported by steel plates, iron rods and galvanized steel pipes. The researchers used the studio based research approach in the execution of the project. The procedures employed are divided into three as Materials and preparation; Exploration of wire weaves; and Fabrication of the light fittings.

❖ *Material and Preparation*

The desired gauge of brass and copper rods for the fabrication of the framework or armature for the weaving processes were not readily available on the market. Especially in the desired material. So the researchers had to melt some brass and copper scraps to obtain ingots for the work as shown in fig. 10, 11 and 12. Upon obtaining the ingots as shown in Fig. 12, they were milled into varied thickness of rods and wires for the construction of the skeletal frame that will support the weaving process. Also, a bobbin of 22 gauge (0.64mm) copper wires as shown in Fig. 13, was flattened through the rolling mill, annealed and twisted (Fig. 14, 15 and 16) for weaving process. Medium solder was prepared and used in all the soldering procedures.

Fig. 9: Copper scraps

Fig. 10: Melting scraps for ingot

Fig. 11: Pouring of the molten metal

Fig. 12: Ingots

Fig. 13: 0.64mm copper wire

Fig. 14: Flattened copper wire

Fig. 15: Twisting of copper wire

Fig. 16: Twisted copper wires

❖ *Exploring wire weaving*

Under this, three test projects were engaged to enable the exploration of the various weaves under the plane and twill weaves. A Spider on Web (Plain Weave; Mask (Plain Weave) and Diamond (Twill Weave)

➢ *Test piece 1 - A Spider on Web (Plain Weave)*

The weave employed in the creating of the web was the plain weave: this was done by interlacing twisted copper wire which represented the weft to copper rods arranged in a rotational manner that represented the warp as shown in 17. In order to create contrast between the spider and the woven web, the spider was created by doming two pieces of sheet metal as shown in Fig. 19 and fixed to the limbs then to the web as shown in Fig. 20 and 21 respectively.

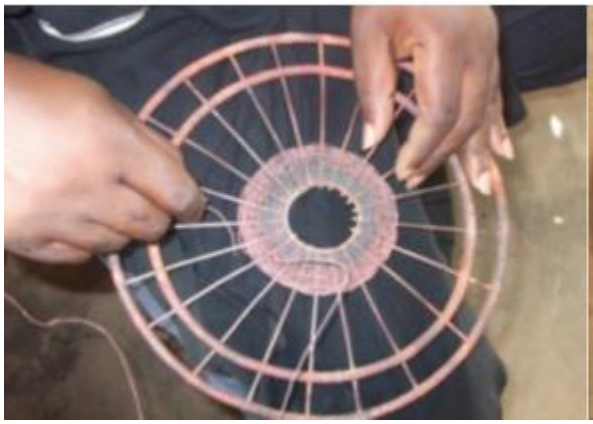

Fig. 17: Weaving the web

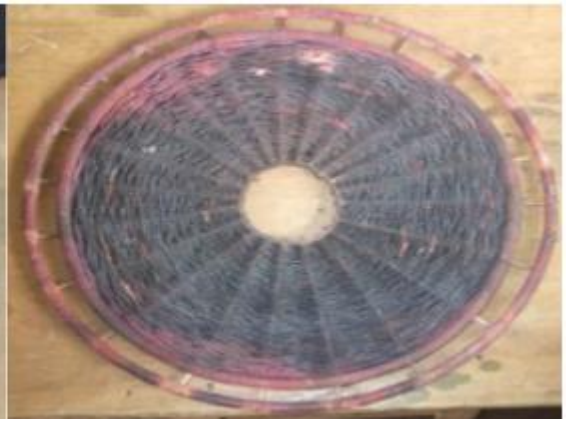

Fig. 18: The completed woven web

Fig. 19: Doming of spider's body

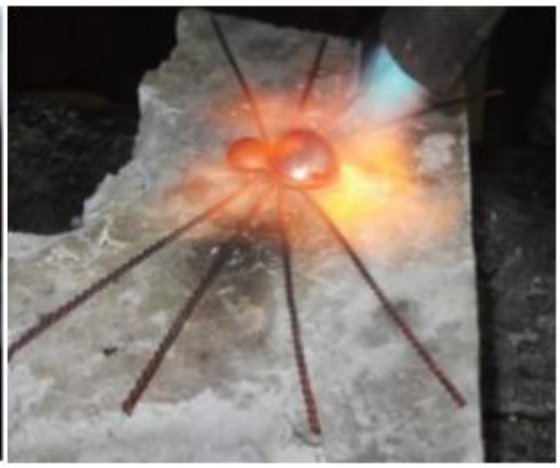

Fig. 20: Soldering the spider's legs

Fig. 21: The spider attached to the woven web

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➢ *Test Piece 2 – Mask (Plain Weave)*

A mask was created as the second test piece and it had a length of 250mm, breadth of 85mm and height of 60mm, this was also made in copper. The weave pattern used was the plain weave. This was done by building an armature of the mask using copper rods with thickness of 2mm. The reason for the armature was to support the weaving process, give form to the weave and to let the mask look three-dimensional. Copper wire both smooth and twisted and also copper strips were used in the weaving so to create variation and textures in the weave. These are shown in figures 22, 23, 24 and 25 respectively.

Fig. 22: Soldering the armature

Fig. 23: Completed armature

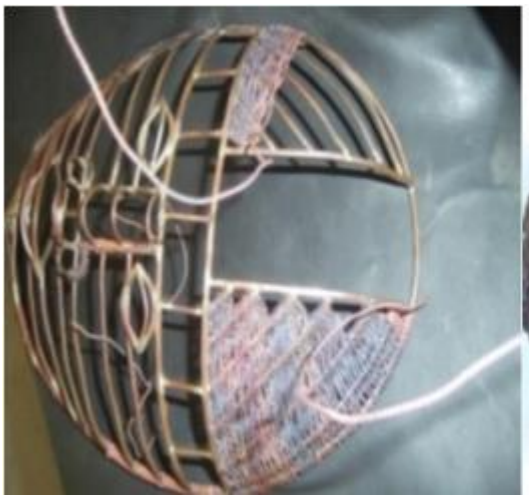
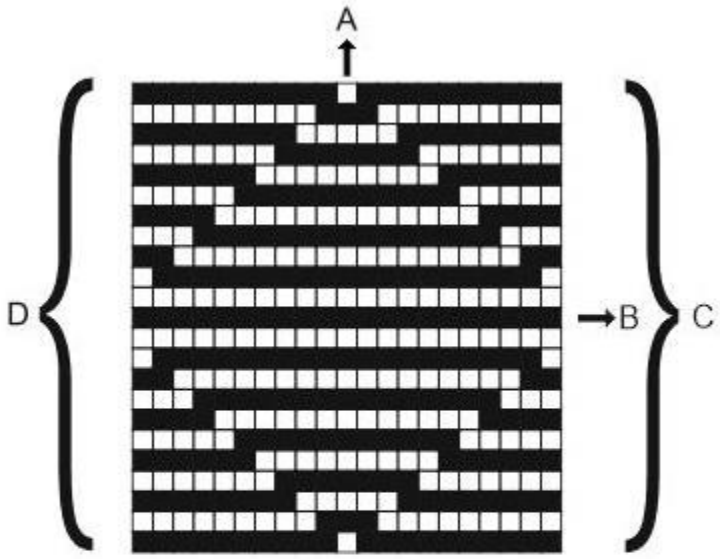


Fig. 24: Weaving process

Fig. 25: Mask completed

➢ *Test Piece 3 - Diamond Twill Weave*

The diamond twill weave was experimented in addition to the plain weave. The procedure that the researchers followed in doing this weave was not exactly what pertains in textiles when doing the twill weave. Copper and Brass strips were the elements used in making the weave. This was intended to make the warp and weft distinctive. To obtain the diamond shape, a vertical midpoint had to be determined as 'B' shown in fig. 26. Using that as a starting point, the warps (picks) were made to interlace with the weft (ends) from the left and the right side of the midpoint. The subsequent picks from the midpoints were extended one step each at every level. This process was continued till the design got to the horizontal midpoint as shown in fig. 26 as 'A'. From there each pick was reduced step by step at each level and when each process continued, the design then started closing up to complete the diamond shape as in figure 27 and then completed as presented in figure 28.



A - Vertical midpoint
B - Horizontal midpoint
C - Right side
D - Left side
Black - Weft
White - Warp

Fig. 26: Mapping graph of the diamond twill weave

Fig. 27: Interlacing of weft to warp

Fig. 28: Completed diamond twill weave

❖ *Fabrication of the Light Fittings*

➢ *Design Development*

Design development was conceived carefully bearing in mind the production of light fittings using the wire weaving technique. The researchers used forms and motifs that bear Ghanaian concepts for the fittings. This was deliberate so as to bring variety into the design of the light fittings since majority of light fittings on the market are of foreign in origin and bear foreign design concepts. For the easy manipulation of the wires for the weaving process, the technique at hand which is the wire weaving informed the shapes and forms during the designing stage and also those that was selected during the project. Another factor that influenced the researchers' design was the availability of materials, tools and equipment and also considering the time frame in which the project had to be executed. Since the purpose of the project was not only for aesthetical use but also for utilitarian purposes, thus to give light or to illuminate an environment. The researchers had to consider some technical properties during design such as the angle at which the bulb holders should be placed and the concealment of the bulb in the shade. This is to make sure the project function effectively upon production.

Pendant lamp is a type of lamp that is hanged from to the ceiling of buildings for illumination and aesthetic purposes. A major feature of this type of lamp is that it is either hanged by a metal rod, tube or chains to the ceiling of the building. Different concepts were developed in this regard to arrive at fig. 29 which was further developed into a more elegant version presented in fig. 30. For easy weaving and fabrication, the concept was broken down into four parts A, B, C, and D presented in fig. 31. And this was the weaving sequence that was used.

Fig. 29: Pendant lamp design

Fig. 30: Pendant lamp design

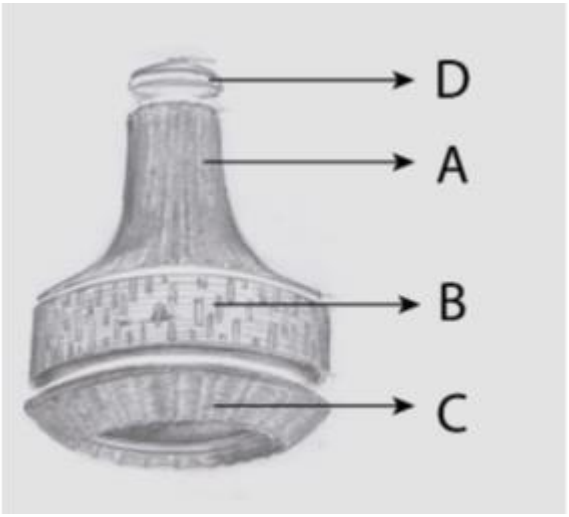


Fig. 31: Pendant lamp in sections

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The sconce was also taken through similar process base on the concept of the spider and its web. This gave rise to the concepts displayed by figure 32. This was also followed by the table lamp as in fig. 33.

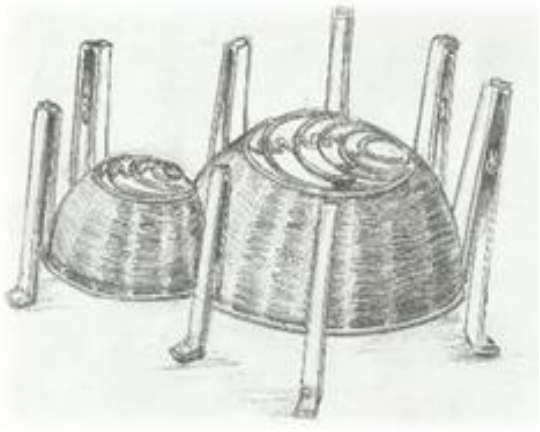

Fig. 32: Sconce design

Fig. 33: Table lamp design

➢ *Forming and weaving*

The pendant lamp was started by cutting 3mm round copper rods into 25 pieces, in lengths of 200mm. These were formed by using a specially created wooden template as shown in figure 34 to form a divided "U". Three copper rings were then formed with a mandrel having a diameter of 100mm and the rest of the two having a diameter of 270mm each as in Fig. 35. The stakes that were formed early on were then soldered around two of the rings as in Fig. 36, to complete the skeletal frame of section A (Fig. 31). After the forming of section A, the plain weave technique was employed in the weaving of the whole section as shown in Fig. 37.

Fig. 34: Forming of 'half U'stakes

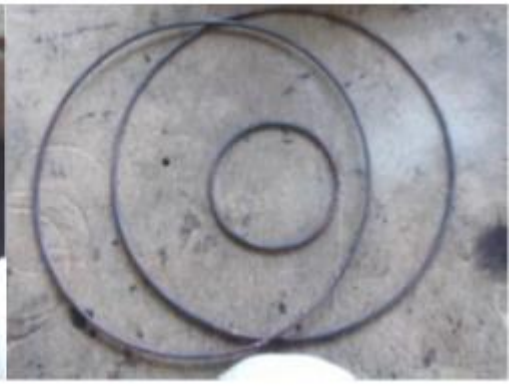

Fig. 35: Formed rings with mould


Fig. 36: Soldering the stakes around

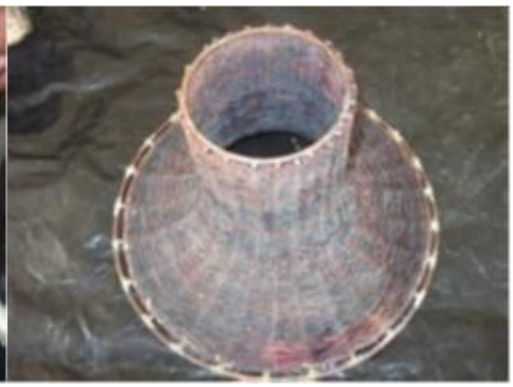
Fig. 37: Section A completed the rings

The same thickness of copper rods 3mm was cut into 25pieces each measuring 50mm long and was soldered to the base of section A as seen in Fig. 38, corresponding with the stakes that formed section A, which formed the skeletal frame of section B. The last of the three rings formed early on in stage 1 during the fabrication of the section A was soldered at the base of section B as seen in Fig. 39. This created the base on which section C was built. During the forming of the skeletal frame of section C, another 25 pieces of copper rods each measuring 50mm in length were formed into a shape as shown in Fig. 40 and soldered to the base of section B as shown in Fig. 41

A copper ring was then formed with diameter of 200mm and soldered at the end of section C to give it strength as seen in Fig. 40. This was to make the stakes well positioned for the weaving process. After forming the skeletal frame of sections B and C, the plain weave was done on section C as shown in Fig. 41 to cover the entire section. The weave pattern used for section B was the diamond twill weave which was explained in detail during the making of the test piece "3" as shown in figure 28. The only difference between test piece three's diagonal twill weave and that of the one done here is the length and size of the copper and brass strips that were used as seen in Fig. 42. After the completion of the diagonal twill weave pattern, which was done separately, it was then soldered around the entire circumference of section B as shown in Fig. 43.


Fig. 38: Framework for section B

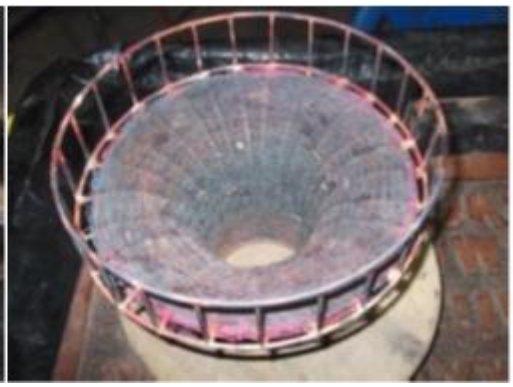
Fig. 39: Soldering the stakes that form section B

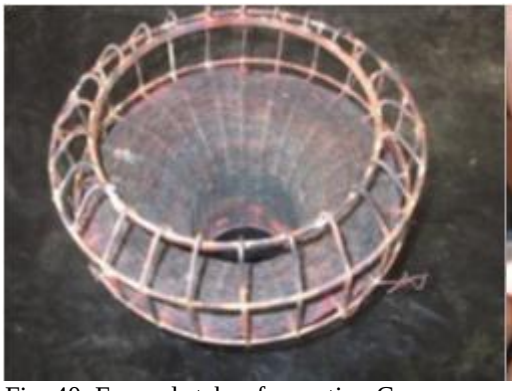
Fig. 40: Formed stakes for section C


Fig. 41 Soldering of the stakes of section C

Fig. 42: Completed skeletal frame of

Fig. 43: Plain weave being done on section C Sections B and C

After the completion of section A, B and C, which constituted the shade of the pendant lamp, copper sheet was domed to form a cap for the top of section A with a locking mechanism to hold it in place. Within the cap is a bulb holder for holding the bulb. At this stage, a chain known as 'double hearts' was woven using 19gauge (0.91mm) copper wires as seen in Fig. 44. These chains are the mount of the pendant lamp. Their purpose is to hold and suspend the pendant lamp in the air when attached to the ceiling of the room. Also 16 pieces of brass Gye Nyame symbols were cut, domed and soldered in pairs to form 8 symbols as shown in Fig. 45. These were then attached to chains measuring 100mm to form charms (fig. 45) attached around the middle portion of the pendant lamp as in Fig. 46. This was done to give the work a Ghanaian touch.

Fig. 44: Weaving of the chain

Fig. 45: Domed Gye Nyame symbols Double Heart 52

Fig. 46: Domed symbols attached to chains

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Fig. 47 Finished pendant lamp with accessories

The sconce was done in two parts. Thus the body which is the shade of the sconce and the box which is the wall mount as well as the lamp holder barer. The frameworks were formed with wooden mandrels as demonstrated in figures 48, 49 and 50. The body is in two parts: the walls and the tops. The part that took the weaving is the walls as shown in fig. 51. Twinning is a weaving technique in basketry which is done by either coiling or winding the weft which is relatively flexible and can be easily manipulated to the vertical warp or the stakes at the point of interlacing to form a weave. The tops were caped with wire spirals decorated and held in position with brass symbols (figures 52 and 53). This was then joined to the base components to get the final form as shown in fig, 54.

Fig. 48: Wooden mould for the forming of the spider

Fig. 49: Forming of rings for the base and top of the spider

Fig. 50: Soldered warp stakes

Fig. 51: Twinning process

Fig. 52: Eccentric ring for top of spider

Fig. 53: Soldering of "Gye Nyame"

Fig. 54: Completed spider sconce

The table lamp started by forming square copper rod with thickness of 3mm into two rings with diameters of 80mm and 270mm respectively as seen in Fig.55. These were used as rims at the top and bottom of the shade. 35 pieces of copper rods with thickness of 4mm and length of 200mm were soldered around the rims to form the skeletal walls of the shade. The soldering process is shown in Fig. 56. Plain weave was done at the top and bottom of the shade using flattened and twisted wires as weavers as shown in Figures. 15 and 16. Whiles smooth wire was used as weavers in creating a woven pattern for the middle which is known as twining as in Fig. 58. After the weaving procedures, some selected Adinkra symbols were pierced in brass and soldered as charms at the lower edge of the lamp shade as seen Fig. 59. Addition to which some local beads were added in the final analyses as shown in fig. 60.

Fig. 55: Formed rings for the shade

Fig. 56: Soldering of the stakes between the rings

Fig. 57: Plain weave procedure

Fig. 58: Twinning procedure

Fig. 59: Charms attached to the edge of the shade

Fig. 60: Completed table lamp

❖ *Finishing*

This project adopted the oxidizing colouring technique which gives an antique look and also cost effective as compared to other colouring techniques. This was done by dipping the items into a metallic sulphide compound. In this process matrix of the metal combine with the chemical which produces a dark surface orientation. Fig. 61 shows some of the items after oxidising.

Fig. 61: Drying after oxidizing

The works were then subjected to a post colouring treatment using abrasives. This process was carried out on the light fittings using steel wool and leather as in Fig. 62 to create high light on the projected areas while leaving the dark colour film in the recessed area to create the effect of depth and height on the surface of the light fitting. After the relieving process, the light fittings were lacquered by spraying as in Fig. 63 to prevent the high light areas from tarnishing and also to permanently fix the oxides on the surfaces of the light fittings.

Fig. 62: Relievingl process

Fig. 63: Lacquering process

IV. RESULTS AND DISCUSSION

The resulting pendant lamp shade; wall sconce and table lamp are presented in figures 64, 65 and 66 respectively. The process and outcome of this project suggest that Wire weaving as a technique can be used to produce metal artefacts with less difficulty within a considerable length of time. However, to create desirable weaves with wire, it is important to relate the sizes of the wires to the design. But to make weaving less tiresome and stress-free, the metal artist should adhere to good workshop practices such as the use of right materials and tools for the right job. This is evident in the selection and making of wires for specific weave structures.

When finishing artefacts that have been made in wire weaving, processes such as sanding, grinding, filing and bathing may be ignored because the weaves turn out to give aesthetically appealing surface textures that should not be tempered with. Moreover, Light fittings which have been made from wire weaving do not give visual textures when fixed with high wattage bulbs. The lower the wattage, the better the impression it creates regarding visual textures. Furthermore, light fittings made of broader or bigger gauges of wires produce outstanding visual textures compared with smaller gauges.

Fig. 64: Pendant lamp (Martaba)

Fig. 65: Wall sconce from the spider concept

It was realised at the end of the study that, Wire weaving as a technique is not as cumbersome and time consuming as some fellow craftsmen claimed it to be the reason why they do not use it often as a fabrication technique. The application becomes less stressful by using the appropriate gauge of wire in relation to the size and design being worked on. By this, it is easier to manipulate the wire to create weaves. When basic workshop practise such as frequent annealing during the weaving processes is adhered to, the weaving process becomes easier and less tiresome. It was also observed that the size of the wire gauge or strips used in creating a weave pattern also determine whether or not you will get visual textures. The broader or bigger gauges of wire and strips gave more pronounced results whiles smaller gauge of wire gave either little or no textures. Compactness of weave also played a major role in obtaining visual textures.

Fig. 66: Table lamp

V. CONCLUSION

The result of the study from the exploration stage to the production of light fittings using the wire weaving technique have revealed that wire weaving is not time demanding and difficult as it is claimed to be by some metal artists. If the mechanical properties of the metal is taken into consideration when choosing materials for the weaving process and the right fabrication processes are adhered to, such as the malleability of the metal, the wire gauge in relation to the type of weave and the frequent annealing of the metal so it does not snap during the weaving process. Moreover, weaving techniques result in intricate textures on the surfaces of respective objects. These textures are either small or big but depend on two factors: the type of weave and wire gauge or size employed.

Also the texture obtained is not only determined by the weave structure or style but also the rendition of the wire prior to the weaving. The texture created on the surfaces wire woven objects are much explicit and need little or no filing, abrasion or even buffing. Finally, the researchers will like to state that the light fittings produced using the wire weaving technique are of utilitarian and decorative purposes and should be seen as such. last but not least, the results of this study is a contributions to the basis for students and metals smiths for the further exploration of wire weaving technique.

RECOMMENDATIONS

Based on the findings of the study, the researchers came up with five main recommendations as follows:

- Wire weaving technique should be considered and used by jewellers and metalsmiths because it can be used to produce aesthetically appealing metal artefacts with less difficulty within a considerable length of time. This can be achieved by paying attention to the relationship between wire sizes, weave patterns and the design as a whole.
- Good workshop practices such as frequent annealing of wire and metal strips should be adhered to, so that the manipulation of the weaves becomes less tiresome during weaving process.
- Metal artists who want to venture into production of metal article using wire weaving can decide not to finish their works using finishing processes such as sanding, grinding, filing and buffing may end up deforming the weave patterns.
- The users of wire woven light fittings who desire interesting visual textures in their rooms or surroundings should fix low wattage bulbs.
- It is also recommended that to achieve outstanding visual textures, bigger gauge of wires and broader metal strips should be used in the creation of the shade for the light fittings.

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