INTERVENTIONAL APPROACH TO PLAQUE DESIGN IN GHANA; TAFO CEMETERY FOR A STUDY

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By

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A thesis submitted to the School of Graduate Studies,

Kwame Nkrumah University of Science and Technology, Kumasi in

partial fulfilment of the requirements for the degree of

MASTER OF PHILOSOPHY IN PRODUCT DESIGN TECHNOLOGY

Faculty of Art

College of Art and Social Sciences

June, 2016

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DECLARATION

I hereby declare that this submission is my own study towards a Master of Philosophy in Integrated Art (Product Design Technology) and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any degree of the University, except where due acknowledgment has been made in the text.

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ABSTRACT

Plaques have been used in Ghana for many years. They have been used to commemorate buildings, monuments and the dead. In spite of the numerous purposes they serve and their usage in the country, it is one of the profitable local industries that much attention has not been given to. The advocacy for developing small scale industries to reduce unemployment rate in the country is of paramount importance to every nation, which the local plaque industry is no exception. However, a major setback identified in the local plaque industry, specifically on plaques produced at Tafo cemetery is that, "the text on the base material fades easily" debasing the desired effect of the plaque; imperatively, plaque is supposed to last for a lifetime to be able to serve its intended purposes.

Moreover, findings made reveal that no proper research work has been done to study the local plaque industry to explore its avenues to see where it falls short and how it could be improved to support national development and livelihood. The researcher is of the view that developing the local plaque industry in terms of plaque production is another important ground for national development since it is one of the lucrative industries which when looked into will generate avenue for employment for the unemployed graduate artists and also improve the quality of plaque produced by the industry. It is in this light that this research into local plaque industry in Ghana has been done.

The researcher adopted the experimental, descriptive and case study research methods based on the qualitative research approach for the study; this was used to analyze and describe the processes, methods employed to execute the project work as well as the experiments conducted in manipulating the selected materials, processes and techniques adopted through data collected towards the production of the sample plaque(s). The purposive sampling was

employed to select artist or artisans who must have produced a plaque(s) for academic work/project or artists/artisans who produce plaques for commercial purpose. Simple random sampling was also used to select plaque buyers and scrap dealers. Moreover, the researcher used interview guide and observation as data collection instruments for the study. Findings made are as follows:

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1. Aluminium and ceramics can be manipulated creatively to produce plaques
2. Silicone sealant can be used to create permanent text inscription on ceramic base
3. Anodize/painted aluminium can be used to create text that can resist corrosion
4. Metals can be used in their smaller quantities to make them unattractive for stealing

ACKNOWLEDGMENTS

To God be the glory for granting me the knowledge and strength to bring this project to a successful end. I am grateful to Mr. Eugene Padditey who has played a very good supervisory role, and whose interest in the progress of my work led to the successful completion of this thesis. My sincere thanks also go to Dr. J. O. B Boahin for his motivation, time, patience, friendship and also giveng a sense of direction in my work for their knowledge and skills. To my wife Mrs. Bridget Ansah-Asiedu, my mother Cecilia Ofosu, and my aunty Mrs. Gyemebi Ofosu, I say God richly bless you for your financial and spiritual support.

Lastly, I extend my profound gratitude to all friends and colleagues especially Mr. Inkum Pual. May the good Lord richly bless you all.

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CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter shows the framework of the study. It plots the background to the study, statement of the problem, objectives of the research, research questions, delimitations, limitations, definition of terms, importance of the study and organization of rest of the text.

1.2 Background to the study

Plaques have for some time been an imperative piece of humankind's history and customs and in that capacity, they can be considered as society's great equalizer. Plaque can guarantee that each individual on the planet can be remembered for ages simply like the immense pioneers memorialized for the ages with mammoth statues in the likes of Dr. Kwame Nkrumah; first president of Ghana, Nelson Mandela; first black president of South Africa, Okomfo Anokye; an indigenous priest of the Ashanti Kingdom of Ghana. Without such plaque memorials, obviously, the astonishing commitments and contributions of our forefathers may have lost quite a bit of their merited radiance throughout the years. In addition, plaques guarantee that awesome deeds and incredible individuals will never be forgotten, and they give every other people the same opportunities. For instance, plaques give even the humble and mild the hope - like Abraham Lincoln, George Washington, Thomas Jefferson and the world's other awesome Pioneers being remembered for the ages. (Memorial.net, 2004)

In the past the ideologies of cultures in memorialising the dead differ from one culture to the other in the world. These ideologies, spur from the use of modeled figures to carved heads, and to the use of stools. For example, the Melanesians from the islands of Melanesia in the past believed that all aspect of life is controlled by their ancestral spirits; however, in order to

propitiate them, the people memorialize and honour them with ancestral head figures. The Asantes of Ghana on the other hand also use the blackened stool to represent and memorialised their dead kings. It is based on these ancestral stools that new enstooled kings of the Asantes get their enthroned names from.

Today there are many modern memorialising the dead ways of, which ranges from the use of; flowers, plants, houses, plaques, statues, famous places like parks, public buildings, monuments and others. However, the most commonly used at the cemeteries across the world is the memorial plaques. In Ghana the use of these plaques are no exception; plaques have been use to commemorate the dead, monument, public buildings, events, persons, places etc. This has generated a great demand for its patronage and as a result has become one of the profitable local industries to the very few, the industry thrives on the hands of only the local artisans who use same processes, techniques, tools and materials which some of them are today obsolete. As a result, works produced especially plaques have peculiar problems that run through all the plaques found at the various cemeteries in the country. The researcher is of the view that in this era of modernity, technological advancement and industrial adventure, the local plaque industry is seen as one of the untapped areas which needed exploration.

1.3 Statement of the problem

The local plaque artisans got their training and skills through the traditional apprenticeship system which comes with its disadvantages. Coy (2000) opined that: “apprentice is one who learns by participation or observation in a skilled trade”. He further states that, one Japanese expression for apprentice is "minarai", meaning one who learns by observation. As a result, this system comes with its disadvantages. Boahin (2008) opines that, techniques for production are passed from one generation unto another and as a result, the methods for production remain the same for several years. The local plaque industry operates on this same paradigm; techniques,

methods, tools and materials used had remained- the same over the years, which in one way or the other has affected plaques produced. In addition, the apprenticeship system has renders the local artisans' copycats which has resulted in the production of same copies of plaques design format over the years which have become too common, less innovative and looks one way at the cemetery.

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Another major setback identified, is that, "the text inscription on the base material fades easily" debasing the actual function of the plaque.

Figure 1.1: Plaques with the text inscription fading off
Source: Tafo cemetery

Moreover, metals which used to be one of the main sources of materials for producing plaques in the industry seems to have lost its significance, hence its usage being discarded. When probed into, three findings were realised:

1. the metal plaques rust over the years in the cemeteries as result of corrosion forcing most of the bereaved families to replace them later
2. constant increase in the prices of metal as a result of its high demand by other sectors such as the construction and civil engineering companies and others
3. metal plaque theft

Figure 1.2: A metal plaque removed by scrap collectors
Source: Tafo cemetery

The advocacy for developing small scale industries are of paramount importance to every country. Observations and findings made reveals that no proper research work has been done to study the local plaque industry to explore its avenues to see where it falls short and how it could be improved to support national development and livelihood.

The researcher is of the view that, developing the local plaque industry is another critical justification for national advancement since it is one of the lucrative local industries which when investigated could create avenue for the unemployed graduate artists and furthermore enhance the nature of plaque delivered by the local plaque industry. It is in this light that researching into the local plaque industry in Ghana.

1.4 Justification of the Study Area.

It is very common today in Ghana to see memorial plaques spread across the big and small cemeteries in the country. However, due to the large number of cemeteries and the numerous centers known for making plaques spread across the country, the researcher has selected Tafo in the Kumasi metropolis in Ghana for the study. Tafo is known for its plaque production and large cemetery for burying most of the dead in the Kumasi metropolis of Ashanti religion. Moreover, although these cemeteries and plaque making centers as stated earlier are at different locations in the country they share common similarities. These similarities could be seen in the

areas of: use of material; quick fading of inscription on the substrate, metal plaque theft and less innovative plaques produced as a result of master- apprentice form of training, which encourages copying. Memorial plaques are supposed to last for a lifetime in order to serve its intended purpose. As a means of finding solutions to the above problems associated with memorial plaques produced in Ghana, specifically at Tafo; it has been discussed under the heading; interventional approach to plaque design in Ghana: Tafo cemetery for a study.

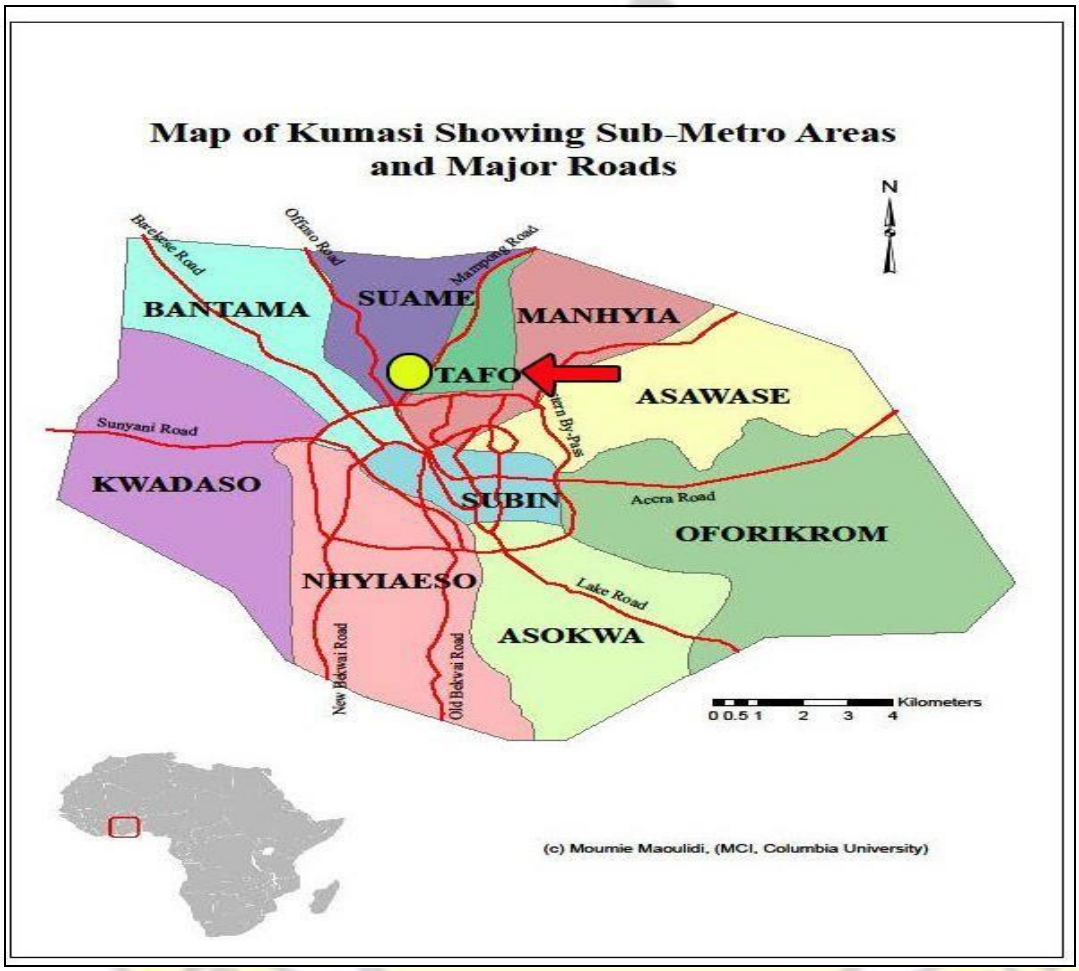

Figure 1.3: The selected area of study indicated on the map of Kumasi Metropolis

Key the yellow circle indicates the location of Tafo.

1.5 Purpose of the Study

To develop alternative strategies to intervene in the problems associated with locally produced plaques at Tafo cemetery.

1.6 Specific objectives

The specific objectives of this study are to:

1. To identify existing locally made plaques found at Tafo cemetery and the causes of problems associated with their production.
2. To explore the existing materials, processes and methods available in order to develop strategies suitable for producing plaques
3. To produce sample plaques based on the study

1.7 Research questions

1. What are the existing types of locally made plaques found at Tafo cemetery and the causes of problems associated with their production?
2. What strategies are there to adopt to minimize the problems of metal theft, metal corrosion and the fading of text inscriptions found on plaques at Tafo cemetery?
3. How can a sample plaque be produced based on the study?

1.8 Delimitation

The research is centred on identifying the types and causes of the problems associated with plaques produced at Tafo cemetery and developing alternative strategies to solve them. The research moreover, focuses on text only memorial plaques rather than any other known plaques that may include images. The study focuses on the use of some selected viable materials and

techniques for making plaque(s). It is also limited to Tafo cemetery in the Kumasi Metropolis of the Ashanti region.

1.9 Limitation

Unavailable access to routers to cut the metal text restricted the font styles and the sharpness of the font edges.

1.10 Significance of the Study

1. The research will generate knowledge about appropriate techniques and methods for registering permanent text on a substrate (base material).
2. The research will unearth the defects of the existing techniques, processes and methods employed by the local plaque artisans and modify them to regenerate value for plaques produced in the industry
3. The documented work will be useful reference material for further studies and appreciation for researchers such as artisans, art educators and art students.

1.10 Definition of terms

Text: words that have been written down, typed, engraved or printed on a surface of a material.

Substrate: any surface that support text or text can be written or printed on

Pleochroism: the property as exhibited by some crystals which enables transmitted colours to be seen along the different axes

Inscribing: to write, engrave, or print as a lasting record

Engraving: to cut figures, letters, or designs on a material surface

Electronegativity - a measure of how willing atoms are to accept electrons (subshells with one electron - low electronegativity; subshells with one missing electron - high

electronegativity)

1.11 Arrangement of the rest of the text

The rest of this report is arranged with chapter two presenting the review of related literature supporting the study. Chapter three entails the methodology and the procedures used for the execution of the practical project works. Chapter four embodies results, findings and discussion of the study. Chapter five deals with summary, conclusion and recommendations for the thesis.

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CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Overview

The study seeks to device interventional strategies that will help solve the problems of text fading, metal plaque theft and bring to light new concepts in plaque design that could be used at the various cemeteries in Ghana. To be able to achieve this successfully various literatures which have direct bearing on the study were reviewed

2.2 What is a plaque?

The term 'Plaque' has varied sense of meanings in professional sectors such as in microbiology, arts and institutional organizations. Encarta English Dictionary (2009), define a plaque as, "a small flat piece of metal, stone, or other hard material that has an inscription or decoration on it and is fixed to a wall or other surface, often to commemorate somebody or something". Merriam – Webster's English dictionary (2012)define plaque as a fancy ornament; particularly the badge of identification of a privileged request, a flat piece (as of metal) utilized for design, a dedicatory or recognizing inscribed tablet.

From Wikipedia (June 20, 2015), plaques are plates of metal, ceramic, marble, cement or plaster of Paris cast, wood and other material, usually attached to a wall, a building, stone, or other flat surface, and bearing either an inscription or a picture in relief, or both, in memory of person(s), an occasion, a previous utilization of a spot, or some other thing. On Baillie Signs.com (June 24, 2015), "plaque is the traditional way of marking a special event or achievement and this is reflected in solid, craftsman-like build quality and use of metals such as stainless steel and plated brass, as well as marking events."It asserts further that, plaques are additionally customarily utilized as signs for the "experts", for example; solicitors, dental specialists, doctors, accountants et cetera.

From the above definitions it could be deduce that plaques are forms of memorials, build with solid or hard materials such as metal, wood, ceramics, marble, plastic, cement cast and others

with text inscriptions or images, use in memory of an object, persons, events, houses, parks and other things. The million questions asked is, why solids or hard materials used. Memorial plaques are supposed to last for the ages to be able to tell the story or conveniently convey the message it carries to the generations; hence the sturdy use of these solids with appropriate technique used to register the text or image assures that plaque will last the ages to convey its message.

In dentistry, the profession that treat oral illness, including sicknesses of the teeth has it that; when the teeth are not properly care for, plaques structure as an aftereffect of a film of salivation, mucus, bacterial, and nourishment buildups that develops on the surface of teeth. This plaque buildup on the teeth hardens, discolour the teeth and become permanent. In the light of this, the word "Plaque" pertains to permanency of something; that is ability to last for a very long time, especially without undergoing significant change.

"…As plaques will be experienced by so many – of both present and future generations – high standards are desirable in all aspects of the work involved; this is especially the case with regard to plaque design, positioning, inscription, and the identification of a suitable and appropriate site, design format and materials…"(Guidance on Commemorative Plaques and Plaque Schemes p7).

2.3 Historical Background of Plaques

The origin of plaques could be traced way back during the Greek and Renaissance era when artists like Myron, Phaidas, Masaccio, Leonardo Da Vinci and other artists began adding their names and signatures to their works as a sign of recognition. However, the earliest plaques were made of metal (brass or bronze) and these plaques were produced throughout medieval Europe from the mid thirteenth through the sixteenth centuries. Functionally, these memorial plaques

were used as a form of sepulchral memorials usually attached to the walls of places of worship and tombs. These plaques survived in its great numbers throughout Europe; usually depict highly conventional figures with brief inscriptions (Encyclopedia Britannica 4 (11th edition, p.434); Badham et al (1999).

In Africa, the early form of plaques produced is evident during the thirteenth and nineteenth centuries in the Benin Empire, present- day Nigeria. The Benin people were known for their rich sculptural tradition, which reap in the production of many sculpture pieces. Among the extensive variety of these creative works produced were the rectangular brasses or bronze plaques. These plaques were used to commemorate important figures and events connected with the Oba's (king) court and important victors amid battles. (Ezra and Kate, 1992; The British Museum June 2015).

2.3.1 Plaque for Honouring the Dead's Family

In 1916 the British government proposed the need to show some form of official gratitude to the families of all British service men and women who lost their lives amid the First World War. A committee was set up and was tasked to find a suitable form of recognition to be given to the next of kin from the bereaved families. The committee in a year's later (1917) recommended that, a plaque should be designed and given to the families. Edward Carter Preston, a medalist from Liverpool's design was selected. The plaque designed, was made of bronze; prominently alluded as the "Dead Man's Penny" on account of the closeness in appearance to the smaller penny coin. The penny coin was a 12-centimeter plate cast in bronze gunmetal, whose design depicted a picture of Britannia and a lion, two dolphins (representing Britain's sea power) and the emblem of Imperial Germany's falcon being shredded by another lion. Britannia is holding an oak spray with leaves and oak nuts. Underneath this was a rectangular tablet where the perished individual's name has been embossed into the plaque. No

rank was given as it was planned to show fairness in their penance. On the outer edge of the plaque, the inscription, 'He died for freedom and honor' is composed underneath the plaque. (Tameside Metropolitan Borough, February 2010; Commonwealth War Grave Commission, February 2010). Symbolically, the issuance of these plaques to the deceased family was considered to be equally important to the member of the family they have lost.

Figure 2.1: Death Penny
Source: The Great War Archive, A community collection (2008)

Functionally, due to the fact that, these plaques are meant to recognise the services rendered to their nation and also to serve as a memorial; it is therefore built with a durable material with a lasting technique (casting) that has rendered the inscription and the images permanent.

Today it is common to find these plaques in most British homes and museums in London, which are intact as if they were produced today

2.3.2 Blue Plaque Scheme

In the year 1816 under the influence of William Ewart (British politician) and Henry Cole (civil servant), The Royal Society of Arts set up a scheme in the world, the first of its kind to commemorate historical events with plaques. The most famous of the commemorative plaque among the scheme was the blue plaque. Howard Spencer (2008) in his article “Making History”

described blue plaque as; an elegant markers of the link between famous figures and buildings usually residences. It is evident that, the first blue plaque was disclosed in the year 1867 to remember Master Byron at his birthplace, 24 Holles Road, Cavendish Square. However the earliest verifiable marker to survive recognizes Napoleon III in Lord Road, St James's, which was also put up in that same year. The first plaque shading was blue, yet this was changed by the producer Minton, Hollins and Co to chocolate colour to save money. In 1901, the local government authority - the London County Council assumed total control of the scheme. The London Area Gathering (LCC) in its ability gave much thought to the future design of the plaque; which they revise the original design of the Society's plaques to uniformly blue, with laurel wreath and the LCC's title added to the design but the basic shape was maintained, this design was prominent from 1903 to 1938. In the 1920s, saw the experimentation on other viable materials like metal (bronze), stone and lead in the creation of plaques; shape and colour were likewise changed. The blue plaque design in 1921 was changed after it was found that ceramic was much less expensive than encaustic and other known materials utilized. (English Heritage, June 2011).

This scheme has proceeded to this present day, having been directed progressively by the Royal Society of Arts (1867–1901), the London County Council (1901–1965), the Greater London Council (1965–1986) and English Heritage (1986 to date). (Rennison and Sumeray, 2003; English Heritage, June 2011; Institute of Historical Research, June 2011)

Figure 2.2: Blue plaque

Source: Wikipedia, the free encyclopedia 2014

2.3.3 The Essence of Plaque and its Significance for Burying the Dead to the African

Memorial plaques play important role in the memorialization process in every African society. As opined by psychologists, memorialization forms an imperative part of any family's grieving process; subsequently families who had lost a friend or family member set up a unique spot for relatives and companions to visit for the duration of their lives to explicitly recollect their relative's life.

Memorialization spurs from the world's view that an important life is found in maintaining harmony with the soul of the dead relative-the "living dead". However to maintain a peaceful coexistence between the living and the soul of the dead; Ofori (2012) in his article (230242) "A taste for Ghanaian funerals and some strange burial practices of the world" featured on Monday, 20th February, 2012 at Ghanaweb.com, highlights three common things as far as disposition of the dead matters and these could be seen in: Organization of funeral rites, rituals, and ceremonies; Securing of a sacred place for burying the body and memorialising the deceased with a plaque. Mbiti (1992) affirmed that, the soul of the perished will keep on influencing the lives of his living relatives with favours or reviles relying upon how he or she was dealt with and remembered by the living. Hence when a person dies a memorial service is organized to give a final farewell to the person, amidst a permanent site for burial; a tombstone is built over the grave with a plaque bearing the dead person's name, dates of birth and death. Significantly, this is done in memory of the deceased and also for easy identification of the site, so that a periodic visit could be paid by the relatives to show their love, respect and also to lay flowers.

2.4 The Origin and Nature of the Local Plaque Industry in Ghana

In Ghana, information on early production of memorial plaques and their first usage is not known since there are no documentations or oral tradition done to support its first usage and early production in the country. But information gathered from the plaque centers across the country indicated that, memorial plaque might have been introduced to Ghana, the then Gold Coast by the Dutch and the British, who bury their dead and honour them with these memorials. An evidence is a plaque found in the main courtyard of Elmina Castle dedicated to a Dutch governor who died barely three months at post.

Figure 2.3: Plaque dedicated to a Dutch governor who died at post
Source: Quarty, 2007

Moreover, the early memorial plaques in Ghana are also evident during the British rule, at Christiansburg war cemetery constructed in 1941 which served as a burial ground for commonwealth soldiers who died during the Second World War and other non-world war burials. The Christiansburg Memorial, which forms the passageway to the burial ground, recognizes more than 450 men of Gold Coast enlist who died in West African region amid the Second World War, whose graves are obscure or are situated to the point that perpetual upkeep is unrealistic. (Commonwealth War Grave Commission, June 2015).

Currently in Ghana, memorial plaques have assumed a wider dimension in all the cemeteries in the country notably in Kumasi and Accra. However, the ideologies of the different cultures in country towards the dead and the need to create a mark for easy identification thrived the

local plaque industry in Ghana. As stated earlier, as to how and when the industry came to the country could not be ascertained, but it was said that the local artisans who were very dexterous tried their hands on it after careful observation made on the headstones found at the British cemeteries in the country. The industry at Tafo, in the Kumasi metropolis is basically the main centre for the production of plaques in the Ashanti region. Production processes in the country are conventional which make the practice of the plaque business concentrated at the big cemeteries in the cities notably Awudome and Tafo cemeteries.

Another factor explaining the concentration of the industry at the cemeteries in the cities in the country is the ready accessibility and availability of material.

According to Fofo (2015), a plaque artisan and a pioneer in the industry at Tafo cemetery, the industry came to Tafo as a result of the cemetery. According to him plaque making at the cemetery used to be a job done by very few people, however with a constant demand for the plaques and its patronage, the industry suddenly began to boom, these attracted people to the industry, who learn as apprentice before setting up themselves. The apprenticeship form of acquiring skills, according to Boah in (2008), techniques for production passed from one generation unto another and as a result, the method for production remains the same for several years.

Although the local plaque production stands as one of Ghana's lucrative local industries capable creating jobs to curb the unemployment situation among the youth, for one reason or another, much attention and studies has not been made about the industry making it less attractive for the youth. The industry is at the mercy of the local artisans who over the years have produced same type of plaques pregnant with the same faults as they existed before.
However, this study seeks to come with alternative strategies to curb the problem.

2.5 Types of plaques

Ideally, there are different types of plaques, mostly the differences is seen in the type of material and the method used in its production. Various types of literature on plaques were considered by the researcher. But for the purpose of this research work the following types of memorial plaques were reviewed:

Bronze Memorial plaque

Brass Memorial plaque

Ceramic plaque

Aluminium plaque/Anodized aluminium plaques

2.5.1 Bronze Memorial Plaque

These types of plaques are made with alloy which comprises a greater amount of copper, zinc, tin and in some cases small amount of lead. Essentially bronze plaques are made in two ways, it is either incised or cast, depending upon the look and duplicate or pictures required on the plaque. Bronze plaques are most ordinarily seen attached to tombstones and showing the dates the individual was conceived and passed on. Bronze memorial plaques, are a unique approach to guarantee your adored one's identity is associated with years to come. Aside from the basic information such as dates and names, they incorporate decorative designs that can highlight in picture shape; the uniqueness of a friend or family member's identity.

Wallis (2014) was with the view that, Bronze plaques are an awesome approach to pay tribute to a special individual or essentially give information to an area. They offer an enduring, sturdy solution both indoor and outdoor, characteristically; bronze plaques are solid and strong. Cast

bronze plaques do not rust when exposed to the elements, in any case, will normally oxidize after some time, rendering a natural patina as seen on more seasoned copper objects. Tarnish - Bronze plaques commonly contain a blend of copper and tin which after sometime around 5 to 10 years will discolour into a greenish dark colour. The green comes from the copper and the dark effect is a result of the tin. To keep the bronze from discoloring it must be maintained by sealing with wax yearly or a clear paint. (Franklin Bronze2014; Memorials.net June, 2015)

Figure 2.4 Bronze Memorial Plaques
(Source: CastBronzePlaque.com)

2.5.2 Brass Memorial Plaques

According to Encyclopedia Britannica. (2012), “Metal called brass is an alloy of copper and zinc, of historical and enduring importance due to its hardness and workability”. From the thirteenth to the seventeenth century in Europe, great brasses were utilized to commemorate the dead. Engraved metal (brass) plates, portraying the dead, were set into the surface of the tomb and frequently were decorated with engravings, heraldic devices, and are of different

design format fitting to the individual's life and circumstances. More than 4,000 of these brass plaques still exist in Britain today. (brass**.** (2012). Encyclopedia Britannica.).

From Sign-maker.net (2015), brass is the conventional material for commemoration plaques. Often brass plaques are incised with unpainted letters. Others too are engraved more deeply and filled with colour. The main disadvantage with brass plaque is that it must be constantly polished to stay shiny.

Figure 2.5: Engraved brass memorial plaque Figure 2.6: Coloured filled brass-plaque

Source: Sign-maker.net, 2015

2.5.3 Ceramic plaque

Advanced ceramics (2012) Encyclopedia Britannica describes ceramics as traditionally inorganic, nonmetallic solids that are prepared from powdered materials, are manufactured into items through the utilization of heat, and show such trademark properties as hardness, quality, low electrical conductivity, and fragility. This type of plaque has an extremely long life and is waterproof and can withstand most weather conditions.According to Photograve (2008) a professional engraving company in Australia that produces plaques and name plates, ceramic plaques are remarkable when compared with plaques made with other materials, in that they can be full-colour, and photographs utilized can closely match to the copy. Moreover, ceramic

plaques are weatherproof and tough and can be utilized either inside or outside. They are prominently requested as photograph tombstone dedications including pet remembrances, building commemorations, and corporate designs for floors or walls.

2.5.6 Aluminum Memorial Plaques

According to Allplaques.com (2015), aluminum plaque exudes style and grace with their shimmering silver tone characteristics that contrast beautifully with dark colours. An aluminum plaque is lightweight and will never rust. These types of plaques are created either as cast aluminum with substantial dimension between the backgrounds, or thinner aluminum engraved plaque.

2.5.7 Dark Bronze /Anodized Aluminum

These plaques are perfect for memorials as they look shrewd and are maintenance free. They are produced using 1.5mm dark bronze or anodized aluminum. The text is scratch engraved through the dark overlay to reveal the white or silver colour underneath.

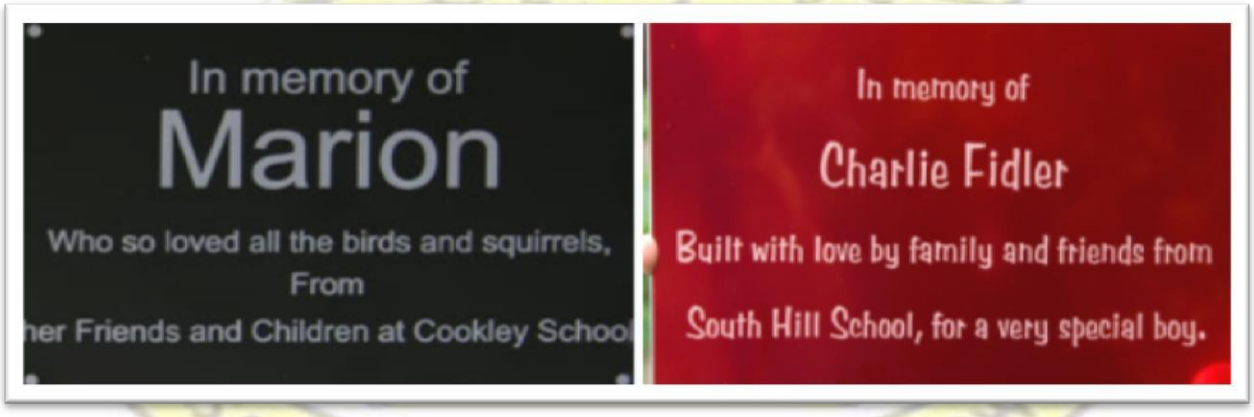

Figure 2.7: Dark Coloured anodize aluminium plaque Source: the Sign Maker, 2015

2.6 Materials for Plaque Production

Merriam- Webster's Dictionary (2012) defines material as the elements, constituents, or substances of which something is composed or can be made. It further states that material is

something that may be worked into a more finished form. Microsoft Encarta (2009) also defines material as something used in making items; the substance used to make things. The materials which are useful for making plaques are many. However, much literature will be reviewed on metals, ceramics and adhesive materials; this is because these materials formed the basis upon which the final projects will be built on.

In addition to this, one of the objectives for this study is to explore the existing materials used for making plaques at Tafo, of which metal and ceramic are typical example. It is therefore necessary to review them in order to know their defects and potentialities necessary for making plaques. For instance, in the leather industry, Boahin (2008) agrees with Petersen (1961) that, it is important to choose the right kind of material (leather) in the correct thickness and pliability for the article one intends to produce. Boahin further asserts that, to make the right selection of leather for the right job, the leather craftsman needed to have at least some knowledge about the kind of leather he intends working with. Moreover, in the wooden section, Bray (2003) as quoted by Agyemang (2010) that, it is considered normal that a carpenter or cabinetmaker should have knowledge of the properties of the wood to be used for a particular task; woodworker would want to know how hard the wood is, how straight the grains are, its properties when sawn, planed or chiselled. Similarly it is also imperative for all other artisans or craftsmen working with a material, to have knowledge of the material they intend to use, since similar factors apply. In the light of this, plaque artisans must know the nature of the number one material they will be working with, as well as, other essential items.

2.7 Metal

Any of a class of substances described by high electrical and thermal conductivity, malleability, ductility and high reflectivity of light. (Metal**.** (2012). Encyclopædia Britannica). Additionally, metals are a group of compound components that display all or the majority of the

accompanying physical qualities: they are solid at normal temperatures; opaque (except in extremely thin films); great electrical and thermal transmitters; radiant when cleaned; and have a crystalline structure when in the solid state. (Microsoft Encarta 2009).

Tarr (2010), as quoted by Agyemag (2010), partly uphold that, “a metal is a chemical element that is a good conductor of both electricity and heat and forms cations and ionic bonds with non-metals.” However, the word “metal” originated from the Greek word "μέταλλον" - which sounds métallon, in the English language. According to him, the word "μέταλλον” stands for “mine", this is probably because the mining done at the time was targeted at metals. However, the chemist was with the view that, “a metal is an element, compound, or alloy which have properties of high electrical conductivity”. He further asserts that, “in a metal, atoms readily lose electrons to form positive ions (cations)”. Those particles are encompassed by delocalised electrons, which are in charge of the conductivity. The solid produced is held by electrostatic communications between the ions and the electron cloud, which are called metallic bonds (Tarr, 2010).

Moreover, Agyemang (2010) opined that, the generally accepted definition of metal focuses on the bulk properties of metals. According to him such bulk properties includes: ductility; malleability; good conductors of electricity and high reflectivity of light, while non-metals are generally brittle (if solid), lackluster, and are insulators. Although, Agyemang (2010) focuses his definition of metal on the bulk properties of the material (metal); it is imperative to note that, within the general limits of the meaning of metal, the properties of metals vary from one metal to the other. For instance, comparatively some metals are grayish in colour, yet bismuth is pinkish, copper is red, and gold is yellow. some metals show more than one colour, a phenomenon usually referred as pleochroism*;* the melting points of metals extents from about - 39° C (about - 38° F) for mercury to 3410° C (6170° F) for tungsten. Osmium and iridium

(particular gravity 22.6) are the densest metals, and lithium (particular gravity 0.53) is the slightest thick. The majority of metals crystallize in the cubic system, but some crystallize in the hexagonal and tetragonal systems. Bismuth has the most minimal electrical conductivity of the metallic components, and silver the highest at standard temperatures. The conductivity of most metals can be decreased by alloying. All metals expand when heat is applied and contract when cooled, however certain composites, for example, platinum and iridium compounds, have to a great degree low coefficients of expansion. (Microsoft Encarta, 2009).

However based on the above definitions and findings the researcher can conclude that, though the generally accepted definition of metal focuses much on its bulk properties; it is also prudent to add that there are distinctions within the properties as pertain to the different types of metals we have.

2.7.1 Types of metals

Metal is produced using metal minerals (ore), which must be mined and prepared to change them into usable materials. It is uncommon for metals to be utilized in its raw state. Regularly they are blended with different metals to enhance their properties a process usually referred to as alloying. It is base on these mixtures upon which different types of metals are made.

According to Carbon, Mould and Cave (1989), all metals belong to one of these two groups: Ferrous metals and Non-ferrous metal**.** They further stated that, all metals are also either pure metals or alloys.

***Ferrous metals*:** are those which are made mostly irons with the addition of smaller amount of other elements, to enhance their properties. Examples of these are mild steel, cast iron, tool steel.

Table 2.1 Identification of Ferrous Metals with simple test at the workshop

Metals	Test		
	Drop on anvil	**Nick and hammer in vice**	**Grind**
Mild Steel	Medium pitched ring	Bends before breaking Shows uniform grey lustre on fracture	A long thick stream of pale yellow spark which explode and fork
Carbon Steel	High ringing note	Bends a little and then breaks. Silvery white, fine, crystaline structure.	Orange sparks burst from a thick stream of line.
High speed steel	Medium metallic ring	Resists blow and then breaks cleanly. Very fine, crystaline structure.	Dull red sparks barely visible close to the wheel
White cast iron	Very dull note	Breaks cleanly. Finer, white fracture	Dull red stream of sparks close to the wheel
Grey cast iron	Dull note	Snaps easily, coarse, dark fracture.	Dull orange stream of sparks close to the wheel

Source: Mould and Cave, 1989

Non-ferrous metals: do not have iron in them, examples of these are: aluminum, copper, lead, zinc and tin. Ferrous metals do not attract magnet when put closer.

Pure metals: comprise of single component, which implies that it is a substance having only one type of atom in it. For instance, the regular unadulterated metals are aluminum, copper, iron, lead, zinc, tin, silver and gold.

Alloys: are blends of two or more unadulterated metals, or one or more pure metals blended with different components or elements. However, alloys are made to create materials which have blends of properties not all accessible in the unadulterated metals, and to satisfy requirements for which no unadulterated metal is suitable. Moreover, the properties of alloys are oftentimes far not the same as those of their constituent elements and such properties as strength and corrosion resistance might be impressively more prominent for an alloy than for any of the separate metals. Consequently, alloys are for the most part utilized than unadulterated metals. It is with this reason that explains the endless range of metals we have today. Alloys are also grouped into ferrous alloys that contain iron, example; stainless steel (steel and chromium), high speed steel (steel and tungsten); and nonferrous alloys that contain no iron, example brass (copper and zinc), duralumin (aluminium and copper).

(Microsoft Encarta, 2009; Carbon, Mould and Cave, 1989)

2.8 The Structure of Metal

Chapman and Peace (2001) as cited by Agyemang (2010) held that, with a specific end goal to comprehend the conduct of materials, it is judicious to take a gander at their physical make up or structure. According to Clark (2000; 2012):"metallic structure of metals are giant structures of atoms held together by a metallic bonds. "He uses "Giant" to describe, "the large but variable numbers of atoms present – depending on the bit of metal. "However,

Agyemang asserted that; Van Vlack (1973), McCreight (1991), Chapman and Peace (2001), Mayan (2010) and others used atom as the smallest part into which a component (metal) can be separated and still hold the chemical properties of that component (metal) as the basis for illustrating the structure of metal. Agyemang further states that: '' Chapman and Peace liken the atom to the ecosystem advocating that, atoms of all elements and for that matter metals have the same basic structure but only differ in size and weight''. The below figure illustrates the structure of an atom.

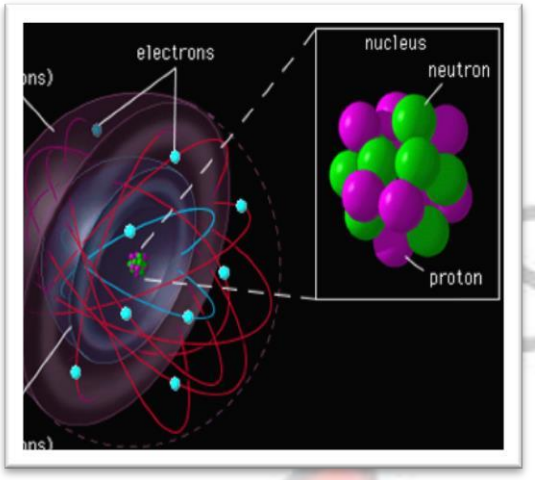

Figure 2.8: The atomic structure
Source: Encyclopædia Britannica, 2012

The nucleus or centre of the atom consists of an association of protons and neutrons. Orbiting around the nucleus are light particles with negative electrical charges known as electrons. These electrons determine the physical and chemical behaviours of a metal. (Encyclopædia Britannica, 2012)

2.9 Metal production

The term metal production refers to all the procedures included in the transformation of a crude material, for example, a metallic mineral, to a last shape in which the metal can be utilized for its purposes. According to Van Clack (1973), as cited by Agyemang (2010), the major operation in the processing of metals and alloys is removing them from the original source and refining them into the state or composition required by the user. Moreover, according to chemists. Some metals typically occur in nature uncombined with different elements and can be put to use with relatively minimal extra treatment. However in the dominant part of cases, metals occur in nature as compounds, and should first be changed over to their basic state. These made them

possible to be dealt with in a wide assortment of ways in order to make them usable for various pragmatic applications.

2.10 Properties, Composition and Uses of Some Selected Common Metals

Mudd (1972), as quoted by Agyemang (2010), is of the view that the properties of a metal are those features which give it its own particular nature or identity. He also states that the properties determine the use to which the metal could be put and the process by which it could be worked.

However, McGrath (1995) asserts that, experimentation is one of the most rewarding ways to discover how metal works and how one can use it. In evidence to his words, experimentation with metal has already produced thousands of results in ornamentation and various constructions due to its flexibility and adjustability. Table 2.2 shows the properties, composition and uses of some selected metal in a tabular form below.

Table 2.2: Properties, Composition and Uses of Some Selected Common Metals

NAME	MELTING POINT	COMPOSITION	PROPERTIES	USES

Aluminium Aluminium alloys, example Duralumin	650˚C	Pure metal Aluminium + copper (4%) and manganese (1%)	Grayish-white, light, soft, malleable, ductile and highly conductive to heat and electricity. Corrosion resistant. Can be welded and soldered by special processes. Ductile, malleable, light, work-hardens, and machines well Good fluidity in pouring, good machineability, improved hardness, toughness. High fluidity	Aircraft, boats, railway coaches, engine cylinder heads, blocks, pistons and crankcases, window frames, saucepans, roofing sheets, aluminium foil for packaging and insulation, electrical cables and conductors, castings. General purpose casting alloys etc.

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Copper Copper alloys, example Brass	1100˚C 980˚C	Pure metal Copper +zinc approximately. (65%) (35)	Red, malleable, ductile, tough. High heat, electrical conductor. Corrosion resistant. Can be work with when hot or cold. Easily hard and soft soldered. Yellow, very corrosion resistant though it tarnishes easily. Harder than copper, casts well, easily machined and easily hard and soft soldered. Good heat and electrical conductor.	Wire, especially electrical cables and conductors. Soldering irons bits and welding nozzles, copper foil for car radiators, printed circuits and gaskets. Roofing, castings. Forgings, ornaments, valves, propellers etc. Castings, forgings, ornaments, valves, propellers.
Copper alloys Bronze	980˚C	Copper (90 to 95%) + tin (5 to 10%). Sometime other elements are	Reddish-yellow, harder and tougher than brass, hard-wearing, corrosion resistant and easily	Bearings, springs, instrument parts, gears. Air, water and steam valves and fittings.

		added, example phosphorous for phosphor-bronze	machined	Pumps, castings for statues
Cast iron	1000˚C to 1200˚C	Remelted pig iron with small additions depending on scrap steel	A wide range of alloys with varying properties. Hard, brittle, cheap, strong, good in compression and selflubricating. Malleable cast iron is white cast iron annealed to make it softer, more ductile, more machineable and to increase tensile strength	Used for heavy crushing machinery, car cylinder blocks and heads, vices, machine tool parts, car brake drums and discs. Horticultural machinery and agricultural implements. Machine Handles and gear wheels.
Steel Mild steel	1400˚C	Alloys of iron and carbon (less than 0.15%) Iron and carbon	Properties, working, qualities and uses vary considerably with the different types of steel. Soft, ductile, tough and malleable.	Wire, rivets, thin sheets, cold pressings, drawn tubes General purpose steel, girders, angle iron,

Medium carbon steel		(0.15 to 0.30%)	High tensile strength, ductile, tough, fairly malleable, softer than medium and high carbon steels. Because of low carbon content it cannot be hardened and tempered.	plates, sheet, tubes, drop forgings, nuts and bolt etc. Garden tools, shafts, axles, springs, wire ropes.
		0.30 to 70% carbon	Stronger and harder than mild steel, but less ductile, tough and malleable.	

Source: Caborn, Mouid and Cave (1989)

2.11 Corrosion effect on Metal products

Corrosion is wearing of metal due to chemical reaction, for the most part oxidation. It happens when gasses or liquids chemically attack uncovered surface of the metal, and is quickened by warm temperatures and by acids and salts. Normally, corrosion items (example rust, patina) stay on the surface and protect it. Removing these deposits reexposes the surface, and corrosion

continues. (Encyclopædia Britannica 2012).However, corrosion affects metal product in the following ways:

1. Loss of product efficiency
2. Contamination of a product
3. Health: pollution due to escaping products from corroded equipment
4. Safety: example corroded metal in bridges and other constructions can collapse

2.11.1 Methods of Controlling Corrosion in Metal.

The effects of corrosion on metal works have seen a lot of research done to enhanced metal properties that will be able to withstand corrosion and other effects that affect metals. Mudd (1972) was of the view that the properties of a metal are those features which give it its own particular nature or identity. He further states that the properties of metals determine the use to which the metal could be put and the process by which it could be worked.

According to Encyclopædia Britannica (2012), some materials naturally are corrosive resistance; whiles others needed to be treated to withstand. Among the common ways by which metals can be protected against corrosion are coating, painting, galvanizing and anodizing etc.

Coating: application of any blend of film-forming materials that may incorporate colour, solvents, and other additives, which are applied to the surface of metals to cure or dry. This film-forming material serves as protective cover for the metal. Metal surface coatings incorporate paints, drying oils and varnishes, engineered clear coatings, and different items

Painting: oil paint is applied to cover all the surface of the metal either by spraying or by using brush. The oil paint when dried serves as a protective cover for the metal. Moreover an advance forms of metal painting which is: Powder covering applies an enriching finish that is like paint,

however with more prominent quality. The procedure includes dissolving dry plastic powder onto the metal to create a textured, matte, or shiny covering.

According to Mould, Carborn and Cave (1989), the powder coating uses a process known as fluidization, where air is blown through a powder to make it behave like liquid, so that when the metal is dipped into it all parts of the metal are evenly coated

Galvanizing: the use of zinc covering on iron or steel to protect them against exposure to the climate and resulting rusting. A properly applied Zinc (galvanizing) may shield from climatic corrosion for 15 to 30 years or more. As discontinuities or porosity create in the covering, galvanic or electrolytic activity follows; the iron or steel, however, is protected by sacrificial corrosion, a situation in which, the length of the zinc and the iron are in contact, air oxidation saves the iron and affects the zinc. (galvanizing**.** (2012). Encyclopædia Britannica)

Anodizing: this comprises of electrically spraying of an aqueous oxide film onto the surface of a metal, for example, aluminum, which serves as the anode in an electrolytic cell. In the most widely recognized type of anodizing, which utilizes a 15 percent sulfuric acids, colour can be added to the oxidation process to get a coloured surface. (anodizing**.** (2012). Encyclopædia Britannica).

Passivation: this is utilizing a light layer of material, for example, metal oxide to make a protective cover on metals against corrosion Cathodic Protection; this is a specialized method used to control corrosion of metal by making it the cathode of an electrochemical cell.

2.12 Finishing in Metal

Metal finishing is a treatment given to the exterior part of metal items by applying a slender integral layer to its surface. This is done to enhance the appearance of the metal aesthetically.

There are diverse sorts of metal completing procedures that can be utilized for an assortment of purposes. In light of this, prerequisite knowledge of the major finishing methods equipped the artist to choose a metal finishing process and its appropriateness for a given job. However it is imperative to note that; the life span of a metal depends mostly on the finishing given to them. Some of the major finishing processes are outline below:

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2.12.1 Metal plating

According to Caborn, Mould and Cave (1989), a thin film of metal is deposited on the surface of the metal using electroplating bath. This metal finishing process is the most common means of improving the appearance of metal products and protecting surfaces from chemical attacks. For instance chromium and nickels are widely used on steel products; example car parts to prevent corrosion and enhance its aesthetics. Silver and gold are often plated onto less expensive metals for jewellery and other metal products. Metal plating gives various advantages as an end result procedure. It can enhance metal item's quality, resistance to corrosion, surface friction, and physical appearance. It is likewise a helpful choice for covering different metals.

2.12.2 Brushed Metal

Dissimilar to plating, brushed metal finishing is an effective technique for evacuating surface flaws. These finishing uses a machine designed to make a uniform textured parallel grain surface to smooth of the exterior part of the metal. An abrasive belt or wire brush is normally utilized to accomplish this impact. Moreover, the particular course of the belt or brush can make marginally adjusted edges vertical to the grain. (ThomasNet.com.2015)

2.12.3 Buff Polishing

A buff polishing machine is used, to smoothen the surface of the metal; this machine employs a cloth-like wheel to polish the product’s surface, bringing about a high, polished sheen. The

procedure is frequently utilized for decorative items that benefit by shine and smoothness. Buff finishing machines have a tendency to round out an item's edges, and because of the fabric wheel's extent restrains, the procedure is less compelling for applications requiring intricate, delicate or recessed components.

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2.12.4 Metal Vibratory Finishing

Vibratory machines are utilized to remove sharp edges from products by positioning the product (metal) inside a drum loaded with rough pellets and a substrate, a tumbling vibration is applied which makes a uniform random textural effect on the exterior part of the metal. The machine's cycle velocity and size of vibration are generally variable, permitting effective treatment for a scope of little to substantial measured parts of the metal

2.12.5 Sand Blasting

Sand blasting machines are regularly utilized in works requiring a uniform matt surface. The procedure (otherwise called bead blasting) expels sand, steel shots, metal pellets or different abrasives into a substrate at rapid speed. This createsa smooth effect, clean textured surface, especially in soft metals like aluminium.

2.12.6 Powder Coating

Powder covering applies an improving finishing that is like paint, yet with more durable solidness. The procedure includes dissolving dry plastic powder onto the metal to create a textured, matt, or polished cover or coat.

According to Mould, Carborn and Cave (1989), the power coating uses a process known as fluidization, where air is blown through a powder to make it behave like liquid, so that when the metal is dipped into it all parts of the metal are evenly coated.

2.12.7 Oil finishing

To protect metals from rusting it is smeared with oil or light grease. These served as protective agent against water, air and other environmental conditions that causes rusting. Caborn, Mould and Cave assert that all loose scale from forging, grease, dirt and other particles should be removed before oiling.

2.12.8Lacquering

With this method, the metals are thoroughly clean, polish and degrease before a lacquer or vanish with fine brush or spray diffuser is used to apply the lacquer or vanish.

2.12.9 Hot Blackening

Hot blackening machine spreads a dainty layer of dark oxide onto the metal surface to make a matt dark finishing with high scraped area resistance. It is a high-temperature process in which the item is embedded into a progression of tanks containing cleaners, caustics, and coolants. Hot darkening is most normally utilized as a part of the creation of car parts, apparatuses and guns.

2.13 Literature on ceramics

Since the need to explore the existing materials in order to understand them and their suitability for plaques is one of the requisite for this study, it is therefore pertinent to review on ceramics in order to understand the nature, composition and its distinctive characteristics in order to apply it rationally.

2.13.1 Ceramics

The word ceramics is a Greek word “keramo”, which means "pottery", which thus is gotten from an older Sanskrit Root, signifying "to burn". The Greeks utilized the term to signify

"burned earth". In this manner the word was utilized to mean to a product gotten through the activity of flame upon earthy materials. (National Chen Kung University, 2004; 2012).

According to Dr.-Ing. Dipl.-Ing., most people think of ceramics as craftsmanship, dinnerware, earthenware, tiles, block, and toilets. He alludes to the aforementioned items as traditional ceramics. Woodford (2000) also advocates that:“ceramics once referred purely to pottery and articles made by firing materials extracted from earth”.

Today, ceramic envelop an endless exhibit of advanced materials that a concise definition is practically inconceivable. In support to this statement, Woodford (2000) advocates that:“ceramic has much broader definition”. Along these lines, ceramics are by and large considered as inorganic and nonmetallic solids with a scope of valuable properties, including high hardness and quality, to a great degree high dissolving point, and great electrical and thermal insulation. He further asserts that, the best-known ceramics included: stoneware, glass, block, porcelain and cement; yet the general meaning of a ceramic; a nonmetallic and inorganic solids-so wide that it covers a much more extensive scope of materials.

Ashby and Johnson 2002, advocates that, “ceramics are material both of the past and future; they are the most durable of all materials – ceramic pots and ornaments survive from 5000 BC.” Also, it is their strength, particularly its ability to withstand high temperatures that produce enthusiasm for them today.

Mason 2014, opine that:“ceramics are traditionally described as inorganic, nonmetallic solids that are prepared from powdered materials, which are fabricated into products through the application of heat, and display characteristic properties such as hardness, strength, low electrical conductivity, and brittleness.”Kopeliovich 2012 asserts that: “ceramics are nonmetallic, inorganic compounds formed from metallic (Al, Mg, Na, Ti, W) or semi-metallic

(Si, B) and non-metallic (O, N, C) elements." Looking at the definitions as pointed out by different people, it could be deduce that, ceramics have been with man for so many years and are considered as non-metallic and inorganic compounds, exhibiting characteristics such as low electrical conductivity, strength, hardness and brittleness.

However, Harper (2001) puts the definition of ceramics into two phases with regards to technology. In relation to Harper's assertion, today with advancement in technology there are number of ceramics material that exhibit qualities more than the characteristics stated above. For instance there are ceramic materials that are good conductor of electricity.

Figure 2.10 shows the distribution of ceramics compounds on the periodic table; indicated by a combination of one or more metallic elements (***in light blue colour***) with one or more nonmetallic elements (***in dark blue colour***).

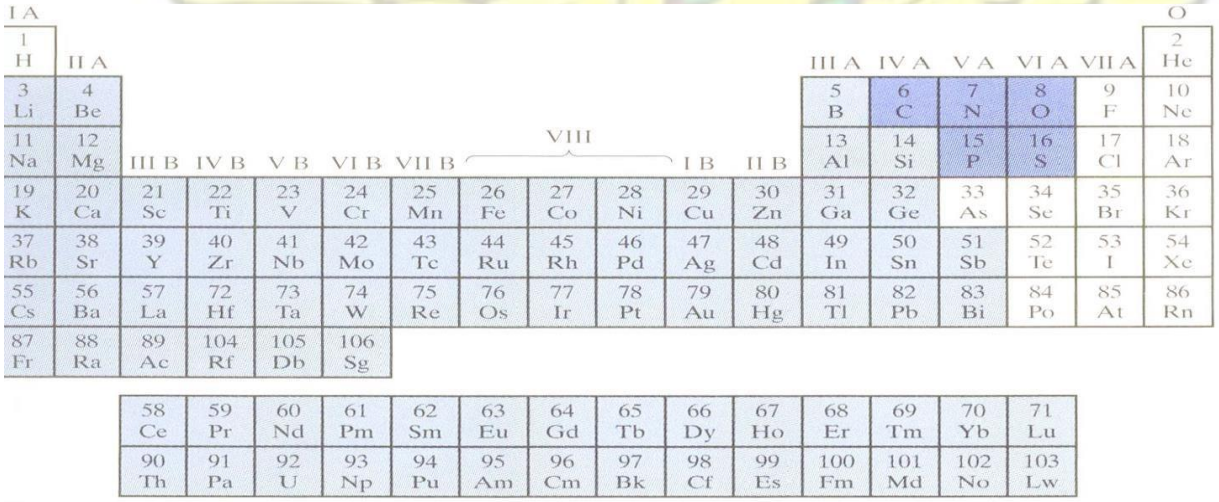

Figure 2.9 the distribution of ceramics compounds on the periodic table **Source: http://www.ts.mah.se/utbild/mt7150/051212%20ceramics.**

2.13.2 Classifications of ceramic materials and its sources

Ceramics varied in appearance, behaviour, structure and composition owing to the fact that, it is obtained from combining different compounds, which exhibit different characteristics. It is

also necessary for the artist or plaque artisan to have a fair knowledge of the sources and characteristics of ceramics in order to select the type of ceramic material for the right job. Dr. Dmitri Kopeliovich 2012; a professor of Material Engineering classifies ceramic into two: Application base system and composition base system.

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2.13.2.1 Application base system

This system classifies ceramics material based on what they are used for or the type of ceramic product. For convenience, the application base system has been grouped into two major categories, which have been further separated into more particular item groupings or market segments. The two categories are the traditional ceramics and advanced ceramics. (Kopeliovioch, 2012; The American Ceramic Society, 2015).

2.13.2.2 Traditional ceramics

The traditional ceramic materials are obtained from natural clay minerals and quartz sand. According to The American Society of Ceramics (2015), Traditional applications comprise products like dinnerware or ovenware and building products like tile or windows. For specifics, traditional ceramics have classified under the products and its segments.

Table 2.3: Classification of traditional ceramics: products and their segments

Segment	Products
Structural clay products	Brick, sewer pipe, roofing tile, clay floor and wall tile (i.e., quarry tile), flue linings
Whitewares	Dinnerware, floor and wall tile, sanitary ware (vitreous china plumbing fixtures), electrical porcelain, decorative ceramics

Refractories	Brick and monolithic products used in iron and steel, non-ferrous metals, glass, cements, ceramics, energy conversion, petroleum, and chemicals industries, kiln furniture used in various industries
Glasses	Flat glass (windows), container glass (bottles), pressed and blown glass (dinnerware), glass fibers (home insulation)
Abrasives	Natural (garnet, diamond, etc.) and synthetic (silicon carbide, diamond, fused alumina, etc.) abrasives are used for grinding
Cements	Concrete roads, bridges, buildings, dams, residential sidewalks, bricks/blocks

Source: The American Ceramic Society, 2015

2.13.2.3 Advance ceramics

In advancement in technology there are now ceramic products that exhibit characteristics and properties that are as tough and electrically conductive as some metals. Advance applications exploit the advantages of some specific mechanical, electrical, optical, biomedical, chemical properties of ceramic materials. Table 2.5 summarizes the market segment and their products

Table 2.4: Classification of advanced ceramics: products and their market segments.

Segment	**Products**
Automotive	Diesel engine cam rollers, fuel pump rollers, brakes, clutches, spark plugs, sensors, filters, windows, thermal insulation, emissions control, heaters, igniters, glass fiber composites for door chassis and other components

Aerospace	Thermal insulation, space shuttle tiles, wear components, combustor liners, turbine blades/rotors, fire detection feedthrus, thermocouple housings, aircraft instrumentation and control systems, satellite positioning equipment, ignition systems, instrument displays and engine monitoring equipment, nose caps, nozzle jet vanes, engine flaps
Chemical/petrochemical	Thermocouple protection tubes, tube sheet boiler ferrules, catalysts, catalyst supports, pumping components, rotary seals
Coatings	Engine components, cutting tools, industrial wear parts, biomedical implants, anti-reflection, optical, self-cleaning coatings for building materials
Electrical/electronic	Capacitors, insulators, substrates, integrated circuit packages, piezoelectrics, transistor dielectrics, magnets, cathodes, superconductors, high voltage bushings, antennas, sensors, accelerator tubes for electronic microscopes, substrates for hard disk drives
Environmental	Solid oxide fuel cells, gas turbine components, measuring wheels/balls for check valves (oilfields), nuclear fuel storage, hot gas filters (coal plants), solar cells, heat exchangers, isolator flanges for nuclear fusion energy research, solar-hydrogen technology, glass fiber reinforcements for wind turbine blades
Homeland security/military	Particulate/gas filters, water purification membranes, catalysts, catalyst supports, sulfur removal/recovery, molecular sieves

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2.13.2.4 Composition base system

The composition base system can be best understood by its basic chemical composition. This system classifies ceramics material by the nature of the microstructure of the material; which is the amount and type of crystalline phase and component parts of the ceramic material.

Figure 4.11 summarizes composition base system below:

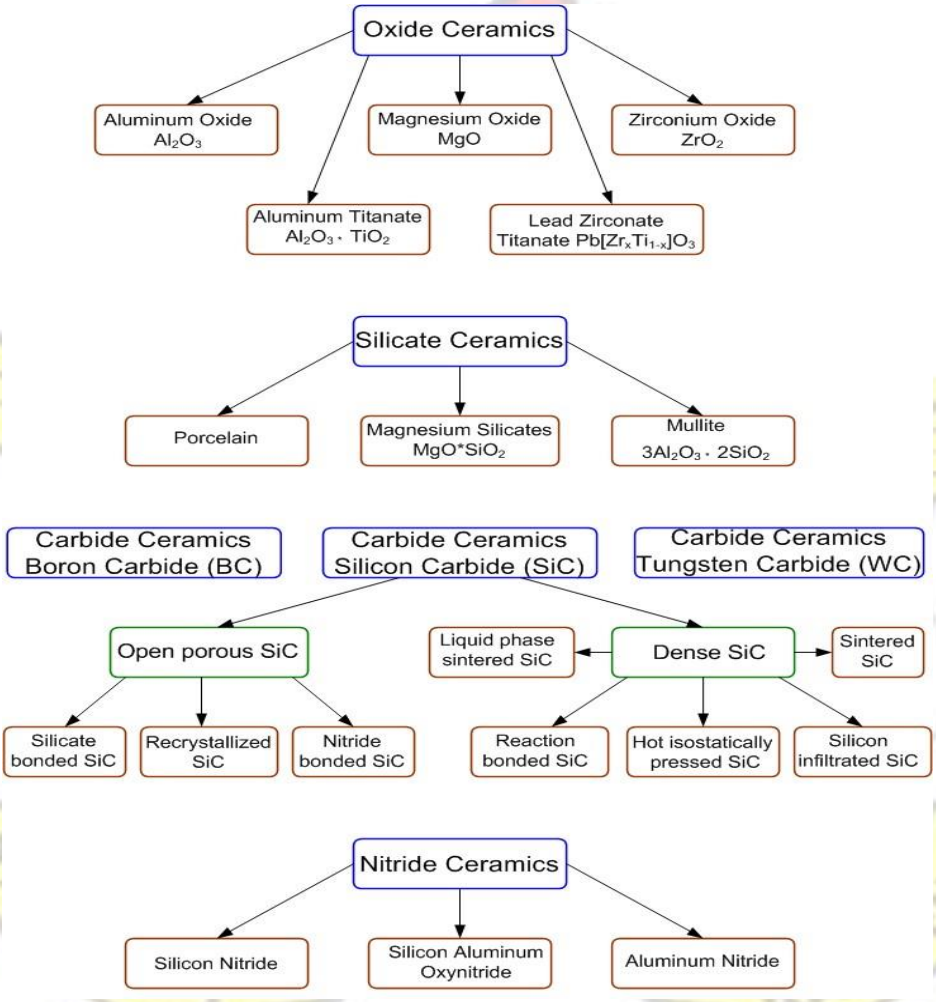

Figure 2.11: Composition base system of ceramics
Source: Substech.com

Advance knowledge in ceramics classification and its market segment will assist the artist in determining the type of ceramic materials to choose for a job and its availability in the market.

2.14 Structure of Ceramics

In order to understand the behavior of ceramics, it is important to study the physical make up or structure of the material. By structure of ceramic, it refers to the architectural organisation of the ceramics that comprises the arrangement of atoms and the distribution of bonding in a ceramic material. Ceramics usually have a mix of more grounded bonds called ionic and covalent. The two types of bonding mechanisms occurring in ceramic materials (ionic and covalent) concurrently exist in the same ceramic material. Every type of bond prompts diverse attributes. These qualities or attributes showed by the type of bonding and the structure helps determining the kind of properties a ceramic will have. (American Ceramic Society 2015)

2.14.1 Ionic Bonding

Ionic holding happens between two elements with a huge distinction in their electronegativities (metallic and non-metallic), which become ions (negative and positive) as a consequence of the exchange of the valence electron from the element with decrease electronegativity to the element with increase electronegativity (Kopeliovich 2012)

Figure 2.12: Transfer of electrons in ionic bonding
Source: www.substech.com

As a consequence of the electron exchange the sodium atom turns into a positive charged ion cation and the chlorine atom turns into a negative charged ion anion. The two ions draw into each other by Coulomb force, creating a compound (sodium chloride) with ionic bonding.

Ionic bonding is non-directional.

2.14.2 Covalent Bonding

It happens between two elements with low distinction in their electronegativities, usually non-metallics, external electrons of which are shared between the four neighboring atoms. The quality of ionic bond relies on the measure of the charge on every atom and on the radius of every atom. The higher the number of electrons is being shared, is the higher the force of attraction or the stronger the covalent bond. Covalent Bonding is strongly directional. Figure 2.16 shows the sharing of electrons in covalent bonding.

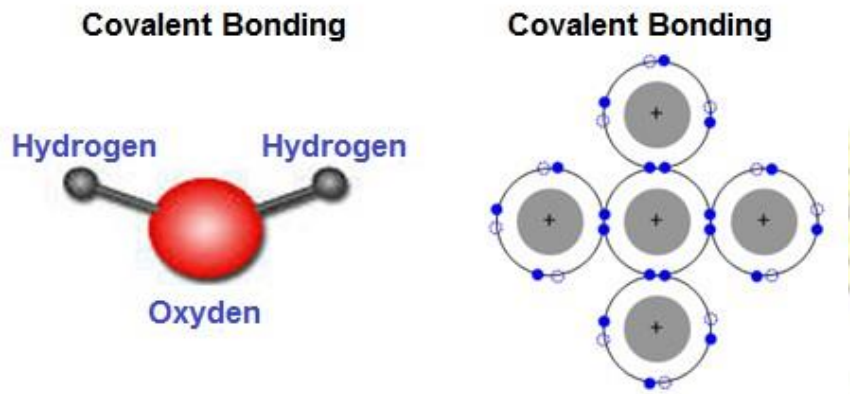

Figure 2.14: Distribution of shells in covalent bonding Source: www.substech.com

2.15 Crystal structure of ceramics

Kopeliovich (2012) said that: "the crystal structure is also responsible for many of the properties of ceramics." According to Altinoz et al, (2009) asserted that:"ceramics are predominantly ionic in nature which has crystal structures of charged ions; where positivelycharged (metal) ions are called cations; and negatively-charged (non-metal) ions are called anions." According to them:"the crystal structure for a given ceramic depends upon two characteristics" which may include:

1. The magnitude of electrical charge on each element ion, recognizing that the general structure must be electrically neutral.
2. The relative size of the cation(s) and anion(s), which decides the type of interstitial site(s) for the cation(s) in an anion lattice.

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2.16 Imperfections in Ceramics

Many of the important properties of materials are due to the presence of imperfections. Basically imperfections in ceramics are irregularities or defects in the arrangement of its constituent particles. These irregularities are collectively called Crystal Defects. Rethwisch (2009) was with the view that, sometimes the imperfections are purposely created and used for a specific purpose. Imperfections in ceramics crystal include point defects and impurities.

2.17 Properties of ceramics

Chris Woodford (2000) opines that ceramics are best known as brittle solids which can withstand high temperatures. He further advocates that, "the different materials used in ceramics can give them wide range of properties. "However, as adopted from EngineersHandbook.com (2004; 2006) the properties for which ceramics are most often selected include:

"High-temperature resistance (High melting temperatures.);

High electrical resistivity (Although some ceramics are superconductors.);

Broad range of thermal conductivity (Some ceramics are excellent insulators);

High hardness (Many ceramics are brittle.);

Good chemical and corrosion resistance;

Low cost of raw materials and fabrication for some ceramics;

Good appearance control through surface treatments, colorization, etc."

Woodford (2000) and Redmond (2008) also defined and classified ceramics properties into the following categories:

Durability: the ability of ceramics to exist for a longer period of time without significant deterioration.

Strength: this is the forces required in various directions to set a ceramic apart. Some of these are tensile strength, compressive strength, tensional strength, stresses and strains.

Brittleness: the resistance of a ceramic to change of shape to an extent that fractures occurs before any change take place. Compare to metals, almost all ceramics are fragile (brittle) at room temperature; that is, when subjected to pressure, they break, with almost no plastic distortion before break.

High electrical conductivity: the quality or power of ceramic material to conduct or transmit electricity. But there are exceptions; ceramic materials have an extensive variety of electrical properties. Subsequently, ceramics are utilized as separators (poor conduits of power), semiconductors (more prominent conductivity than insulators yet not as much as great transmitters), and conductors (great conductors of electricity). (Microsoft Encarta, 2009)

Thermal resistance: the ability of ceramics to withstand high temperatures; most ceramics melt at very high temperatures, hence, even at a very high melting point; these materials oppose deformation and retain high strength under pressure.

***Chemical resistance*:** the resistance of ceramic material when it comes in contact with other liquids, gases, alkalies and acids. Ceramics are more resistant to corrosion than plastics and metals.

Aside the above mentioned properties, ceramics properties can also be adjusted by chemists to suit the intended purpose. For example, most advance ceramics are compounds of oxygen, carbon, or nitrogen with lighter metals or semimetals. In light of this, some industrial ceramics are less thick than most metals. Thus, a light ceramic part might be pretty much as solid as a heavier metal part. Ceramics are additionally to a great degree hard, opposing wear and abrasion. The hardest known substance is diamond, trailed by boron nitride in cubiccrystal structure. Aluminum oxide and silicon carbide are likewise amazingly hard ceramic materials and are at times used to cut, grind, sand, and clean metals and other hard materials. These account for the fact that ceramics could have endless properties and for that matter used in diverse ways to achieve thousands of results by the plaque artisan or artist.

2.18 Uses of ceramics

The uses of ceramics are vast, and have many applications. For convenience, Dr.-Ing. Dipl.Ing (2004) has group the uses of ceramics under the following headings:

Aerospace: field of engineering that designs and builds, testing, and operation of vehicles working in outer space or the earth's sky. The used of ceramics in this field include; Space shuttle tiles, warm obstructions, high temperature glass window and fuel cell.

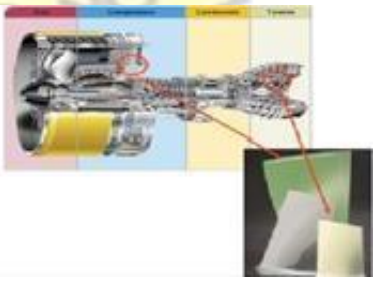

Figure 2.15: Ceramic component used in Aerospace engines
Source:Dr.-Ing. Dipl.-Ing. (2004)

Consumer Uses: dish sets, windows, earthenware, corning product, magnets dinnerware, clay tiles, lenses, home hardware and microwave transducers.

Figure 2.16: Home ceramic wares
Source: Dr.-Ing. Dipl.-Ing. (2004)

Automotive: industrial ceramics are made into segments for vehicles. Samples incorporate; Catalytic converters, ceramic filters, airbag sensors, ceramic rotors, valves, sparkle plugs, pressure sensors, thermistors, vibration sensors, oxygen sensors and so forth.

Figure 2.17: Ceramic components in automotive engines
Source: Dr.-Ing. Dipl.-Ing. (2004)

Medical (Bioceramics): ceramic items or parts are utilized in therapeutic and dental applications, primarily as implants and substitutions. Samples are; Orthopedic joint substitution, prosthesis, dental rebuilding, bone implants and others.

Figure 2.18: Bioceramics
Source:Dr.-Ing. Dipl.-Ing. (2004)

Military Structural: ceramics parts are used for ground, air, maritime vehicle, rockets sensors ceramic radomes (front row) on Patriot missiles

Figure 2.19: Ceramic components in missiles and military tanks
Source: Dr.-Ing. Dipl.-Ing. (2004)

Computers: Separators, resistors, superconductors, capacitors, Ferroelectric segments, microelectronic packages.

Other Industries: Fired bricks, cement, membranes and filters, lab hardware.

Coating agent: ceramics are used as coating material for most metals in the engineering sector.

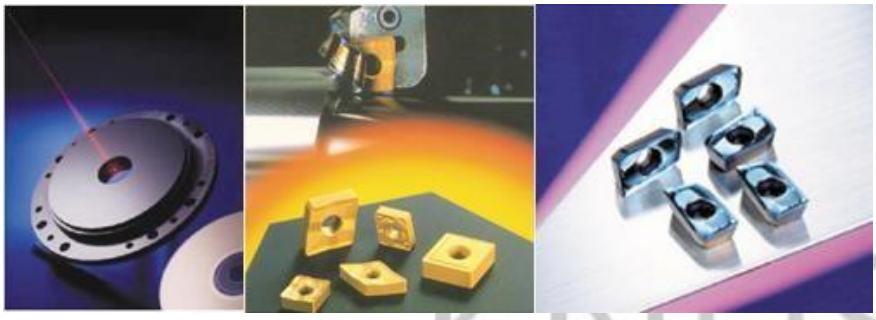

Figure 2.20: Ceramic used as coating agents for material protection
Source: Dr.-Ing. Dipl.-Ing. (2004)

In view of the above, it can be concluded that, many of the properties found in ceramics are the strong primary bonds that hold the atoms together and form the ceramic material. Moreover, in contrast to metallic bonding neither ionic nor covalent bonding form free electrons, based on this attributes ceramics have very low electric conductivity and thermal conductivity. Since ceramic have ionic and covalent bonds that are stronger, ceramics materials are stronger and harder as compared to metals. The strength of the ionic and covalent bonds also determines high melting point, temperature and chemical stability of the ceramic material.

2.19 Lettering

Collins English Dictionary-12th Edition (2014) defines lettering as the act, art, or technique of inscribing letters on to something.

Webster's New World College Dictionary (2010) also defines lettering as the process of putting letters on something by inscribing, printing, painting, engraving etc. Adiyaa and Akosah define lettering as the art of writing, printing or engraving alphabetic symbols into words.

However, from the definitions, letters can be a printed material such as a book; or written as seen in our note books and wall hangings; or engraved as seen on materials such as wood, glass, ceramics, metals and other surfaces. Lettering can be registered on a surface of an object or

material by any one of the following processes or techniques: inscribing, printing, painting, engraving etc.

According to Brako-Hiapa (2006) lettering can be categorized into two basic forms; the built up form and the calligraphic form.

The built up form: letters are more constructed or drawn rather than written. That is they are often confined to mathematical construction, the outlines are drawn first and then filled in with ink or paint.

The calligraphic form: These categories all letters produced by means of square, oval, flat, or round-ended tool capable of producing an image on a surface by leaving an ink mark. However, Brako-Hiapa also highlighted a number of factors one need to consider when selecting and using letters; which include: legibility, uniformity, spacing and the type of job.

2.19.1 Techniques for Registering Letters/Text onto a Surface

There are many ways by which letters/fonts can be registered on a material or a surface. However a selected process or technique may be peculiar to a particular type of object(s) or material(s).

2.19.1.1 Sandblast lettering

This refers to the method of utilizing sandblasting to make etched letterings or purposeful marks on materials like ceramics, marble, metal, stone and others. In registering the letters on the surface, the sandblasting equipment propels the sand to the material it is directed toward through deliberate manipulation of the sand to particular spots on the surface of the material to be designed in a manner that will allow the design to take shape. The base of a sandblast letter is level and has a marginally pitted impact from where the coarseness has etched the lettering

away. One advantage of this type is it offers a variety of font's style and sizes. (www.cleevelymemorials.co.uk)

2.19.1.2 Incimar lettering

An engraver machine is used to create fonts that are similar to a hand cut font with a "V" cut centre. One disadvantage of incimar lettering is that font and size are restricted. This is so since the blade is custom to cut only type of font. (www.cleevelymemorials.co.uk)

2.19.1.3 Hand carved lettering

This is a traditional type of lettering and has been practice for centuries. With this type the craftsman or artist carves letters with the help of chisel or gouges unto the surface of the material such as stone, wood etc. (www.cleevelymemorials.co.uk)

2.19.1.4 Laser engraving lettering

The laser machine uses beam which emits from the controller to etch letters onto a surface. The controller usually a computer controls the directions, intensity, speed of movement, and spread of the laser beam aimed at the surface. The trace of the laser beam is carefully regulated to achieve a consistent removal depth of lettering on the material.

Since letters/font done with these methods are usually left a sunken relief letters on the material, the inscription can be left natural or fill with paint, gold or leaded to give contrasting letters against the base material.

2.20 Joining Ceramics with Dissimilar Materials

The need to join ceramics with other materials arises due to the fact that most ceramics components work well with different materials. For example, it can include specific usefulness

or give added advantage to a product example; as hard wearing surfaces, ultrahard materials in cutting apparatuses, for corrosion resistance or high temperature protection. As ceramics are not being utilized as a part of disengagement, joining is an undeniably indispensable innovation for the integration of the materials. (Hanson and Fernie, 2000).

However, there are numerous conceivable methods for joining ceramics to themselves and to different materials permanently. According to Hanson and Fernie (2000), numerous essential issues must be considered before joining, such may incorporate choice of materials, best practice and joint design format. In view of this, Taylor (2016) advocates that:"a selected method used will depend on one of the following factors: desired component function example strength; electrical insulation or wear resistance; materials to be joined; operational temperature; applied stress; required level of joint hermeticity and component design cost."

Taylor (2016) added that, the two essential variables are the comparability of the materials to be joined and the required temperature capacity. For convenience, Taylor gives the temperature ability of various joining media beneath.

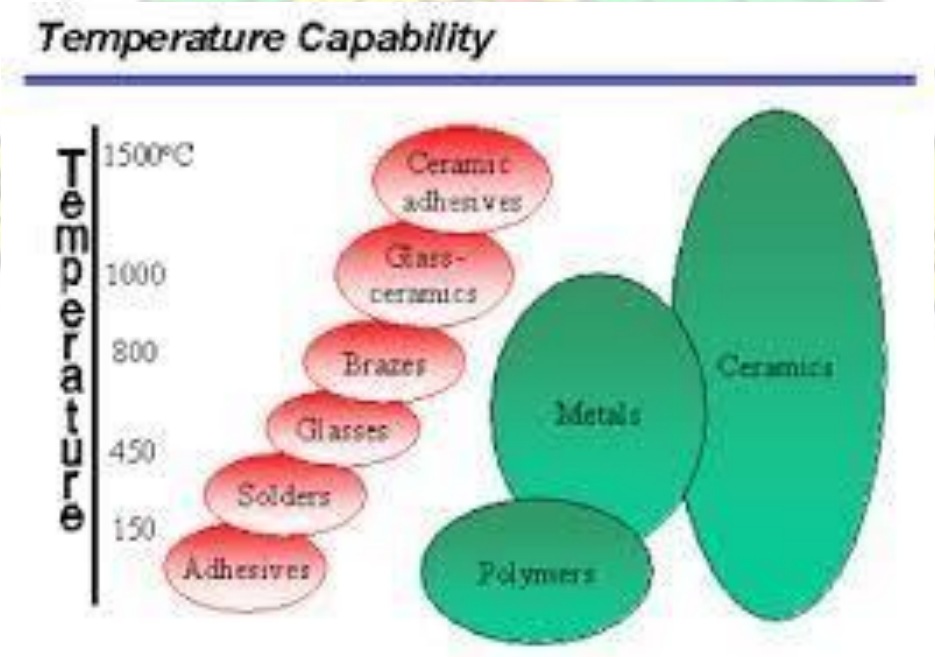

Figure 2.19: Temperature capability of some joining media.
Source: Taylor (2016)

2.20.1 Methods of Joining

Robert W. and Messler (1993) highlight three fundamental options for joining namely: mechanical, adhesive and welding (subdivided into brazing and soldering). However, the technology for making joining in ceramics according to Taylor (2016) opines that, joining varies from mechanical fixturing to direct bonding. Figure 2.20 outlines the joining method and it sub methods.

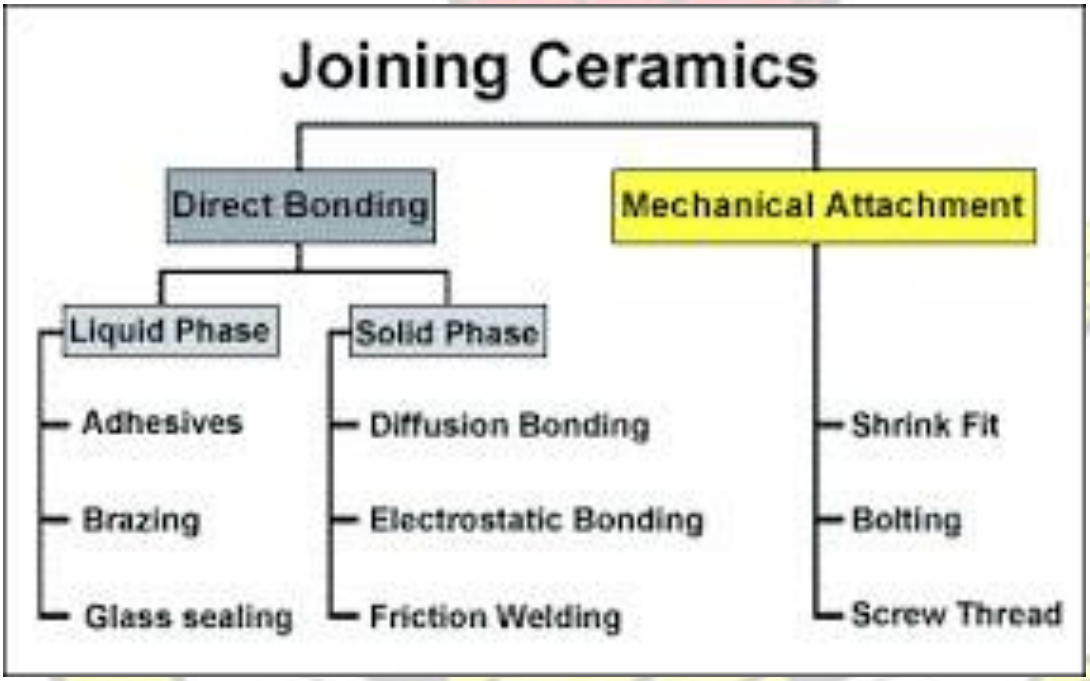

Figure 2.20: Joining methods for Ceramics and other materials

Source: Taylor (2016)

2.20.1.1 Mechanical Attachment

With this type of joining, Robert and Messler (1993) asserts that, attachment of component or material are made possible through a design feature of the component or with a fastener-a

supplemental device that exchanges loads between two components without depending on any basic or secondary atomic or molecular bonding attractions. According to them, attachment or joining is accomplished totally through mechanical attractions from either physical interference or friction, or both.

From the above it can be inferred that, mechanical attachment uses one of two forms of joining either by supplemental devices called fastener or design feature that are part (integral) to the component. Examples of these integral design features are flanges, interlocking members or protrusions, roughen gripping surfaces and deformed features such as crimps, hems, punch marks, or stakes. Examples of fastener include both unthreaded and threaded types such as rivets, pins, keys, nails, grommets, eyelets, retaining rings, bolts, screws, clips, nuts etc.

2.20.1.2 Advantages and Disadvantages of Mechanical Attachment

The major advantages of this type of joining are: it allows disassembly which is essential during maintenance and repair; chemical composition or the microstructure of the component being join are not altered or disrupted. Its limitation lies on the concentrated stress left on the joint at the point of joining which is the main cause of failure in most joint designs

2.21 Adhesive Bonding

With this type of bonding, materials are joined with the use of a substance fit for bonding the two materials together by surface attachment attraction force. The attachment of the materials depend on a combination of varying degrees of microscopic mechanical locking and chemical bonding through an important primary or secondary atomic or molecular forces. The substance used to cause the attachment is called an adhesive, which most often is apply to the parts to be joined at the joint mating or faying surface. The main advantage of Adhesive bonding is the cause of little or no disruption of the microstructure of the part being joined. But may cause varying degrees of chemical alteration due to the attachment that occurs over the surface of the

joint, loads are spread, and stress concentrations are reduced. However, its limitation spans from the susceptibility of the adhesive to environmental degradation. (Robert and Messler, 1993).

2.21.1 Welding

Welding is the process of joining two or more materials by applying either heat or pressure or both to produce primary atomic or molecular bonds across the interface. According to Robert and Messler (1993), the process of welding may or may not include the need for a filler material of the same or different composition but of the same basic type of materials being joined. Traditionally welding and welding processes were commonly associated with metallic materials, but today it is possible to produce welds in ceramics and polymers. Robert and Messler (1993) also advocate that, the relative amount of pressure or heat or both needed to cause a weld varies. In relation to this they have categorize the amount of heat or pressure needed to form a weld as follows:

Fusion welding*:* welding is formed when enough heat is used to cause melting of the base material or materials with little or no pressure, except to bond the joint component in contact.

Solid – phase or nonfusion welding*:* only pressure is apply to cause a physical contact between the atoms and molecules of mating joint components. But in extreme case, where no heating is used, the process is commonly called cold welding. One special form of solidphase welding known as diffusion bonding, which uses varying degrees of pressure and temperature in appropriate combinations to accelerate diffusion kinetics in the solid state.

According to Robert and Messler (1993), there are two subdivisions of welding in which the base materials are heated but not melted, filler is added and melted and little or no pressure is applied. The two subdivisions of welding are:

2.22.2 Brazing

It is a welding type in which the joint is warmed to a suitable temperature in the presence of a filler material having a liquidus above 4500C (840F) and below the solidus of the base material(s). Bonding is accomplished without melting the substrate(s). The filler material is spread between the close fitting faying surfaces of the joint by wetting of the substrate and capillary flow. Bonding in brazing usually depends fairly significantly on inter-diffusion between the filler and the substrate(s)

2.22.3 Soldering

This is a type of welding like brazing, which requires the use of filler that melts and a substrate that withstand melting. However it is different from brazing in terms of temperature requirement, for instance whiles brazing requires temperature of 450^0 C soldering requires less. The joining force of soldering employs a form of mechanical locking which is a combination of microscopic interlocking of some feature of the component being soldered including the microscopic interlocking between the solder and substrate asperities.

Currently with advancement in technology, there are other process for joining materials that are either a variation or hybrids of the fundamental processes of mechanical fastening, adhesive bonding, brazing and welding. Some of these hybrids and variations are review below: metallic and ceramic systems which cannot be bonded by conventional fusion welding techniques. The bonding process produces joints with a uniform composition profile, tolerant of surface oxides and geometrical defects.

The transient liquid phase bonding (TLPB), according to Hanson and Fernie has the ability to produce a bond at a lower temperature than that at which it will be ultimately used. The

In addition to these forms of joining, some special hybrid and variation processes also exist which combines two or three type in joining components or materials together. Examples include;

i. ***Revet-bond*** – combines mechanical fastening by riveting and adhesive bonding.

ii. ***Weld-bonding****:* combines welding and adhesive bonding ***iii. Weld-brazing****:* combines welding and brazing.

2.23 Literature on some selected materials for this project

2.23.1 Aluminium

Aluminium (Al) is a compound of oxygen and other elements and a brilliant white metal which melts at a temperature of 660° C (1,220° F). The most inexhaustible metallic component, it constitutes about 8.1 percent of the Earth's crust. In its raw state it is malleable and pliable, however it can be alloyed with different components to improve its quality and give various useful properties. Aluminum composites or alloys are light, solid, and formable by all known metalworking forms. Aluminium can be cast, joined using a number of methods, and machined well, and they acknowledge a wide assortment of finishes notwithstanding its low density, a significant number of the utilizations of aluminum and its compounds depend on its high electrical and thermal conductivity, high reflectivity, and high resistance to corrosion. Its corrosion resistance is as a result of continuous chain of film of aluminium oxide that forms around and rapidly grows on a nascent aluminium surface exposed to air.(aluminium processing(2012). Encyclopædia Britannica.)

According to Agyemang (2010), aluminium is one of the most familiar metals because of its usage for domestic saucepans and other engineering works such as the building of

aeroplanes.He asserts further that, Aluminium does not only refer to aluminium in its pure state but also to all other alloys based on aluminium, all of which have vastly different properties.

Generally aluminium alloys are priced for both their lightness and non-rusting properties. With properties related to their softness they vary between very soft and very hard. Most of the alloys machine well but have the tendency to build up deposits on tools. Fabrications are normally done by riveting or bolting parts together. Finished Aluminium comes in different forms; this is available in sheets, bars or angles, or as castings that sometimes find their use in the workshop.

2.23.2 Properties of Aluminium

The properties of aluminium may be categorise into the following:

Weight: aluminiun is less dense; one of the best properties which make it the most opted metal for lighter works. It has a thickness that is one-third of that of a steel yet shows high quality

Strength: aluminum compounds normally have tensil strength of range between 70 and 700 MPa. Compare to most steel types, aluminum are not brittle at low temperatures. Rather, its increase in strength low temperature yet diminishes at high temperatures above 100 degree Celsius

Linear expansion: comparatively aluminium, has moderately substantial coefficient of linear expansion.

Machining: aluminum is easily worked with utilizing most machining techniques, for example, cutting, punching, boring, twisting and so on.

Formability: aluminum's malleability makes it simple to be manipulated into rolling of strips and foils, bending and other forming operations.

Conductivity: it is a good conductor of heart and electricity.

Joining: able to be joined; highlights encouraging simple jointing are regularly fused into profile design.

Corrosion resistance: aluminum's ability to resist a great number of chemical when it comes in contact.

KNUST

2.24 Silicone

Silicone is a kind of bonding substance that contains silicon and oxygen atoms. The main raw material is silicon (Si); trailing after oxygen, silicon is one of the most abundant elements in the Earth's crust. It is a compound in that; they are most ordinarily discovered joined with oxygen as silica. The silica is often lowered to obtain silicon metal, which is reacted with different composites to create silicones: "a class of synthetic resins with both organic and inorganic attributes". Silicone comprises of a backbone of exchanging atoms of silicon and oxygen known as a siloxane linkage (Si-O-Si), which are connected with different organic groups. Distinctively, silicones are very impervious to high and low temperatures, oppose degradation by UV beams, repulse water, and display a scope of different qualities. Also, they are created in numerous products including silicone liquids, resins, fluid rubbers and solid rubbers.

Shin-Ets (2005) opined that: "…play a vital role in practically all fields including the electronics industry, the transportation industry, chemicals, textiles, foods, cosmetics, and the construction industry''

In addition to this, it is additionally utilized as a part of numerous zones in light of its solidness, both synthetically and thermally. Silicone paste is likewise impervious to weathering and moisture, not at all like numerous different glues. This flexible substance comes in various

forms that can be blend or use as a solitary item. It can be devised for use on a wide choice of surfaces and can likewise be adjusted for use with natural solvents and acidic chemicals. Able to withstand hot and frosty temperatures, silicone adhesive is a top selection in numerous holding applications. (Silicone-silicon.com June, 2015)

KNUST

2.25 Sealant Adhesives and Material Compatibility

Sealant materials come in many forms and types, however the most critical sealant specifics for a work is to consider is the sort of material the sealant is intended to work with. Utilizing a sealant on an incompatible product material can be a potential danger in its viability or render it totally futile. In addition, it is essential to consider various key factors, including stability, bond quality, and suitability to a proposed application (Continuing Education Center, 2016; HIS Engineering, 2016).The accompanying table 2.6 records the material compatibility of some common sealant groups and cure.

Table: 2.5: Sealant adhesive and its material compatibility

Composition	Cure Method	Material Compatibility					
***	***	Ceramic	Concrete	Metal	Plastic	Porous	Ruber
Acrylic	Various	x					

Elastomer	Various					x	
Epoxy	Room temp					x	x
Phenolic	Thermoset			x			
Polymer	Hotmelt		x	x	x		x
Silicone	Room temp	x	x	x	x		x
Wax	Hotmelt	x		x			

Source: (IHS Engineering, 2016)

Ceramics are oxides, carbides, nitrides and other non-metals with high dissolving temperatures. Ceramic parts are good and attach well with various sealant materials, including acrylic, silicone, epoxy, and polyurethane.

Concrete and cements are utilized to manufacture structures, establishments, walls, bridges, and different structures. Basic concrete sealants incorporate fluid silicone, polyurethane froth, and silicone/foam hybrids

Metal parts are usually joined utilizing silicone sealant, which is particularly perfect with iron, copper, aluminum, and steel. Polyurethane and other polymer sealants are likewise ordinarily used to seal metal joints.

Plastics are organic, synthetic, or handled materials made of thermoplastic or thermosetting polymers. Polyurethane/silicone cross breeds work best with plastic parts. Some sealant materials are contrary with certain plastic materials. For instance, polysulfide and unadulterated polyurethane sealants may bring about acrylonitrile butadiene styrene (ABS) or polyvinyl chloride (PVC) parts to solidify and break.

Porous surfaces are secured with little holes or openings. Sealants for this joining of permeable parts regularly have high thickness or a gel-like consistency, and incorporate elastomers, polymers, epoxies, and silicone.

Rubber on the other hand, elastomer parts are described by a high level of flexibility and elasticity. Epoxy and polyurethane/epoxy hybrid sealants function well with rubber materials.

In addition, sealant material/adhesives such as silicone also works best as bonding agent between dissimilar materials like ceramic and metal.

2.25.1 Properties of silicone sealant

1. Ability to withstands very high and low temperatures
2. Good resistance to water, ultra-violet beams, oxygen and ozone
3. Very low toxicity
4. Resistance to many chemical such as acid, alkalis, salt and others

2.25.2 Uses of silicone sealant

Silicone comes in different types and forms its usage is seen in homes, construction industries, automobile and others.

2.25.2.1 Home Repairs and Maintenance

Silicone sealant is used in the homes to repair projects, where it is especially useful for caulking joints and cracks. Water-resistant silicone is regularly used to fill holes and to seal off any gaps and seams. It can also be used to level surfaces in the home. For example, **R4 hjfdx+ 2. Sealant and Bond for Glass- a**type of sealant, surpassing the abilities of most other adhesives. Known to be flexible and durable, it has strong binding properties that can be applied to almost any surface, including plastic, metal, and glass.

It is regularly utilized as a part of fixing glass on aquariums. With its water-resistant properties, it gives a perfect option for glass tank producers. It is additionally utilized for glass-on-glass applications, including glass beautifications and works of art.

2.25.2.2Construction Sealants and Adhesives

Commonly used in commercial and home construction, silicone adhesive is utilized as a sealant or bond on materials that will be presented to different climatic conditions, including direct daylight, downpour, strong wind, or cold temperatures. This incorporates fixing glass windows in structures, and also fixing the crevices between the glass windows and edges.

Silicone sealant is additionally utilized as a coating and washroom sealant.

2.25.2.3 Automobiles, Electronic Devices, and Appliances

Silicone adhesive is utilized as a part of assembling for a wide assortment of merchandise, from vehicles to machines. Its capacity to withstand compelling temperatures makes it a perfect holding agent or sealant for assembling durable products. The automotive industry uses a silicone sealant almost anyplace a joint or interface is expose to high temperatures – this incorporates motor gaskets and forced-induction systems. It is likewise effective for some

vehicles motor applications; it is frequently utilized as a part of auto gaskets that have a high-temperature environment.

Aside automobiles, silicone sealant is utilized as a part of the assembling of electronic gadgets and machines. Here it is utilized as both a sealant and holding operators. It is usually used to seal cables and sensors in machines and electronic gadgets.

KNUST

2.26 Porcelain

From Wikipedia, the free encyclopedia define porcelain as a ceramic materials made by warming materials, usually including kaolin, in a furnace to temperatures range of 1,200 and 1,400 °C (2,200 and 2,600 °F). According to McMahon (2003), porcelain is a type of ceramic, characterized as being very hard, translucent-white and was first fabricated in China since the 600s, and in Europe since the 1700s. She added that, since it was connected with China and much of the time used to make fragile plates, mugs, vases, and different works of compelling artwork, it is some of the time known as "fine china."

From the internet, http:/www.mark4antiques.com/index htm, porcelain is a type from the general term ceramics which generally refers to products made of fired clay.

2.26.1 Types of Porcelain

McMahon (2003) categorizes porcelain into hard paste porcelain and soft paste porcelain. She further explains that, some artists make the differences between hard paste porcelain; made in the customary Chinese style and soft paste porcelain, declaring that only soft paste is true china, however the terms are utilized reciprocally by most of the rest of the world.

2.26.1.1 Hard-paste porcelain or true porcelain

This is a type of high-fired ceramic product that displays translucent properties and is made from kaolin (white mud) and petunse (a kind of Feldspathic rock). The kaolin is refractory and binds a piece together while in the furnace and petunse fuses into a natural sort of glass that gives it its smoothness and splendor. True or Hard Paste Porcelain is normally fired at 1450 °C. It allows for "tighter" modeling and more robust shapes, even in complicated or very thin designs. Most designed Porcelain Figurines, Urns, Centerpieces and so forth are made utilizing True or Hard Paste Porcelain of this type.

2.26.1.2 Soft-paste porcelain or artificial porcelain

The termed ‘soft’ is use to denote this type of porcelain as a result of its capacity to be cut with a file which Hard paste porcelain cannot. Soft paste porcelain is additionally made of the same materials as Hard Paste, but the distinction between the two is in the temperatures used while firing in the kiln, the Soft-past uses temperature at around 1200 °C. In view of this lower Kiln temperature, Soft Paste Porcelain has a tendency to be more granular and permeable since the component materials do not vitrify (intertwine) as compared to Hard Paste Porcelain. In addition to this, the surface is fairly less white or splendid and has a practically plush or marble-like feel to the touch.

Additionally, bone-ash (ashes from burned animal bones, mostly cattle) is at times added to the composite (kaolin and petunes) of hard paste porcelain referred as bone China. The presence of the bone ash is; bone ash contains lime and phosphoric acid, which helps in combining all of the elements and allowing for a steadier final product, even at the lower temperatures required for Soft Paste Porcelain. In manufacturing setting, this implies less damage as a result of breaking in the Kiln and less waste or rejects, thus less cost. In Decorative Arts terms, it implies that an article with no less than 30 percent blend of Bone

Ash, can likewise accomplish a comparative splendor and translucence, ordinarily seen on Hard paste Porcelain, however at the lower expenses of producing Soft Paste.

Other than a true experimental examination performed at a Lab, a brisk and reasonable approach to affirm if a thing is made of a specific type of porcelain is to look at an unglazed uncovered or broken piece to decide how permeable or granular its interior body is. As a fast dependable guideline, granularity implies Soft Paste, while minimized and intertwined implies Hard Paste; Bone China is more splendid than Soft Paste yet less so than Hard Paste. Additionally, by and large, Hard Paste Porcelain is the sturdiest of the three types, with Bone China coming next and Soft Paste third.

Finally, some different terms utilized for porcelain includes: Soaprock or Soapstone Porcelain: utilizes soaprock, a soft Steatite mineral that feels like soap, likewise called French Chalk. Biscuit (other name Bisque): Unglazed Porcelain (of numerous types) or Earthenware which has been fired only once. It has a distinct marble-like appearance, also called Parian ware, and is used mostly for Modeling or Busts.*(*www.marks4antiques.com)

2.27 Uses of porcelain

Julian (2010) opines that, the many uses of porcelain have been found for a great number of applications. According to him, a standout amongst the most surely understood employments of porcelain at the present time is in the field of dentistry, where porcelains are used as forms of veneers and bridges, due to their close resemblance to the properties of the set of real teeth. Because of their high resistant characteristics, they are best used to combat stains as compared to other materials. Julian further put other uses of porcilain as follows:

In engineering use, porcelain veneer is utilized as sheathing as a part of top quality building applications, both for exterior and interior. A wide range of structures, including homes, child

care centres, office edifices, historical centers, and skyscrapers, are utilizing this enamel as a part of their design. It is additionally utilized as a wall board for writing in school classrooms, in signs and restroom dividers, and as linings for passages and subways. Porcelain tiles are utilized on floors and walls, both inside and out. They are fabulous in bathrooms and kitchens where moisture is an issue, since they are actually water-resistant. These tiles are additionally extremely attractive and come in a variety of hues, styles, and sizes. Porcelain makes to a great degree tough flooring as can be authenticated by antiquated mosaic floors that in any case look flawless hundreds of years after they were installed. In our homes we owe the magnificence and usefulness of numerous basic products to porcelain enamel. Bathtubs, sinks, toilets, stoves, clothes washers and dryers, water warmers, flame broils, and broilers are all covered with porcelain enamel. Thus it makes them look pleasant, as well as it has properties that make it an excellent choice for these applications. Since it will not stain, scratch, assimilate moisture, be harmed by chemical cleaning products, or rust, it gives a surface that makes our gadgets and washroom fixtures stay looking pleasant for longer period of time.

In addition to the many uses of porcelain, it also has huge impact in producing companies such as food production, agricultural uses, petrochemical products, metropolitan waste water facilities and commemoration plaques, to give some examples. As researchers keep on finding more uses for porcelain materials. It is for sure that other applications will soon be developed for more uses of the porcelain materials.

2.28 Cement

From Microsoft Encarta (2009), define cement as any material that hardens and becomes strongly adhesive after application in plastic form. It further states that:“the term cement is often used interchangeably with glue and adhesive”. In architecture the term generally refers

to a finely powdered, fabricated substance comprising of gypsum mortar or Portland cement that solidifies and adheres when water is added.

Cement serves as a bond between elements, in that it sets and solidifies and can tie different materials together. "Cement" originates way back from the Roman expression opus caementicium, used to portray masonry resembling modern concrete that was produced using smashed rock with burnt lime as binder. (Wikipedia, the free encyclopedia, 2016).

Encyclopædia Britannica 2012, generally classified cement as an adhesive substance of all kinds, but, in a narrower perspective, it refers to cement as binding materials used in building and civil engineering construction.

However, cements for constructional works can be characterized as being either hydraulic or non-hydraulic, depending on the capacity of the cement to set in the presence of water ***Non-hydraulic:*** cement of this type does not set in wet conditions or underwater; rather, it sets as it dries and reacts with carbon dioxide present in the air. It can be damage by some forceful chemicals in the wake of setting.

Hydraulic cements**:** (e.g., Portland cement) it adhere to a solid state because of a substance reaction between the dry elements and water. The chemical response results in mineral hydrates that are not extremely water-solvent as are entirely strong in water and safe from substance attack. This permits setting in wet condition or underwater and facilitate shields the solidified material from substance attack. The chemical process for water hydraulic cement found by old Romans utilized volcanic powder (activated aluminium silicates) with lime (calcium oxide).

2.29 TYPES OF CEMENT, COMPOSITION AND USES

For convenience the type, composition and uses of cements have been grouped in table 2.8 below:

Table 2.6: Types of cement, composition and uses

Types of Cement	Composition	Purpose
Rapid Hardening Cement	Increased Lime content	Attains high strength in early days it is used in concrete where form work are removed at an early stage.
Quick setting cement	Small percentage of aluminium sulphate as an accelerator and reducing percentage of Gypsum with fine grinding	Used in works is to be completed in very short period and concreting in static and running water
Low Heat Cement	Manufactured by reducing tricalcium aluminate	It is used in massive concrete construction like gravity dams
Sulphates resisting Cement	It is prepared by maintaining the percentage of tricalcium aluminate below 6% which increases power against sulphates	It is used in construction exposed to severe sulphate action by water and soil in places like canals linings, culverts, retaining walls, siphons etc.,
Blast Furnace Slag Cement	It is obtained by grinding the clinkers with about 60% slag and resembles more or less in properties of Portland cement	It can used for works economic considerations is predominant.
High Alumina Cement	It is obtained by melting mixture of bauxite and lime and grinding with the clinker it is rapid hardening cement with initial and final setting time of about 3.5 and 5 hours respectively	It is used in works where concrete is subjected to high temperatures, frost, and acidic action.
White Cement	It is prepared from raw materials free from Iron oxide.	It is more costly and is used for architectural purposes such as precast curtain wall and facing panels, terrazzo surface etc.,

Coloured cement	It is produced by mixing mineral pigments with ordinary cement.	They are widely used for decorative works in floors
Pozzolanic Cement	It is prepared by grinding pozzolanic clinker with Portland cement	It is used in marine structures, sewage works, sewage works and for laying concrete under water such as bridges, piers, dams etc.,
Air Entraining Cement	It is produced by adding indigenous air entraining agents such as resins, glues, and sodium salts of Sulphates etc during the grinding of	This type of cement is specially suited to improve the workability with smaller water cement ratio and to improve frost resistance of concrete.
	clinker.	
Hydrographic cement	It is prepared by mixing water repelling chemicals	This cement has high workability and strength

Source: www.theconstructor.org

2.30 Conclusion

The review of related literature has given the researcher a deeper understanding with regards to the processes, methods, behaviour and properties of materials used for making memorial plaques. Moreover, discoveries were made on researches related to ceramics and metals more especially classification and appearance pertinent to the selection of ceramic and metal for specific purposes. The researcher was also enlightened on some adhesive types, lettering registering techniques and joining techniques for joining dissimilar materials.

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter has been grouped into two parts; the first part is made up of the research methodology used for executing the project work. It is arranged as follows; the research design which comprises the case study, descriptive and experimental research methods; population for the study; sampling; data collecting instrument used; libraries visited; study areas; primary and secondary sources of data. The second part consists of the manipulation of some selected materials, using appropriate processes and methods to produce sample plaques.

3.2Research Design

The main purpose of the study is to find interventional approaches to improve upon the problems associated with plaques produced at Tafo by the local plaque artisans. The researcher adopted the experimental, descriptive and case study research methods based on the qualitative research approaches for the study. Bernard (1995); Denzin and Lincoln (2000) as quoted by Mensah (2011), were with the view that the purpose of qualitative research tries to investigate issues, comprehend and answer questions. It is utilized to acquire knowledge into the traits of individuals, behaviour, value systems, concerns, inspirations, goals, culture and way of life. It likewise searches out the "why" and not the how of its subject through the investigation of unstructured data. Best (1981) opines that, qualitative research is the type in which the description of observations is not ordinarily expressed in quantitative terms. In actual sense this does not imply that numerical measures are never used in qualitative research, but it is not largely dependent on numbers. That is to say research approach of this type is usually based on quality rather than quantity as used in this project.

Ary et al (2002) are of the view that qualitative research method investigates the qualities of relationships, activities, situations or methods within a given context. Prior to this, in this research work, data were gathered through interviews and observation to ascertain the causes of the phenomenon. The approaches involved in selecting suitable processes, methods in relation to selection of materials to produce plaques that are comparatively cheaper, devoid of text fading, free from corrosion and to minimize the problem of metal plaque theft were described in qualitative terms.

3.2.1 Case Study Research

A case study is a description of a real situation that lends itself to the application of methods and also invites reflection and provides an opportunity for discussion. (Tryfos, 1996; Leedy and Ormrod, 2005; and Cohen et al., 2007).In this study, the activities including the processes, methods, materials used by the local plaque artisans to produce plaques at Tafo cemetery needed to be looked into, analyzed in order to identify the root causes of the problems. The case study was adopted by the researcher so as to discover the true nature or inner relationships of the problems as they exist and the needed interventions necessary to curb the phenomenon.

3.2.2 The Descriptive Method

According to Leedy (1981), “the descriptive method deals with a situation that demands the technique of observation as the principal means of collecting the data.” Nyante (2010) was with the view that:“data collected in descriptive research are particularly susceptible to distortion through introduction of bias judgment into the research design”. Although descriptive research depends upon perception for the securing of data, the data must be organized and well-presented chronologically so that valid and precise conclusions can be drawn. He further asserted that, it is a type of research that essentially looks for accuracy of the phenomena as it exist at the time and describes precisely as what the researcher observes. The descriptive

method was used to describe the processes, methods employed to execute the project work as well as the experiments conducted in manipulating the selected materials and processes and techniques adopted through data collected towards the production of the sample plaque(s).

3.2.3 The Experimental Methods

According to Ary et al (2002), the experimental research presents sequential and logical methods for answering questions. It intentionally and efficiently controls certain stimuli, treatments or natural conditions and watches how the condition or conduct of the subject is influenced or changed. Experimental research makes it possible for the research to be replicated. In addition, Best (1981) advocates that experimental research method describes what will be when certain variables are carefully controlled or manipulated. Experimental research manipulates one or more independent variables in controlled settings. It focuses on relationships between variables and draws conclusions.

The experimental method was used for investigating into the processes, methods and properties of the existing materials in order to ascertain their suitability and effectiveness relevant for making plaques. This was done through careful manipulations of materials (taking into account the properties of the materials), Experimental research gives a precise and logical methods for answering questions. It intentionally and methodically controls certain boosts, treatment or natural conditions and watches how the condition or conduct of the subject is influenced or changed. Experimental research makes it possible for the research to be replicated. Experiments conducted provided the researcher with concrete and in-depth knowledge on which techniques or methods to adopt to achieve the objectives of the research.

3.2.4 Library Research

Literatures documented were gathered from the following libraries:

- KNUST Main, library, Kumasi
- Faculty of Art Library, Kumasi
- Kumasi Polytechnic Main, Library
- The University of Education Winneba Library, Kumasi branch

Data were also collected from the following sources: internet and documentary sources from books, unpublished thesis, journals and periodicals.

3.3 Population for the Study

According to Sidhu (1984), population is characterize as the complete set of people, items or events having regular discernible qualities in which the researcher is intrigued. It may also refer to as the aggregate of totality of objects or people with respect to which inductions are made in a sampling study. Population does not necessarily refer to people but may also refer to objects. It may be finite if its members can presumably be counted or infinite if its members cannot be definitely known. The population for the study consisted of artists from various fields including pottery and ceramics, sculpture, graphic design and metalwork. The population for the study is a heterogeneous one.

3.3.1 Target Population

Fraenkel and Wallan (1993) opines that, target population is the type which the researcher would really like to generalize and is rarely available. He further explains that target population is usually large and difficult to access by the researcher. For this reason, researchers usually take a sample size from the target population for their study. The target population for the study included all plaque artist/artisans within the Kumasi Metropolis.

3.3.2 Accessible Population

Accessible population is the type which the researcher is able to generalize. Population that the researcher is able to access is what is termed as the accessible population. The accessible population for the study was made up of plaque buyers, plaque artists/artisans either trained through apprenticeship or formal education or doing it for commercial purpose or as an academic work. The study area is restricted to Tafo, Center for National Culture and KNUST all in the Kumasi Metropolis; these three areas were selected because plaque artists/artisans needed for the study were found there. Again these areas were known for plaque making and other works such as ceramics works, sculptural works, and mixed media works etc.

3.4 Sampling Technique

According to Quartey and Awoyemi (2002), sampling is a subset of the population and comprises of people, items or events that form the population. It is a selected group which is fair and an adequate representation of the entire population of interest. However, Nyante (2010) advocates that, the use of sampling technique in research is very important in that when the population is very large, it cannot be satisfactorily covered. Also when the data is unlimited, the use of sampling technique is very helpful. Moreover, when the number of individuals to be studied is manageable, intensive studies become possible. There are various types of sampling techniques within which a researcher can choose from depending on the type of research being undertaken.

This study employs the simple random sampling method where members from the parent population were randomly selected and studied; with the reason that this sampling eliminates biases and helps the researcher to obtain reliable or authentic data. Simple random was used to select plaque buyers and scrap dealers.

Moreover, the purposive sampling was also employed to select artist or artisans who must have produced a plaque(s) for academic work/project or artists/artisans who produce plaques for commercial purpose. This sampling technique was used because the researcher needed only those artists or artisan who produced plaque(s).

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3.4.1 Sample Size

In all, one hundred (100) plaque artisans and buyers were selected as the sample for the study. The sample included forty (40) local plaque artisans; ten (10) from department of communication design comprising 2 lecturers and 8 students; ten(10) from Department of Ceramics comprising 2 lecturers and 8 students; ten (10) from Department of Painting and Sculpture comprising 2 lecturers and 8 students; ten (10) from Department of Industrial art (metal section) comprising 2 lecturers and 8 students; ten (10) from Department of Integrated Rural Art and Industry comprising 2 lecturers and 8 students and ten (10) plaques buyers. The sample size has been summarise below: **Table 3.1: Summary of sample size**

Population	**Location**	**Sample size**
Local plaque artisans	Tafo cemetery and Center for National Culture, Kumasi	40
Lecturers and Students	Department of Communication Design, KNUST	2 8
Lecturers and Students	Department of Ceramics, KNUST	2 8
Lecturers and Students	Department of Painting and Sculpture, KNUST	2 8

Lecturers and Students	Department of Industrial Art (metal section), KNUST	2 8
Lecturers and Students	Department of Integrated Rural Art and Industry, KNUST	2 8
Plaque buyers	Kumasi	6
Scrap buyers and collectors	Saume Magazine and Aboabo, Kumasi	2 2
Total		100

3.5 Data Collection Instruments

Instruments for collecting data, also known as research devices or tools are means through which a researcher gathers his or her data. These tools or devices include: interview, observation and questionnaire. For the purpose of this study; interview and observation were the adopted tools used for the data collection.

3.5.1 Observation

Nyante (2010) opines that, "observation is regarded as the most direct means of studying people when one is interested in the overt behaviour." He further asserts that observation is a natural way of collecting data for research. Observation as used in research is of two main forms; the participant and non-participant observation. However, the non-participant observation type was used for this research to gather the information needed**.** It is type of observation in which the researcher is not directly involved in the activities or situation being observed but sits directly on the sidelines and watches what is going on. Nyante (2010) opines that, this type of

observation helps to gather realistic and true data since the subjects being studied are not aware that they are being observed and for that matter will be in their natural selves. The researcher during the study employed non-participant observation to observe the production activities of the local plaque artisans. This gave the researcher prerequisite knowledge based on the techniques, methods, tools and material used by the local plaque artisans which contributed greatly towards the making of the alternative plaques.

3.5.2 Interview

Interview is described by Sihdu (2003) as:"a two-way method of interaction which permits exchange of ideas and information." Mensah (2011) advocates that, it is unique as it were that it includes the accumulation of data through direct verbal cooperation between the questioner and the interviewee. It usually requires the actual physical proximity of two or more persons and generally requires that all the normal channels of communication be open to them. Interview can be described as a conversation with a purpose and the purpose is geared towards gathering of information (Berg, 2007). For convenience, Berg has categorized interviews into three main types namely: "structured interview, semi-structured interview and the unstructured interview".

Turkson (2011) as cited by Ntim (2015) 'with regard to unstructured interview technique, the interviewer does not predetermine the questions to be answered by the respondents. It does not follow strict procedure and logical pattern. It gives room for flexibility'. This is to make respondent feel free to express themselves. The conversations were recorded unaware since some of the localartisans' fidget at the sight of the recorder, so the researcher had no choice than to tap the conversation unaware of the respondents.

3.6 Primary Data

Primary data were the essential data gathered through the application of the research tools adopted: interview and observation. The keen observations made on the activities of the local plaque artisans and the plaques found at the cemetery served as a resource for collecting primary data on the tools, materials, methods and processes for producing plaques. Views gathered from people who were well versed in the area of the study, which include; lecturers, masters and senior apprentices form the foundation of the research findings, upon which the alternative strategies were developed.

3.7 Secondary data

Secondary data were obtained from the libraries visited, adequate secondary data that are relevant to the study, were gathered from several documented literary materials from sources such as: books, articles, journals, encyclopaedias, catalogues, magazines and the internet.

3.8 Data Collection Procedure

The interviews were conducted in one of these two ways: on a one-to-one and one-to-many basis. The researcher asked the questions and the respondents provided answers. Adoption of unstructured interviews helped in gathering data from art lecturers from the various departments, KNUST; students' artists, KNUST; local plaque artisans at Tafo and Center for National Culture, Kumasi; plaque buyers, Kumasi. The interviews were audio-taped and later transcribed. Copies of the transcript were later sent to the interviewees for them to ascertain whether the information gathered was exactly what they gave out.

Adequate secondary data were also obtained from books, publications, thesis, and internet. With reference to the data collected, the researcher identified the various methods, processes and material properties and characteristics necessary for the research work to be carried out.

3.9 Data Analysis Plan

The primary and secondary data collected were assembled, described, analyzed, interpreted and served as a guide for achieving the set objectives of the study. Data were described in words and where numerical data are used they come in the form of simple tables.

Conclusions and recommendations were finally made base on the data collected.

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3.10 Data Collection for Research Question One

What are the types and causes of the problems associated with plaques produced at Tafo cemetery?

a) *Types of plaques produced at Tafo cemetery?*
b) *Causes of the problems associated with plaques produced at Tafo cemetery*

The objective of this research question was to investigate into the causes of the problems associated with locally produced plaques at Tafo cemetery with the view to identifying or finding alternative approaches as a means to improve upon the qualities of plaques produced at the cemetery. Since the plaque industry seems to have been left in the hands of the local plaque artisans, case study was used to probe into the activities of the local plaque artisans to unearth the root cause of the problems. The researcher adopted the non-participatory observation and interviews to critically analyze and assess the impact of the operations of the local artisans in relation to the effects the operations had on the plaques produced.

Moreover, one identified cause (metal plaque theft) which was not a direct cause by the operations of the artisans was also assessed in relation to the provision of alternate approaches to minimize them. Data gathered from primary and secondary sources were the yardstick for developing the alternate strategies and also answering the research question one.

Below are the causes of the problems identified.

1. Fading of text as a result of poor material/media usage and their inability to withstand the changes in weather conditions.
2. Removal of metal plaques caused by corrosion and metal scrap dealers who removed and sell them as scraps for quick money.
3. Less innovative plaques produced over the years as a result of same procedures transferred from one master to the apprentices.

Plate 1: Metal and Porcelain Memorial Plaques with faded text

Source: Tafo cemetery, 2015

Plate 2: Removed Metal Memorial Plaque by scrap collectors Source:

Tafo cemetery, 2015

3.11 Data Collection for Research Question Two

What strategies are there to adopt to minimize the problems of metal theft, metal corrosion and the fading of text inscriptions found on plaques at Tafo cemetery?

In order to developed and adopt alternate strategies that will help minimize and improve on the quality of plaques produced at Tafo, the researcher relied greatly on the available processes, methods and technologies gathered through the review of the related literature, observations made at the various working sites, experiments and ideas gathered from lecturers, students and artisans who are experts in the field. The ideas gathered were translated into concrete form and developed into alternate strategies, some of the technologies adopted were tested to identify their suitability while others were possible strategies identified and proposed to replace some of the old media used as means of enhancing the quality and also to ensuring a permanent registration of text on the substrate or the base material. The adopted alternative strategies are presented and discussed in chapter four.

3.12 Data Collection for Research Question Three

How can a sample plaque(s) be produced based on the study?

3.12.1 General Working Procedures

This section deals with the systematic processes that were followed in the execution of the project work. Based on the data collected series of technologies as in the formsof tools and equipment, techniques, processes, media and materials were adopted.

3.12.2 Tools and Equipment for making plaques

Tools and equipment come in many forms and each type of tool or equipment has a type of work designed for. However it should be noted that some of these tools and equipment can only

be used for a specific type of job while some are multipurpose and can be used for different kinds of works. Among the tools and equipment selected include:

1. Felt saw
2. Hack saw
3. Cutter
4. Metal ruler
5. Filing tools
6. Sand blasting machine
7. Hand trowel.
8. Soldering iron
9. Scissors
10. Knifes
11. Pencils
12. Caulking gun
13. Squeegee
14. Hand driller
15. Lead
16. Soldering iron

3.12.2 Materials and Media Used for the Plaques

The study employed ceramics- porcelain as the base material for the project. Other materials used include metal (alloys and anodixe/anodixe alluminiun), silicone sealant, rubber sticker material, cement, sand and iron rods, wooden frames and others.

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3.12.3 Techniques Adopted

1. Stenciling
2. Sandblasting
3. Joining techniques used: adhesive and soldering

3.13 Activity one: experimental test of some available adhesives on ceramic and metal to determine their possible application.

Adhesives work best when used to join materials having the same properties, joining two dissimilar materials such as metal and ceramics required adhesives that can adhere to both materials. With this reason it was therefore necessary for the researcher to look at how some of these adhesives could still hold between the two materials. The data collected outlines a number of adhesives that work best on ceramics and metals. However, since the researcher intends pasting aluminum (smaller unit) to porcelain base (bigger unit) it was necessary to test their adhering capabilities. The adhesive sample selected for the study was Acetic silicone sealant (common name silicone), this type was selected from the lot based on the following properties which was the basic requisite for the experiment:

1. Ability to withstands very high and low temperatures
2. Good resistance to water, ultra-violet beams, oxygen and ozone
3. Very low toxicity
4. Resistance to many chemicals such as acid, alkalis, salt and others

3.13.1 Surface adhesion test for aluminum and porcelain

The surface area of about 1inch x 1inch of aluminum and porcelain were roughened, this was to give room for both surfaces to receive enough sealant for adhesion necessary for joining.

The sealant was applied between the aluminum and porcelain using the same surface dimension to ascertain their adhesion strength. After this the joining were left for some time to dry. Observations were made after curing to ascertain how well the bonding has been made between the materials; followed by lifting test(with thumb nail and the chisel edge) this was to check the strength ability of the bond. The observations and findings of the experiment helped the researcher to make certain decisive decisions when joining aluminium to ceramic

Plate 3: Surface adhesion test of metal and ceramics using silicone sealant

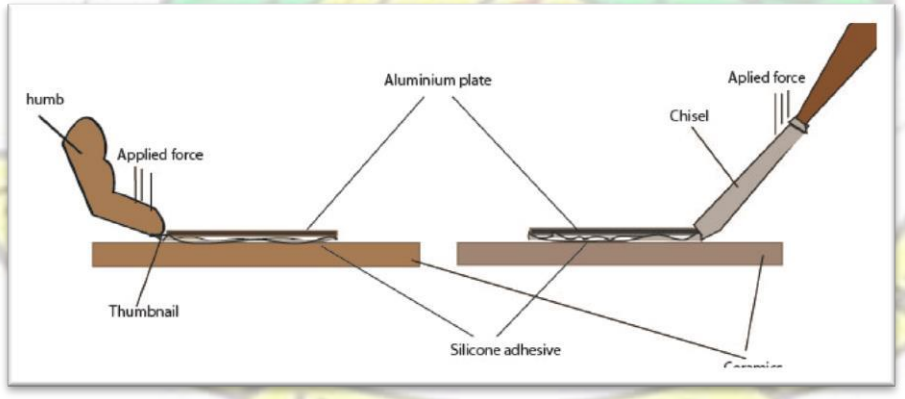


Figure 3.1 Thumbnails and chisel lifting tests

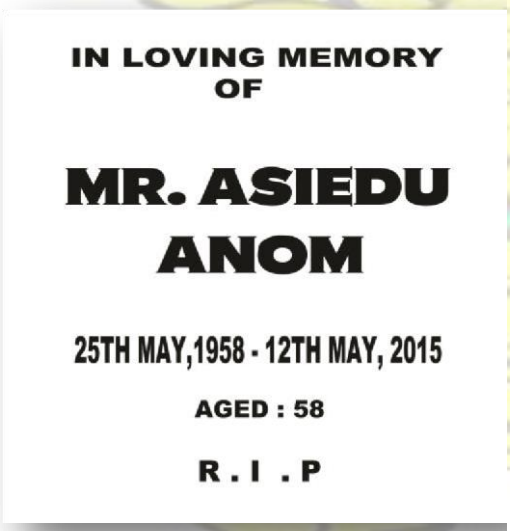
3.14 Identification, Collection and Processing of Materials for the Project

The various materials needed were collected for the project. Since most of these materials were on it raw state, those that needed to be worked on were processed to suit the part in the project accordingly. Aluminum coated and non-coated, porcelain, tiles, tiling grout, cement, sand and tiling cement.

3.14.1 Activity two: cutting text from aluminum plate

Step 1.Aluminum plate having a size of 12x12 inches with thickness measuring about 0.5mm was selected and the surface thoroughly cleaned.

Step 2. A rubber sticker with a printed text measuring 12x12inch were pasted on the aluminum, making sure that it has been smoothly pasted. It should be noted that registering the text on the sticker can be done in two ways, either by hand written or by printing. The plates below show the two ways by which the text or lettering can be registered on the rubber sticker.



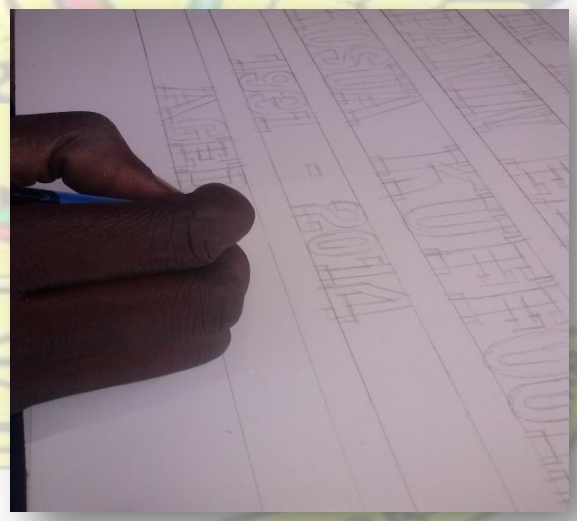


Plate4: Printed text Plate 5: Hand written text

Step 3. The text were then cut out using the printed/written lettering as a guide with the help of the felt saw, scissors and the knifes

Plate 6: Pieced text from aluminium

3.14.2 Activity three: cutting of tiles into smaller units

Step 1. A white tile of about 14 x 14 inches was divided into sections about 2 inches each apart.

The tile is then cut into rectangular blocks using the marked outlines as a guide.

Plate 7: Marked ceramic tiles

Plate 8: Cutting of tiles

3.15 Production of the projects

3.15.1 Designing

The ideas adopted for the projects were represented in thumbnail sketches. These ideas were then transformed into a concrete form in Rhinoceros. This was to guide and give a feel of how the finished works will look like.

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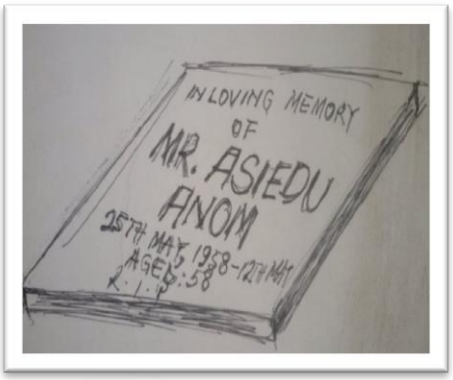

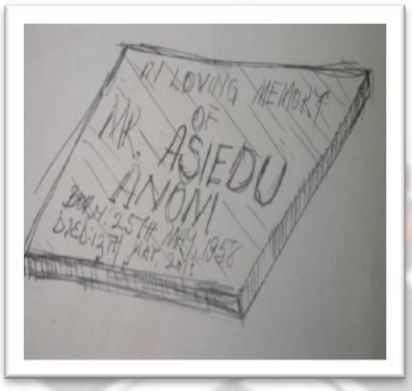

Plate 9: thumbnailsketch 1 Plate 10: thumbnail sketch 2 Plate: 11 thumbnail sketch 3

3.15.2 Design in Rhinoceros

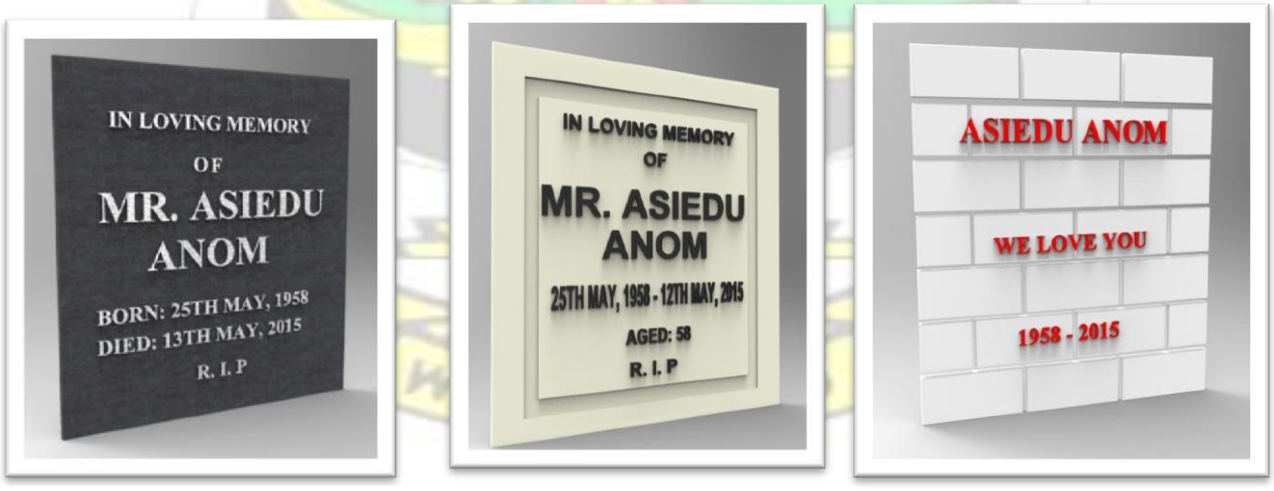

Plate12: Design 1, 2 and 3 in rhinoceros

3.15.3 Project one

Step 1: A wooden frame of size 21x18inches was constructed to be used as a support for the mortar that will receive the cut ceramic tiles.

Plate 13: Cutting of wood to the

Plate 14: Joining the pieces together

Plate 15: The wooden frame required size

Step 2: the base of the frame was supported with plywood (a little bigger than the frame). A metal mesh was then place inside the frame to serve as armature for the mortar.

Plate 16: Prepared frame ready to receive the mortar

Step 3: Mixture of tile sand (a special sand prepared from sieved sand), cement and sand were used to form the mortar. This was mixed with water to a consistency that would be able to hold the cut tiles. The mortar was then used to fill the frame to the brim and was levelled.

Plate 17: Preparing the mortar

Plate 18: Filling the frame with mortar to receive the tiles

Step 4: The adhesive (acetic silicon sealant) was applied to the inner part of the aluminum cut out text. The texts were then arranged and pasted on the rectangular ceramic tiles. The extra projections added to the text were then bent to lock at the back of the tiles as reinforcement before they were firmly pressed onto the mortar as shown below:

Plate 19: Applying silicone to back of font

Plate 20: Pasting text on the tile

Plate 21: locking the text at the back of tile

Plate 22: Pasting the tile with the text

Step 5: After all the text on the tiles have been arranged on the mortar. The next was filling

of gaps in-between the tiles with cement bursts. The debris was then cleaned and the rubber stickers were removed to expose the colour of the text as illustrated with pictures below.

Plate 23: filling the gaps with cement burst

Plate 24: Cleaning debris from the work

Plate 25: The rubber sticker was removed to expose the text

3.15.4 Project two

Step 1: Preparation of porcelain for the text registration using the sandblasting technique. A black porcelain tile measuring 21 x 20 inches was selected and the surface thoroughly cleaned. A plain rubber sticker having the same size of the porcelain tile was then pasted on the porcelain tile. A second one with the printed text (plate 4 above) was pasted on the porcelain for the second time; this was to serve as the template text on the base porcelain. The text was stencilled cut and the cut portions removed. This was done so that the stencilled portions, which will form the text inscription, will be the only part to receive the sand grits from the sandblasting machine to create the text.

Step 2: The sandblasting gun was used to engrave the surface of the porcelain tile by directing the gun's mouth towards the stenciled parts only. The sandblasting gun uses pressure to force out sand grits through the nostrils to the part which needed to be engraved, the grits gradually cut through the surface leaving flat sunken in text on the porcelain surface.

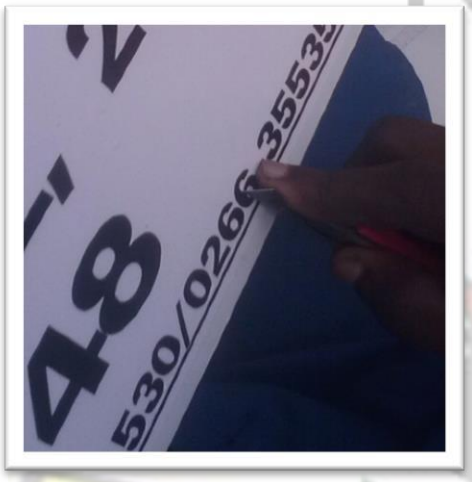

Plate 26: Cutting the stencil

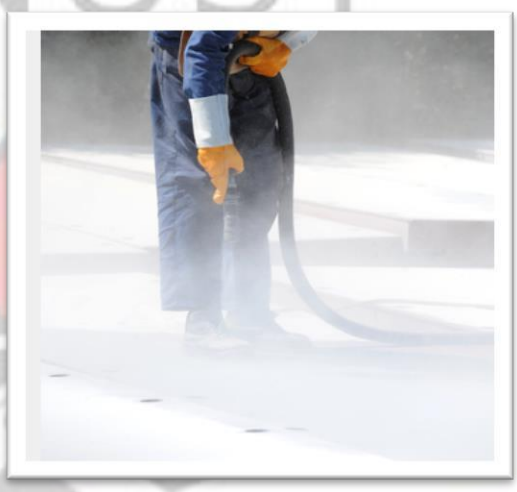

Plate 27: Engraving the text with sandblasting machine

Plate 28: The engraved text

Step 3: After engraving the text on the porcelain, the text areas were perforated; this is to enable the soldered piece of aluminiun rod attached to the back of the text to be inserted and bent to lock at the back of the porcelain as additional reinforcement to the pieced aluminiun text. The

acetic silicone sealant was then applied to the engraved text area, followed by pressing the individual pieced aluminium text firmly on the adhesive areas on the porcelain.

Plate 29: Perforating holes on the text Plate 30: Applying silicone and pieced text on the base

After the silicone had dried, the stencilled sticker was then removed from the porcelain leaving the aluminum pieced text firmly adhered on the porcelain.

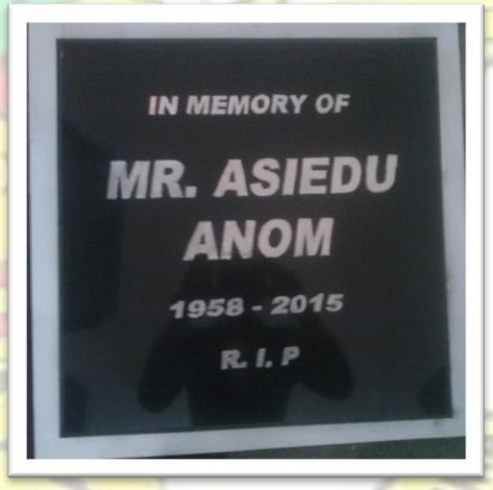

Plate 31: Removing the stenciled sticker Plate 32: Pieced aluminium text firmly adhered Step 4: the finished work was then washed to remove dirt and excess sealant.

Plate 33: Washing the work to remove debris

3.15.5 Project three

Step 1: Off-white porcelain with size 21 x 21inches was selected. A plain rubber sticker was used to cover the surface of the porcelain. Another sticker with a printed text was pasted on the first sticker. The letters were sandblasted as done in project two.

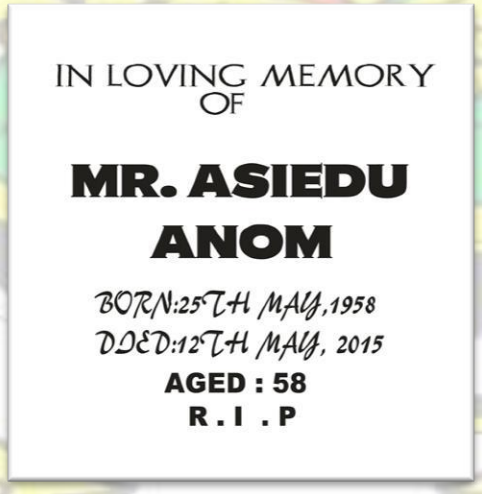

Plate 34: Printed text to be stencil cut

Step two: the silicone sealant (black) was applied onto the surface of the cut stencil. A squeegee was then used to spread the sealant to fill the engraved letters/text receptacle. The sealant was

then left to dry, after it had dried the sticker was removed and cleaned to remove all debris on the surface.

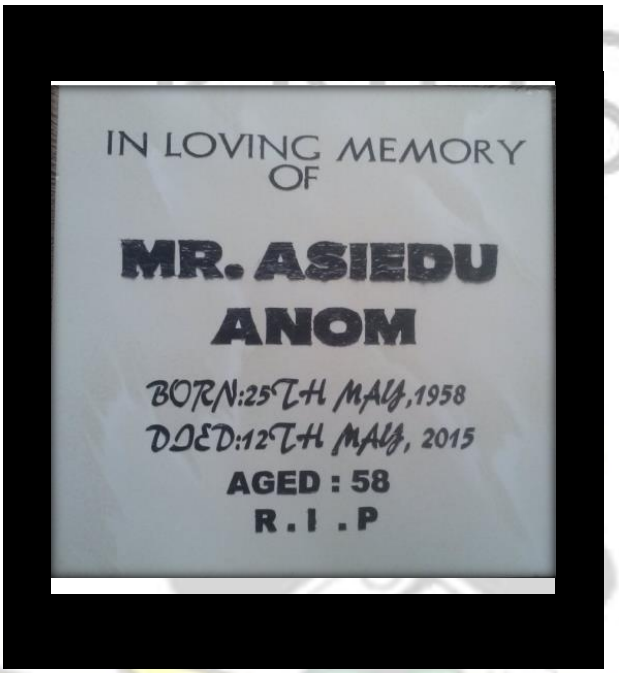

Plate 35: Dried silicone text on the porcelain base

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF RESULTS

4.1 Overview

This chapter covers the presentation and discussion of results as well as the findings made in the study. With reference to interviews conducted, primary and secondary data collected and observations made were the basis of finding the results for the objectives of the study; the findings has been carefully analyzed and the data have been presented and discussed in accordance with the objectives and their respective research questions of the study.

4.2 Discussion of Results for Research Question One

What are the causes of the problem with plaques produced at Tafo cemetery?

The objective one of the study is to identify the causes of the problem with locally produced plaques.

In order to satisfactory answer research objective one, the researcher resorted to finding the root causes of the problems associated with locally produced plaques at Tafo cemetery. The problems which directly affect both the quality and the local industry were identified and interpreted as follows:

4.2.1Text Fading

Based on a careful analysis made on the plaques found at Tafo cemetery it was deduced that the lettering or text fades easily on the base material as a result of the effect of changes in the weather conditions which affects the ink used for the text inscriptions. When probed into the phenomenon the following observations were realized; comparatively, it was realized that plaques found on tombs which are under the shade especially those found under the trees at the cemetery seem to last a little longer than those found in the open. However, the ink used by the local artisans was found to be ink meant for interior works, but instead they used it on oudoor plaques. Figure 4.1 shows some of the inks used.

Figure 4.1: Spray paints

Moreover, in some few cases where Acrylic ink (known for its distinctive characteristics such as quick drying, permanent, water resistant and non-clogging) was used, it was realized that they gradually fade or at times peel off. This caused was found to be attributed to the operations of the local plaque artisans. Moreover, engraved text receptacles created on the base material (ceramic) were found to be not deep enough to contain enough ink which makes it easier for the ink to lose its opacity from the rays emitted by the sun or washed away gradually by rain.

Figure 4.2: Acrylic ink

4.2.2 Corrosion

Findings made through observation on metal plaques at the cemetery indicated that, as a result of lack of proper treatment gave in to metal rust over the years. With the introduction of ceramic and later marble plaques, many of the bereaved families have no other alternative than to resort to them. It was evident that about 75% of plaques found at the cemetery are now made of ceramics predominantly porcelain, with about 20% being marble and 5% being metal plaques respectively. However aside this challenge, it was revealed that many buyers now prefer the ceramic plaques which are cheaper, durable and aesthetically appealing due to its glossy surface.

4.2.3 Metal plaque theft

Metals can be recycled to produce other metal products. This as a result has generated jobs for people who collect old discarded metals and sold them for money. The economic benefit of the

scrap metal trade at the international level is so great. In 2010, according to Wiener (2011) the United States alone earned more than $30 billion from exports of products manufactured from scraps. As a result, this has seen high demand of scrap metals from the world. However, Keeley (2008) asserted that high demand of scraps raised prices of scraps. The rise in prices of scraps, especially the non-ferrous metals, has incited an upsurge in metal theft from the built environment by scrap collectors who wants to make monies at all cost. For instance, the demand for copper has fuelled a conspicuous rise in the pillaging of the built environment around the world (Bennett, 2008; Broni-Sefah, 2012).

Indications at the cemeteries visited shows a lot of old metal plaques removed as a result of metal scrap theft. From the interview conducted, it was observed that due to metal plaque theft buyers often opt for either ceramics or marble plaques which are not stolen. Moreover, as a result the use of metals for plaques at the cemetery is shunned by the local artisans when asked they claim their customers do not buy them. However, its usage currently at the cemetery are for site marks for new graves and are often replaced with ceramics or marbles headstones when the tombs are later built on the graves.

4.2.4 Informal system of education

The local plaque artisans acquire their skills through the apprentice system of training, which Coy (2000) defines as, one who learns by participation or observation in a skilled trade. From the interview conducted the educational levels of the respondents (plaque artisans) predominantly males indicated that, about 43.8% of the artisans had no formal education whilst 56.2% had some form of education, either primary, junior high or senior high school level. Out of those with formal education, 33.8% could read and/or write. The remaining 59.2% can neither read nor write. The educational level of the artisan is illustrated below in hierarchical order**.**

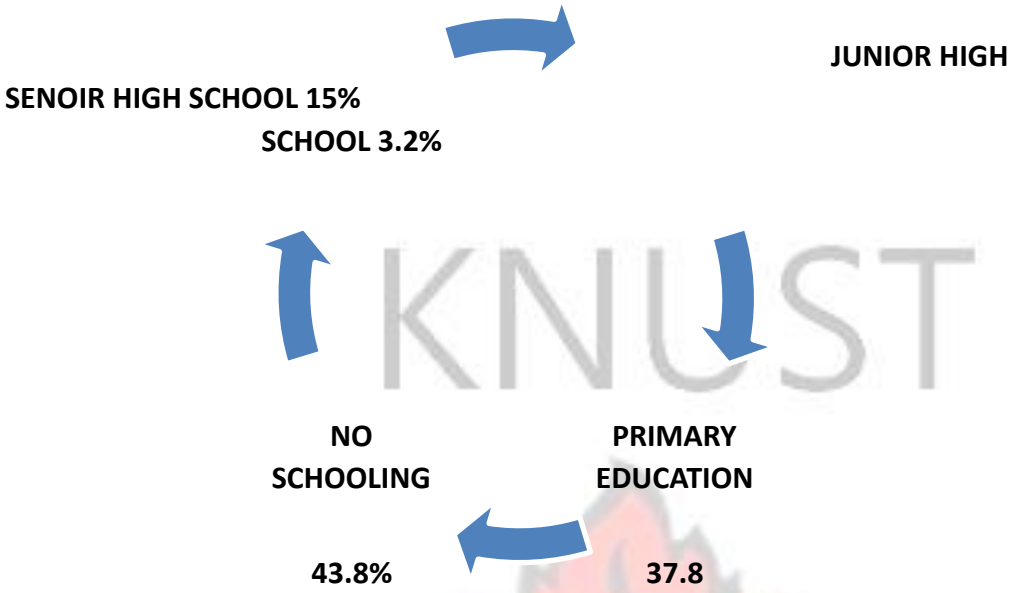

Figure 4.3 Educational levels of the artisans at Tafo and Centre for National Culture

4.3 Weaknesses of Apprenticeship System of Education on Local Plaque industry Following the field observation, the below weakness were observed:

The masters were seen as the only source of knowledge acquisition at the various sites visited. Larbi (2009) explains that, teaching in the apprenticeship programme is based on only the master's knowledge because there is no curriculum or any reference books. He further asserted that there is no possibility of being abreast with modernity or science and technology. The masters transfer the same skills acquired from their previous masters over the years to their apprentices. These skills acquired by the masters over the years are seen as part of their tradition and they are therefore not willing to accept any new skills or change. This has resulted in the industry producing same number of plaques at the cemeteries. In other sense the apprentices may also in turn continue in the same light and there would not be any improvement in the industry which does not support the local plaque industry.

4.4 Discussion of Results for Research Question Two

What approaches or strategies are there to adopt to minimize the problem of metal plaque theft, corrosion and fading of text inscriptions?

The objectives of developing suitable strategies that will help curb the problem of metal plaque theft, corrosion and fading of text inscription at Tafo cemetery. With reference to the data collected, interviews and the observations made the following findings were realized:

4.4.1 Impact of Scrap theft on Metal Plaque

From the interview conducted it was observed that the prices of scraps have greater influence on the specific metal type, its collection and demand. As asserted by Keeley (2008), demand raises the prices of scraps. This has resulted in the keen interest of some scrap collectors who pillaged these metal types from the built environment that have not reached their end-of-life. A visit paid to two buying scraps centres at the Suame magazine and Aboabo indicated that the demand and price for aluminium and steel scraps were higher compared to other metals. This has made aluminium and steel scraps the type of metal scraps well sort for by the scrap collectors.

On the other hand, Metal plaques found at the cemetery were either done in steel or aluminium which is the main targets to scrap theft, due to its high price and demand. Following the findings made on the activities of the scrap collectors with regards to the demand for the metal type and its price. With reference to project one and two, the strategies identified and adopted were represented and interpreted below:

4.5 Cut Metal Text on Ceramics

From the information gathered from the field visit; ceramic plaques at the cemetery comes with engraved text inscriptions filled with either spray paint or acrylic paint. However, metal plaques

on the other hand are coated with oil paint and the text inscription incised on it, with few at times being hand written with paint. According to the Scrap Collectors interviewed, bulk metals when collected saves time and attract good price as compared to the smaller ones which their collection are tiresome and do not attract good price. To the scrap collectors they consider them as complements to the bulk ones, so their collection is minimal.

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4.6 Joining Metal and Ceramics

Hanson and Fernie (2000) opine that, joining ceramics with other materials arise as a result of its important roles played in conjunction with other materials. For instance, it can add particular functionality or provide added benefit to a component. The researcher realized that the easiest and convenient way of creating metal text inscription on ceramics is by joining.

With reference to the data collected, Robert W. and Messler (1993) proposed three fundamental options for joining namely:

Mechanical: joining achieved through mechanical forces from either physical interference or friction, or both; mechanical attachment uses one of two forms of joining either by supplemental devices called fastener or design feature that are part (integral) to the component.

Adhesive: joinings are established with the aid of a substance capable of holding two materials together by surface attachment attraction forces. The attachment of the materials depends on a combination of varying degrees of microscopic mechanical locking and chemical bonding through important primary or secondary atomic or molecular forces.

Welding (subdivided into brazing and soldering): Welding is the process of joining two or more materials by applying either heat or pressure or both to produce primary atomic or molecular bonds across the interface.

Dr Wendy Hanson and Dr. John Fernie was with the view that, many important issues must be considered prior joining, such may include materials selection, best practice and joint design.

In addition, Taylor (2016) advocates that, a selected method used will depend on one of the following factors:

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1. desired component function;
2. materials to be joined;
3. operational temperature;
4. applied stress;
5. required level of joint hermeticity;
6. component design and cost.

4.7 Test of Some Available Adhesives on Metal and Ceramic to Determine their Suitability for Joining

From the literature review on adhesives, it was realised that some adhesives are compatible with some materials whiles others are not. In order to ascertain the suitable adhesive that could adhered metal cut out texts on ceramics base, some selected adhesives were tested using the thumbnail and chisel edge lifting test. The selected adhesives and their material compatibilities are summarize in the below table

Table 4.1: Test result of adhesive and material compatibility

ADHESIVE TYPE	**Material Compatibility**	
	Ceramic	**Metal**
Acrylic	✓	
Epoxy	✓	✓

Phenolic		✓
Polyurethane		✓
Silicone	✓	✓
Cyanoacrylate (super glue)	✓	✓
Anaerobic/Surface-Activated Acrylics		✓

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Key: the ticked means the adhesive type is compatible with the material

4.8 Results of the thumb nail and chisel edge lifting test

The test results of the curing and lifting resistibility of the selected adhesives has been summarize below

4.8.1 Ability to Hold after Curing

Key*: *poor, good, very good and excellent;

1. *Poor*: fall off after drying or curing
2. *Good*: less strong but better than poor
3. *Very Good*: better than good but not as strong as excellent
4. Excellent: very strong after curing.

4.8.2 Thumb Nail and Chisel lifting Resistibility

Key: very poor, poor, good and very good;

1. *Very Poor: no/least effort required*
2. *Poor: less effort required*

3. *Good: much effort required*
4. *Very Good: able to resist force*

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Table 4.2: Result of lifting test

Adhesives	**Ability to Hold after Curing (Metal and Ceramic)**	**Lifting Resistibility between Metal on Ceramic base**	
		Thumb nail lifting	**Chisel edge lifting**
Acrylic	Good	Very Good	Good
Epoxy	Excellent	Very Good	Very Good
Phenolic	Good	Very Good	Good
Silicone	Excellent	Very Good	Very Good
Polyurethane	Very Good	Very Good	Good
Cyanoacrylate (super glue)	Very Good	Very Good	Good
Anaerobic/Surface-Activated Acrylics	Very Good	Very Good	Good

From the test results it was realised that epoxy and silicone were found to exhibit strong adhering capabilities between the two materials. However, since the plaques produced were

intended to be use outside (outdoor plaques); the researcher needed an adhesive capable of withstanding the changes in the weather conditions. Comparatively silicone was chosen due to its chemical inertness, resistance to water and oxidation, and stability at both high and low temperatures.

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4.9 Preventing corrosion in metal plaques.

The effects of corrosion on metal works have seen a lot of research done to enhanced metal properties that will be able to withstand corrosion and other effects that affect metals. Mudd (1972) was of the view that the properties of a metal are those features which give it its own particular nature or identity. He further states that the properties of metals determine the use to which the metal could be put and the process by which it could be worked. These prerequisite ideas gathered on metals from the secondary data equipped the artist on the choice of metal necessary for the project. Other aspects with reference to the data collected advocate various treatments that could be used to enhance the life span and the appearance of metals.

According to Encyclopædia Britannica (2012), some materials resist corrosion naturally; others can be treated to protect them. Among the common ways by which metals can be protected against corrosion are coating, painting, galvanizing, use of chemical additives, passivation, cathodic protection, organic coating and anodizing etc.

In addition to these, one could use or select metals which are known for their corrosion resistance abilities in execution an outdoor works. With reference to project 1 and 2 the researcher used both anodize aluminium and alloyed aluminium sheet due to its known high resistance to corrosion. The text were form from aluminium as illustrated below

Figure 4.4 Anodized aluminium cut out text

4.5: Oxidize aluminium cut out text

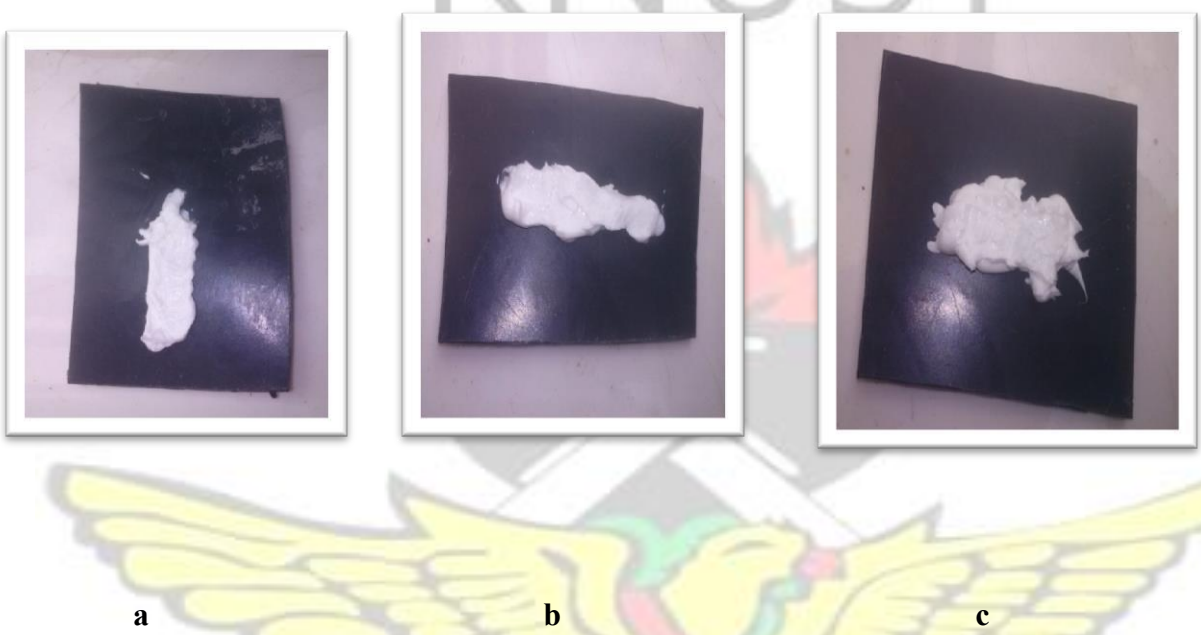
4.10 Ways of preventing text fading on the base material

"As plaques will be experienced by so many – of both present and future generations – high standards are desirable in all aspects of the work involved; this is especially the case with regard to plaque design, positioning, ***inscription (text)****, and the identification of a suitable and appropriate site, design format and materials".* (Guidance on Commemorative Plaques and Plaque Schemes p7, 2011). From this assertion, it could be stated clearly that inscription as in text or image play a very important role in the design of plaques and indeed needed to be treated to last the ages.

In order to correct or find answers to the cause, findings were gathered from the data on alternative material that possesses characteristics required to withstand the diverse effects of the weather. Considering the many uses of silicone, its chemical inertness, resistance to water and oxidation, and stability at both high and low temperatures, and its compatibility with ceramic. The researcher resorted to a number of activities to determine it suitability for creating text inscription on the base material (porcelain).

4.11 Silicone Thickness Assessment Test

The researcher found out that silicon sealant comes in a paste-like form and depending on the user's discretion it could be thinly or thickly applied. Referring to one of the causes which was found to be the inability of the text receptacles to receive enough ink hence the cause of the text fading on the base material. Series drops of the silicone were put on a flat surface to



a **b** **c**

Figure 4.6: Silicone thickness assessment test

Thickness test of silicone ranging from **a** thick, **b** thicker and **c** thickest. From the test, it was observed that silicone once dry does not affect its thickness; however, this can be applied to achieve text character ranging from flat to emboss on the base material which will be very difficult to be washed away by rain water.

4.11.1 Results of Silicone Mouldability Assessment

Silicone is soft and sticky when touched, in order to determine how easy it can be manipulated to form text. The researcher smeared oil in crown cork and was filled with silicone to the brim. After it had dried the silicone were removed from the crown cock. It was observed that, silicone once dried takes the shape of the receptacle, this affirms that silicone can be manipulated to take the text receptacles created on the base material as shown below

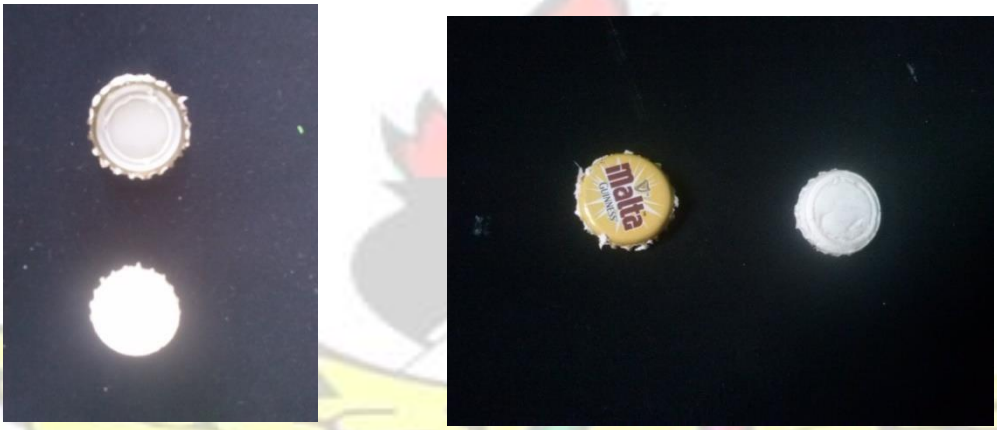


Figure 4.7 Mouldability test result

4.11.2 Results Assessment of the Effect of Temperature on Silicone

Silicone according to Moretto, Schulze and Wagner (2005) is known for its thermal stabilities ranging from -100 to 250 ^{0}C. The effect of temperature on silicone on a material's surface may differ from one material to another. However, in order to determine the effect of temperature on silicone on a porcelain base; different degrees of temperatures were applied and the results have been summarize in the table below

Table 4.3 Temperature Assessment Result

TEMPERATURE RANGE (^{0}C)	EXPOSURE TIME (5 MINS.)	EFFECTS (CHANGES)	REMARKS
20 – 30	5 MINUTES	NO CHANGE	INTACT
35 – 45	5 MINUTES	NO CHANGE	INTACT
50 – 60	5MINUTES	NO CHANGE	INTACT
65 – 75	5 MINUTES	NO CHANGE	INTACT
80 – 100	5 MINUTES	NO CHANGE	INTACT
105 – 115	5 MINUTES	NO CHANGE	INTACT
120 – 135	5 MINUTES	NO CHANGE	INTACT
140 – 150	5 MINUTES	NO CHANGE	INTACT

From the test it was observed that at temperatures from 100 to 150 ºC the silicone became a little soft but return to its rubber-like state after it has cooled.

4.12 Discussion of Results for Research Question Three

How can sample plaques be produced base on the study?

This objective was to produce sample plaques base on the study. With reference to the data collected, knowledge and experience acquired from field observations and the interviews conducted led the researcher to come out with the following plaque designs;

1. Aluminium Cut out Text on Porcelain Base

2. Anodize/Painted Aluminium Cut out Text on Ceramic Base

3. Silicone Text on Porcelain Base

4.12.1 Aluminium Cut out Text on Porcelain Base

From the studies the researcher realised that, metal (aluminium) can be creatively used to form text on a porcelain base. In achieving this, the text inscriptions were cut in aluminium and were used for the lettering. For easy arrangement of the letters, good adhering and positioning of the individual letters to form the text on the base material, text receptacles were created on the base porcelain to receive both the adhesive and the aluminium text respectively. Moreover, plaques are design to last for ages, to ensurethat the aluminium text remain intact on the base porcelain for several years to serve its intended purpose, the letters were reinforced with additional projections created at the back of each letter and were bent to lock at the back of the base porcelain, this was done to enable the text to resist any of the environmental forces that might cause peeling or removal of text on the base material.

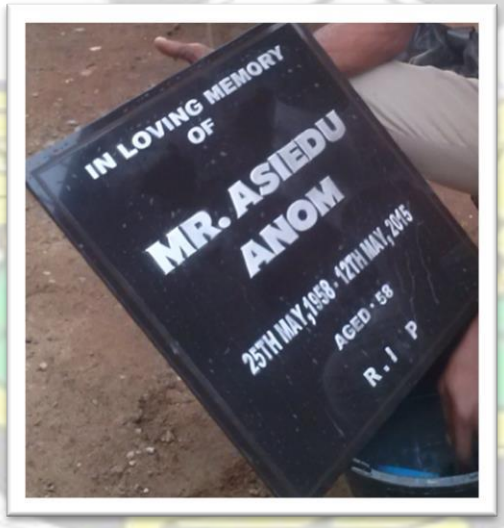


Figure 4.8 Anodize Aluminium Cut out Text on Ceramic Base

To prevent corrosion as well as creating variety in plaques produced at the cemetery, the researcher found out that, metal especially aluminium can be coated with an oxide or painted with pigment to serve as a protective cover against corrosion. The researcher also observed that ceramics can be manipulated to create interesting pattern and use together with anodize aluminium text to produce plaques. In order to ensure text stability and permanency on the base ceramics, the aluminium text were cut with some projections attached which were carefully

bent to lock at the back of the ceramics. These locks served as reinforcement to the text on the base material.

Figure 4.9 locking the attached projections at the back of the ceramic tile

4.12.2 Silicone Text on Porcelain Base

After carefully assessing silicone, the researcher realised that silicone can be used as an alternative material/ink to create the text inscription on the base material (porcelain). The choice of silicone was based on the fact that, it could be easily manipulated when wet and exhibits qualities such as good resistance to water and oxidation, stable at both high and low temperatures, and compatible with ceramic which made it fit to be able to withstand the weather condition that causes the text to fade on the base material at the cemetery.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter outlines the summery of this study, conclusions and offers recommendations.

5.1.1 Summary

Plaques are supposed to last for a very long time to be able to communicate to the present and future generations. A sturdy construction of plaques with the right choice of materials, techniques and design format assures that. However, locally produced plaques lack these bases which as a result have affected the quality of plaques produced. The causes which include; fading of text, metal plaque theft, corrosion which affects metal plaques, same design format of plaques produced over the years and lack of lay down principles in the apprenticeship system of education used to train them(local artisan) gave the needed attention to this phenomenon. However, the need to develop strategies to intervene in this phenomenon was of essence. The main purpose of the study is to develop alternate strategies to intervene in the problems associated with locally produced plaques at Tafo cemetery. The selected ideas based on the study were translated into a concrete form in rhinoceros, which were used in producing sample plaques. This is supported by systematic procedures that can be followed as a guide to produced plaques for better understanding and reference purposes.

The project commenced with a review of related literature on the topic. The data collected was in two forms; primary data and secondary data. The data collected from the secondary source together with primary source equipped the researcher with enough knowledge thathelped in achieving the set objectives of the research work.

Moreover, the case study, descriptive and experimental research design based on the qualitative research approach was used. The activities of the local artisans with regards to tools and materials used methods and processes employed were case studied. Descriptive method was used to describe the various systematic procedures followed to the execution of the sample plaques and the experimental method for investigating into the processes, materials and methods in order to develop alternate strategies to improve the quality of plaques produced at

Tafo .Purposive and simple random samplings were the techniques adopted by the researcher. Observation and interviews were also used as data collection instruments to find answers to the research questions set for the study. The study gives a comprehensive illustrative description of the materials and procedures used in producing the sample plaques. It also discusses the findings of results and finally the conclusion chapter.

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5.1.2 Conclusion

Based on the findings made through interviews, observations done on the field and gathering of information from scholarly articles relevant to the study, the following conclusions were drawn:

1. The root cause of the problems as they exist with plaques produced at the cemetery were identified to be a direct cause, caused by the activities of the local plaque artisans
2. Strategies adopted to produce the sample plaques were based on ideas gathered from the primary and secondary sources of the data, which were translated into a concrete form.
3. The study revealed that the existing materials such as aluminium and ceramic can be creatively manipulated and combined to produce plaques.

Test conducted also revealed that, the flexibility nature of silicone and its ability to take the shape of its receptacles, its compatibility with both metal and ceramic, and its properties such as chemical inertness, resistance to water and oxidation, stability at both high and low temperatures make it a good alternate material for forming text on a base material. However to add quality, innovations to the plaques produced at Tafo cemetery, the researcher came up with the following alternative plaques:

i. *Aluminium cut out text on a porcelain base* ii. *Anodize/painted aluminium cut out text on ceramic base*

iii. *Silicone used as Text on Porcelain Base*

5.1.3 Recommendations

The advocacy for developing small scale industries in the country to absorb the unemployed graduate artists were of essence to this study. From the study it was revealed that, the local plaque industry is one of the lucrative industries which could be explored in order to develop quality plaques to generate income both internally and externally. In the light of this, the following points have been listed as recommendations:

1. Plaque artisans should explore other metals like silver, brass, and copper together with ceramics to ascertain their compatibility necessary for producing plaques.
2. Another aspect of the problem identified which was not tackled because of time constrain was with the photographs of the deceases which also fades easily on the base material must be researched on.
3. Local plaque artisans ought to make utilization of broken tiles which are less costly and promptly available on the market to create less costly plaques however of good quality
4. Ideas from the alternative strategies developed should be adopted by plaque artisans and used as one of the design formats for producing plaques at Tafo cemetery.

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APPENDICES 1

QUESTION GUIDE 1

QUESTION GUIDE PREPARED FOR ART LECTURERS AND ART STUDENTS

OBJECTIVE: To acquire data on plaques in general

1. What are plaques?
2. Have you ever produced plaque before?
3. What did you use it/them for?

4. What materials can one use to produce plaque(s)?
5. By what means can one register permanent text on a base material for plaque?
6. What ink/media/material can one use to register text that will be able to withstand changes in the weather condition?
7. Have you tried any other material such as metal text on ceramic base to produce plaque before?

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QUESTION GUIDE 2

QUESTION GUIDE PREPARED FOR LOCAL PLAQUE ARTISANS

OBJECTIVE: To acquire data on locally produced plaques at Tafo cemetery.

1. What is your level of education?
2. What skills did you acquire in school?
3. How long have you been in the plaque industry?
4. How did you acquire your skills in the local plaque business?
5. How many plaques did you produce in a week and how much money did you earn from them?
6. How did the local industry came to Tafo
7. Who were the pioneers in the industry?
8. What materials did you usually used to produce plaques at the cemetery
9. Why those materials and not any other material
10. Why are ceramic plaques dominant in the cemetery?
11. Why are the text inscription on the base materials often fading

12. Have you ever tried any other material/ink/media apart from the usual ones often used?
13. Are you aware of any other methods or processes for producing plaques apart from what you were thought by your master?

QUESTION GUIDE 3

QUESTION GUIDE PREPARED FOR SCRAP DEALERS AND COLLECTORS

OBJECTIVE: To acquire data on the impact of scrap trade on plaques produced at Tafo cemetery.

1. Where do you gather scrap metals from?
2. What type of metal do you usually collect and why those metals?
3. Are you aware of scrap metal collectors stealing metal to sell?
4. Have you ever thought of stealing metal to sell before?
5. What types of metals are usually stolen?

QUESTION GUIDE 4

QUESTION GUIDE PREPARED FOR PLAQUE BUYERS

OBJECTIVE: To access the impact of consumer preference on plaques produced at Tafo cemetery.

1. Have you ever use plaque before?
2. What did you use it for?
3. Where did you buy it/them from?
4. Why that type of plaque?
5. How much did you buy it/them?

6. Have you ever experienced something happening to the plaque after you have use it for some time?

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APPENDICES 2

OBSERVATION GUIDE

1. Observe operational procedures employed by the local plaque artisans.
2. Observe tools, materials, usage and impact on work produced.
3. Observe the environmental set up at the cemetery and its impact on the plaques produced
4. Observe customers reactions in relation to the plaques they buy.

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