

**THE USE OF BONDED SAWDUST
AS A SUBSTITUTE MATERIAL FOR CARVING**

By

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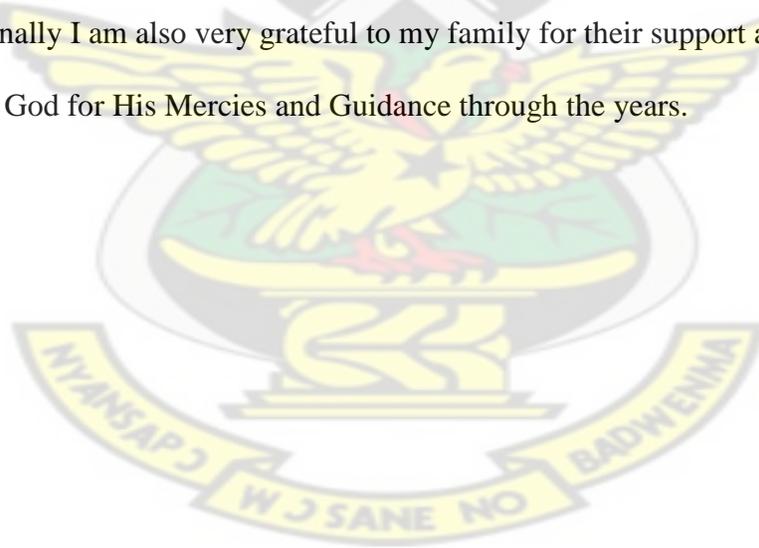
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ABSTRACT

Wood carving as an art has from time immemorial been used to promote, preserve and invigorate Ghanaian culture. However, the stock of some of the preferred tree species used for carving is declining at an alarming rate. The need to ensure the sustainability of the wood carving industry therefore motivated the researcher to find a solution to this problem. The researcher experimented with a recyclable material that could be used for carving instead of the conventional wood. The research experimented with White glue and Sawdust to build blocks which served as carving materials in place of conventional wood. The purpose of the study was to research into the viability of sawdust as a carving material. This research was determined to come up with a substitute material for wood carving, and was specifically concerned with a comprehensive investigation into the viability of sawdust. The study investigated, experimented and taught students how to produce boards from the sawdust blocks created. The thesis discusses, describes and analyses into detail the experiments conducted. The research uses qualitative research and further makes use of quasi-experimental, action and descriptive research designs. The results of the study suggest that “sawdust block” can be carved. The study also reveals that even though sawdust blocks could be carved, its finishing cannot be compared to conventional wood. The thesis recommends that the use of sawdust as an alternative carving material should be introduced and taught in all sculpture departments in Senior High Schools and tertiary institutions.

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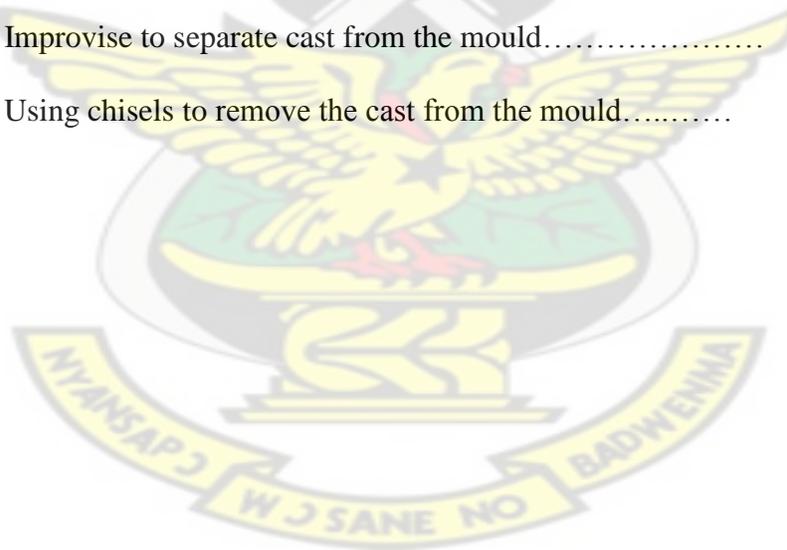
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CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter begins with the Background to the Study, followed by the Statement of the Problem, Research Questions, and Objectives of the Study, Delimitation, Limitation, Definition of Terms, and Importance of the Study, Abbreviations and Organization of the rest of the Text.

1.2 Background to the Study

In spite of the countless number of environmental campaigns, both locally and internationally, the rich forest lands continue to deplete at a threatening speed (Okra 2002). The timber industry is widely opening up and as a result, it is adversely adding to deforestation. Dei (1990) reviewed that even though there is no data on the quantity of wood felled for carving, wood carving activities contribute immensely to the alarming growth rate of deforestation in Ghana.

Okra (2002) shares that the government of Ghana's 15-Year Tourism Master Plan (1996-2010) called for the development and promotion of the traditional carving industry's internal and overseas markets. This has obviously resulted in a quick jump in the use of wood for carving. Consequently, there has been an unprecedented depletion of the stock of the tree species used for carving.

He buttresses Dei's point stating that “woodcarving industry has thus become a key player in the deforestation of Ghana”. Wood resources are depleting at a faster rate as a result of unsustainable practices in the production and marketing of the wood products. It is also sad to note that a significant component of wood is left to waste away during production. According to the UN Food and Agriculture Organisation (FAO 2010) the rate of deforestation in Ghana is 3% per annum.

Duku, Gu and Hagan (2011) report that wood processing waste generated in the year 2008 alone totalled one hundred and twenty eight thousand, two hundred and fifty (128,250) tonnes of sawn wood . In the year 1988, UNDP/World Bank Energy Management Assistance Programme on Sawmill Residue Utilisation reported that sawdust accounted for 21% of the total mill waste in Ghana.

1.3 Statement of the Problem

A cursory look at the operations of the traditional carving industry in Kumasi reveals a consistent mounting pressure on the few remaining tree species that have been used for carving since time immemorial. Some of these tree species are; Sese, Ebony, Danta, Kusia et cetera. The imbalance between demand and supply pose a bleak future for this traditional industry.

As a country, we do not have the luxury of time but to act fast to salvage the collapse of this vital local industry. There is therefore the need to find a workable and action driven solution to the problem.

The many wood processing firms in this country cause so much waste that we do not

have the capacity to dispose of them at the moment. Factoring in the importance of the existence of the wood carving industry as well as ensuring environmental sustainability, this project seeks to reuse these wood wastes for boards that could be used for carving. Here, we process sawdust into an appropriate material that could be used in woodcarving. The researcher embarked upon this project with students in the Visual Art Department of the Armed Forces Senior High School in the Kumasi metropolis.

1.4 Research Questions

- To what extent can sawdust be used to help solve this problem?
- How could this newly formed sculptural material help in the teaching and learning of sculpture in Senior High Schools?

1.5 Objectives

The broad objective of this study is to establish the fact that sawdust could be used as a carving material in replacement of conventional wood. The immediate objectives of the study are;

- To experiment and fashion sawdust into blocks and boards to serve as a suitable material for carving.
- To teach Senior High School students the process of making sawdust boards.
- To help students design and carve art pieces out of the newly created sawdust boards and blocks.

1.6 Delimitation

This study is limited to the adaptation of sawdust for the composition of boards and blocks for carving. The research environments selected for the study were the Kumasi National Cultural Centre and Armed Forces Technical Senior High School in the Kumasi Metropolis.

1.7 Limitation

A considerable number of limitations were encountered in the course of the research. Literary materials related to this research work were few and hard to find. The attitude of students was also not encouraging. It was also difficult getting students to work on the project because they were mostly preoccupied with their academic works.

1.8 Definition of Terms

Particle-board – Engineered wood product manufactured from wood particles.

Sawdust - Dust or small fragments of wood resulting from the cutting of a saw.

Bonded sawdust – A structural material made from wood flakes of controlled length and thickness bonded with an appropriate binder.

Offcuts - The odds and ends of a used material – what is left after the main material has been used.

Log - A bulky piece of wood which has not been shaped by hewing or sawing

1.9 Abbreviations

IIED- International Institution of Environmental Development

FAO- Food and Agriculture Organisation

PVA- Polyvinyl Acetate

UN- United Nations

GDP- Gross Domestic Product

UNDP- United Nations Development Programme

NFI- National Forest Inventory

ERP- Economic Recovery Programme

CIFOR- Centre for International Forestry Research

TIDD- Timber Industry Development Division

1.10 Importance of the Study

- The study will introduce an equally suitable carving material produced out of wood waste to carvers and sculpture students.
- The thesis will serve as a reference material for art students, practising artists, researchers, and art educators in Ghana.
- It will also serve as inspiration for others to research into other alternative materials for sculpture from other waste products.

1.10 Organization of the rest of text

The research work is divided into five chapters. Chapter one introduces the study. It consists of the Statement of the problem, Background of the study, Research questions,

Objectives of the study, Delimitation, Definition of terms, Abbreviations, Importance of the Study and Organization of the Rest of Text.

Chapter two is made up of the available theories and empirical literature related to the study. Chapter three deals with the Methodology used for the study. Chapter four consists of the Presentation and Discussion of Findings. Finally, Chapter five consists of the Summary, Conclusions and Recommendations.

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CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Overview

Only a few researched works have been done on sawdust with regards to its relation to woodcarving. As a result, the related literature review is limited to the few works drawn from related fields of study such as; sawdust, wood, particle board, wood carving, wood species for carving, strength of wood and the strength of particle board.

2.2 Sawdust

Waste is generally defined as the failure to recover the value inherent in a given amount of raw material. Marfo (2010) defines wood waste as any wood that has no longer any value at its present location. In this regard, wood waste could therefore come about as offcuts, shavings, mill residue and sawdust through observation asserts that sawdust is classified as a wood waste.

According to Marfo (2010), wood waste occurs not only during logging operations but also during secondary processing. He further, states that wood waste occurs in the forest as logging waste and occurs as mill waste in the form of sawdust, offcuts, trimmings, slabs edgings and veneer cores. Wood processing wastes such as discarded logs, bark, sawdust, off-cuts, etc., on the other hand, are generated through sawmill and plywood mill processing activities. Duku et al, (2011, p. 410) contend that, “generally, sawmills in Ghana have recovery rates ranging from 20% to 40% of the log input, averaging 33.3%”. As cited in Duku et

al,the FAO estimated that wood processing wastes generated in the year 2008 totalled 256,000 m³, equivalent to hundred and twenty eight thousand two hundred and fifty (128,250) tonnes, based on sawn wood production for 2008. This assertion reveals how sawdust, a regenerative material is left to go waste.

Another report by UNDP/World Bank Energy Sector Management Assistance Project on Sawmill Residue Utilisation in 1988 indicated that sawdust alone accounted for 21% of the total residues generated. In this light, sawdust could also be said to be the volumes of unrecovered saw offcuts produced as a result of wood processing either in the preliminary or secondary stages.

It may also be classified as one of the many kinds of residues produced after wood or timber has been economically exhausted. Offcuts as a result of wood processing activities may vary in sizes and density depending on the machine that is used in the process.

In this research report, sawn offcuts would be the researchers focus. Owing to varied saw blades, even this category of wood waste may be further varied according to size of individual sawdust particles. They may range from powdery smooth to gravel coarse particles.

Their colour may also range from white to dark brown depending on the parent timber from which the off cut was made. Sawdust is abundantly available at saw mills and carpentry shops.

2.3 Particle board

Generally, particle boards are flake boards that can be manufactured from organic materials such as rice husk, wood waste, coconut fruit fibre and the like. Wood particle boards are manufactured from dry wood particles that have been bonded with a binder resin, and are bonded together with pressure and heat. Wood particles for the manufacture of particleboard can be made from almost any type of wood, it could be made from any form of wood residue such as trimmings and shavings from lumber or plywood manufacturing (Carl,1986). Particle board is produced from industrial wood residues such as shavings, sawdust, plywood trim, fines, and chips and can be produced from log and urban wood waste chips (Wilson 2009). These wood particles are bonded with glue present in concentration of 5% and 18% (Larson, et al., 1997).

Particle board, a non-structural panel product which was developed in the 1950s used industrial wood residue from the production of primary wood products like lumber and plywood. These wood residues were previously burnt or sent to a landfill for disposal as waste material. Over the years, the product has evolved into a highly engineered product designed to meet specific end-use requirements. Particle board is produced from industrial wood residues that are refined to small particles that are dried, blended with resin and wax, formed into a mat that is consolidated and cured under pressure and heat, sawn to dimension, and sanded to thickness (Wilson, 2009).

Particle board is produced to densities ranging from about 600 –800 kg/m³. Although (Carl, 1986) states that “lower density woods are preferred” almost any

wood species can be used for particle board production. The term particleboard may also be referred to as a “chip board”, “flake board”, “strand-board” or “wafer-board”.

(Wilson,2009) reveals that 96% of particleboard is produced for making household and office furniture, kitchen and other domestic products. He further indicated that it is only 4% of particleboard that are used for flooring purposes.

2.4 The Strength of Particle Board (Bonded Sawdust)

The strength of particle board primarily depends on the chemical content of the parent wood and binding agent during production process. Chemical modification could improve the dimensional stability of the material Papadopoulos and (Gkaraveli, 2003). Thus, the strength of particleboard unlike conventional wood can be purposefully enhanced by the manufacturer. It may all depend on the chemical composition of the content.

(Rowell,1975) revealed that the natural reactivity of lignocellulosics can be utilized to enhance their properties with the resulting material being superior in terms of performance and versatility. This implies that the nature of wood shavings could also be used to enhance the strength properties of particleboard. Rowell again states that “The basic types of chemical modification use simple mono-functional modifying agents while others use dysfunctional, or even poly-functional modifying agents”.

Thus, the strength of particleboard may depend on the manufacturer as well as the purpose for which he intends to use it. Rowell specifies that one of the most

practical of these is the reaction of a hydroxyl group with acetic anhydride, known as acetylation. To buttress the points asserted earlier, (Papadopoulos & Traboulay ,2002) report that recently, acetylation has been successfully employed to improve the dimensional stability of particleboard.

2.5 Wood

Wood is a complex and highly variable tissue material made of successive stacking of growth rings year after year (Pilate, 2004). Dinwoodie (1989) on the other hand sees wood as a heterogeneous material with varying strength properties.

2.6 The Strength of Wood

Wood formation and development could also be regulated environmentally (Pilate ,2004). Dinwoodie (1989) also defines wood as a heterogeneous material with varying strength properties. He states that strength properties of wood generally increase from the top to the base of a tree. Mellerowicz (2001) revealed wood formation as basically a cyclic activity of the cambium. On the other hand, Winandy (1994) describes wood as a homogeneous mass with multi-layered cell structure. Winandy further explains that individual cells of wood are made up of four distinct cell wall layers. Winandy elaborates that these individual wood layers are composed of three chemical polymers namely: cellulose, hemicellulose and lignin. Even though the chemical properties have much to do with wood formation, the physical make up also contributes to both thermal and mechanical strength of

wood. (See fig.1). Physical properties are the quantitative characteristics of wood and its behaviour to external influences other than applied force. Properties like directional, moisture content, dimensional stability, thermal, pyrolytic and decay resistance properties could significantly affect the performance and strength of wood. This means that although wood grows naturally, its strength can be consciously enhanced environmentally (Winandy,1994).

Wood also as a natural material has its own challenges. Society of Wood Science and Technology (2012) reports that wood shrinks or swells because of different amounts of moisture contained in radial, tangential and longitudinal directions due to its anisotropic nature. Society of Wood Science and Technology (SWST) report, further says that inconsistent moisture content causes internal stress on the parts may result in the shrinking process.

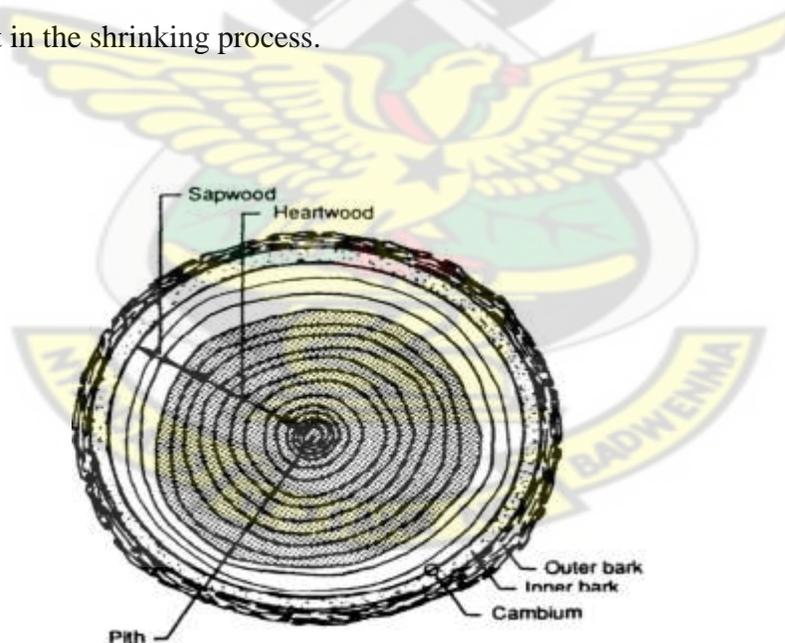


Fig.1 The elements of micro-structure of normally wood visible without magnification.

Source: Forest Products Laboratory, Wisconsin.

2.7 State of the Forest

Forests are essential for health of the environment. They help to control the climate, recycle water and oxygen, prevent soil erosion and provide homes for the most of the world's species of plants and animals. Despite all these benefits, human activities are rendering the forest incapacitated to offer such service to the planet. That notwithstanding, decades of forest recovery policies aimed at salvaging the situation, the rich forests continue to be depleted at an alarming rate (Okra,2002).

According to Park (2001), the developing world lost two million square kilometres of their forest between 1980 and 1995 and most of the loss was in tropical rain forest. According to the Food and Agriculture Organisation (2001), factors like unsustainable agricultural practices, bush burning, excessive logging and other activities contribute to Ghana's high rate of deforestation.

In agreement to the Food and Agriculture Organisation (FAO) report, Okra (2003) also puts on record that it is estimated that about 60% of the Ghanaian forest is lost to agriculture. As stated by Dei (1990), "Forest plants are also invaluable for their medicinal and pharmacological uses". Other activities aside agriculture that contributes to deforestation may go unnoticed. For instance, in 2004, the Timber Industry Development Division (TIDD) estimated that there are more than 40,000 carpenters in the country. This implies that aside woodcarvers and farmers, there are some 40,000 other people who are directly involved in the use of wood.

Other studies also show that wood species felled for carving purposes are many even though they have no official data Dei (1990). The Centre for International Forestry Research (CIFOR) info-brief (2002) reports that during timber harvesting, up to 80% of the wood mass is left behind in the form of the crown, stump and branches. Even though these raw materials could potentially be used for the production of small carved items, they are left to waste.

As at year 2000, Frimpong Manso as cited in Okra (2000) records that less than 11,000 kilometre square of Ghana's total land area is covered by forest, meaning a huge part of the original forest cover has been lost to deforestation. Recently, Marfo (2010) recorded that the current land area of Ghana is about 23.85 million hectares (ha). The Ghanaian forest is divided into two vegetation zones, each with different forest types. The high forest zone (HFZ) forms 34% while the savannah zone also forms 66% of the total land area.

As cited in Domson (2007), Hawthorne (1995) explains that Ghana's high forest zone occupies about 82,000 km³. This high forest zone is sub divided into nine different vegetative segments with distinct variety of plant species corresponding to soil conditions and rainfall. Ghana's deforestation rate is estimated to be approximately 65,000 ha per year. On record, Ghana has about 216 forest reserves that are managed for protection and timber production.

As at 1995 afforestation had fallen short and the country could only boast of 15,000 hectares of plantation by the country's Forestry Department which was

done in the 1960's (Appiah,1996). Since the colonial era, the exploitation of timber for commercial purposes has been part of Ghana's economy. It is only since the start of the Economic Reforms Programme (ERP) 1 in 1983 that deforestation became a serious issue of concern because of the over-exploitation of the forest resources, Okra (2002).

From 1990-2005 Ghana had lost about 20% of its forest cover and the annual deforestation rate as at 2006 stood at 2.0% (Domson,2007). Domson further reports that an estimated 2 million people in Ghana depend on forest for subsistence use.

There is therefore the need to develop the artificial silvicultural industry to supplement forestry resources in order to address the imbalance between supply and demand of the resource (Appiah1996). Forest resources in Ghana are depleting at a very fast rate than before as compared to other developing countries in Africa. Since 1981, the average annual rate of deforestation in Ghana was estimated at 2.0% compared to 0.9% for all tropical forest and 0.6% for Zaire (Okra ,2002). The most sought after tree species like Sese, Ebony, Danta, Kusia which are used as raw materials for carving are said to be rare and locally extinct because they are depleted in the Ghana forest (Asiama,2008).

2.8 The Nature of Ghanaian Wood Carving

Carving is the analytic study of the medium using the requisite tools to remove the unwanted parts to arrive at a final product which has been previously conceived in the storehouse of the mind (Boateng,,n.d, p103.). As stated by Ross (2004) almost

all meanings attached to indigenous art forms in Ghana is on philosophical foundations. Though Ghanaian carvers produce items that are meant for domestic, religious, social and economic usage, Hudson (2011) brings to the fore that the origin of Ghanaian art in any way you look can be linked to the religion of the people.

Some wares are at times also produced to serve both political and educational purposes. Some of the products of Ghanaian wood carvers are mortars, ladles and spoons, door panels, ancestral masks and figures, stools and thrones, drums and other musical instruments, weaving bobbins and other ritual and ceremonial objects (Adu-Agyem,1990). Per this definition, carving does not pertain to the use of only one material.

Different materials could be engaged in carving provided they have the properties that make them workable, as Boateng (n.d) states that “Many media could be used to produce artefacts..... range from wood, ivory, metal, bone, marble, plaster of Paris, stone, PVC and many other forms of hardware”.(p.103)

However, the most available material in a particular community influences the carving medium that dominates their carving practice. Wood carving as an aspect of carving is of ancient origin in Ghana. Amoh (2009, p.9) describes Wood carving as “an age-old tradition in Ghana, practised by various ethnic communities in Volta, Western, Eastern and Ashanti regions”. Owing to the versatility of wood carving with respect to the diverse media used, even though

wood carving is practised in every part of Ghana, it is predominantly practised in the southern part of the country. To attest to this fact, Boateng (n.d) states that “wood carving begun prominently in the forest areas”. (p.103)

Wood carving is seen as an expression of traditional philosophies through art. Owusu (2003, p.13) authenticates this in his observation that “the inspiration behind the traditional woodcarving in the olden days was religious”. Although times have changed, this art form still holds on to its canon rudiments of practice. Boateng (n.d) records that the wood carving industry of the Akans is an indigenous craft tradition that is still vibrant despite the world’s rapid change.

The researcher attests to the fact that Ghanaian wood carving has widened up and improved tremendously. Introduction of modern machinery and tools have enhanced production and the rudiments of design. Boateng(n.d) further states that carving in Ghana begun as a communal form of expression based on the ideas and ideals of the entire community or ethnic group.

It can be said that carving in Ghana as stated by Boateng (n.d.) then was confined to societal functionality in relation to a particular group of people. Even though carving with much emphasis on aesthetics and individual expression was not originally accepted, Boateng (n.d) further indicated that carving in Ghana as a result of the rapid changing world, has now married together both foreign tourists’ tastes and indigenous philosophies.

Thus, bringing into being, works that are now meant to satisfy both local and

international standards regardless of their personal or aesthetic emphasis expressed in the work.

The trade in handicraft has grown into a big prosperous business which is effectively and closely tied with the tourism trade in helping boost the economy of the country. Okra (2002, p.7) attest to the fact that “Woodcarving represents the permanence and continuity of the nation since it is the embodiment of Ghanaian culture”.

Tourists in recent times prefer traditional wood carving to any other art work or craft. Tourists may be so much attached to wood carving pieces because of their traditional meanings. Even though wood carving has transformed through the ages, they are still identified with the culture of the people.

This may be primarily because of the abundance of raw materials in these areas. Boateng reports further that wood as a material is one of the most important materials the Akans of Ghana use in the art of expressing their thoughts, through carving

2.9 Wood Species for carving

As cited in Acquah (1998), the National forest Inventory (NFI) reports that Ghana has more than 680 wood species. Even though there are 680 wood species in Ghana, only 126 species are able to grow to the size capable to be used for all wood working purpose. This therefore indicates that more than one third of the

available wood species in Ghana cannot be used commercially (Okra, 2002)

According to Domson (2007), most of the wood species for the timber market are obtained from the evergreen forest in the south-western part of Ghana. Some of the prominent wood species in the evergreen forest belt are Wawa (*Triplochiton scleroxylon*), Mansonia (*Mansonia altissima*), Danta (*Nesogordonia papaverifera*) and Mahogany (*Khaya ivorensis*).

Even though the exact varieties of wood species used for carving have not been known, Boateng (n.d,p.104) states that “Varieties of tropical wood species used as raw material for carving included the following :Afromosia, Kokrodua Kyenkyen, Mahogany, Odum, Dwuma, Sese, Twenebua,Wawa,Onyina, Funtum, etc.”.

Different wood species may be used depending on their availability in a particular society. Amoh (2009, p.24) reiterates that "indigenous wood carver generally utilizes soft woods often in their green state which are then easier to work ". Other factors like design and the nature of the work to be produced may also be considered in choosing particular wood specie for a work. Amoh (2009, p.12) further states that Wood such as Nyame Dua (*Alstonia gongensis*) and Osese (*Holarrhena wulfsbergii*) are the principal species used. Tweneboa (*Entanchophragma*) for drums, Twafo yeden (*Harrisonia occidentcel*) is for umbrella \frames), Funtum (*Funtumia elastica*) for stools, bowls, combs, Odee (*Okonbaka ambrevellei*) is “evil tree” for religious dolls and Gyenegyene

(*Cedrela mexicana*) among others are the trees commonly carved

Nyamedua /Sinnuro (*Alstonia boonei*) and Funtum (*Funtumia elastica*) are among the most widely used wood species for carving.

They are soft, light weight and not durable. They are promptly affected by shrinkage while drying and pests attack them easily. Amoh (2009,p.25) states that “They are mostly used for making stools, bowls, combs, linguist staffs, Akuaba doll and totemic animal forms”

Adu-Agyem(1990) describes Tweneboa (*Entanchofragma*) as a hard and durable wood which is able to stand the test of time . It does not crack easily and is mainly used for making drums and jewellery boxes.

According to Okra (2003), based on workability, durability and customer demand, just a few of these many wood species available in the Ghanaian forest are traditionally preferred for carving. On the other side, timber industries in the country have specific species they deal with. Acquah (1998) states that the International Institute of Environmental Development (IIED) in its 1995 report estimates that Ghana's supply of most valued wood species on the world market like ; Awiemfosamins, Edinam, Koto, Mahogany (*khaya seregalensis*),Odum (*chlorophora excelsa*) emire,and kusia was predicted to drop by half within five years.

On the other hand, Dei (1990) also records that wood species that are felled for carving are many though their exact number cannot be known. This could also be a contributing factor to the loss of the total forest cover.

2.10 Wood Mills in Ghana

According to Paulus (2009, p.9) “before colonization of the Gold coast trade consisted mainly of local trade. Thus, timber was then used basically for the construction of buildings. It is also recorded that although small quantities of hardwood were shipped towards Europe during colonial time, these could not be described as a comprehensive export activity (Wikipedia)”.

As a matter of development and economic expansion, it is recorded that it was “after 1946 when exploitation of timber started to expand in Ghana due to the introduction of roads, railway and the timber truck” (Paulus, 2009, p.9).

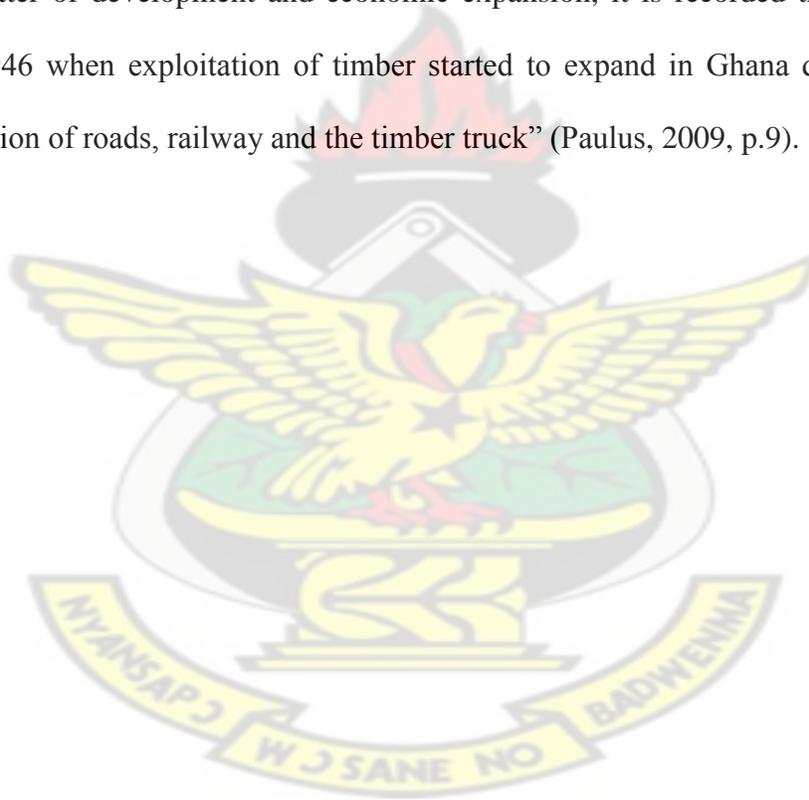


Table 2.1. List of some sawmills in Ghana and their export strength

This is a list of some of the sawmill companies and the quantity of exports they made in the year 2008.

Company	Location	Export volume 2008 (m3)
1. Bibiani Logging and Lumber Co. Ltd.	Kumasi	6.339
2. Logs and Lumber Ltd.	Kumasi	21.767
3. A.G. Timbers Ltd.	Kumasi	10.080
4. Kumi and Co Ltd.	Kumasi	8.530
5. AhwiaWood Products Ltd.	Kumasi	1.596
6. Naja David Veneer & Plywood Ltd.	Kumasi	9.511
7. Sunstex Company Ltd.	Kumasi	1.620
8. SKOD Timbers Ltd.	Kumasi	1.243
9. Samartex Timber & Plywood Ltd.	Kumasi	26.244
10. Swiss Lumber Sawmill Ltd.	Kumasi	4.674
11. John Bitar & Co Ltd.	Kumasi	27.541

Source: TIDD

This indicates that pressure on forestry resources comes along with economic expansion. Paulus (2009) reviewed that the reason why most of the Sawmills are located in Kumasi is the fact that Kumasi has developed during the years into the central timber city of Ghana.

Back in 1989, the sawmills in the country numbered about one hundred and nine including nine ply mills and thirteen mills which added to the inevitable production of large volumes of wood waste annually (Appiah,1996).

During the period between the 1998-1990, the Ghanaian economy had reached a state of virtual collapse caused by falling cocoa prices, inflation and political instability. The government of Ghana in an attempt to rescue the situation had earlier introduced the Economic Recovery Programme (ERP) in 1983.

The account rendered by the Economic Recovery Programme (ERP) alludes to the fact that the economy of Ghana extensively feeds on forestry resources thus, contributing to its depletion because of the imbalances in the rates of extracting and resuscitating the resource.

This saw to the expansion of timber exploitation and the export of logs because it was the fastest way of earning foreign exchange (www.american.edu). By 1990 Ghana had lost more than 80% of its original forest cover (from 8 million to 1.6 million hectare) to the expanding sawmill industry (www.illegal-loggin.info).

Amongst the many ways through which Ghana's timber industry has grown was the introduction of The Ghana Investment Code. This was introduced in 1985 and

it allowed 25% reduction on timber export taxes for lumber and value added products. As a result this made many foreign investors invest in the Ghana timber industry (Paulus,2009). This influx of foreign investors in the industry may still have kept its dominance till date.

According to Hansen (2007), the growth of Ghana's timber industry is on continuous ascendancy. Paulus (2009) review of Ghana's timber industry recorded 105 registered mills: 5 big scale multi-nationals, 25 medium scale and 75 small scale companies' active on the export market as at 2008. Increase in the number of timber firms has also increased the country's total logging operations.

Currently, official estimates suggest that Ghana's total logging is proceeding at about 4 metric tonnes per year. This is alarming because it is four times the sustainable rate. According to the FAO, forest losses between 1990 and 2000, and 2000 and 2005 were 135,000 and 115,000 ha, respectively.

Excessive logging is among the factors attributed to the high rate of deforestation in Ghana. The main timber species used for production by these mills are; Ceiba, Ofram, Wawa, Koto and Mahogany (trade names). The formal timber industry contributes about 6% to Ghana' Gross Domestic Product (GDP) and directly employs about 100,000 people (Marfo,2010)

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter outlines the general procedure used to ensure the successful execution of the research. The chapter discusses the Research design, Library research, Population for the study, Sampling design, Primary and Secondary data, Data collection instruments, Validation of instruments and Data Analysis plan.

3.2 Research Design

The principles and ideas of qualitative research methods were the bases on which the researcher rolled out his procedures and strategies. The research design used qualitative and quantitative research approaches as the main methods for gathering information where descriptive and action research were employed.

As stated by Hesse-Biber (2010) these methods are often mixed up to aid the researcher who seeks a convergence of the data collected by all the methods in a study to enhance credibility of research findings. These research methods have the advantage of providing much data relevant to the study and they also clearly address the scope and range of the study.

3.3 Quasi-experimental

It is a research design commonly employed in the evaluation of educational programmes when random assignment is not possible or practical (Gribbons & Herman, 1997). Quasi-experimental shares with all other experiments a similar purpose to test descriptive casual hypothesis about manipulable causes.

This research design like any other experiment focuses on comparing variables to aid analysis of study. Quasi-experimental research methods stated by (Stanley&Campbell,1963), are the many natural social settings which the researcher can introduce something like experimental design into scheduling of data collection procedures even though he lacks full control over the scheduled experimental stimuli which makes a true experiment possible. It was used in the seasoning and mould preparation stages of the boards. The general work process made use of Quasi experimental in comparing research variables and data collect. This was because the researcher did not have fill control over the scheduled experimental stimuli.

3.4 Action Research

Action research is an interactive process involving researchers and practitioners acting together on a particular cycle of activities including problem diagnosis, action intervention and reflective learning (Avison,1999). Action research is both a participatory and democratic process concerned with developing practical knowledge in the pursuit of worthwhile human purposes which seeks to bring together action, reflection, theory and practice.

This process is done in collaboration with others in the pursuit of practical solutions to issues of pressing concerns to people and more generally the flourishing of individuals and their communities, Brydon (2001). Per these definitions, action research aims at a merger between actions and theories framed within time to produce results. It was by this method that research findings were implemented and tested. The researcher after creating the cast left it for a few days to dry before carving to test the materials viability. The researcher used Action research method in the immediate implementation of research findings to answer objectives 2 and 3.

3.5 Descriptive Research

It is a research design that offers a detailed account of some social phenomena setting experience, group etc. (Ryane,2005). William (2001) states that descriptive research depends on observation as a means of collecting data. He further says that observation examines situations in order to establish what the norm is and what can be predicted to happen again under the same circumstances. According to as Asabere (2011) “Descriptive research has the following types: case study, ethnographic studies, exploratory observation studies, among others” (p.14). The researcher aimed at measuring the behaviour of a variable thus, bonded sawdust against wood in order to draw conclusions about similarities or differences between the two. For this purpose, exploratory observation was used.

3.6 Library Research

The entire thesis is made up a compilation of vital information drawn from related

literature materials that connect to the topic. Visits were made to the KNUST main library, Natural Resources library, Guinness Public library, Atonsu Kumasi and the Department of General Art Studies Library (KNUST).

In almost all of the libraries, the sources of data were via encyclopaedia, internet, books and catalogues. In the attempt to come out with a suitable sustainable material for carving by the use of bonded sawdust, the researcher endeavoured to understand the process of particleboard production in the various sources of data in order to adopt a related data to this study.

3.7 Population

Amoh (2009) defines population as a group of people or objects with common characteristics that are of interest to a researcher. Scientific methods of population identification and sampling strategies were applied. Purposive and convenience sampling techniques were employed. Sawmills identified were based on proximity of their locations. The sampled population was also based on a careful selection.

3.8 Target Population

The target population was the group of all sculpture students at Armed Forces Senior High school in Kumasi and indigenous woodcarvers working at the Centre for National Culture, Kumasi, during the period of the research. (See Table 3.1).

Table 3.1: Sculpture students at the Armed Forces Technical Senior High School, Kumasi and indigenous woodcarvers at the Centre for National Culture, Kumasi.

Form One sculpture students	27
Form Two sculpture students	20
Form Three sculpture students	28
Indigenous carvers at Centre for National Cultural Kumasi.	12
Total number of sculpture students/ indigenous woodcarvers	87

3.9 Accessible Population

A total of 33 people were involved in both experimentation and production processes. They comprised 28 sculpture three students and 5 wood carvers from the Center for National Culture, Kumasi.

3.10 Sampling Strategy

Sampling is the process of shedding a selected subset of a research population (Raune,2005). It is also the set of actual data sources that are drawn from a larger population of potential data source (Sage encyclopedia,2010).The sampling group was taken out of the accessible group of 33 people.

Okra (2002) explains that purposive sampling is appropriate when one wishes to interview persons who are in good position to supply information. After identifying the population, purposive sampling was employed because the researcher believed that though each member of the population was potentially capable to provide the needed

information, individual differences and character traits could also add to the kind of information a person provides.

3.9.2 Data Collection Instruments

For the purpose of this study, the researcher used both observation and interviews for data collection. Informal conversational interviews were conducted using open ended questions (see appendix for interview guide).

The researcher also collected information as an observer-as-participant. That is the researcher served as an observer of the research proceedings as well as a participant. These data collection instruments were employed because of the quasi nature of the study.

3.9.3 Validation of Instruments

To ascertain that all primary information sourced through observation and interview guides were accurate, they were examined by the researcher, peers and finally by the supervisor before they were administered. Secondary source of information from libraries were as well examined by both researcher and peers and then it was finally examined by the supervisor before the information was considered valid.

3.9.4 Observation

It involves collecting information around the world using all of one's senses especially the sense of sight and hearing in a systematic and purposeful way to learn about a phenomenon of interest (Sage encyclopedia,2008). Ott (2001) states that direct

observation is used in many surveys that do not involve measurements. Data collection through observation may be often more real and true than data collected by any other method (Asabere ,2011). Amoh (2009) explains that observation enables the researcher to gather data on:

The physical setting (e.g. the physical environment and its organization);

Human setting (e.g. the organization of people, the characteristics of the groups or individuals being observed. For instance gender or class)

The interactional setting (e.g. the interactions that are taking place, formal, informal, planned, unplanned, verbal non-verbal etc.); The programme setting (e.g. the resources and their organization, pedagogic styles, curricula and their organization).

The researcher observed through the whole process of sawdust collection, preparation of mixture and the preparation of moulds to be carved. Observation was also made by the researcher on the carving process. All these observed facts were validated through series of checks. These triangulations were done by cross checking with interviewees and sampled groups.

3.9.5 Interviews

Interview refers to a personal exchange of information between an interviewer and an interviewee (Raune,2006). Asabere (2010, p.9) defines interview as a “purposeful conversation in which one person asks prepared questions (interviewer) and another answers them (respondent)”. According to Asabere, interview is a process by which

information on a particular subject or area of research is gained thus, through conversation.

One could also define an interview as purposeful conversation with either one person or a group of people (interviewer/s) and an individual or a group of people to gather information on a particular topic.

Interviewing may not also be confined to specially prepared questions. The process of interviewing may be either formal or informal so long as the information needed could be obtained. Interview guides were designed to guide the researcher as to the manner and kind of questions to be asked.

Even though an interview guides served as a yardstick that constrained the researchers questioning, much of the interview processes were conducted in an informal manner. This was to aid the researcher get more information. With the researcher's aim of getting specific questions answered, the nature of respondents and their environment had a bearing on the interview process.

3.9.6 Conducting the Interview

The researcher carried on an informal interviews guided by a well prepared interview guide. Two sets of questions were prepared for both sample groups. The first had to deal with students from the sculpture department. Theirs was more focused on getting much information pertaining to academics/ book knowledge. The second group was the local carvers at the Centre for National Culture in Kumasi.

Their questions were aimed at getting information that pertained to informal appreciation of the researcher's objective for the experiment. Both groups had ten questions each on their interview guides. Both sample groups were constantly visited.

With the indigenous carvers especially, the researcher had a good relationship with them through frequent visits. The sharp contrast between the two sampled groups compensated each other's limitations. One group consisted of educated folks and the other with semi-illiterates. Interviews were conducted in both English and Twi languages respectively. All interviews were conducted directly (face to face) with respondents.

3.9.7 Interview Guide

As reiterated by Ruane (2006:, p.49), "Interview is a purposeful conversation wherein the interviewer has a set of research agenda".

The interview guide gives the researcher the latitude in determining the actual content and direction of the interview. To steer the direction of the interview, interview guides were designed considering the following issues:

Will the questions be easily understood?

Are the questions biased?

Are the questions necessary to be evaluated?

Will interviewees be willing to provide the information needed?

Are the questions applicable to all interviewees?

Do the questions allow the interviewees to offer their opinions or to expand on basic

answers?

Will the questions be straight forward to analyse?

3.9.8 Validation of Interview Guide

The researcher made sure that the interview questions were free from error. The researcher allowed colleagues to examine the research questions and finally the research supervisor before the questions were considered valid for administration.

3.9.9 Validation of Interview Conducted

The validation of the conducted interviews was essentially on the convenience of the respondents. Date, time, venue, and all necessary arrangements were made in advance before the actual activities took place.

3.10 Primary and Secondary Data

The data were collected in the form of primary and secondary data. The primary data comprised all data from interviews, discussions, personal observation and pictures taken. The secondary data comprised the entire literary materials cited and used from the internet, books, articles and Theses on topics that were related to the study.

3.11 Data Collection Procedure

Primary data were assembled through observation and interviews conducted with the aid of validated interview guides with respondents selected from KNUST and CNC ,Kumasi. Photographs were taken during the field work and interactions with respondents.

The secondary data were assembled through library visits to consult the relevant literary materials from books, journals, magazines and newspapers and the internet.

3.12 Tools and materials used for the project

3.13 General work procedures and processes

The materials and tools that were used in the moulding, carving and finishing the project work have been described in this section of the thesis. The tools and materials included, mallet, flat chisels, gouges, sandpaper stains, white glue, mason polish, lacquer and varnish. Other materials used were plastic rubber, spatula, brick and a sieve. The functions of the tools and materials are provided as follows:

Sharpening stone

To keep both gouges and chisels sharp, the sharpening stone was used.

Painting brush

With the aid of a painting brush, lubricants were applied to the wooden moulds. It was also used to apply lacquer and varnish during the finishing stages.

Mallet

The mallet was used to aid carving.



Plate3.1 Mallet

Nail

With the help of a nail holes were punched at the bottom of the rubber containers. This was done to aid easy excretion of the moisture content in the mixture.

A set of chisels and gouges

A set of gouges and chisels were used to carve the moulded sawdust boards.



Plate3.2 Chisels and gouges

Spatula

It was used to level the surface of the formed moulds



SPlate 3.3 Spatula

Cooking oil

It served as a lubricant. This was used to smear the inner part of the wooden mould to prevent it from sticking to the material.



Plate 3.4 Lubricant

Bricks

They served as weight. They were used to compress the mould to strain their moisture content and further aid drying.



Plate 3.5 Burnt Bricks

White glue

It served as a binder in the block making process



Plate 3.6 White glue

Rubber bucket

It was in these containers that the preparations of mixture for the moulds were done.



Fig.3.7 Mixing sawdust in rubber bowl

Sawdust

This material was mixed with glue in different proportions to fashion out blocks that could be carved.



Plate 3.8 Mixed Sawdust in plastic bags

Sieve

Different pieces of sieve with varied sizes were used to sieve sawdust particles. This aided the researcher to have sawdust of varied particle sizes.

Wooden mould

A wooden frame was used for moulding mixed sawdust and glue into blocks.

Stains

To enhance the beauty; of the work, stains were applied to some of the works before they were polished.

Sandpaper

They were used to sand the works in order to give them the desired smooth touch.

3.13 General work procedure and processes

3.13.1 Acquisition and treatment of sawdust

The researcher sourced for raw materials needed for the project from sawmills located around Santasi in Kumasi. Acquiring sawdust was easy because sawmills seem to have a problem disposing them off.

For this study, the researcher has classified his raw materials thus, sawdust into smooth, semi smooth, coarse and semi coarse. The researcher noticed that the sawdust particles collected varied in sizes and colour. It is this characteristic that the researcher used to sort and also name the different groups for the purpose of easy identification. Sawdust collected was sieved through screens of different sizes and eventually grouped according to the different sizes in the preparation for their use as carving materials.



Plate 3.8 smooth sawdust

The researcher first experimented with the finest category of saw dust collected. This category of sawdust with smooth particles at a glance may look very appropriate for board making. Its fine nature suggested the possibility of the particles to interlock during use. In other words, individual particles still stand on their own even after bonding. Hence the dried casts are not able to well. The end product therefore became brittle. Secondly, it was observed that even though blocks could be made out of smooth sawdust despite its brittle nature, they could be used in making small blocks meant for simple art works.

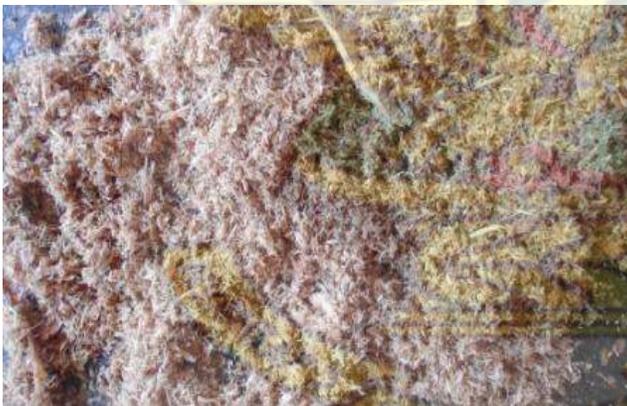


Plate 3.9 Semi-smooth

It was assumed that they could hold the binder very well. Owing to the fact that the particles were quite bigger, they were assumed to interlock each other very well. Blocks made out of semi smooth sawdust were solid and compact. Its brittle propensity was much minimal compared to the former group (smooth sawdust).

Coarse and Semi-Coarse sawdust



Plate 3.10 Coarse



Plate 3.11 Semi coarse

Both coarse and semi-coarse sawdust particles were observed to have similar reactive properties to bonding. They had a far better bonding ability than the former two. They could hold glue very well. Their individual particles interlocked well. However, boards created from coarse and semi coarse sawdust had uneven surfaces as well as large pores in them respectively. They also had haphazardly arranged grains. Board created from this type generally did not have an appealing appearance.

3.13.2 Making of Sawdust Blocks

Objective One

The first objective of the work was to experiment and fashion sawdust into blocks and boards to serve as a suitable material for carving in line with this objective of the study, the researcher had to build sawdust blocks for the carving experiment.

The researcher used carpenters glue as the main binding agent. A study into the manufacture of particle-board gave the researcher an idea of how manufacturing of particle-board is done.

Basically, particle-boards are manufactured to serve as flooring material and are generally used for carpentry works. This research work was intended to produce particle-boards thick enough for carving. Thus, the manufactured boards were to wield properties similar to wood used for carving. According to Dinwoodie (1989), wood is considered a heterogeneous material that varies in strength. The researcher therefore had the liberty to produce a material suitable for his intent. The researcher's aim was to come up with a kind of material capable of withstanding chisel and hammer blow. This type of particle-board was also going to be used for both “in-the-round” and “relief” carving.

The researcher started off by trying to come out with a mould that could help him achieve his aim.



Plate 3.12 Plastic containers

In the first experiments conducted, the researcher made use of plastic cooking oil containers which were readily available at no cost. With aid of a large pair of scissors , the top parts were cut off leaving a large base as found suitable for the purpose of serving as a mould for the sawdust(see plate 3.12 and 3.14). The manner in which they were cut gave room to adequately fill them with sawdust for the moulds.



Plate 3.13 cutting plastic container cut into two



Plate 3.14 The prepared containers ready for use



Plate 3.15 Packs of sawdust in black polythene bags



Plate 3.16 The process of packing sawdust into a lubricated container

These plastics did not allow for lubricants, the researcher had to destroy the mould after the casting process. In other words, removal of the cast from the plastic mould was difficult. Also because the plastics did not allow air penetration, both air and water were trapped in. The researcher then had to improvise ways to deal with this phenomenon. With the help of nails, holes were made all over the plastic containers (moulds).

This was to aid the easy escape of both water and air. The researcher further noticed that though both air and water contents were induced out of the mixture, parts of the mixture exposed dried faster than the other pin-holed portions. The researcher resorted to the careful removal of the plastic moulds. This could be done after some days of sun drying to aid a degree of hardening of the cast. Though this procedure had to take place at the wet state of the cast the removal were carefully done in order not to distort the form of the cast.

Applying weight to mould

Industrialized particle-boards are produced for kitchen furnishing. They are usually compressed with the help of heat. This they do to aid drying and improve compatibility. The researcher on the other hand decided to apply weight, heat and natural air in different ways. One out of the three moulds was heavily compressed with cement block (plate 3.16). The first mould was labelled “A ”



Plate 3.17 A heavy cement block being used to exert weight

The second mould which was labelled “B” was periodically aided to dry with the help of an electronic dryer and the third mould labelled “C” was left to dry on its own.

The researcher observed that Mould “A” that was compressed with weight immediately started to “bleed”. The moisture content which was to serve as the binder began to drip profusely.

Due to the enormous loss of the binder, the moisture content, the whole mass became extremely brittle. Effect of the binder at this point was not much noticed. Upon drying, the researcher noticed that even though there was much loss of the binding content at the beginning of the drying process, the completely dried mass appeared compact and it exhibited no sign of binder deficiency.

The second mould that was aided with an electronic dryer also produced a different outcome. The researcher identified that even though the wet mould reacted positively to the application of heat, the effect of the heat only affected the exterior leaving the interior wet. The intensity of heat on the outer layer of the cast appeared to have burnt.

The researcher had to cut through the cross section to be able dry the moisture content trapped inside the mass. Unlike the first cast, the second drying process appeared cumbersome and time wasting. The third cast that was left to dry on its own required a longer drying time. This was because whilst the moisture content of the other cast were forced to dry through exertion of weight and the use of heat, the moisture in this mould was supposed to dry alongside the solid content.



Plate 3.18 well dried casts 'A' 'B' 'C'

Carving the mould

Conventional carving tools were used to experiment the carving of the formed casts. The researcher decided on carving an object in- the-round out of Mould C. Though the material seemed to be comfortable to carve, it also had its challenges. First of such challenges was the effect of grain pattern of the mould. The grain pattern appeared to have been mixed up. Unlike conventional wood for carving, this allowed the material to be properly worked with only with well sharpened tools. The researcher noticed that any tool that appeared not to have been well sharpened splits the individual grains of the mould. The researcher also decided to allow an indigenous carver to experiment with it to give the research a balanced spectrum. Woodcarvers at the National Centre for Culture were engaged in this part of the study.

The Nature of Wood Carving at The Centre for National Culture in Kumasi.

Carving basically is an expression of indigenous beliefs and philosophies through art. Per motive behind the establishment of the centre, all artisans are endeavoured to promote Ghanaian culture through their various art works.

Carvers at the centre carve traditional expression and philosophies according to the carver. Even though they try as much as they can to portray cultural diversity through carving, some particular artefacts appeal so much to buyers. Also some buyers crave for personal interpretation being incorporated in their works. As a result, production of artefacts now depends on customers taste, size of work and season.

Basically, there are two groups of carvers at the Kumasi Centre for National Culture. Even though both groups are indigenous carvers, one group is into drum carving while the other undertakes a general practice of art.

Although these are grouped into two based on their location and kind of practice each carver works on their own. Although apprenticeship goes on here, majority of the carvers are master carvers who have sojourned from elsewhere to practice (ply) their trade at their present locations. For the sake of study, the group that engaged in the general carving practice was suitable to work with. They were made up of five members consisting of four masters and one apprentice.

Even though they practice carving, generally they mostly do jewellery boxes, drums, dolls and Adinkra panelled designs. In as much as they worked individually, they did consult themselves when it comes to work. Each other's expertise had a bearing on the other. They primarily work with some specific wood species for e.g; Tweneboa and

occasionally Teak. Majority of the raw materials is gotten from Sefwi in the western region. To them timber as a raw material is not close to extinction. Their only concern is that workable species are sited very far in deep forest lands. The researcher used random sampling to select three out of the five master carvers. The researcher believed that each member of the population wielded an equal chance and depth of experience of being selected and hence providing the necessary information needed for the study (see plate 3.19).



Plate 3.19 A group of indigenous carvers at the Centre for National Culture Kumasi

Though these carvers have a lot of experience with regards to carving and carving materials, they seemed not to have experience with the object of the researchers study. They were also given the room to operate with no restrictions. They came out with two

works. The outcome of their works was very encouraging compared to the amateur disposition of the student carvers. Their finishing did not suggest they had difficulty with it. (See plate 3.20)



Plate 3.20 'Adinkra' A sawdust carving by carvers at Centre for National Culture, Kumasi

Finishing

On the other hand, finishing of the works also came up with its own challenges owing to the seeping nature of the cast. The finishes applied appeared to seep into the material due to its porous build up. Owing to this fact, lacquered as well as varnished works still appeared matt. Nevertheless, the interlacing appearance of the material gives the work a beauty of its own. Since the use of both lacquer and varnish appeared not to have any

visible effect on the works, the researcher resorted to staining as a form of finishing (see plate 4.1).

Objective two

The second objective was to teach Senior High School students the process of making sawdust boards and blocks and also to design and carve art pieces out of the new material.



Plate 3.21 A group of students being introduced to the project.

The students had to be given a detailed explanation on what they were about to do and its importance. Their sculpture background made it easier for the researcher to make them understand the concept of the project they were embarking on.



Plate 3.22 Preparing the mixture by adding white glue to sawdust

Though the researcher had prior knowledge of his material, for the sake of the students, he experimented with them through different approaches. This was intended to give them a better understanding of the process they were going through. We initially started by adding a quantity of undiluted carpenters glue for our mixture. However, undertaking the process revealed that adding a high concentrate of carpenters glue to sawdust could not produce an even mixture bringing about bumpy lumps. Since the students had knowledge in the preparation of plaster of Paris, a suggestion was made by one of the students. He proposed that we should apply the process they use in mixing plaster of Paris. The mixing process was then changed. This time, small quantities of sawdust were added at a time to a solution of carpenters glue and water. The ratio of the mixture was three parts of water to one part of glue.



Plate 3.23 Preparing the mixture by adding sawdust to glue



Plate 3.24 Wooden moulds being lubricated

Lubrication of the moulds was very important. Since the material which being used for casting was the same as the mould it was likely that the two materials were going to be bond together. Using a painting brush, ordinary cooking oil was used to lubricate the moulds. This was done to aid easy separation of the mould from the cast after drying.



Plate 3.25 Prepared mixture was packed into well lubricated moulds

Using the hand, the wooden mould was filled with sawdust paste. The paste was compressed to fill every corner of the mould (see plate 3.25).



Plate 3.26 A well-dressed mixture packed in a mould

At this level, the hand could not help to achieve the smoothness the researcher desired so with the help of a spatula the packed mould was then dressed to give it a smooth and an even surface.



Plate 3.27 Bricks were packed on the moulds to exert weight to achieve compactness

One of the prepared moulds was covered with a slice of plywood and a pack of bricks laid on the mould to exert pressure whilst the other mould was left without any exerted weight (see plate 3.26). We wanted to compare the drying speed of both and at the same time measure the impact of weight on the prepared mould.



Plate 3.28 Dried mixture in a mould

After two weeks of allowing the mould to dry, we went back to remove the cast in order to work with it. We started by trying to take the cast out of the mould. It was discovered that the mould on which the slice of plywood was placed appeared to have an uneven surface. This was due to the fact that the lubrication did not have the desired effect on the mould. The lubricant appeared to have dried up because of the long period the mould was left to dry. The cast were then forced to be separated from the moulds with the help of chisels. Parts of the moulds had to be destroyed.



Plate 3.29 A group of students using a chisels to remove a mould

Even though the cast was removed successfully, the difficulty we encountered was a major threat to the deformation of the cast owing to its soft nature.



Plate 3.30 Checking of the lubricant's effect on the cast



Plate 3.31 Trying to improvise a way to separate the cast from the mould



Plate 3.32 Using chisels to remove the casts from the moulds



Plate 3.33 Parts of the mould were destroyed by the process

Working with the cast

The next task was to carve something out of the sawdust blocks created. The idea was to come up with something basic owing to the students' technical limitation with regards to wood carving. The students were grouped into two. Without any particular order, each of these groups was to come up with something they could carve. The first group decided to work on an Adinkra symbol, whilst the other wanted to carve an inscription.



Plate 3.34 Sketching on the boards

With little supervision from the researcher and their sculpture teacher, the students applied their knowledge in wood carving in executing this new task. Though the difference in both conventional wood and the created cast seem not to be much, there were still some technicalities to be critically considered. The colour of the boards did not make pencil marking visible. The students then decided to print their designs on paper, paste it on the board and carve from it directly.



Plate 3.35 Testing their hands on the material

The weight of hammer blows in wood carving appeared to vary. Sawdust moulds were not as dense as conventional wood of the same size. The intensity at which a mallet will be used in conventional wood carving also varied. Sawdust moulds could not be carved according to the pattern of their grain movement. This happened because grains were haphazardly patterned.



Plate 3.36 Students seriously working on their projects

Carving intricate parts appeared to be challenging. Relief areas that had little attachment to the base of the work were likely to pull off.

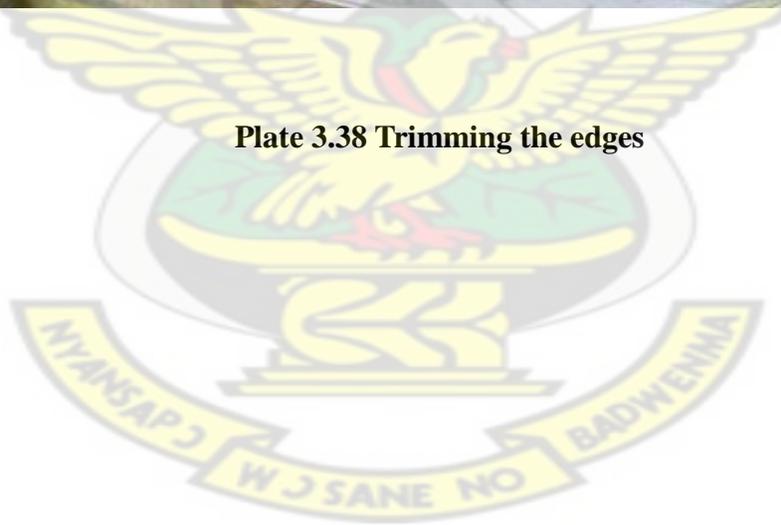


Plate 3.37 A closer look at the board

It was discovered that unlike conventional wood, portions mistakenly cut off could not be glued back. Relief works did not stand out until either the background or the carved parts were stained.



Plate 3.38 Trimming the edges



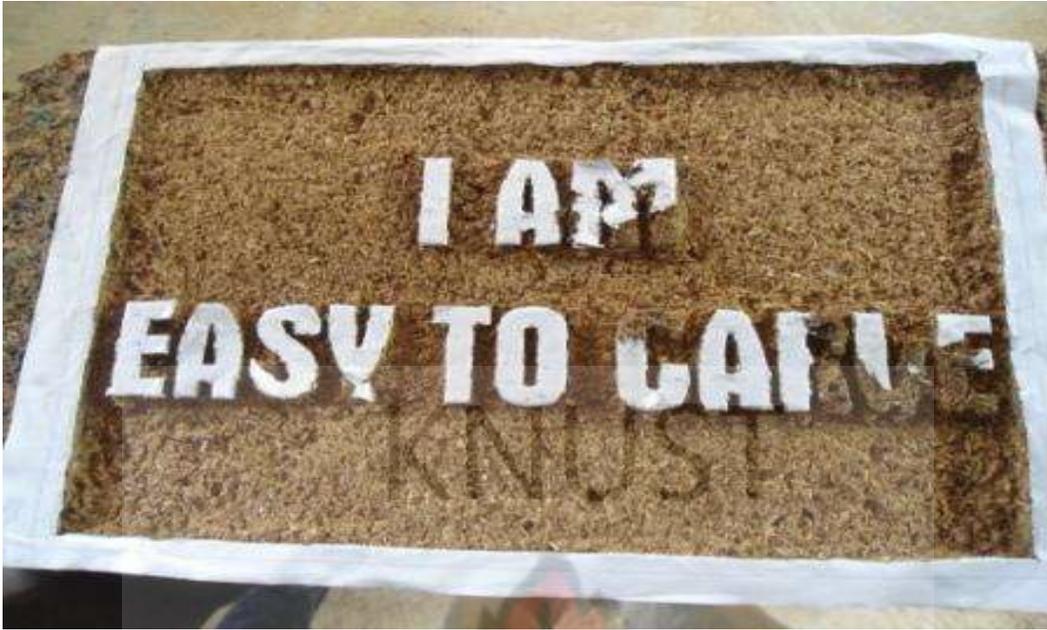


Plate 3.39 Samples 'A' and 'C' Relief carving from sawdust

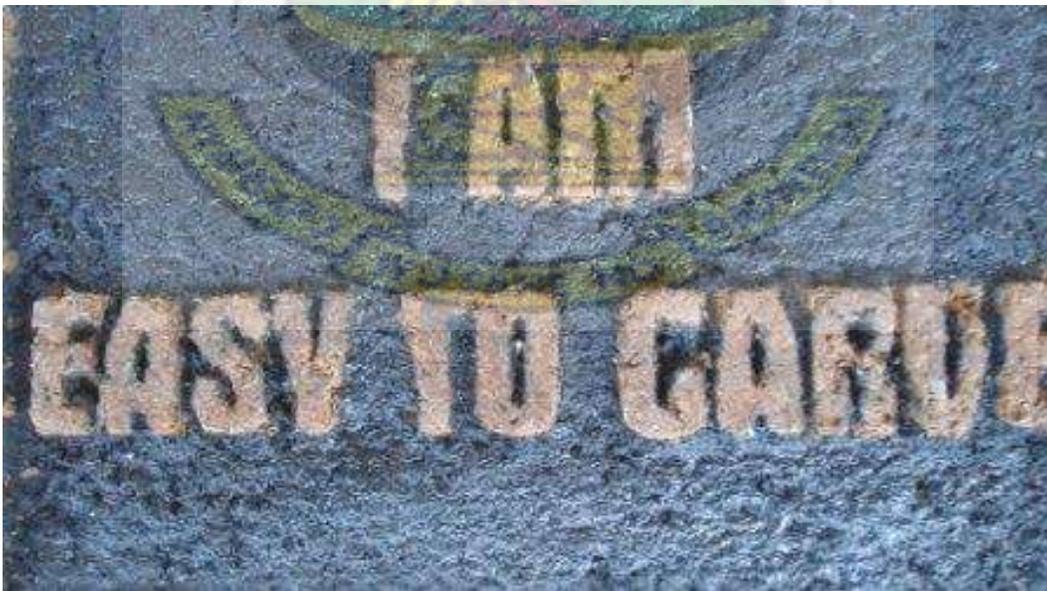


Plate 3.40 A finished relief work from sawdust



Plate 3.41 'Up & down' a relief work carved from sawdust blocks



CHAPTER FOUR

PRESENTATION AND DISCUSSION OF FINDINGS

4.1 Overview

This chapter presents and discusses the results of the use of saw dust as a raw material in the building of blocks and boards for carving. It also discusses and evaluates the effect of glue, water and other environmental phenomena on the sawdust moulds. The data for this chapter were gathered through observation of the entire project and experiments conducted to confirm the suitability of sawdust boards for carving. This has been described below.

4.2 Major Findings on Materials

Having performed the experiments, the researcher observed that sawdust could be processed into moulds and could be used for carving. All the four categorized sawdust samples used for the study proved and justified the researcher's assertion that sawdust could be processed to serve as a substitute to wood.

4.2.1 Observation of Experiment A

It has been revealed by experiment AI that smooth Sawdust does not respond very well to the board making process. Though it reacts well to bonding to some extent, its ability to be carved is the least as compared to the others. The researcher found out that the nature of smooth sawdust retards cohesion even after it is glue bonded.

The structural composition of individual particles in smooth sawdust makes them stand apart. Boards made of smooth sawdust are brittle. Secondly, it was observed that even though blocks could be made out of smooth sawdust despite its brittle nature, they could be used in making small blocks meant for simple art works.

4.2.2 Observation of Experiment A2

On the other hand, semi smooth sawdust reacted better to the bonding procedure. They could hold the binder very well. Owing to the fact that the particles were quite bigger, they tended to interlock each other very well. Blocks made out of semi smooth sawdust were solid and compact. Its brittle propensity was much minimal compared to the former group (smooth sawdust).

4.2.3 Observation of Experiment A3

Both coarse and semi-coarse sawdust particles were observed to have similar reactive properties to bonding. They had a far better bonding ability than the former two. They could hold glue very well. Their individual particles interlocked well. However, boards created from coarse and semi coarse sawdust had uneven surfaces as well as large pores in them. They also had haphazardly arranged grains. Board created from this type generally did not have an appealing appearance.

4.3 Findings on the Reaction of Wood Dust from Different species

Although the researcher started with the aim of using sawdust to create boards regardless of the kind of parent wood specie the sawdust came from, however the researcher had the opportunity to collect sawdust which had dominating proportions suggested to come from a particular wood with regards to their colour ,smell and strength. The researcher observed that even though bonding in the context of this experiment depended solely on the glue, the dominance of certain species in a collection either enhanced or retarded the bonding process.

4.3.1 Yellow dominated Sawdust

The researcher observed that a collection of yellow dominated sawdust had a very good bonding property. Its compatibility was rated above all the others. They allowed cast to be taken off a day after the mixture was poured into the mould. Blocks appeared solid even when they were freshly prepared and the casts still had high water content.

4.3.2 White dominated Sawdust

Even though white sawdust collected bonded well, it had a high brittle property. Its nature made its preparation have a greater dependency on the moulds used. Unlike the yellow sawdust it could take about a week before a mould could be ideally removed from the mixture. Owing to its brittle nature, the mixture had to be allowed to dry a little bit longer in the mould otherwise they could break if attempt was made to remove the mould.

4.4 Effect of both high and low concentrates of white glue

The researcher's observation of all the experiments carried out revealed that the intensity of white glue solution did not have much bearing on the outcome of the boards. The response of a board built with a high concentrate of white glue was the same as the one built with a low concentrate of white glue. It was found not to have any effect on drying time, strength and binding capacity of the mould.

4.4.1 The effect of water

Water in the whole experiment served as a vehicle which drove both sawdust and glue into a complete mass. However, the researcher observed that the quantity of water used had an effect on the drying time of the cast. A smaller quantity of water used resulted in a faster drying period and vice versa.

4.4.2 The effect of heat

The application of heat does not appear to facilitate a good drying process. Heat was observed to have effect on only the outer parts of the mould.

4.4.3 The effect of induced pressure

The study revealed that induced pressure is effective and aids the drying process. The researcher observed that cast on which weight was applied dried faster than the others without weight. Water content in pressured cast drained faster than unpressurised moulds. On the other hand, it was noticed that if lubrication is not intensified, pressured cast stuck to the moulds thereby creating rough cast surfaces.

4.5 Findings on Tools

The researcher observed and found out that the regular tools that are used for woodcarvings could equally be used on bonded sawdust. Though the properties in wood and bonded sawdust are almost the same, tools with sharp cutting edges work more effectively on sawdust. The effect of blunt tools on bonded sawdust is much more deforming as compared to its effect on conventional wood.

4.6 Effect of lubricants

The researcher observed that though lubricants were smeared inside of the moulds, the material still seemed to find proper attachment to the mould in which the blocks were built.

4.7 Finishing

The porous nature of sawdust cast does not allow the carver to have the desired finishing effect on the work. It appears that the porosity of the material allows the applied finishing to seep into the work thereby not giving it the aesthetic effect desired. Carved sawdust pieces do not appeal very well as compared to conventional wood during finishing. However, despite the porous nature of sawdust cast, they also tend to have their own distinct beauty if carefully finished.



Plate 4 .1 “Her face” a lacquered carved piece

4.7.1 APPRECIATION OF Two of the Works.

(A) Her face

“Her face” is a carved piece made from bonded sawdust. The original cast from which the work was carved was composed of semi coarse sawdust particles (Experiment “B”). It has been carved with ordinary carving tools. The piece portrays the face of an African woman. It has been finished by lacquering. The material make up of the cast gives the work a matt finish adding a unique touch to the work. The nature of the parent material did not allow the carver to bring out the details. Hence the viewer may enjoy it better

when observed from a distance.

Interpretation of results

The work was inspired by the many female figures mostly carved by the Ghanaian sculptor. This inspiration brought forth the challenge that if any subject could be experimented, the African female face with its unique contours and beauty was the best subject for execution. The carver believed that if the female African face could be carved, then the material could be used for any other work.



Plate 4.2 “Black mask” a stained carved piece

(B) Black mask

Black mask is an African mask carved out of white glue bonded sawdust. The original cast from which the work was carved from was composed of coarse sawdust (Experiment “C”). It was carved with well sharpened chisels. The work has a scooped back that gives a hollow opening to both eyes. Though it has been finished by lacquering, the finishing still appears to have sipped giving the work a matt appearance . The multi-

coloured grain particles give the work a different sense of beauty.

Interpretation results

The work was inspired by a story told in a local Ghanaian movie. The story unfolds the disparity between the interpretation given by foreigners and contemporary Ghanaians with regards to carved African mask. Though it is branded evil by most indigenes, foreigners use it as money making objects in foreign museums. This work conveys the message that although most African art pieces are functional, some also have intrinsic aesthetic values.

4.8 Reaction of Local Wood Carvers

- A prior knowledge of the material gave them the idea as to the approach needed to be applied. Hence they remarked that carving without prior knowledge of the material could immensely affect the whole carving process.
- According to the carvers sawdust boards are termite proof and therefore could be better preserved than conventional wood.
- They would not mind to work with it in future provided they will be able to get the sizes they may need.
- They had problems with the manufacturing process. They believe that because of its long drying process, time bound projects could hardly be executed with this material.

- They also commented on the fact that because sawdust boards are made from a combination of dust from different wood species, it is just like carving with conventional wood.
- The material requires well sharpened tools to work on it.
- They believe that the challenges they encountered with regards to its finishing dents the general workability of the material.

4.9 Reaction of Students

The researcher could not get so much from the students. This was attributed to the fact that they did not have much experience. However 16 out of the 28 students stated that:

- They enjoyed the experience.
- They admitted to have difficulty in carving the material. They however attributed it to inadequate carving experience and blunt tools.
- They did not enjoy the finishing of the work.
- They expressed the interest of using the material again in the future.

4.10 Summary of Findings

The entire mould building process took approximately two weeks. These long drying periods determined when the cast were ready to be worked with. The mould could ideally be cast in materials that could be easily detached without necessarily affecting the mould. Plastic containers were found to be the most suitable for the

work. The use of plywood posed a lot of trouble during the detachment process after the mould was completely dry. The researcher observed that lubricants like oil could not be relied on for easy detachment of the moulds.

Though sawdust moulds could be carved just as wood, experiment revealed that only extremely well sharpened tools could do the carving to expectation. Any blunt tool was found to peel the mould off rather than carve it. The researcher also observed that pieces carved out of bonded sawdust would be best for interior use than exterior usage. This was because sawdust moulds could not withstand rain as compared to wood. Moulds that came into contact with rain were susceptible to reverse to their original state if handled well and left to dry. It was however observed that if a mould is left in continuous rain, the individual particles tend to flake off.



CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter deals with the summary, conclusion, and recommendations to the study.

5.1 Summary of the study

This research sought to:

- To perform an experiment on how to process sawdust to serve as a suitable alternative material for carving.
- To teach Senior High School students the process of making sawdust boards.
- To help students design and carve art piece out of the newly created sawdust boards and blocks.

Wood carving is a traditional vocation which has seen extensive expansion throughout the ages. Despite its addition to the economic boom, no one can brush aside its negative effect on our forests. It is evidently clear that the excessive loss of timber/wood to both wood carving and wood processing activities may lead to a total collapse of this craft. Even though just a few wood species are traditionally accepted for carving, the introduction of new species in the carving industry points to the fact that there is a dwindled availability of raw materials.

Therefore the researcher began to find out the extent to which raw materials for carving are scarce. It further probed into how viable wood waste/sawdust could be recycled to suit carving.

Chapter two of the research work covered review of related literature on the study. It included both theoretical and empirical review of wood, its formation and make up. It also covers a review of sawdust formation, particle board and other relevant literary works related to the study.

Chapter three dealt with the research methodology. Qualitative method of research was used in conducting the study. Both online and traditional libraries were visited to collect data on issues related to the study. Population and sampling techniques are also stated. Where necessary, tables and diagrams were used to give further explanations. The data collecting tools used were interviews and observations. The researcher introduced 75 students to a new sculptural material whilst 12 carvers on the other hand were introduced to a new material for carving. The researcher observed and interviewed participants. Chapter three also dwelt on the entire processes and procedures used for the experiment.

Chapter four is made up of presentations and discussions of findings. Chapter five presents the summary, conclusions, and recommendations. Results from the experiments and the products indicate that sawdust can be used as an alternative material to wood carving.

5.1.1 Principal Findings

The research results reveal that because of the brittle nature of sawdust boards, it requires sharp tools to carve it. Unlike conventional wood, carving sawdust boards, become cumbersome if sharp tools are not used. Carved sawdust boards are not durable and therefore may require careful handling. Works carved out of sawdust boards may flake

with time. Although carved sawdust boards are beautiful, their finishing may not be appealing as compared to conventional wood.

5.2 Conclusions

The result of the study confirms that treated sawdust can be used as a substitute material for wood carving. The researcher further recognized that even though pieces could be carved out of moulded sawdust, carved wood pieces are more appealing than carved sawdust. This may be due to its structural make - up and probably its finishing challenges. In terms of durability, sawdust boards may require much careful handling as compared to conventional wood. Despite the fact that the research had positive results, some forms of challenges were encountered. Inconsistent weather pattern was a major setback to the success of the work since the researcher relied on natural elements to dry his moulds, inconsistent weather delayed the work. Few existing research works on the topic made the researcher walk an extra mile to fetch data for the work. This limited the speed of the work. Lack of adequate practical carving knowledge of Senior High School students also had a toll on the speedy execution of the work.

5.3 Recommendations

Having undertaken a thorough study on the viability of sawdust as a substitute material for wood carving, it is deemed necessary to present some recommendations. The researcher is of the firm belief that these recommendations will help in improving the art among sculpture students and traditional carvers. It would also enhance its teaching and learning in schools and colleges in the country. These suggestions are of relevance to the

government, curriculum planners in the ministry of education, the tourism sector and all other parties responsible for the preservation of the Ghanaian cultural heritage.

The use of sawdust as an alternative material should be introduced in all sculpture departments in Senior High Schools.

Further research works should be done on this topic to totally exhaust the viability of sawdust.

Art faculties in the various universities across the country should encourage students to further undertake research works on sawdust.

The Ghana Education Service and other stakeholders of the art fraternity should encourage students to undertake viable and environmentally sustainable projects.



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APPENDIX

Interview guide

Research Question: To what extent can sawdust be used to help solve this phenomenon?

Name of interviewee:

Area of specialization:

Educational level:

Date:

1. How different are sawdust boards from conventional wood?
2. Are there any similarities between sawdust boards and conventional wood?
3. Do sawdust boards require any special tool to be carved with?
4. How does the grain make of the board affect carving of the work?
5. How does the rough nature of sawdust boards affect sanding of the work?
6. How best can it be finished?
7. Is it enjoyable to carve?
8. What is your overall perception of the material(sawdust)