

Improving Safety Communication in Jewellery and Metalsmithing Workshops using Chasing and Repousse Techniques

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Abstract

Adhering to Safety Practices in Ghana and around the world has always been through safety personnel and safety symbols; but when it comes to the local Jewellery and Metalsmithing Studios, from observation made, the impact of safety symbols is low as compared to the big industries. The local jewellery and metalsmithing studios in their haste to catch up with the modern technology through improvised means, endanger themselves in so many hazards and these are done out of complacency. Due to this attitude, apprentices also graduate and open their own shops with less attention to safety. To maximize and ensure the impact of safety symbols on jewellers and metalsmiths, this research seeks to promote the use of local jewellery and metalsmithing techniques in creating safety symbols that are positioned strategically to inform safety rules daily. With the use of qualitative research interviews and studio based research, the researchers have explored repousse and chasing as a metal forming technique and have used the end result in composing three different safety alerting devices based on conceptual art. The study was studio-based oriented with the focus on workshops in Kumasi and its environs including KNUST with global implications. The interviews conducted were one-on-one and focus group types. The respondents who participated were fifty (50) and were made up of active men and women in the field or workshop. The criteria used for assessment were; positioning and visibility of symbols, materials used in production and routine checks done by safety experts. A number of literatures; both books and on-line contents also helped in giving a clear guide as to what is legal and even how to build an art piece suitable within the safety context. The end product of this conceptual art lies between the use of sonorous and visual means of promoting or craving attention towards safety, daily. The research recommends further study into how to strategically inform workers of safety at low cost on daily basis in order to maximize the number of safety-conscious workers in the local jewellery and metalsmithing industries in Ghana.

Keywords: *Jewellery, Metal, Chasing, Repousse, Malleability, Metalsmith, Symbol, Concept*

1.0 INTRODUCTION

The Labour Department of Ghana Annual report on workshop injuries, in the year 1999 had its figures stand at 4,088 and as at the year 2000 the records gave 8,692 work-related accidents which were also reported to the Department for compensation. In the year 2015, an annual report gave a total of 113,448 persons who had reported injuries and from that, there was a clear increase in work related injuries (Asumeng, Afful & Agyemang, 2015). This clearly indicates a compromising attitude due to conditions and challenges faced by occupational safety and health system to enforce to the fullest safety practices in Ghana. In most cases accidents in jewellery workshops happen based on certain factors that could have been avoided; for instance, a KNUST student who was forging a metal piece on an anvil in one of the workshops on campus nearly got injured by a chip of hot metal. The incident indicates clearly that there was nothing to inform safety at this workplace and as a result nearly ended a student's life. A lot of such cases happen almost every day in most of the local Jewellery and metalsmithing workshops in Kumasi and its environ but are ignored having no agency to caution workers on daily basis. An annual report on the loss of lives at workshops in relation to human resource brings an urgent need for safety promoting signage or agency to help manage and improve safety at the workplaces.

As important as Safety is to every working environment, sometimes out of so many reasons jewellery and metalsmithing workers neglect and compromise with practices of safety culture and tend to put their lives at risk. Workers who find themselves in these situations can be held responsible for their actions but not in all cases because most of the active workshops do not have any safety symbol alerting workers from time to time. Another group of people who endanger themselves are the visitors who enter the working environment without paying attention to hazards around. This incident inspired the researchers to investigate how to minimise or avoid the occurrence of such accidents through the use of artwork produced with techniques of interest to the artist. Using chasing and repousse as the main forming method, the study intends to explore both visual and sonorous means to communicate safety. The final output is intended to help promote safety at the workshop through a conceptual art. This innovation is intended to improve safety communication at the jewellery and metalsmithing workshop by so doing reduce accidents. The objectives of the study were

to examine existing workplaces' safety signage in jewellery and metalsmithing workshops to serve as a guide for the production of an art-oriented piece and to create an art piece using repousse and chasing techniques that incorporate safety symbols and sound as a means of assisting safety at the jewellery workshop.

Safety according to Ridley & Channing (2003) is acting a way and manner which avoids injurious circumstances; that is, not hurting yourself or others presently or in the future by doing something which causes injury, now or 20 years down the road. The effective prevention and reduction of hazards at workplaces begin with a thought of value for human life in general before thinking of it as the life of a worker. The working environment does not consist of workers alone but visitors and neighbours surrounding the premises, therefore decisions taken to promote safety should be made clear and understood by everyone in and around the workplace.

Hoyle (2009) stated that the International Organization for Standardization (ISO) makes the safety symbols a necessity for all workplaces to fix a lot of safety images which connote the various dangers a worker is exposed to, in his or her working environment. By these measures put in place, there has been an indirect alertness created but still the small industries are not often checked for compliance. Well, this is obvious and can be seen in most of the local jewellery and metalsmithing workshops in Kumasi and its environs. Symbols over the years have been used to communicate alertness of hazards, prohibitions, and dangers in and around the workplace. This research seeks to promote public safety through repousse and chasing art techniques. The reason being that in as much as the safety symbols are playing their roles in alerting workers, there is the need to capture it in an artistic way to make the symbols more attractive and inspiring to the particular user in this case the jeweller and the metalsmith.

Civilization has always found ways to communicate through images to the rest of the world, especially when language was in its' infancy, such as drawings and paintings on caves. Safety signs came into existence during industrialization and when cars emerged. In 1968, a convention in Vienna made a move to standardize certain shapes and colours of road and safety signs so they would be recognizable in different places, which finally came into effect in 1978 (History of Safety Signs (2019)). According to Ells and Dewar (1979) figurative signs communicate more effectively than written text and this is partially founded on observed evidence that in some circumstances they tend to do better than written signs, especially where viewing conditions are not clear enough. Colour is a composition of pigments and as anything under the sun or heat gets to fade out, so do colour pigments find themselves subjected to fading. Safety symbols subjected to this kind of conditions breaks the communication link between symbols and users of facilities. There are so many ways to draw attention to an object, but in this research the potential of sound and aesthetics were considered. A lot of safety symbols have popped up and have gone through a lot of transformation. These transformations were done according to the kind of working environment and have been added to the old popular safety symbols. An example is the New BS ISO 7010 seen in Figure 1.



Figure 1: Safety symbols reviewed by ISO (International Standardization Organization).

Source: ifsecglobal.com

It is important to choose the right materials because a degraded or partially detached safety sign compromises the legibility and understanding of its message. If your safety signs end up exhibiting the defects, they will unnecessarily be putting your company; and that might lead to both workers and visitors getting hurt. This could possibly lead to litigation for “failure to warn” or “inadequate warnings.” Signage and label materials must be matched to your facility’s environmental conditions, the intended location of signs, and planned installation methods. The following are some of the critical factors to consider when selecting materials for your new workshop according to Clarion Safety Systems, (2013). Indoor vs. outdoor conditions, Fade resistance, Temperature variations, Temperature extremes, lighting conditions, Emergency lighting conditions, Graffiti-resistant characteristics, wash down conditions, maintenance and cleaning procedures among others. It is based on these factors, that certain materials were selected to guide the research. All necessary factors were considered in order to bring out a quality artistic safety symbol.

A workplace or workshop is where one learns to use tools and machines to fabricate needed items. In achieving a highly safe working environment, there are certain policies which needs to be strictly followed and habits that need to be built within the worker through the supervisory and managerial skills of the leadership of workplace (Shangali & Raab, 2018). These safety policies do not only save lives of workers but they also help prolong the life span of certain tools and machines. In other words safety does not pay in only one way but comes with so many benefits (Safety Works Maine (2014). Some well-organized fabrication companies, have

safety symbols fixed on or just around the machine being used and this is a standard way of situating a safety sign but sometimes for compromising reasons these signs are fixed at obscured places as observed during the preliminary study. The illustration in Figure 2 shows a guide of how a safety sign should be located. It outlines three major factors that influence the good positioning of a safety symbol. One of the factors has to do with the sizes of the symbols which should be considered in order to be noticed easily. Another is the light source around the symbol.

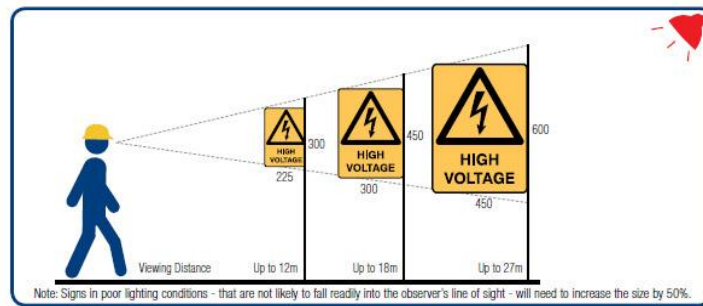


Figure 2: Safety sign viewing distance guide

Source: National-site-safety-au.

Apart from the symbols on walls to communicate with, one needs personal items to shield one's self from the daily hazards at the working environment. These items range from head worn gadget down to foot wears. These include proper clothing, removal of tie and jewellery, proper eye protection and proper shoes.

Signage is a word that can be used for a collection of signs, which find themselves in the same category. Meis and Kashima (2017) define signage as a tool for behavioural change and it's normally used in influencing the behaviour of users of a facility or society. According to History of Safety Signs (2019) when it comes to designing, selecting and implementing signage, there are four obligations to be met. It must: Mandate, Prohibit, Safeguard, and Warn.

As this research seeks to promote the original safety symbol in the system, it has become a prerequisite for the researchers to look at the lasting material and vital element that makes up perfect signage. Based on this, the appearance in terms of colours and flatness should be considered, so that the conceptualized safety symbol will have traces to the standard ones. Again, History of Safety Signs (2019) opines that each and every colour has a specific message they convey to users of a facility. The red colour is used to signify danger and the colour green signifies where one can find a first aid and emergency exit. Blue is also meant for constructing walkway direction.

According to observance made during the research and the researchers own experience, it was seen that workers who do not want to perceive safety will be unable to behave safely because they do not know the magnitude of their actions. In this era of industrialization, it is generally held that employees are responsible for accidents unless employers could be proven to be negligent (Aldrich, 1997). In relation to the labour laws of the Ghanaian state, the employer must ensure every necessary equipment or training for its workers. In accordance with the Labour Act of Ghana, section 118-121 of the *Labour Act 2003* (Act 651), it is obligatory on the employer to ensure health, safety, and welfare of persons at the workplace by minimizing the causes of hazards inherent in the working environment. The employer must ensure careful and safe use, handling, storage and transport of articles and substances; and provide the necessary information, instructions, training and supervision as needed.

The word chasing in a layman's understanding is moving forward or perceiving an object in focus to catch up with. In the context of this research, Corwin (2010) explain chasing includes various work done on the front such as Planishing, lining, matting, and making crisp edges on forms that were raised from behind that is repousse. According to Brepohl (2020) chasing and repousse are often confused and not without good reason since the two techniques go hand in hand. Corwin (2010) also argues that even though chasing and repousse are often used together, it is possible to have either one without the other. The repousse technique which is often used together with chasing was coined out of a French term.

The French word repousse refers to a technique that dates from antiquity and has been used widely with Gold and silver for fine works. It literally means 'pushed up'. While repousse is used to work on the reverse of the metal sheet to form a raised design on the front of the work, chasing on the other hand is a technique used to refine raised portions from the front. It is derived from the noun chase, which refers to groove, furrow, channel, or indentation. These techniques use the plasticity of the metal to form shapes and in the course of it no material is lost or wasted (Meis & Kashima, 2017).

When discussing the aesthetic features of repousse, a lot can be said taking into consideration various artworks such as the scene designs on cups, wall hangings, war shield, door panels, wine jars and medals (Shahbabu, Dasgupta, Sarkar, & Sahoo, 2016). Works produced by this technique stand out real in relief and give a feeling of three-dimensionality as captured in Figure 3 and because of this; it needs a skilful hand and sharp imagination to begin the working process. Works of this nature crave much attention because of their unique organic looks and beauty. Looking at the potential, the study intends to use these media to promote the safety symbols at workplaces. Brepohl (2020) traces that conventional jewellery metals have been one of the most efficient materials associated with this kind of art because of the working processes involved (Malleability). High karat gold, fine silver and copper respond very well, while pale brass, nickel silver and steel require greater effort. Aluminium comes in once in a while when one wants to minimize cost. These have been tested over the years and proved to be the most appropriate to work with, even though there are personal

preferences when it comes to fashioning them into art pieces as seen in Figure 3. Possible materials for this technique include gold, copper, silver and aluminium.



Figure 3: Aluminium Repousse work

Untracht (2011) highlighted that before a metal can get a good repousse state, in terms of depth and perspective there is the need to create a pitch. This pitch is contained in an iron bowl and is heated to the consistency of bread dough as shown in Figure 4, so it can allow the metal to be shaped with good support. Modern repousse pitch is made of a mixture of things including pine resin or asphalt tar, waxes and fillers like fine clay and sand, repousse tools (Safety Works Maine (2014). The metal is then taken through a process called annealing where metal to be used is heated to red hot to make it workable after cooling down, afterwards the metal is washed with sulphuric acid and rinsed with water. Its surface is dried with clean cloth and placed on the (bread dough like) pitch. The pitch is then placed on a sandbag to prevent it from tipping off.

During chasing one must hold the tool for chasing and repousse as shown in Figure 5, in right angle towards the surface of the sheet with the left hand and with the hammer in the other hand; tap the end of the punching tool. The tip must be focused on the lines of the designs and run through with continuous taps until design pops up and then repousse is started from the reverse of the sheet.



Figure 4: A Bowl of pitch



Figure 5: Chasing and repousse tools

It is stated that for one to achieve depth and perspective clearly and detailed obviously from a distance, one needs to give it shading. This shading of the repousse are achieved by dipping the repousse work in a solution of Sulphur and then rubbing the high spot with the palm of the hand and silver sponge. The whole process is called oxidation. Right after the oxidation process, a fine film of wax or lacquer is applied to prevent the air from further oxidizing the metal (aluminium) and eventually turning it black. In Metal Product Design, joining process involves welding, brazing, soldering, screwing, riveting and sometimes epoxy resin. The various joining methods mentioned above can either be used in conjunction with one another or alone depending on how tight the joint needs to be secured. During the working processes, sometimes two flats surfaces which need to be joined may need a joining method like welding, soldering or epoxy resin based on the end product perceived.

2.0 MATERIALS AND METHODS

This study has its focus among other things, on how to apply the repousse and chasing techniques to produce metallic safety symbols which combines a sonorous feature in the field of safety and also how jewellers and metalsmiths could integrate the techniques in their everyday line of manufacturing functional works of art. The content of this section includes the research methods employed, concept development, sketches, Computer-Aided-Design (CAD), fabrication processes and appreciation of the resulting art pieces. The research design employed was the qualitative research method to bring out the thought on the designs. Qualitative research is typically concerned with inductive analysis of a social reality with a descriptive and explanatory orientation (Guest, MacQueen & Namey, 2011; Haq 2014). The production of an artwork goes together with written procedures that details step by step processes applied. The study was studio based oriented with the focus on workshops in Kumasi and its environs including KNUST with global implications. The interviews conducted were one-on-one and focus group types. The respondents who participated in the study were fifty (50) and active men and women in the field or workshop.

The researchers accomplished the objectives of the research through Studio-Based Research. The repousse and chasing techniques used for making the art piece gives a lot of advantages to the artist in relation to other methods that could have been employed. These benefits include material saving and weight reduction. The journey through production began with two practical tests of the repousse and chasing techniques. Two safety symbols were selected as designs to be worked with on an aluminium sheet. One of them was repousse and chase of the “no smoking sign” as shown in Figure 6 (A), depicting a cigarette crossed out with a bar done in aluminium material as shown in Figure 7 (C). The second experiment was done in aluminium too, also depicting an artistic combination of a hard hat, goggle, ear muffs and a gas nose mask as shown in Figure 6 (B) and Figure 7 (D). These tests on the materials paved the way and facilitated the researchers’ application of the repousse and chasing techniques in the fabrication of the Safety symbols.



(A) ISO no smoking symbol

(B) ISO hard hat protection symbol

Figure 6: Description of the subject matter of the repousse safety symbol
Source: IFSEC GLOBAL



(C) Test piece 1

(D) Test piece 2

Figure 7: Test pieces of repousse and chasing safety symbols

2.1 Concept Development

An outline of the idea development process by the researchers were 1) Sketching of Conceptual designs, 2) Redesigning the sketched work with outlines on computer using CorelDrawX7 Software and 3) Rendering the final design in 3Dimensional view with the help of Rhinoceros 5 and Keyshot5 software

2.2 An Outline of Fabrication Processes

After the concept development the fabrication processes of the finished items were carried out as follows: 1) Preparation of the aluminium metal sheet for repoussé, 2) Tracing of the safety symbol outline with chasing tools, 3) Repoussé Begins, 4) Welding process, 5) Finishing by Spraying, 6) Assembling the three sections (repoussé part, chiming mechanism and welded metal frame) and 7) Evaluation of the finished piece

2.3 Design Inspiration

This was done with the intent of promoting safety at Jewellery and metalsmithing workshops. The design inspiration was derived from five objects namely, **Gankogui (Double Bell)** as shown in Figure 17, **Egg shape** as shown in Figure 21 (A), **Umbrella** as shown in Figure 15 (A-C), **Motor Gears** as shown in Figure 8 and **Horn inspiration** as shown in Figure 12. These were chosen based on their daily functions in the lives of workers. They also represent a mouth piece for conveying deeper abstract meanings of safety symbols. The researchers took into consideration the designing of suitable back frame that will allow the art piece to stand out in order to maximize it potentials in promoting safety. The design process continued with accurate drawing of outlines developed out of the sketches, with the help of CorelDraw graphics designing software. This was done to help get accurate dimensions or guide during fabrication. After these outlines were developed, there was the need to see how the final piece will look like in 3Dimensional view and with the help of a modelling software it was modelled. Thereafter the Keyshot5 rendering software was used in giving the various layers of the model a finishing material rendering. This brought the modelled ideas to life graphically.

2.3.1 Motor Gears Design Concept

Railway Technology (2017) states that gears or cogwheel is a rotating machine part having cut teeth, or cog, which mesh with another tooth part to transmit a torque. Geared devices can change the speed, torque, and direction of power source. Volkov and Copyrights @Kalahari Journals

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Babichev (2014) also writes that elements of the theory of mechanisms and machines, including gear units, begun to develop inseparably with the mechanics, starting with the construction of the pyramids in ancient Egypt, and may have been even earlier. Mankind has been using gears for several thousands of years. In ancient Egypt they were also used in irrigation systems and in their daily activities to make work easier. In this research it represents the ripple effect of workshop accident from one section of the company or an individual and how linked up we are in terms of being in the same working environment. Inspirations derived from this object was also explored through sketches, as shown from Figure 9 (A-C), CorelDraw outline and 3D modelling as shown in Figures 10 and 11. The repousse as shown in Figure 30 to 31, aspect of the project begun after getting a fair idea of the finished outcome on paper and all these processes aided in the composition of the art piece.



Figure 8: Motor gear
Source: 1HZ-timing-gears (1) motor gears

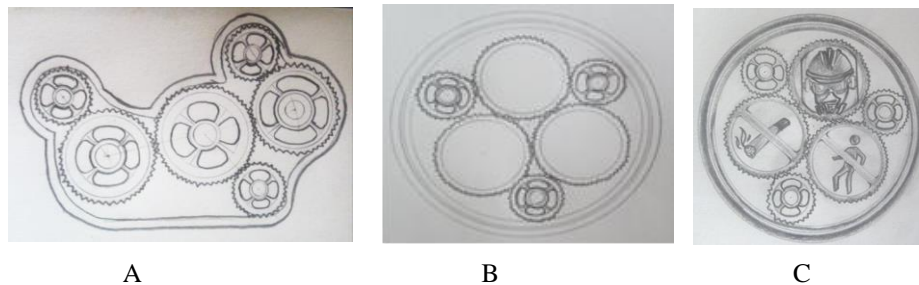


Figure 9: Motor gears concept sketches (A-C)

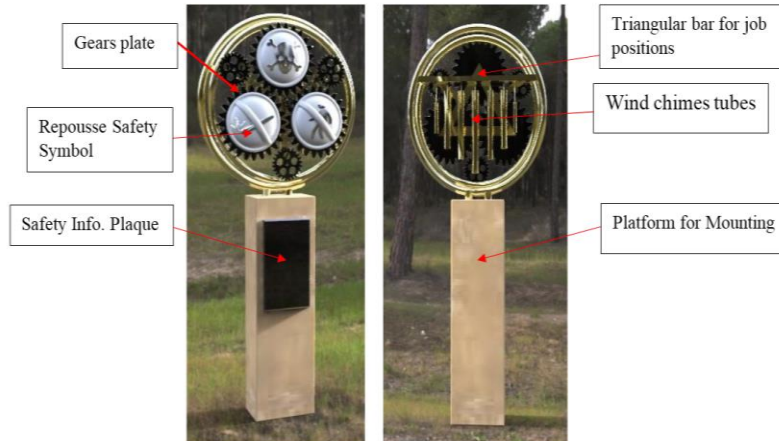


Figure 10: Keyshot 3D rendering of motor gear concept

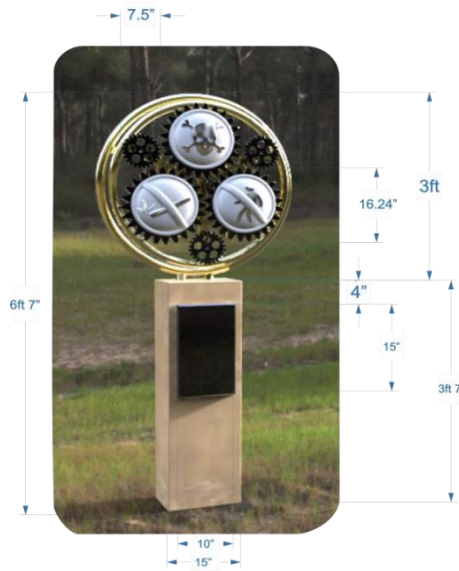


Figure 11: Dimensions of final chosen motor gear concept

2.3.2 Horn Concept

The wild buffalos' Horn as shown in Figure 12 was chosen for its textures and also an inspiration was derived from its general functionality in the ancient times. In history, horns were blown to produce sounds in order to warn the whole town of enemies or danger approaching just for citizens to run for safety. Based on this fact the researchers conceived the idea as an appropriate medium to demonstrate how necessary it is to promote safety in a hazardous environment using horn inspired designs. The horn symbol is called in twi "abeben" as local language of the Ashanti. This horn part of the art piece was formed slightly different from the other ideas above. Figure 13 (A-F) shows progressive sketches of the horn concept. Horn concept was designed to serve two purposes: safety symbol alert and tools shelf at the workshop.



Figure 12: Wild water buffalo

Source: Disney-Animals.Fandom.com

2.3.2.1 Horn concept progressive sketches

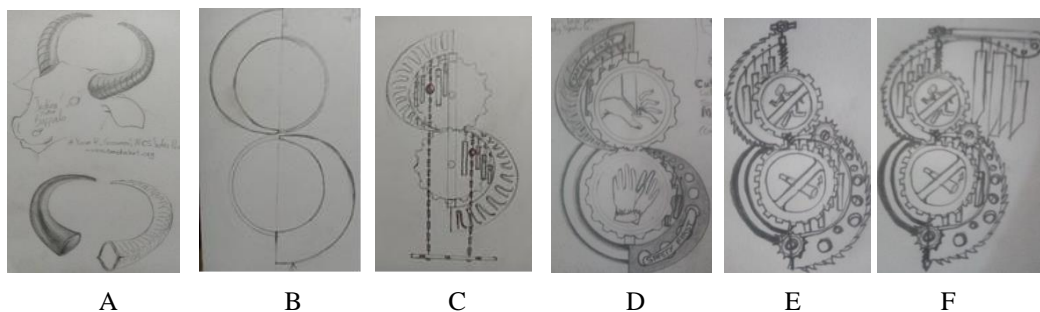


Figure 13: Horn concept progressive sketches (A-F)

2.3.2.2 Horn concept in 3-Dimensional view

After getting the outline from coreldraw, 3D modelling begun with extrusions and organic surface manipulations of the repousse part as shown in Figure 14 (A-B). The Figure 14 (C-D) shows the full view of three-dimensional feel of the finished output with the help of Keyshot5 rendering software.

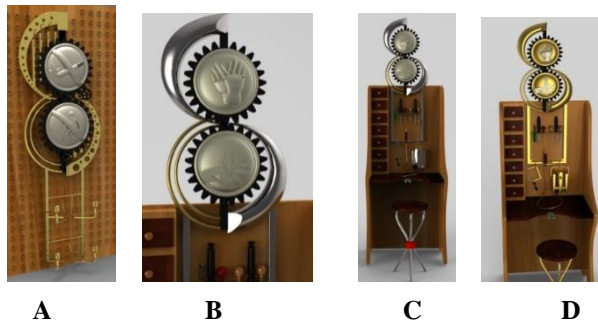


Figure 14: Horn concept in three-dimensional view (A-D)

2.3.3 Umbrella concept

This concept was chosen based on the literal understanding of an umbrella being an object which provides shade. The sun rays are beneficial in our daily activities just as the dangerous machines being used in various workshops but can sometimes be a hazard. The umbrella in combination with the gears in this concept, depict a worker who communicate with safety symbols and automatically comes under safe environment. Figure 15 (A- C) shows coreldraw outlines which served as a dimensional guide during the fabrication process.

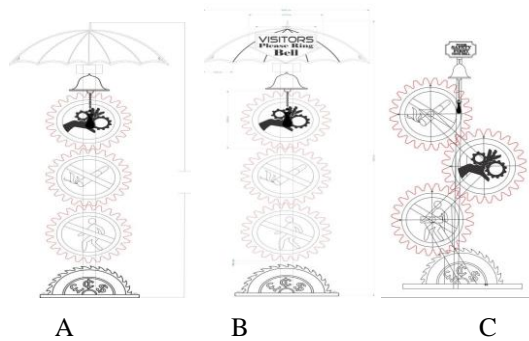


Figure 15: CorelDraw outline drawing of sketches

The rhino software was used in getting three-dimensional feel of the final output before fabrication began. In getting the three-dimensional process to start, the sketches were transported from the CorelDraw outline file to the Rhino5 software interface. It was on these outlines that modelling through extrusions began as shown in Figure 16.



Figure 16: Rhinoceros and keyshot 3D design of gear concept

2.3.4 The Gankogui concept

2.3.4.1 Double bell

The locally made musical instrument, named the Gankogui or Gongong as shown in Figure 17, is used by most of the local indigenes especially the Ewes, Ga, Krobo and Akan tribes during festivals as an accompaniment with other instruments. It was also used in drawing attention of villagers in order to get the chief or kings' message across the township. This device is made from iron and comes in various sizes. When struck with a stick, it does produce a sound like “gang” and “gong” (Helen, 2017). It is assumed that its name was derived from the sound it makes when struck. Inspirations picked from this object was further developed through sketches as shown from Figure 18 (A-D) to aid in the composition of the conceptual art piece.



Figure 17: Gankogui (double bell)

2.3.4.2 Gankogui Concept progressive sketches

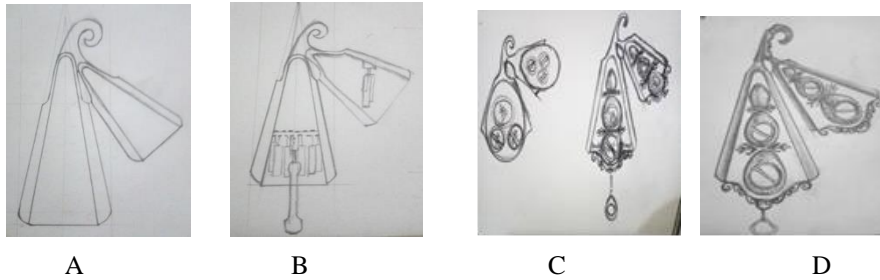


Figure 18: Gankogui sketches (A-D)



Figure 19: KeyShot rendering



Figure 20: Front close view of brass model

The ideas shown in figures 19 and 20 were modelled in several colours in order to make it easier when assigning different materials during the KeyShot material rendering. The KeyShot rendering software has a lot of materials that can be used on a model, ranging from liquids to any solid element on earth. Based on this wide variety of options, the researchers chose to render the model in three types of metal that are common to identify. These metals were the aluminium, copper and brass.

2.3.5 Egg Concept

The Egg is naturally delicate, yet it is considered as a source of life worldwide. Based on its familiarity in terms of daily use, the researchers thought it wise to include it in order to draw attention with ease and also to have a deeper impact on the user's mind. Inspirations derived from this object was further explored through sketches, as shown in Figure 21 (A-C) to aid the composition of the art piece.

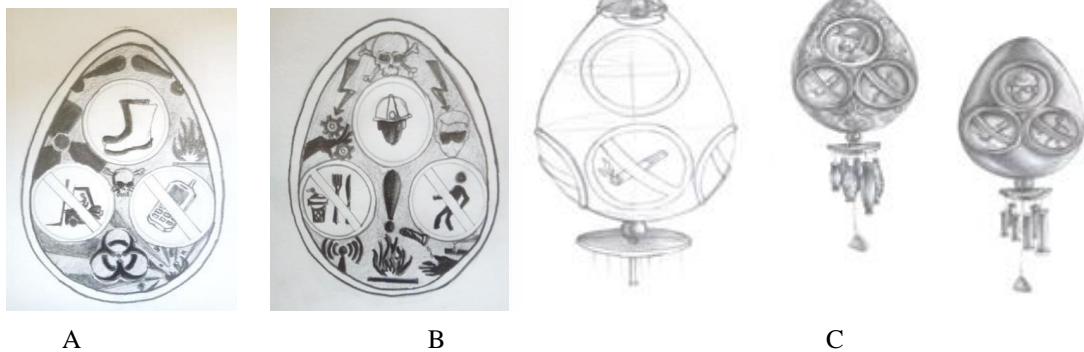


Figure 21: Egg shape concept (A-C)

2.3.6 Chimes Concept

The wind chimes as shown in Figure 22 on the other hand as described by Feng (2017) is a wind-compelled, sound inducing sculpture piece, that has a long and varied history — dating back to old Asian culture where rattle of dried bones hanged in ancient gardens to scare away birds. Chimes were also placed on early ships to alert crews in noticing a wind change. Inspirations picked from this object was further developed through sketches as shown in Figure 23 (A-E) to aid in the composition of the conceptual art piece. The various sketches made are shown below.



Figure 22: Chimes

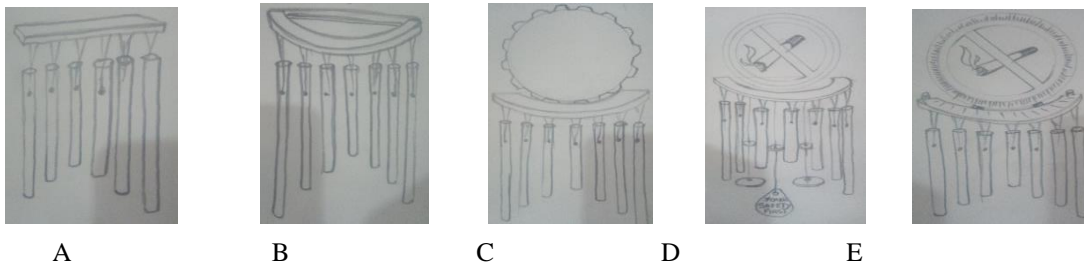


Figure 23: Metallic chimes concept (A-E)

2.4 Materials, Tools and Equipment

This section deals with the materials, tools, equipment, and methods employed to fabricate the repousse and chase safety symbols.

2.4.1 Materials used

The researchers opted for the aluminium sheet as the material fit for the technique because of its affordability and reasonably good working properties. Copper even though having more superior working properties was not selected because of its high cost. The whole process began with the purchasing of galvanized iron round pipes ($3/4$), flat bars (1 mm), round rod, electrode, bolt and nuts, metal to metal glue, paper, wood and alsphatum.

The chosen designs were printed out on an A4 sheet paper with a white background as shown in Figure 24. This is the known medium for transferring a design unto a metal sheet. White glue was used to stick the paper onto the metal surface.



Figure 24: Designs on paper

Wood as shown in Figure 25 was also used in giving support to the back of the design being traced. Alsphatum chunks were melted and used as a pitch to hold the repousse in place as shown in Figure 26.



Figure 25: Wood slab support for chasing



Figure 26: Asphalt chunk in pitch box

2.4.2 Tools and equipment used

The tools used in executing the work were: chasing tools, chasing hammer, pitch box, sand bags, pliers, metal ruler, shears, tweezers, files (smooth and rough), adjustable jewellers saw frame and blades. Corwin (2010) states that, mallets are hammer-like tools that move metal sheet surface without thinning it. Over the centuries these have been made from wood, animal horns, and leather. Rubber mallets are great to use with both metal and wood repoussé punches.

The necessary equipment used during the study included: anvil for straightening the bent corners of the repousse, fire forges for annealing the sheet. Gas cylinder was used for powering the blow torch, to enable focusing flames on metal sheet during annealing, welding equipment for joining the cut metal pipes, surface grinder machine for grinding off bumps in order to obtain a smooth surface and spraying machine also for giving the fabricated work piece a finish, the drilling machine, chop saw machine and bending equipment were also used.

2.5 Fabrication Processes

This basically talks about how the chosen ideas were built based on cutting, bending, joining through welding, riveting, grinding, applying of filler, sand papering and the spraying of the final piece. The fabrication process had two parts namely: the repousse of aluminium sheet process and the welding process (Iron rods & Pipes). The fabrication of each idea chosen began with the repousse process and then followed by the welding. In all, three ideas were fabricated out of the five generated.

2.5.1 Repoussé Process of the Motor Geared Concept

In preparing of the aluminium metal sheet for repousse, it was cut to the size of the design as shown in Figure 27(A) and then annealed to a malleable state or easy to work with as shown in Figure 27(B). The annealing process was done using a blow torch with heat of temperature about 300°C on the aluminium sheet.

2.5.2 Annealing Process

The annealing process made the metal soft enough, such that it was pushed without a tear on the material surface. This was done in order to help manipulate the surface easily with punches to create that three-dimensional feature. Immediately after the annealing, the metal was left to cool and from there the printed design was glued to the metal sheet.



A



B

Figure 27: Annealing of the aluminium metal sheet

2.5.3 Tracing of the Safety Symbol Outline with Chasing Tools

The tracing of the design began with gluing of the printed design onto the metal sheet surface as shown in Figure 28. The corners of the metal sheet were nailed to a wood slab to stabilize it as shown in Figure 29.



Figure 28: Glued design on metal sheet



Figure 29: Nails for corners of metal to wood

After that, the tracing process began with the help of the chasing hammer and tracing tool. The chasing hammer was used in hitting the tracer punch fixed in line with the outlines of design on the metal sheet as shown in Figure 30. The next thing after chasing the surface was to examine from the back (shown in Figure 31), whether every outline had been traced out clearly enough before burning off the glued sheet. The next process was to hit it from the back.



Figure 30: Chasing of glued designs



Figure 31: Back view of chased outlines

The glued outline designs on sheet were burnt off as shown in Figure 32, and the work piece was then fixed in a pitch box filled with asphalt. The burning off was done to get rid of glued sheet and also to anneal the metal sheet. The fixing of the metal sheet in asphalt as shown in Figure 33 was done to keep the sheet stable and to receive the hitting impact from the back during repousse. In order to move metal at the point of contact without sinking the surrounding area, there was the need to have a supportive, yet elastic material. The material needed to grab onto the metal while it was being worked. Pitch and wood slabs satisfy these needs, which is why metalsmiths and jewellers use it to support everything from large sculptures to small objects. The versatility of pitch enables artists to raise forms and chase details in metals as diverse as aluminium, copper, silver, and gold (Corwin, 2010). In the case of this research, an asphaltum was used because of the availability of it on the market, even though there were other types like northwest pitch works and red German in the system.



Figure 32: Burning off chased design



Figure 33: Fixing chased design onto pitch

At this stage the metal sheet had cooled down and was ready to receive punches from the wooden mallet and repousse tools. The image in Figure 34 shows the hitting from the back using an improvised wood tool, while the other in Figure 35 shows the front view of the repousse removed from the asphalt.



Figure 34: Back view of repousse design
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Figure 35: Front view of repousse design

In order to get rid of the blackish surface on the repoussé sheet, the annealing was repeated and after getting a clear surface as shown in Figure 35, the design was pierced out with jewellers saw frame as shown in Figure 36. The number of pierced out designs are shown in Figure 37 and 38 (A-D).



Figure 36: Piercing out of repousse



Figure 37: Latter stages of pierced out repousse symbols



A B C D

Figure 38: Unsprayed finished repousse safety symbols (A-D)

2.5.4 Welding Process of Frame (Motor Gear Concept)

The welding process began with the bending of galvanized round pipes into circular shape using the bending mill as shown in Figure 39. The circular metallic frame served as a foundation on which all other parts of the work were welded.



Figure 39: Bending of galvanized pipes on a bending mill

The circularly shaped bent pipes were welded to straight round pipes at the upper section of the circle. That was done with the help of electrode rods and welding machine as shown in Figure 40.



Figure 40: Welding of galvanized pipe joint

After getting the desired shape of the metallic frame, the rough and bumps on joints were ground with the grinding machine as seen in Figure 41.



Figure 41: Grinding off bumps on joints

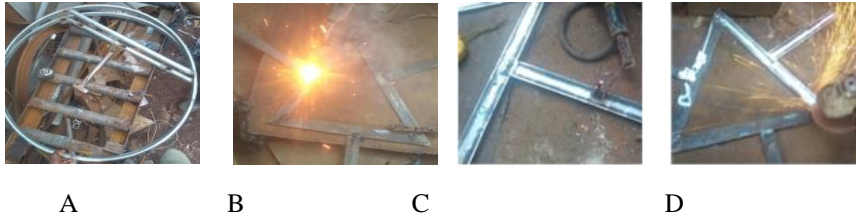


Figure 42: Welding the flat bars (A-D)

The final welded piece of the circular and cross pipes is shown in Figure 42 (A). The triangular shaped flat bar (to be welded between the two circular welded pipes), was formed by cutting and welding pieces together as shown in Figure 42(C). Rough joints were ground using the grinding machine as shown in Figure 42(D). The gear symbol was also pierced out using the jewellers saw frame as shown in Figure 43(A) and added to the main frame through a bolt and nut locking mechanism. The various parts of the whole safety conceptual art piece were assembled together as shown in Figure 43(B and C). It was then sprayed in gold and black paint as a finished piece as shown in Figure 44 and 45.

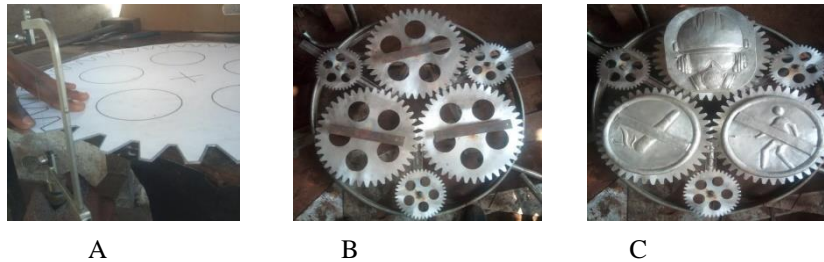


Figure 43: Assemblage of gear concept after welding (A-C)

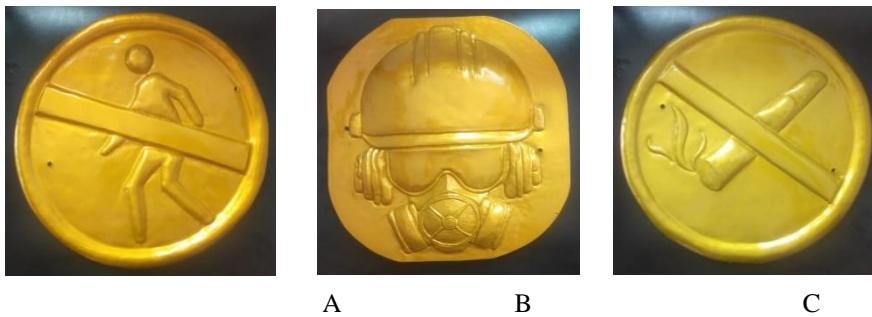


Figure 44: Sprayed surface of repousse design (A-C)

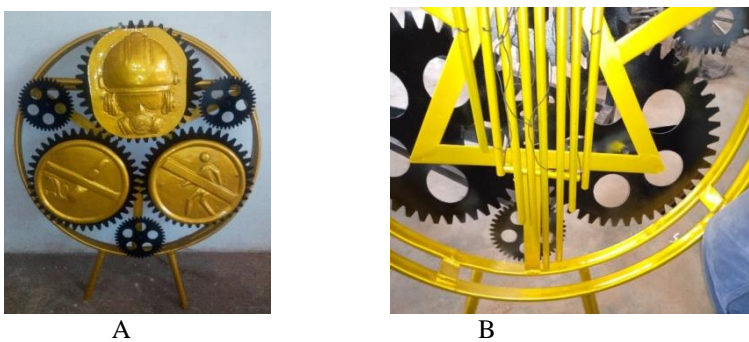


Figure 45: Assemblage of final gear concept (A-B)

2.5.5 Gears Under Umbrella Concept Fabrication

2.5.5.1 Repousse Process

This particular circle shaped repousse is 12 cm in diameter, smaller than the ones in Figure 30. Its size was reduced because it was meant for the door and before one opens a door, he or she might have been close enough to see these symbols clearly. All accessories of this conceptual piece were fixed on a metallic frame which helped in getting the whole piece fixed on the door.

The conceptual art had its final repousse part rendered in silver shine hair-like dust as shown in Figure 46 (H-I). Enamel spray was used on its surface to create contrast. Apart from this minor addition of enhancement, all the process shown in Figure 46 (A-G) was done just like the repousse processes described earlier.

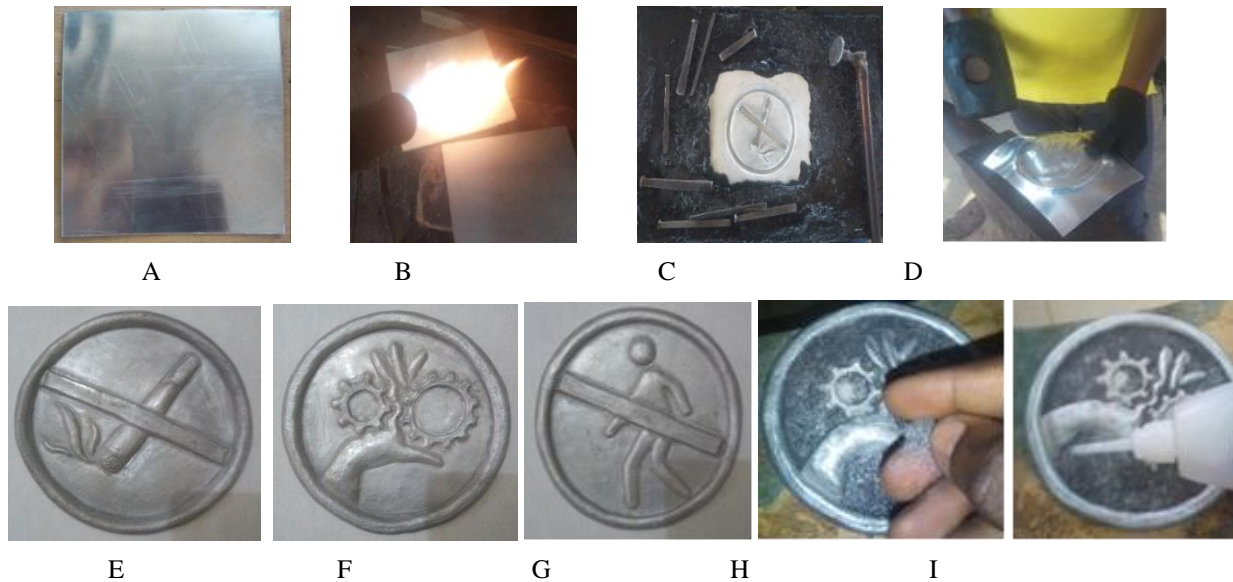


Figure 46: Repousse process (Gears under umbrella concept) (A-I)

2.5.5.2 Welding Process of Gears under Umbrella Concept

The fabrication of the gears under umbrella concept was done to support the gear disk, repousse symbols and the hanged bell involved. It began with the cutting and bending of rods as shown in Figure 47 (A-C).

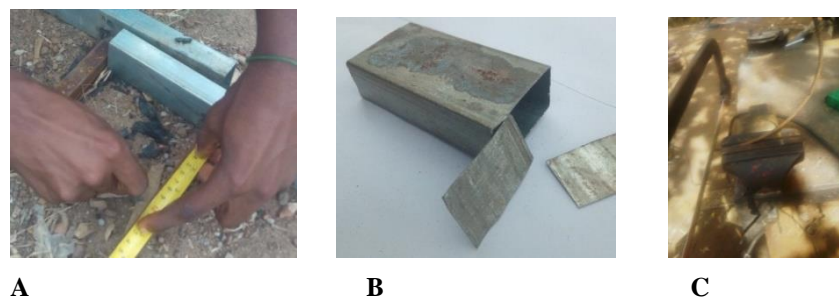


Figure 47: Cutting and bending of rods (A-C)

The Figure 48(A) shows the checking of alignment before welding the various parts. The checking was done with a L-Square rule and the joining done using electric arc welding, as shown in Figure 48(B). The welding of the various parts continued until the skeletal structure was formed as shown in Figure 48 (C) through to Figure 49 (A-B).

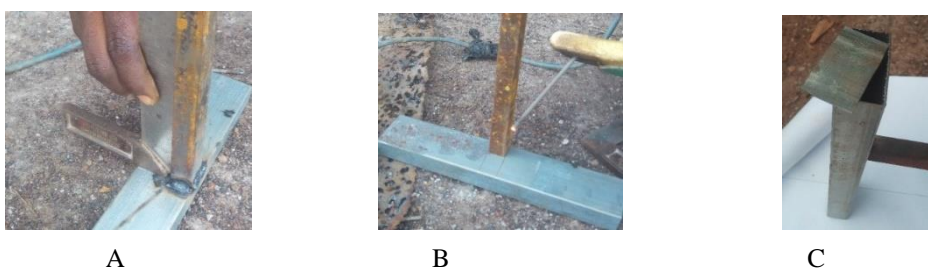


Figure 48: Checking of alignment before welding (A-C)

After that the body filler was used in covering the dented edges as shown in Figure 49 (C), then sand paper was used on the dried body filler to give it a smooth finish as shown in Figure 49 (D-E). That was necessary in order to get a smooth surface after spraying as shown in Figure 49 (F).

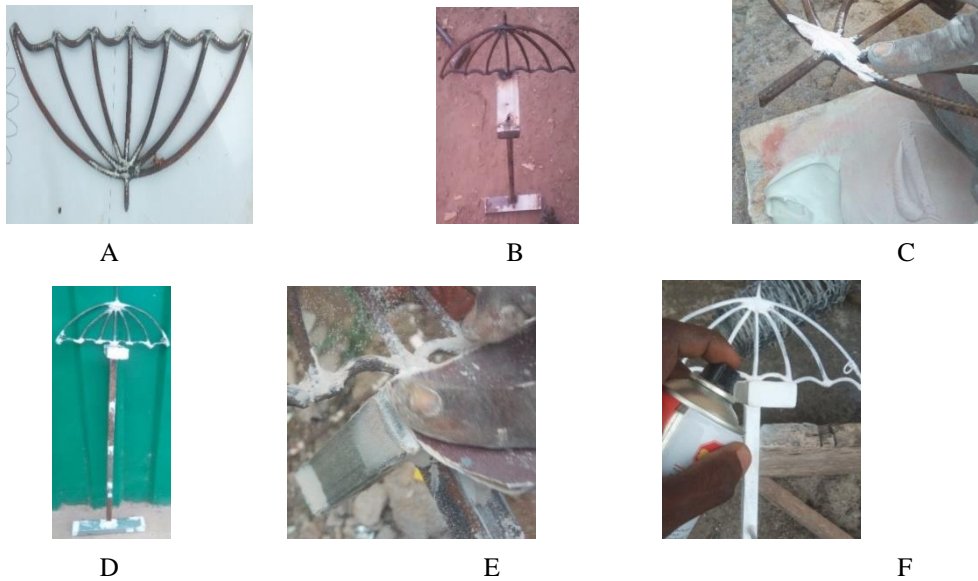


Figure 49: Getting smooth surface after spraying (A-F)

Finally after the sanding process, the whole body was first sprayed in white followed by the final orange colour as shown in Figure 50 (A). The choice of orange colour was informed by standard safety requirement used in cautioning. Figures 50 (A) and (B) show the spraying process and the sprayed piece (umbrella structure) respectively.

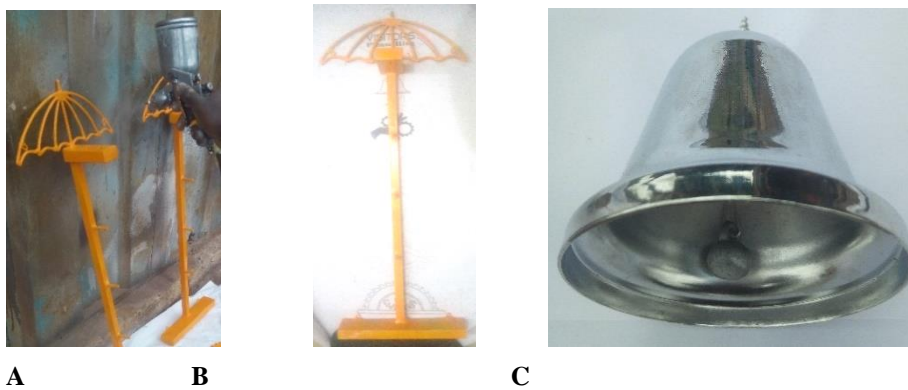


Figure 50: (A) Spraying process (B) Sprayed piece (C) Bell

All other accessories which included the bell shown in Figure 50 (C), the gears and the repousse symbols were assembled on the skeletal umbrella frame to complete the piece. The final piece is shown with different backgrounds in Fig. 51.

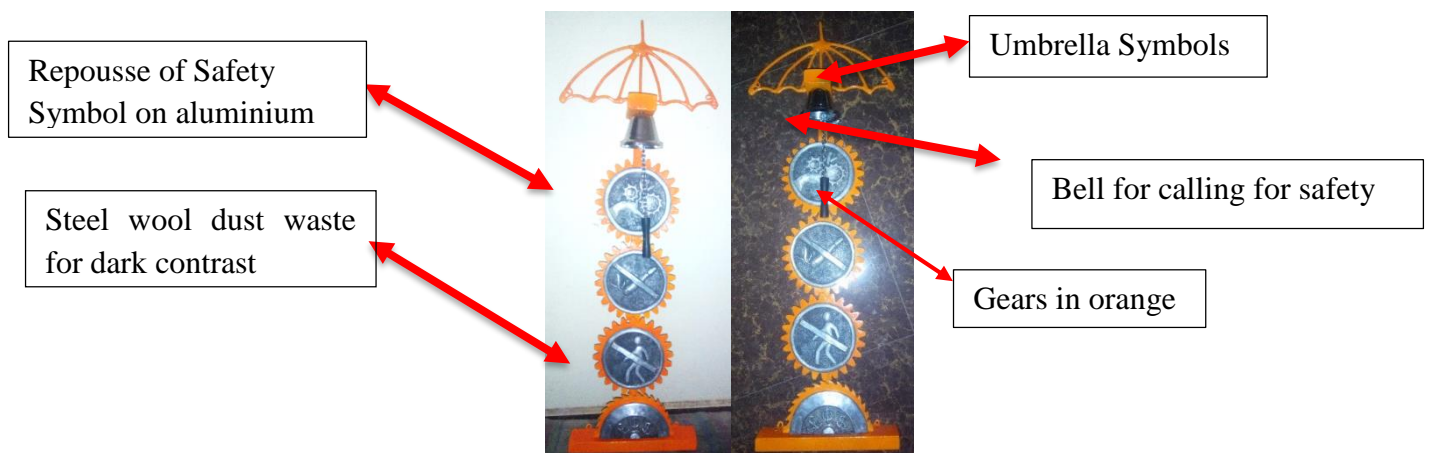


Figure.51: Finished piece (Gears under umbrella concept)

2.5.6 Horn concept fabrication process

The gears to be fixed beneath the repousse part was the first step to the fabrication aspect. First, the design was pasted unto the surface of the perspex material and with the help of Jewellers' saw, the gears pattern was cut as shown in Figure 52(A-C).

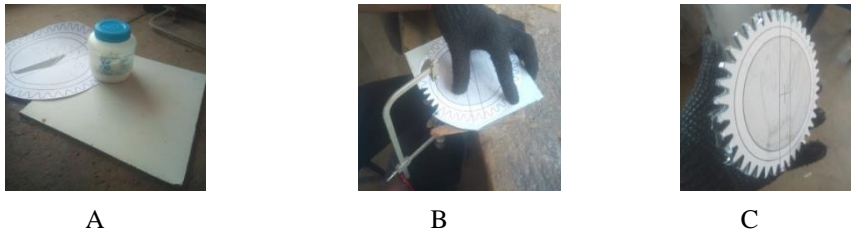


Figure 52: Horn concept fabrication process (A-C)

2.5.6.1 Repousse Process of the Horn Concept

The repousse part of the horn concept began with annealing of the aluminium sheet, after which the horn design was glued to the surface and chased separately as shown in Figures 53(A) and (B). After tracing the outlines, the glued sheet was burnt off to give way for the repousse process as shown in Figures 53(C) through to (I).

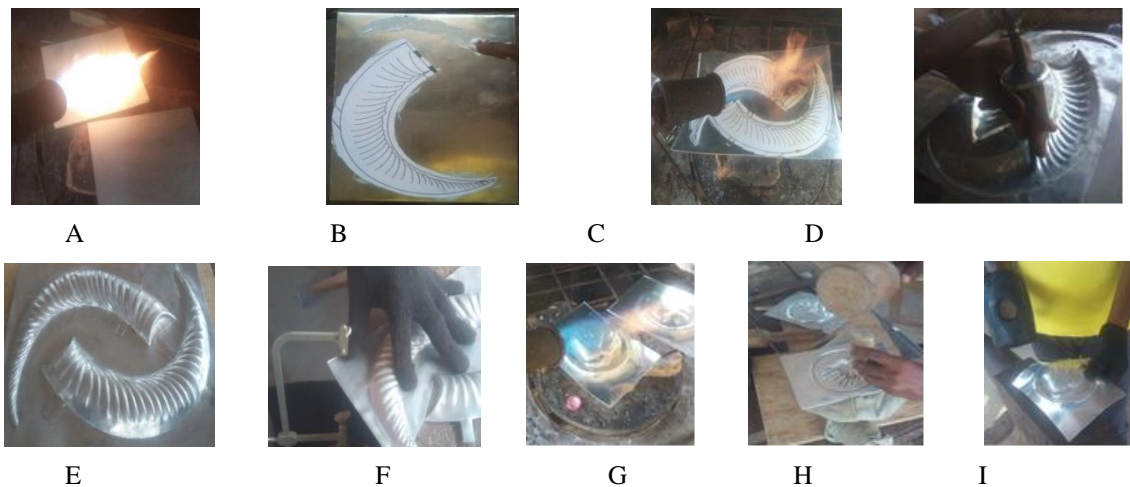


Figure 53: Repousse technique process of horn concept (A-I)

The wing like flaps in Figure 54(A) was bent over slightly as shown in Figure 54(B) before fixing them on the metallic frame as shown in Figure 54(C). That was done to help fix the repousse accurately and with ease. That was followed spraying.



Figure 54: Locking mechanism for the horn to be fixed on the skeletal welded frame (A-C)

2.5.6.2 Fabrication process of the horn concept (back frame)

The forming of the back frame of the horn concept commenced with the bending of a one-inch-thick rod and cutting of square pipes as shown in Figure 55 (A-C).

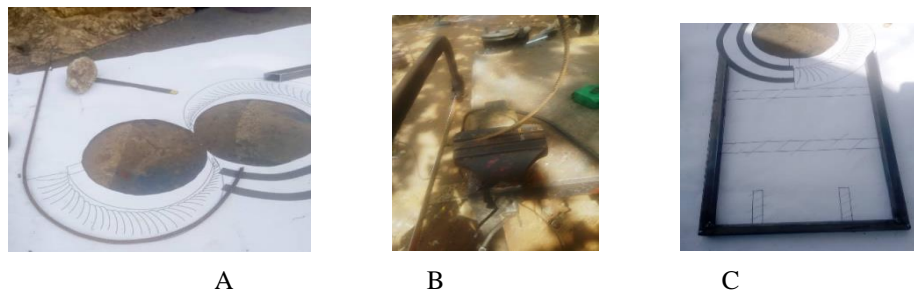


Figure 55: Fabrication process of the horn concept (A-C)

2.5.6.3 Welding Process for the Horn Concept

Joining of the square pipes cut earlier was accomplished by means of arc welding as shown in Figure 56 (A-C). The bolt and nuts were fixed on the gear disc to serve as a locking mechanism as shown in Figure 56 (C) circled in red. That was also welded and excess bolt length was ground off with the hand grinding disc machine as shown in Figure 57 (A).

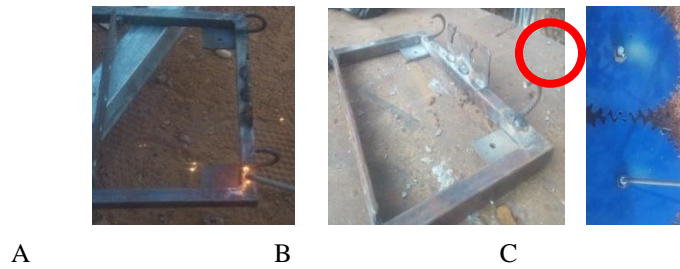


Figure 56: Welding of Joints (A-C)

The welded joints of the main frame for the horn concept were ground, followed by application of filler and sanding as shown in Figure 57 (B-C).

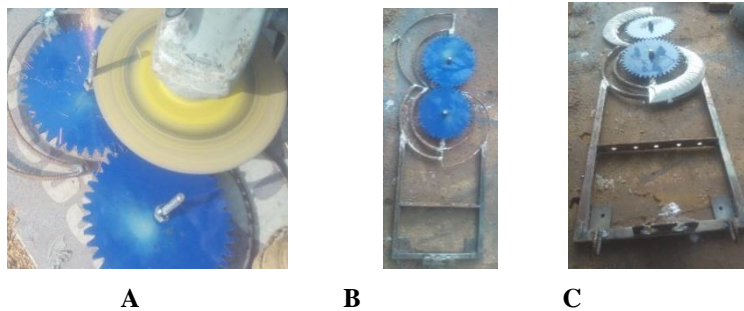


Figure 57: Different fabrication stages (A-C)

2.5.6.4 Finishing of the Horn Concept

The horn and the tool shelf parts of the piece were sprayed in gold as shown in Figure 58 (A-B) by means of a spray gun as shown in Figure 58 (A). The gear part was sprayed in black as shown in Figure 58 (B) to project the repousse (horn part). The final piece (horn concept) is shown in Figure 59, with some working tools mounted in the tools shelf.

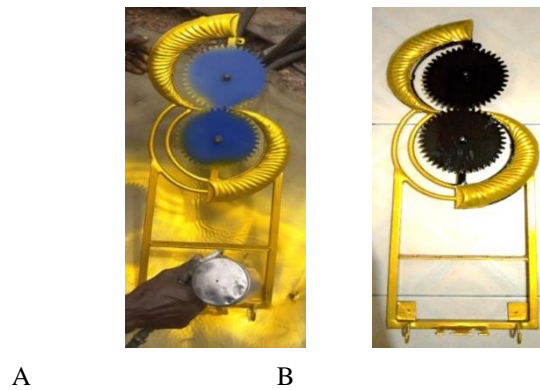


Figure 58: Spraying Process



Figure 59: The final horn concept (sprayed)

3.0 RESULTS AND DISCUSSION OF FINDINGS

This section, gives all detailed findings obtained during the production processes. The findings were based on the outlined objectives. A detailed appreciation of the work was touched on with regards to the finished works. In studying the existing workplaces' safety signage within the jewellery and metalsmithing workshop, the researchers sought to find out what safety signage meant through personal visitation to workshops, articles and books written on it. The researchers found out that every workplace using tools and equipment needed safety symbols as an access rule for engagement and this is an obligation by law. These rules are what have been illustrated in a text-based graphics. For example, prohibitory act such as "No smoking" as shown in Figure 6 (A), has been designed in silhouette cigarette figure with a red bar crossing it out depicting no smoking in such an environment. These rules are put in place to prevent explosions which could amount to loss of all kinds of company resources. Interestingly, even though it is a life and death issue, workers in these local industries tend to ignore safety signage put in place based on certain factors like poor visibility of signs, positioning and material state after years of use and complacency. These factors put the life of workers and even equipment life span in danger and even families and those depending on the workers. It is based on these safety issues that safety rules are to be held in high esteem in every situation. Asumeng et al. (2015) indicate that Ghana allocates money for casualties in workshops, but these funds could be saved for other purposes if only we promote safety through art works such as the conceptual art in Figure 45, 51 and 59 on daily bases.

3.1 Findings

1. Safety symbols are categorized into four by the International Standardization Organization (ISO) in Figure 1 (Prohibitory, Mandatory, Warning, Safe condition).
2. Per the research made, common materials known for making safety symbols are; plastics sheets, stickers, metal sheet and Photo luminescent materials.
3. Daily safety checks in most local jewellery and metalsmithing workshops are not practiced per the observation made by the researchers.
4. In a visit to some jewellery and metalsmithing workshops in Kumasi and its environs, complacency among others, are key factors in ignoring most safety symbols in these local industries.
5. The effects of neglecting a safety symbols' information have long and short-term impact on human lives. This fact is based on observation from various campus studios and jewellery and metalsmithing workshops visited.

With objective one in focus, an art piece that incorporates safety symbols and sound was created in order to promote safety symbols daily within the working environment. A number of relevant safety symbols to the study were chosen for the design process based on the type of work done in the workshop. Conceptual designs were developed through progressive sketches from inspirational items as shown in Figure (8, 12, 17, and 22). These items were picked based on their daily functionality and also familiarity to the workers. The intensions behind these choices were that through these composed pieces, workers could relate better and be informed to promote safety among themselves in the working area on daily basis. One of the art pieces, the Gear concept shown in Figure 45 conveys a message of ripple effect of unsafe practices in the work area. Another one also informs you to announce your presence through a bell fused to safety symbols. The Gears under umbrella concept as shown in Figure 51 also help seek attention when vulnerable in a busy environment. The last one also promotes safety by incorporating safety symbols into the design of a tool rack, (Horn concept, Figure 59). The incorporation of chimes and safety symbols into a conceptual art piece was meant to enhance the of promotion safety.

3.2 Findings

1. Design must always have an inspiration such as shown in Gear concept in Figure 45, in order to communicate deep information.
2. Proper Designs must be different yet having traces back as shown in Figure 59, to the former in order to probe questions within the minds of its users.
3. Having in mind the sizes of materials and equipment needed for certain techniques during the design process, also help achieve accuracy in the fabrication processes. Challenges posed by the fabrication processes were due to the fact that, petty items like the screw sizes for fixing works on a wall, as shown in Figure 51, were considered a bit late in the design processes.

3.3 The Fabrication of Selected Ideas

After settling with these three design concepts as shown in Figure (8, 12, 17, and 22), the fabrication processes also began with purchasing of materials involved. Aluminium sheet was used for the safety symbols using the repousse and chasing techniques and also various square and round pipes were cut to measurement and joined together through welding. The welded part served as a supportive back frame on which all repousse works were mounted. A part like the gears made up of aluminium sheet went through piercing using the jewellers saw. This process was difficult due to the design concept but at the end gave an accurate cut piece. The safety symbol made using the repousse and chasing techniques received much attention since it was going to be the main point of focus in the whole composition. In order to achieve this, a steel wool was first used in giving the surface polished finish appearance. Afterwards they were sprayed according to standard safety symbol colours for it to have a link with the current ones in the system.

3.4 Findings

1. Listing out materials to be used informs the kind of tools and equipment to be used therefore making one to work within means.
2. Sometimes knowledge about materials, prevent certain component damage within the work process. For example, the locking of alucobond material as shown in Figure 56 (C) between bolt and nuts through welding posed a challenge of not welding too close due to fear of 'alucobond' melting.
3. When fabricating a piece, one must be opened to new and efficient ideas. Galvanized pipe was the initial material proposed for the chimes in Figure 45 (B) but because of its heaviness in relation to steel pipe, the researchers chose to use light weight steel pipe instead. The result these steel pipes gave when chimed, sounded amazing as compared to the galvanized pipes.
4. Conveying and positioning of the fabricated art piece must be factored in right from the beginning to prevent one from evitable damages during movement of the whole piece.

3.5 Appreciation

3.5.1 Motor Gear Concept

The motor gear concept was named after how gears work according to a torque. One gear disc rotates and automatically influences all the others to move. This fabrication conceptualized the worker or working environment to relate with how gears work generally in a machine. The intent of this work is to promote safety through daily encounter. The Motor Gear Concept functions as a mounted signage which will be encountered daily before entering the working environment. This metal art piece stands at 3 feet tall without the pedestal and 6.7 feet tall with pedestal. Each gear measures 16.24 inches in diameter and the aluminium repousse of safety symbols, 13 inches in diameter. The aesthetic features of this art piece appear in gold and black. The gold spray paint symbolizes the value of safety in every work place just as money is of value in every production. The black sprayed gears also depict the repercussion of the actions of each worker in a workshop. The third part which is in the shape of a triangle was sprayed in gold too, and also depicting how safety issues should be valued and practiced right from the top-ranking members at the work place to the least person in the Jewellery or metalsmithing shop. This is in relation to a triangular flow of power from the apex to the base. Pipes of different sizes were fixed on the backside to chime when wind blows to draw attention while in the busy working environment.

3.5.2 Horn Concept

The Horn in ancient times had a lot of purposes; the main one on which an inspiration was picked from is the use of it as an instrument for announcing safety. Horns were blown to alert citizens to run for safety when a city was attacked. In the designing of this art piece through to the fabrication, the horn remains an intergral part of the whole. The horn being positioned on the side of the safety symbols and gears signifies the need to promote safety right from the picking of a tool to the laying down of it. This is the reason why it has been fixed together with a tool rack. This horn concept art piece stands at 30 inches tall and 11 inches wide. It consists of two aluminium repousse of horns, two repousse of safety symbols, gears and a tool rack. The horn and safety symbols were sprayed in gold paint to depict the level at which safety is valued and needed to be promoted through daily encounter with tools at jewellery and metalsmithing workshops. This was done with the notion that high value is accorded to gold resource in any part of the world. The gear disk was sprayed with black to depict the ripple effect of accident in the jewellery and metalsmithing workshops as said earlier. Beneath this symbolic signage is a tool shelf or rack fused to it. This was done to promote safety consciousness at work through fusion of tools to safety symbols.

3.5.3 Umbrella Concept

This Umbrella concept is based on the principle of protection, where one obeys access rules (Safety symbols) and automatically comes under the Umbrella of safety. At various local jewellery and metalsmithing work places, most of the workers do not comply with safety rules and out of complacency go on with their work until an accident happens then they now think of safety. This art piece is meant for the door and to be encountered before entering the work area. This will benefit both workers and visitors in the busy working environment. The work stands at 30 inches tall and 12 inches wide. The back frame on which the umbrella sits and the gear disc on which other accessories were built was sprayed in orange to conform to standard safety warning signs. With this particular aluminium repousse of safety symbols, the surface was finished with waste particles from steel wool which was used in polishing. It was later sprayed with glossy shine substance to maintain the actual aluminium material.

3.6 Aesthetics

The surface appearance of aluminium is stunning when finished up with glossy spray as shown in Figure 46 (C), but the researchers decided to explore using a bright coloured spray for the finishing as shown in Figure 58 and it gave a nice attention craving look as compared to raw aluminium glossy finish.

Fusion of safety symbols and tools shelf as shown in Figure 59, (horn concept) raised concerns such as why a tool rack which usually stands separated is now fused to a safety symbol. However, the combination is intended to fulfil the attention craving part of the second objective.

4.0 CONCLUSION

Safety issues in jewellery and metalsmithing workshops within Ghana and around the world are, to a large extent, compromised. The problem is believed to be the result of complacency and negligence as observed from various workshops within Kumasi and around the world. A lot of major and minor accidents happen each day in such workshops but are ignored. The research was motivated by the desire to draw attention to the urgent need for stakeholders to be more conscious of safety in the workshop through conceptual art with the ultimate aim of promoting safety. Repousse and chasing as an art technique known by most of the Jewellery and metalsmithing workers was used in promoting this agenda. This art technique was used on an aluminium sheet with standard safety symbols being the main focus.

The outcome of this studio-led research has shown that repousse and chasing techniques together with others such as the welding technique can be used in building a conceptual art piece which promotes effective communication of workshop safety through both aesthetic and functional means. The researchers can boldly say now that, several pieces of repousse can be reproduced easily with accuracy and less time as compared to the older method in the jewellery and metalsmithing studio.

The conceptual way of building these safety symbols with art in tuned procedures has added to the body of knowledge by giving an alternative medium for conveying safety message in a working environment. Wind chimes fixed into the safety symbol has added up to the standard way of craving attention towards safety information as compared with the modern technological devices on the market.

5.0 RECOMMENDATIONS

The following were the recommendations made which were categorized under two main topics;

5.1 Academia

The issue of safety in jewellery and metalsmithing workshops in Ghana seem not to have been given the needed attention over the years, there is therefore the need for the problem to be researched in different angles including the psychological aspect, just as this study has explored same through conceptual art, the results of which will help inculcate safety consciousness into workers, right from the handling of tools to the shutting down after the days' work.

The researchers recommend to the Metal section of the Industrial Art Department of KNUST and Dr. Hilla Limann Technical University and all other institutions involved in metal art to work towards modernization of these ancient but still relevant metal forming methods. This, the researchers believe can rebrand the repousse and chasing techniques making it more attractive to the current generation.

5.2 Local Artisans

The researchers encourage the local artisans of Ghana to explore the potentials of repoussé and chasing techniques in satisfying the needs of other institutions outside the art community. The researchers believe this would showcase and create ready market for such products abroad.

The use of repousse and chasing should not be limited to the making of jewellery and decorative pieces but should be pushed beyond boundaries into areas such as architecture and the welding and fabrication sub-sectors of the Ghanaian construction industry.

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