

**USING LAMINATED BAMBOO IN THE PRODUCTION OF
SELECTED TRADITIONAL GHANAIAAN ARTIFACTS**

BY

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DECLARATION

I hereby declare that this submission is my own work towards the Master of Philosophy degree 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 other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Although bamboo has made dramatic impact on many Ghanaian communities, its potentials have not been fully exploited to enhance the economy. One major reason is that most Ghanaians do not have adequate technological know-how on the use of bamboo in producing wooden items. This has resulted in the over dependency on local species of wood for art and other end uses. The potential of using bamboo for the production of some traditional Ghanaian artifacts has not been fully explored in Ghana. For this reason, the local wood species are being depleted, wildlife is getting more and more endangered, and the impact of this depreciation of the forest and wildlife is taking a progressively higher toll on human life in Ghana. It is against this background that the researcher has studied and produced some traditional Ghanaian artifacts which hitherto, were done in wood. This would help to reduce the pressure on wood and wooden products. The research methods used are descriptive and experimental. The research tools employed are observations and interviews. The project revealed that bamboo could be used as near perfect substitute for timber. Recommendations were made to draw attention to policy makers on how to use bamboo to help arrest the current situation of depending solely on our local wood resources in producing wooden artifacts or products and also to improve the people's living standard.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Bamboo is a material with numerous uses such as building, furniture and fencing. Although this non-timber forest product is a good material, its traditional use has been restricted to the construction of temporary structures and is used where cheap and inferior materials are needed.

Diminishing wood resources, particularly in Ghana and other countries in the tropics have drawn attention of governments to bamboo, a material that is renewable, environmentally friendly and widely available. Bamboo grows rapidly and adapts to most climate conditions and possesses properties superior to most fast growing plants.

1.2 Statement of the problem

Although bamboo has made a dramatic impact on many Ghanaian communities, its uses have not been fully exploited. In spite of efforts made by some stakeholders like Africraft, Adinkrahene Concept and Pioneer Bamboo limited to establish bamboo factories to expose the potentialities of bamboo to Ghanaian societies, a greater number of Ghanaian craftsmen do not have the knowledge for processing bamboo into boards for carving. This has resulted in

over dependency on local species of wood and these local wood species are being depleted.

1.3 Objectives of the study

The objectives of this study are;

1. To study the production methods of selected traditional art forms.
2. To process and laminate bamboo for the production of the selected traditional art forms.
3. To produce the selected traditional art forms using the laminated bamboo boards.

1.4 Justification of the objectives;

1. The study of the production methods of selected traditional art forms gave adequate information for their production in bamboo.
2. The processing of laminated bamboo boards for the production of the selected traditional art forms provided an alternative to traditional wood species.
3. The production of the selected traditional art forms using the laminated bamboo boards confirmed the suitability of the laminated bamboo board for the production of traditional art forms.

1.5 Research questions

1. What processes are involved in the production of the selected traditional artifact?
2. How can bambusa vulgaris be laminated into boards and blocks for the production of the selected traditional artifacts?
3. How can laminated bamboo be used for the production of the selected traditional artifacts?

1.6 Delimitation

This study is limited to the processing of Bambusa vulgaris into laminated board for the production of traditional art forms.

1.7 DEFINITION OF TERMS

Delimiting - Removal of branches from the bamboo culms.

Splitting - Cutting the bamboo longitudinally into strips.

Radial knife- A tool for splitting bamboo.

Boiler - A container for heating or boiling of bamboo.

Preservatives- Any organic or inorganic substance applied to bamboo to prevent pest infestation.

Lamination- Boards made by bonding layers of bamboo strips or wood.

Polyvinyl acetate – This is the type of glue used in bonding two surfaces

of wooden boards.

Lumen - The inner lining of bamboo culms.

Scraping - Removal of the outer covering of bamboo using a sharp tool or blade by rubbing.

Pyrinex 48EC - An agro-chemical preservative.

Stakeholders - A person or group of people who have a share or a personal or financial involvement in a business.

Bambusa Vulgaris -The green bamboo that is widespread in Ghana.

Bambusa vulgaris var vitata- The yellow or yellow and green striped bamboo species found in Ghana.

Bambusa bamboos- The green bamboo with a bigger culm.

1.8. IMPORTANCE OF THE STUDY

This study has;

1. Provided an alternative material to the traditionally known woody material for producing traditional art forms.
1. It has suggested a way out of over dependency on the traditionally known woody material for producing traditional art forms.
2. It has exposed for exploitation, the potentials in bamboo.

1.9 ARRANGEMENT OF TEXT

The chapter one of this project report ushers in the reader and provides a guided tour to the entire thesis and it outlines the background to the study, the statement of the problem, the objective, justification, research question and delimitation. The rest are the definition of terms, importance of the study and the arrangement of text

Chapter two reviews literature relevant and related to the study and this provides the background to the research problem. This refers to the critical examination of documented information available on the topic under discussion for the purpose of linking up with the subject most relevant to the study. It provides the foundation for the entire study and presents information on what other researchers have done on the importance of the use of bamboo in the production of some works of art.

Chapter three also deals with the methodology employed, This includes the sampling techniques applied in data collection from the field and the general procedures in the execution of the project.

Chapter four discusses the results and findings of the project.

Chapter five is the summary, conclusions and recommendations and this is followed by the references.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Overview

This chapter is a disclosure of information relevant to the study. In this the following topics have been reviewed: Bamboo in Ghana, Traditional uses of bamboo in Ghana, Non traditional uses of Bamboo in Ghana, Lamination of bamboo, Traditional carving in Ghana, Material for traditional carving in Ghana and History of traditional carving in Ghana.

2.2 Bamboo

Bamboo is an exceptional material for limitless applications ranging from handicrafts and utility items to industrialized products and structural components of bridges and buildings. With such wide applicability, it offers incredible business potential for rural communities and business opportunities for industry.

From the report made available by the International Network for Bamboo and Rattan (INBAR) (1998), it was stated that, compared with other woody plants, Bamboo is a fast growing plant. It was further affirmed that it takes between forty to sixty days for Bamboo to reach a maximum height. Examples of some giant Bamboo was stated to have reached a height of thirty to thirty six meters and could endure all kinds of circumstances but fire.

2.3 Bamboo in Ghana

According to Baah (2001), there are seven known species of bamboos in Ghana. These are *bambusa arundinacea*, *bambusa bambos*, *bambusa multiplex*, *bambusa pervariabilis*, *bambusa vulgaris*, *bambusa vulgaris var. vitata* and *dendrocalamus strictus*. Among these, *bambusa vulgaris* is indigenous to Ghana.

2.4 Traditional uses of bamboo in Ghana

Due to its comparatively short life span, bamboo is, customarily, and usually used for purposes that do not necessitate much permanence. The culms, whole or split, provide fencing material for courtyards, outdoor kitchens and bathrooms in rural dwellings and low-income areas in the cities. Culms split into two halves provide temporary roofing that last two or three years. Split or whole culms are used to make seats that are fixed to the ground, often under shady trees to provide relaxation. Handicrafts such as spoons and spatulas are made from the split culms; sharp spikes are made from the split culms for various purposes, such as roasting sticks for kebab and a spike for removing snails out of their shells.

2.5 Non-traditional uses of Bamboo

In recent years in the building and construction industry, Steiner (2006) said wawa poles that were once used as props for scaffolding and for casting concrete flooring have become scarce and expensive and have been replaced with bamboo culms.

In the craft industry whole and split culms are carved into various decorative items.

In the furniture industry bamboo culms are complemented with timber wood for the manufacture of furniture. Steiner *et al* (2013) opined in more recent years the

technique of splitting the culms of *Bambusa vulgaris* into slivers for various uses is becoming a novel practice.

Bamboo slivers are being used to weave baskets and basketry-related products. Spits and slivers are bonded together by means of glue to form laminated ply bamboo that can be used for most purposes for which timber wood is required.

Laminated bamboo lumber using bamboo in its natural cylindrical form poses several challenges. Laminated bamboo lumber is a relatively new concept that involves gluing together bamboo material in various forms to form rectangular boards, similar to lumber. Despite its commercial potential, only a small body of research on Laminated Bamboo Lumber exists in literature.

As resource availability declines and resource demands increase in today's modern industrialized world, it is becoming increasingly necessary to explore opportunities for new, sustainable building and constructional materials (Meadows *et al.* 1992). Wood, for example, has recently gained popularity in the green building community because of its environmentally beneficial characteristics: wood is promoted as renewable, biodegradable, sequestering carbon from the atmosphere, low in embodied energy, and creating less pollution in production than steel or concrete (Falk 2009). Bamboo has similar environmental characteristics (van der Lugt *et al.* 2006; Lee *et al.* 1994; Rittironk and Elnieiri 2007; Nath *et al.* 2009). Most notably, it is highly renewable; bamboo stalks reach maturity in eight years. Its strength is comparable to that of wood. As such, it makes an appealing candidate as a structural material. With adequate research, it is conceivable that bamboo could become a sustainable alternative to current building materials. In a study by van der Lugt *et*

al. (2006), an environmental Life Cycle Analysis (LCA) of bamboo is presented in an effort to quantify the environmental effects of using bamboo as a construction material. The results of this analysis show that, in some applications, bamboo has achieved “factor 20” environmental impact, which means that it had 20 times less load on the environment than currently used alternatives. Environmental impact is expressed in units of environmental cost, which is defined as: “fictitious societal costs (monetary factors) connected to the prevention of environmental damage by certain interventions (e.g., emissions)” (van der Lugt *et al.* 2006). Lack of knowledge and experience with bamboo were seen as contributors to much inefficiency and unnecessary cost currently associated with bamboo construction. These inefficiencies and costs are expected to diminish as familiarity with this material increases. Bamboo, being a hollow tube, is efficient in resisting bending forces, having a large ratio of moment of inertia to cross-sectional area. It is difficult, however, to create connections for this shape, and tubes cannot be used in applications where flat surfaces are required. Laminated Bamboo Lumber (LBL) resolves these deficiencies in the natural shape of bamboo because it is formed in rectangular sections that are more suitable for use in traditional structural applications. LBL has been created in research studies by using adhesive to join strands or flattened surfaces taken from the culm (i.e., bamboo stem). The result is a composite rectangular structural member having highly renewable characteristics that make it competitive, in this regard, with commonly used building materials.



Plate 1 Bamboo Floor Board

2.6 Bamboo board

A bamboo floor is a type of wooden board manufactured from the bamboo plant. The majority of today's bamboo products of this kind originate from China and other portions of Asia. Moso bamboo is the species most commonly used for boards.

2.7 Characteristics

Bamboo is an attractive alternative for flooring because of its physical similarities to hardwoods. Bamboo floor manufacturers and sellers promote its strength and durability as well as its resistance to insects and moisture, and they say the material is also "eco friendly". The hardness of traditional bamboo boards ranges from 1180 (carbonized horizontal) to around 1380 (natural), while newer manufacturing techniques including strand woven bamboo range from 3000 to over 5000 using the Janka hardness test. Others have comparable Janka ratings, with a higher number

indicating a harder material: red oak (1290); white oak (1360); rock maple (1450); hickory (1820); and Brazilian Cherry / Jatoba (2350).^[1]

2.8 Construction processes

Different forms of bamboo boards exist. Each varies in its manufacturing process and differs largely based on economic viability and local preferences. The most common form, particularly in southeast Asia, uses thin bamboo stems that are cut as flat as possible. They are cut to similar lengths and can be stained, varnished, or simply used as it is. They are then nailed down to wooden beams or bigger pieces of bamboo stems. This form results in more space between each bamboo stem; flatness and tightness is not emphasized. This technique is usually used on stilted houses, resulting in better air circulation especially during the warmer summer months.

The manufactured bamboo boards commonly found in North American markets is highly processed. Bamboo board is typically made by slicing mature bamboo poles or culms into strips. These culms are crosscut to length and then sliced into strips depending on the width desired. The outer skin and nodes are removed to remove starch and sugars the strips of bamboo are boiled in a solution of boric acid or lime. The bamboo is then dried and planed. Natural bamboo color is similar to beech wood. If a darker color similar to oak is desired, the bamboo goes through a carbonizing process of steaming under controlled pressure and heat or dyeing. The carbonizing process can reduce the floor's final hardness significantly compared to non-carbonized bamboo, rendering it softer than some pines and softer than more common red oak.

Most bamboo board producers use Urea-Formaldehyde (UF) adhesive in the lamination process. Though the use of UF resins, which emit Volatile Organic Compounds (VOCs), is harmful to indoor air quality, bamboo board uses a relatively small amount compared with other materials, such as particleboards. Bamboo board products that are not suitable for formaldehyde use are available, including some listed in the Green Spec Directory. The panels are then heat pressed to cure the adhesive. The cured boards are then planed, sanded, and milled. Finally an ultraviolet curing lacquer is applied to the boards.

Manufactured bamboo boards are typically made available in planks with either vertical- or horizontal-grain orientation. In vertical bamboo board, the component pieces are stood vertically on their narrowest edge and then press laminated side to side. The effect is a lined, almost uniform look to the surface of the finished floor plank. In horizontal bamboo board, the slats are arranged in a horizontal direction, on their widest edge, and then joined side by side with adjacent pieces using a high-pressure laminate system. The characteristic nodes of the bamboo are visible on the finished horizontal surface.

2.9 Environmental impact

Bamboo has also gained a reputation as an eco-friendly, highly renewable source of material. As a grass, bamboo grows much faster than wood. Moso Bamboo is the primary species used for the manufacturing of flooring and plywood. Moso bamboo can grow up to 1.5m in 24 hours and some reach their maximum height in 40 to 50

days. It takes about 3–5 years for bamboo to reach full maturity. Traditional hard woods can take 20–120 years to mature.

Bamboo can be harvested without the need to replant because the root system is left intact when it is harvested. The rhizome root structure has the ability to hold the soil in place preventing erosion.^[4] Rhizome root structures are horizontal stems that grow below the surface and help a plant reproduce vegetatively. Plants with rhizomes will colonize or spread laterally. The Lacey Act recently strengthened the accountability in the sourcing of timber products. However enforcement is still in question.

Bamboo reaches maturity in five years which is the optimal age to harvest. In a sustainably harvested forest only 20% of the forest is harvested annually allowing for 100% harvest in a five-year period. In its natural environment it will need no irrigation, no pesticides, and no fertilizer. Bamboo has few pests, so pesticides are not required. Bamboo certified the United States standards of the Forest Stewardship Council (FSC) that meets criteria for environmental sustainability and social responsibility, and several flooring products are available with this option. Bamboo can sequester up to 70% more carbon per year than a hardwood forest. All these factors keep the carbon footprint low.

The United States Green Building Council's LEED program allows points for the use of bamboo floors by virtue of it being a rapidly-renewable resource.

Since the majority of bamboo timber comes from China, it has to be shipped to the international destinations by boat and then by truck to vendors. A study which

compared the embodied energy (including transportation) of bamboo flooring from Hunan Province, China to Denver, Colorado favored locally-sourced concrete above bamboo flooring due to the additional carbon costs associated with transport.

Controversy exists over agricultural and manufacturing issues related to the production of bamboo floors, including the environmental effects of deforestation in order to plant bamboo and the use of carcinogenic chemicals such as urea-formaldehyde in the glues used for lamination in some products.

2.10 Traditional Carving in Ghana

According to Boateng William a researcher at the Ghana National commission on culture for UNESCO, carving in Ghana begun as a communal form of expression based on the ideas and ideals of the entire community or ethnic group.

Deviation from community or acceptable standards of expression into other aesthetic expressions using wood or other media was tabooed by the community. According to Boateng, carving was done expressively under the dictates of clan leaders, religious leaders, chiefs and other opinion leaders. This allowed very little room for individual expression and creativity. Nevertheless, carving still sustained communal and social life in many ways. Carving produced a multiplicity of drums for traditional orchestra and ensembles and promoted solidarity, social cohesion and entertainment.

Carving according to Boateng William, provided for a wide range of household equipment. Examples of these are mortar, pestle, wooden bowls, ladles, combs,

stools, chairs, walking sticks, linguist staves and countless arrays of traditional games.

The others include canoes, hoe handles, boxes, beds, cupboards, swords and many more.

2.11 Materials for Traditional Carving in Ghana

Carving, according to Boateng W, is the analytic study of the medium using the requisite tools to remove the unwanted parts to arrive at final product which has been previously conceived in the mind of the carver.

It requires the use of a particular set of carving tools in order to facilitate easy carving process and the realization of the ultimate goal.

According to Boateng William, varieties of tropical wood species used as raw material for carving included the following: Afromosia, Kokrodua, Kyenkyen, Mahogany, Odum, Dwuma, Sese, Twenebua, Wawa, Onyina and Funtum.

The trees for carving were not felled off hand without passing through certain ritual purification methods. The trees for carving were considered during those days as abodes, dwelling places or receptacles for certain unseen spiritual forces or supernatural spirit and powers. Some of these supernatural spirits, according to Akan mythology were at certain times very violent and malevolent. Others were considered to be friendly and benevolent. So in order not to incur the wrath of any malevolent spirit inhabiting in any of these wooden species for carving, it was proper to go

through certain ritual purification practice to dislodge these supernatural spirit inhabiting the tree to make the wood accessible to the carver.

At certain times, a ram, some fowls and bottle of schnapps or other alcoholic beverages were used in the rituals to dislodge completely a strong spirit. The offerings varied in their presentation because some offerings. The very tough and malevolent spirits demanded higher sacrifices and at times at the expense of human lives.

The strange beginnings of the carving profession embodied the manufacture of carving tools. Carvers manufacture their own set of tools from iron. Rather, for convenient sake, creativity was a hallmark and therefore saw them skillfully through productions. Tradition had it that, after the carver has successfully manufactured all the tools he needed, he has to pacify the tools before using them. Special libation prayers were offered to the ancestors and the gods to protect the carver from injuries during the use of the carving tools. During those days, tetanus was not known as a fatal disease. The carvers were dying from cuts from tools as a result of tetanus. Ignorance of the causative factors for the rampant accidental cuts from tools and associated deaths made the carvers apportion the cause of strained relations between them and the ancestors. So, anytime one was to be apprenticed as a carver, or when a carver acquired a new set of tools, the tools had to be pacified to solicit good and cordial relations from the ancestors and the gods. During the purification rituals, strong alcoholic drink were poured on the tools as special libation prayers were offered. At certain times fowls were slaughtered if frequent deaths have been recorded within that guild of carvers.

Surprisingly enough, when the tools were pacified, deaths from the tool cuts reduced drastically. The writer is of the opinion that, the minds of the carvers were psychologically prepared to alleviate impending dangers and fear of death from tool injuries and this as a result might have strengthened their egos and kept them on with their mass productions.

2.12 History of Traditional Carving in Ghana

In Ghana, wood carving began prominently in the forest areas. This devolvement was partly due to the abundance and easy accessibility of the raw materials for the carving, which was wood, coupled with the people interest in the profession. Among the Akans of Ghana, carving was practiced. It was not practiced on a wide scale by many carvers. Rather it was practiced by few carvers in the community.

This limited number of carvers were seen as the privileged minority because they were so skilful in the execution of the art that people saw them as having been endowed with special talent from God which has bestowed on them immense potential to create artistic master pieces beyond normal human capabilities.

This privilege minority was accorded special respect and their opinions were respected in the community. Akan wood carvers who were versatile in the production of all kind of wood carvings were called “OHENE DWUMFOUR” literally translate as “the chief carpenter”. Akan traditional carvers were greatly admired for their ingenuity and practicality of their stylizations.

As the carving profession progressed over the years in Ghana, and particularly among the Akans, it remained an exclusive preserve for only males. No female was allowed to carve. Only the males who were acclaimed to be endowed with special talents upheld the tradition.

The carver produced a lot of wooden utensils for use in the home, drums for festivals and durbars, masks for recreation and rituals, stools, beds, combs, rattles and the chief's regalia and paraphernalia. The carvers have been in their productions and thus have made significant contribution to the betterment of communal, social, economic and religious life. A lot of figurative sculptures were produced to form the basis of ethnic religious practices. Among the Akans, when the Akuaba doll and other figurative sculptures were being carved, pregnant woman were not allowed near the carvers until the figurative sculpture has been successfully carved and polished. It was believed that if the pregnant woman sees unfinished carving, it would affect the development of the foetus in the womb. Unfinished carving has a lot of deformities which receive attention as the carver progresses with the carving. So, it was a belief shared among the Akans that when the deformities of the unfinished carving attract the attention of the pregnant woman it may affect the orderly growth of the foetus. This belief and other taboos associated with the carving profession made it to be secluded from public places. It was therefore done in a closet and not out there in the open. The secluded nature of the profession made it not only sacred but increased concentration of the carvers. The carvers therefore carved with precision, speed and accuracy and realized further improvement in skill and technology.

Ghanaian carved products go beyond figurative sculpture into the production of many things for use in the family. These include traditional games like Oware, Dame and Archery. Archery is rarely practiced in Southern Ghana, unlike the North where traces of this ancient game is still practiced during festive occasions. Archery employs the use of specially manufactured bows and arrows.

Carving in the contemporary sense does represent a complete break away from how it exists in the past. It still thrives on most of the past carving traditions. Places like Ahwiaa in the Ashanti Region of Ghana widely employ the use of indigenous carving technologies that have characterized the profession since time immemorial. This wood carving tradition has made Ahwiaa a major tourist hub for the search of souvenirs.

There are many carvers scattered all over the country who are doing good business. Carving in Ghana as practiced by the traditional carvers, represent a different scenario from that of the intellectual class. They both have different aesthetic expression. Whichever way these expressions find themselves, they solve a lot of problems within the community because of the patronage each category receives.

CHAPTER THREE

METHODOLOGY The descriptive and experimental methods of research were adopted to collect data for the research. The descriptive research method was used to describe existing conditions and the experimental research method was used for the designing and carving with laminated bamboos. Pre-experimental design was chosen for this project because it employs a single group and although it has a disadvantage of lower validity; it is very practical and sets the stage for further research

3.1 Library Research Conducted.

Library research was part of the study. The Kwame Nkrumah University of Science and Technology main library, the College of Art library, Department of Art Education library, library of Institute of Renewable Natural Resources , Faculty of Engineering library and the Faculty of science library, all in the Kwame Nkrumah University of Science and Technology were visited a couple of times .Other libraries the researcher visited were British Council library, Forestry Research Institute of Ghana library, Fumesua in Kumasi, Library of the International Network On Bamboo And Rattan and Centre for Scientific and Industrial Research library at Fumesua all in Kumasi. Books, publications, periodicals, magazines and theses were the sources from which secondary data were collected.

3.2 Research Conducted in Industry.

The researcher visited the following Bamboo Preservation Centers; Assin Fosu Bamboo factory where he was taken through the primary processing stages, and the preservation of the bamboo. At the factory, the researcher interviewed the Managing Director and Production Manager of the factory. The chief technician was also interviewed on the primary and secondary processes of their plant. The processes were the splitting of the culms which were done with a machine described as the boom splitter, planing of the splitters to remove saturated silica epicap and sugar concentrated lumen lining in the inner part of the bamboo. Thermal treatment with Dursban 4E takes about three hours, before drying in the solar dryer. The dried treated bamboos were laminated into boards. Twenty technicians at the various stages of preservation were also interviewed.

At Kumasi Logs and Lumber limited, the Managing Director of the company was interviewed on the various stages involved in the preservation of bamboo. The production manager was also interviewed while conducting the researcher round the plant. Other technicians at the processing and preservation point were also interviewed about their operations at the preservation plant. Nineteen technicians in all were interviewed.

The lecturer in charge of Rattan and Bamboo in the Department of Integrated Rural Art and industry was another person whom the researcher interviewed on preservation and lamination of bamboo. Apart from discussing the processes involved in bamboo lamination, removal of the lumen lining the inner portion of the

bamboo was of great importance to him. The researcher was shown some works of students which, as a result of poor preservation and lamination methods, have been attacked by pests and opened up. The lecturer said thermal treatment with chemical preservatives is the surest way of preservation, especially when the lumen has been removed. The head of the bamboo research project and his deputy at the Forestry research institute were also interviewed on the various methods in bamboo preservation and lamination. They also affirmed diffusion, painting with chemical preservatives, sap displacement and thermal treatment with chemical preservatives.

A total of 42 bamboo workers were interviewed on preparatory, preservation and lamination methods they use to ensure the durability of their products.

They all agreed on initial harvesting of bamboo, followed by splitting and planing off of the outer epidermis and the lumen, and then diffusing in Dursban 4E mixed with water for 24 hours, followed by drying, gluing, planing and polishing. These workers were selected from CSIR Kumasi, Assin Fosu bamboo factory and Okponglo, bamboo factory in Accra.

3.3 Sampling.

Sample in the context of this study is a portion, piece or segment that is representative of a whole population. The purposive and stratified random sampling method was used.

3.3.1 Characteristics for the Population of Study.

Population concept is fundamental to both descriptive and analytical research. For this study the researcher considers population as group of persons having information on bamboo preservation and lamination. Within this context, the managers of bamboo industries, plant operating staff of bamboo industries and bamboo craft workers, bamboo researchers, and teachers of bamboo art are considered to constitute a population.

The population was divided into three categories comprising :

(A) The Senior officers of institutions and establishments (Managers of bamboo factories, teachers and lecturers of bamboo art.

(B) Technicians of Bamboo industries and research institutions.

(C) Artisans working in bamboo.

1.	Category A	10
2.	Category B	90
3.	Category C	<u>60</u>
	Total:	<u>160</u>

A total potential population for this research project was one hundred and sixty.(160 respondents) made up of senior officers of institutions and establishments, technicians working in institutions and establishments and Artisans working in bamboo.

The criteria for the selection of population were as follows:

1. Only senior officers of institutions and organizations were selected.
2. He or she must be involved in the processing and preservation of bamboo in a factory, or research institution, with working experience of at least five years.
3. He or she should be a bamboo craftsman with at least five years of working experience.

POPULATION LEVEL

CATEGORY A (STRATUM 1) Managing Directors / Senior officers	10
CATEGORY B (STRATUM 2) Technicians of Bamboo industries and research institutions.	90
CATEGORY C (STRATUM 3) Artisans working in bamboo.	60

EQUALIZATION LEVEL

CATEGORY A	CATEGORY B	CATEGORY C
------------	------------	------------

STRATUM 1

STRATUM 2

STRATUM 3

RANDOMIZATION 70%

7	63	42
STRATUM 1	STRATUM 2	STRATUM 3

SAMPLE

TOTAL	FROM	STRATUM	1 + 2 + 3
7	+	63	+ 42 = 112

DATA LEVEL

COLLECTION OF DATA FROM 112 RESPONDENTS

Schematic Overview of stratified Random Sampling Design.

3.3.2 Justification of Sample Picked / Selected

Based upon the above information, the researcher considered a sample of 112 (70%) to be a representation of the total population. The 112 became accessible population. Although this sample constitutes a homogenous population, each category is different from the other.

The significance of the above categorization is that it would help to determine the validity of data collected from the sample selected. It is expected that the factory information from the manager of the plant should not be so different from that given

by technicians operating the plant and should be comparable to information received from Artisans working in bamboo.

The Stratified Random sampling technique used by the researcher, sub divides the population into smaller homogenous groups in order to get more accurate representation. This reduced biases and allowed the researcher to generalize his finding to the entire population. This technique was therefore employed to select the sample of 112 (70%) of the entire population. The minimum of 70% was chosen because the researcher considered 70% of the sample as an acceptable figure since the total number of respondents in this research was about 160.

The total sample was shared among the three strata (categories A, B, and C) of the total population. Each stratum is homogenous. The number of subjects needed in the sample was computed according to calculated percentages.

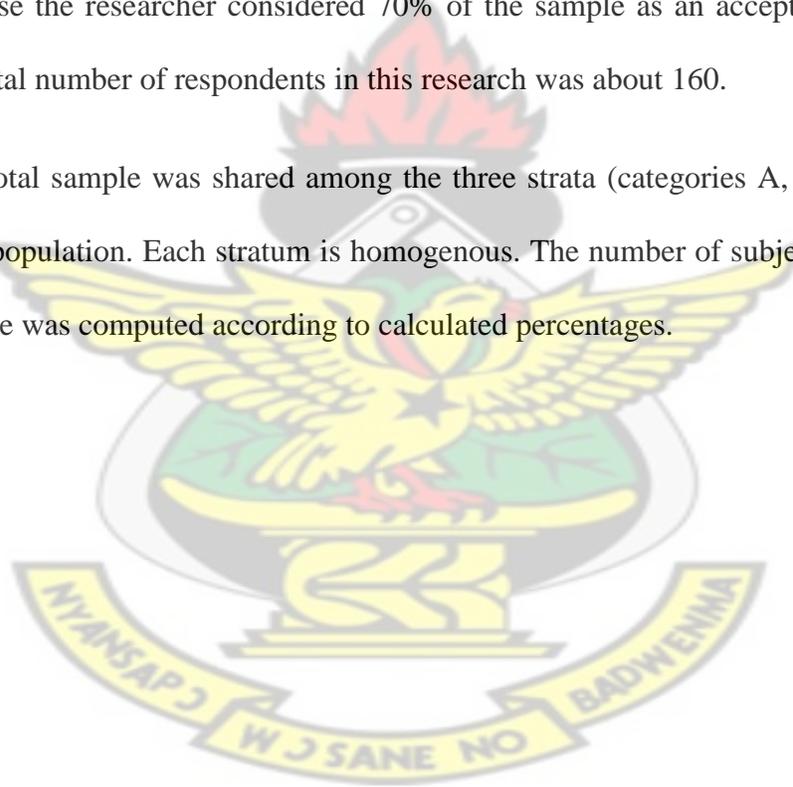


TABLE 4.1 SELECTION OF SAMPLE

STATUS	NO. IN SAMPLE	PERCENT OF TOTAL
CATEGORY A (STRATUM 1)	7	6.25
CATEGORY B (STRATUM 2)	63	56.25
CATEGORY C (STRATUM 3)	42	37.5
TOTAL	112	100.0

Category A (Stratum 1) $10 \times 100/160 = 6.25$

Category B (Stratum 2) $90 \times 100/160 = 56.25$

Category C (Stratum 3) $60 \times 100/160 = 37.50$

3.4. The Survey Instruments.

The survey instruments were interview and observations which were used to solicit data from respondents, concerning the preservation methods adopted for preserving bamboo and the operation of the components of plant for giving the preservative treatment to bamboo.

3.5 Interviews Conducted.

Formal interviews were also conducted. The interview was relevant to the research because it was the main data gathering device used, apart from observation. In this respondents were willing to talk to the researcher and to give out information relevant to the study.

Interviews were conducted at work places of all the respondents using tape recorders. The medium of communication was English for people who fell in category A, English and Twi for category B, and Twi for people in category C.

3.6 Observation.

On the spot observation of preparation, preservation and lamination of bamboo was carried out by the researcher at all the preservation point visited by the researcher. These were done to enable the researcher see, understand, photograph and document the processes adopted at the various preservation points and also to see some of the fabrication techniques used for producing bamboo artifacts.

3.7 Data Collection

The researcher employed the descriptive and experimental research methodologies for the research. The primary data were solicited from seven (7) senior officers of institutions and establishments. These include two managers of bamboo factories, their deputies, two heads of research institutions and one lecturer in bamboo art and technology from K N U S T, Kumasi.

The Secondary data were collected mostly from documentary sources (books, publications, periodicals, charts, brochures and thesis). In all the places visited, efforts were made to collect the necessary data. Data collected from technicians

and artisans were all assembled, analyzed and used where necessary for the project.

KNUST



CHAPTER FOUR

GENERAL PROCEDURES IN EXECUTING THE PROJECT

4.1 Introduction

The method adopted for the execution of the project was simplified to enable a lay person read, understand and follow the procedures to process bamboo for carving.

The project started with the harvesting and processing of bambusa vulgaris. This type of bamboo is also found in Ghana and it is more abundant than any other species of bamboos in the country. It is one of the sympodial species found in Ghana, for instance this particular plant in Plate 2, is from the Kwame Nkrumah University of Science and Technology Botanical Garden.



Plate 2 Bambusa vulgaris in the KNUST Botanical Garden

After harvesting of the bamboo, the culms were cut into lengths of 150cm using the power cross cut saw.



Plate 3. Cutting of the Bamboo into Lengths of 150cm



Plate 4. Cross cut Bamboo ready for Splitting

The bamboo was further processed into splits of about 25mm width. This was gently and gradually done on the circular saw in Plate 3.



Plate 5. Splitting of Bamboo



Plate 6. Split Bamboo

After splitting the bamboos, the lumen which is the inner lining and the epidermis were planed off, thus reducing the thickness of the splits and getting rid the nodes. The planing resulted in the production of bamboo parallel strips as shown in Plate 6 and 7.



Plate 7. The Planning of the Bamboo Strips.



Plate 8. Planed Bamboo Strips.

The planning of the strips reduced the attractiveness to pest infestation, because in a personal communication Steiner explained that, the lumen of the bamboo is sugar saturated and is the most attractive part of the bamboo forming the principal food of the degrading agents. He further said that the epidermis is impermeable to water and must be scraped off to ensure permeability by soluble preservatives during preservation.

The strips were preserved by boiling in chloropyrofous based chemicals in the proportion of 480 grams per liter called Dursban 4e. The strips were boiled for three hours and was left submerged for 24 hours after which they were removed and staked to dry.



Plate 9. Preservation of Bamboo Strips



Plate 10. Gas Fired Bamboo Boiler for Preservation

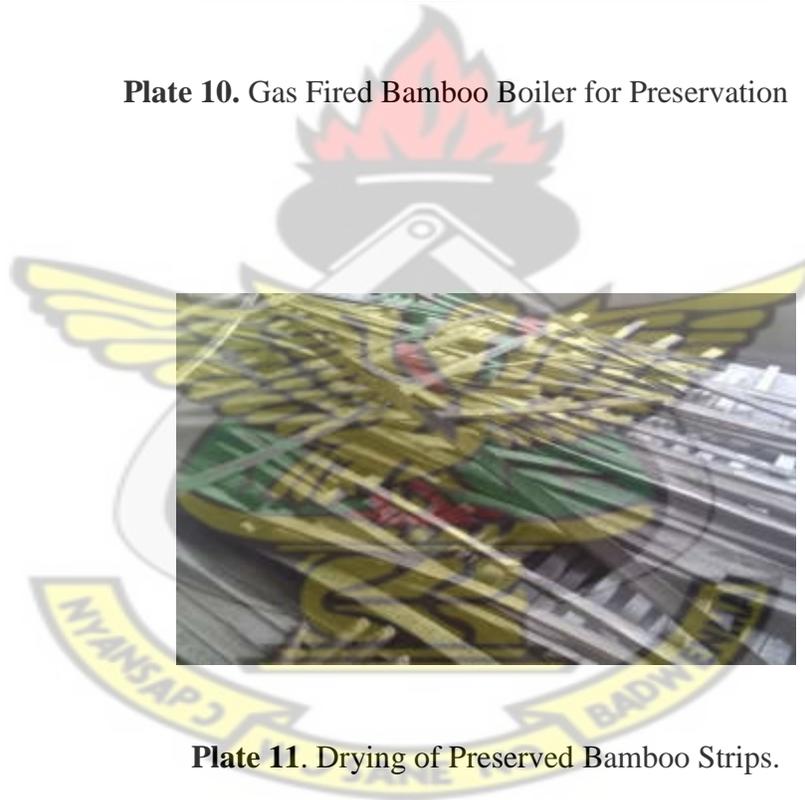


Plate 11. Drying of Preserved Bamboo Strips.

When the drying was completed, the preserved strips were painted with poly vinyl acetate in composition with dursban 4e, the base chemical containing the chloropyrofous. They were after that arranged side by side ways and clamped in a specially designed clamps for laminating bamboo manually.



Plate 12. Clamps for Lamination of Bamboo with Strips to be Laminated.

Several strips of previously planned and preserved bamboo strips were glued together and clamped for 24 hours. The result of the clamping was a rough board and this was planed smooth. Plate 12.



Plate 13. Laminated Bamboo Strips ready for Planning

After planning of the laminated board, it was subjected to light test to check openings that might result due to limitation associated with manual manipulation of material in the lamination process. The test results revealed openings and these were refilled with glue mixed with preservatives and clamped for 24 hours. Plate 14.



Plate 14. Gluing of Opening

After the second clamping of the board, a second light test was conducted after which the bamboo board was used to produce selected traditional artefacts.

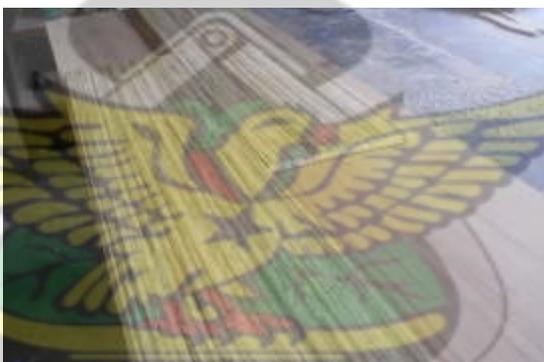


Plate 15. The Processed bamboo Board

4.2 Samples of Traditional Ghanaian Artifacts made with Laminated Bamboo

4.2.1 The Traditional Stool

Traditional stools are carved from ‘sese’ one of the local timber species in Ghana. Traditionally, ‘sese’ is used because of its softness and unique

characteristics. This project proves the idea that laminated bamboo made from three year old bamboo has the softness properties that can make 'sese' and can be used to produce a traditional stool.

Method

1. A laminated bamboo block measurement of 60cm x 30cm x 12cm is produced out of which the seat of the traditional stool is made.
2. The same length and width but lesser thickness of 8cm is produced as the base of the stool.
3. The middle support of the stool is also made of laminated bamboo of thickness of 8cm square, out of which the two support of the traditional stool are cut with a bandsaw. Mortise and tenon joints are prepared for the support of the seat and the base.
4. The various parts of the stool are sanded with various grades of sand paper.
5. The various members are put together using bondex glue.
6. Sandy sealer is applied to the surface of the members to seal the pores spaces to prevent the wax from penetrating into the bamboo.
7. The bamboo traditional stool is waxed to enhance its appearance as in Plate 16.



Plate 16. Traditional Stool made from Bamboo

The traditional stool is mostly carved with Sese and Afromasia. These two wood species are soft enough to allow the carvers to carve it using their carving tools. Using laminated bamboo made from three years old culm has the softness properties that can nearly match Sese or Afromasia wood. Hence can be used in carving the traditional stool.

The traditional stool is made possible after a careful study of the various traditional stools we have at the selected carving centers visited. The band saw was used to cut the seat of the stool to give it the slightly curved surface. The base and the middle members were also cut separately using the band saw. To assemble them, the mortise and tenon joints were constructed under the seat and on the base of the stool and the middle section fixed in position to come out with the result as in Plate 6. The problems faced were the lamination of the seat and the base of the stool which has a thicker board.

4.2.2 The Akuaba Doll

Akuaba doll is one of the fertility symbols of most communities in Ghana. It is believed that if a woman looking for a child keeps the Akuaba doll, she will have a child of her own in no time. The Akuaba doll can be used in a living room or the bedroom.

Method

1. The design of the Akuaba doll was made on paper.
2. The design was transferred onto the laminated bamboo block.
3. The v-gouge was used to mark the outline of the design.
4. The narrow band saw was used to cut the outline of the design.
5. The U-gouge was used to block the design on the laminated bamboo.
6. Other chisels were used to carefully carve out the Akuaba doll as in the design produced.
7. Various grades of sandpapers were used to smoothen the Akuaba doll starting from grade 60, which was roughest to 80, 120 and finally grade 160 which is the smoothest.
8. Sanding Sealer was applied to seal the pore spaces on the surface of the Akuaba doll.
9. Wax was applied to finish it.



Plate 17 shows Akuaba Doll carved from Bamboo

Akuaba doll is carved from the Sese and Afromosia woods. Like the traditional stool, they are also carved with the carver's knives because these woods are soft enough to allow the carvers to use their sharp carving knives to carve the Akuaba doll made with the one year old laminated bamboo.

The Akuaba doll was produced using a very sharp chisels and gouges. Blunt chisels and gouges made some of the portions of the doll split because match pressure has to be exerted on the chisels with the mallet to carve the doll out.

With the gentle application of the mallet on the sharper chisels and gouges the Akuaba doll was carved out without any problem. The result was very interesting as the laminating process has provided the Akuaba doll with exciting colour and appearance.

4.2.3 The Jewelry Box

A jewelry box is a box in which jewelries are kept. It can be made of clay, wood, plastic, metal or any material that can serve the purpose. This project shows that laminated bamboo can be used in making the Jewelry box. The jewelry box is usually kept in the bedroom.

Method

1. The design of the jewelry box was made on paper.
2. The desired measurement of 13cm by 13cm of the jewelry box was also taken.
3. The various members of the jewelry box were cut to the desired measurement.
4. The various members were firstly glued together and later nailed.
5. The lid was also measured and cut to size and the knob placed on it.
6. Various grades of sand paper were used to sand the jewelry box.
7. Mansion polish was applied to the jewelry box and neutral polish was used to polish it.



Plate 18 Jewelry Box

The jewelry box is mostly produced using hard woods like Mahogany, Odum and Mansonia wood species. These wood species are used because they are hard and durable. A treated laminated bamboo produced from five to seven years old culms have the hardness properties to match the wood species mentioned above and can therefore be used in the production of this particular jewelry box.

The jewelry box was constructed using a single ply laminated bamboo. The various members of the box was marked on the laminated board and cut out with band saw. But joints were used to construct the box. The lid of the box was also prepared and placed in position. No problem was encountered during the construction of the jewelry box since the design is very simple. The result has come out successfully as expected because strict adherence to measurement has been into account so the joint fit perfectly into their respective positions.

4.2.4 The Candle Stand

The candle stand is one of the traditional Ghanaian artifacts which are found in one local handicraft shops usually made in wood. Laminated bamboo is used to produce this candle stand. It can be used in the living room, bedroom and the kitchen.

Method

1. The design of a candle stand was made as in Plate 19.

2. Based on the design a laminated bamboo block of size 15cm x 40cm was made.
3. The lathe machine was used to turn the laminated bamboo to the required shape and measurement.
4. The turned laminated bamboo candle stand was sanded.
5. A metal plate was cut and placed at the top of the candle stand as in Plate 18 to prevent the fire from the candle from burning the top of the candle stand.
6. A small hole was drilled in the metal plate place at the top the candle stand and small metal pin was inserted to hold the candle in position as in Plate 19.
7. The candle stand was waxed with mansion polish and finished with neutral wax polish.



Plate 19 Candle Stand

The candle stand is mostly made with Red wood, Odum, Mahogany and Mansonia. The woodworkers use these types of woods because they have the hardness properties and they allow the various shapes to be turned out with the lathe turning machine. Laminated bamboo made with five years and above bamboo culm has the hardness properties to match the wood species mentioned earlier on.

A laminated bamboo block of size 15cm by 40cm was made. This laminated bamboo block is fitted into the lathe machine and the required design on paper transferred onto the laminated bamboo block by using the various chisels and gouges meant for that purpose. The end result is the candle stand in Plate19. No problem was encountered during the turning of the candle stand and the result was just as expected.

4.2.5 The Oware Game

Oware is one of the traditional games mostly played among the Akan speaking people of Ghana. It is said that in the past, one of the Denkyira kings Ntim Gyakari was playing oware with the wife while his men were at war with the Ashantis. The Ashantis captured him and he was beheaded. The Oware can be used in the living room.

Method

1. The design of the Oware game was made.
2. Two laminated bamboo blocks measuring 44cm× 4cm×7cm was prepared.

3. The six (6) circular depressions with a radius of 5.5cm were also carved in each of the laminated bamboo blocks with the C- gouge.
4. The groove for the hinges to join the two blocks together was also made.
5. Various grades of sandpaper were used to smoothen the carved surfaces of the circular depression in the laminated bamboo block.
6. Sanding Sealer was applied to the surface to seal the pore spaces.
7. Two small size hinges were fixed in the grooves created for them to join the two blocks together.
8. Wax was applied to the whole Oware game to finish it.

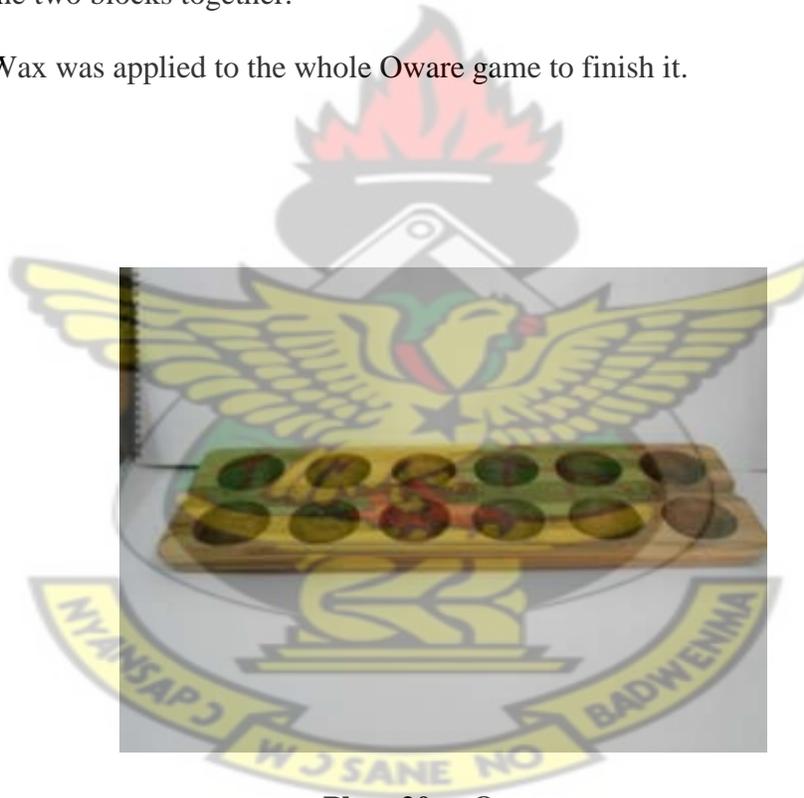


Plate 20a Oware



Plate 20b Oware

The Oware game is mostly made in the carving centers using the soft woods like Sese and Afromosia. This project is made using a laminated bamboo made from a two year old culm.

The Oware was made out of two laminated bamboo blocks. Each of the laminated bamboo blocks has six (6) circular depressions in which four (4) small marbles are placed. The Oware can be made on a broader laminated bamboo block containing all the twelve (12) circular depression. For simplicity this particular Oware was made using two laminated bamboo blocks joined together by the use of hinges and screws in Plate 19 a. when the Oware is closed, after using, it will appear like the picture in Plate 19 b. the advantage is that it can be carried along or transported easily from one place to another. Few problems were encountered in the fixing of the hinges initially but with a

careful study of the whole setup again, the problem was solved and the result has come out successfully.

4.2.6 The Mask

Mask plays an important role in our Ghanaian traditional set up. Masks are used for decorations, agriculture as well as spiritual purposes. The mask can be used in the offices and the living rooms.

Method

1. The design of the mask was made on paper.
2. The design was transferred onto the laminated bamboo block and the board.
3. The V-shape gouge was used to make the outline of the design.
4. The U and C shaped gouges and chisels were used to carve the mask as in the design.
5. Various grades of sand papers were used to smoothen the mask. Starting from the coarse grades to the finer grades.
6. Sanding sealer was applied to the sanded mask to seal the pore surfaces on the surface of the carved mask.
7. Wax was applied to the surface of the mask and polished.



Plate 21a. Mask



Plate 21b. Mask

Mask is carved in the carving centres using the soft wood species like Sese, Cedar and Afromosia. Like the Akuaba doll, the carvers using the carving knives, carve the mask as per the design made. Laminated bamboo made from two year old culm was used to carve this particular project.

Two masks were produced. One on a flat laminated bamboo board and the other on a laminated bamboo block. On the flat laminated bamboo board, the design of the mask was drawn onto the laminated bamboo board using a 2B pencil and the V-gouge was used to carve on the outline of the design. The small U and V gouges were used to carve the details of the face of the mask as it appeared in plate 21a. The second mask (plate 21b) was produced using a laminated bamboo block. The design was drawn on the block and the various chisels and gouges were used to carefully carve the mask out. The result was quite good except that the second mask was a little bit heavy. If a lighter weight is preferred, the back of the mask must be carved to produce that result.

4.2.7 The Tissue Paper Box

The tissue paper box is mostly produced with cardboard but this research has proven that laminated bamboo could be used to produce a tissue paper box. The tissue paper box can be used in the office.

Method

1. A strip of laminated bamboo measuring 2cm by 20cm was cut.
2. The strip was further split and used to construct a car case measuring 11cm by 8cm by 23.5cm.

3. A thin laminated bamboo board measuring 10.3 cm by 0.5cm by 21cm was cut and fixed at the base of the carcass of the tissue paper box.
4. The side of the carcass was covered with a split bamboo from the inside of the carcass.
5. The slot for the cover of the tissue paper box was made.
6. The cover of the tissue paper box measuring 10cm by 0.5 cm by 21cm was finally prepared and the opening for removing the tissue paper was cut using the piercing saw.
7. The cover was then slotted into the opening made for it.
8. The tissue paper box was sanded with various grades of sand papers.
9. Mansion polish was first applied to the surfaces of tissue paper box.
10. A neutral polish was finally applied to polish it as in Plate above.



Plate 22. Tissue Paper Box

A tissue box is usually made in cardboard or chipboard, thin sheet of plywood and Wawa one of the wood species. One year old culm was cut, split and planed to produce this tissue box.

The tissue paper box took some time to construct because the members of the sides have to be worked on separately. A carcass was constructed and the side members fitted into the carcass from the inside. A slot was made for the lid which has got an opening to remove the tissue paper. The base was also cut and placed in position. The lid is slotted in, to complete the tissue paper box as in Plate 21.

4.2.8 The Laminated Bamboo Panel

The Damba dance is one of the traditional dances found in the northern part of Ghana. This project shows that a treated laminated bamboo panel can be carved to produce the above wall hanging. This project work can be placed in the living room and offices.

Method

1. The design of the Damba drummer is made on paper and transferred onto treated laminated bamboo measuring 27cm by 37cm.
2. V-gouge is used to carve the outlines of the design.
3. The small V-gouge and U gouges were used to carve the Fugu worn by the Damba drummer.
4. Various grades of sand papers were used to sand the surface of the carved drummer.

5. Black and white acrylic paints were used to paint the fugu and the trousers worn by the Damba drummer.
6. Mansion polish was applied to the surface and neutral polish was used to finish it.



Plate 23. Damba Drummer

Wooden panels are mostly made using hard woods like Mahogany, Sapele, Odum and Mansonia. This project is made from a treated laminated bamboo of five to ten year old bamboo culm. This bamboo has the hardness properties that can match that of the hard woods.

The Damba drummer was produced using a laminated bamboo board measuring 27cm by 37 cm. The design of the Damba drummer on paper was transferred on the laminated bamboo board using 2B pencil. The V-gouge was used to carve the outline of the Damba drummer. The small U and V gouges

were used to carve details of the design. Black and white acrylic paints were used to paint the fugu dress worn by the drummer and brown paint for the body of the drummer as it appeared in Plate 13. No problem was encountered during the production of this artifact.

4.2.9 The Kitchen Stool

The kitchen stool is one of the wooden artifacts that are found in almost all traditional kitchens in Ghana. Most of these kitchen stools are made of wood. Laminated bamboo is used to produce this particular project.

Method

1. The design of the kitchen stool was made as in plate 23.
2. The two legs were cut to the desired measurement.
3. The other members were cut and lipped.
4. Various grades of sand paper were used to smoothen the various members.
5. Test assemble was made to correct all necessary mistakes.
6. Glue was applied and nailed.
7. The nail punch was used to push the nail head into the laminated bamboo to hide them.
8. Putty was applied to seal the holes created by the nail punch and allowed to dry.
9. Smooth sand paper of grade 120 was used to smoothen the whole assembly

10. Sandy sealer was applied to the whole kitchen stool to seal the pore spaces.

11. Mansion polish was finally applied to the surface of the kitchen stool to finish it.



Plate 24 Kitchen Stool

The kitchen stool is mostly made using hardwood like Odum, Sapele, Mahogany and Red wood. Treated laminated bamboo of five to ten year old culm can be used to produce a kitchen stool without any problem. This is because a laminated bamboo produce from such a bamboo culm has the hardness properties that is comparable to that of a hard wood.

The kitchen stool was the simplest to construct. The measurements of the legs, seat, side corners and the support for the legs were taken and cut out from the

laminated bamboo board. The various members were put together using one and half inches nail and a hammer. The result is the picture in Plate 24.

4.2.10 The Wooden Comb

The traditional wooden comb is one of the traditional wooden artifacts which signify the beauty of the black woman. This artifact is used as a wall hanging and it can be placed in the living room or the bedroom.

Method

1. The design of the comb was made on a paper.
2. A laminated bamboo board measuring 30cm by 15cm was made.
3. The design on the paper was pasted on the laminated bamboo board.
4. The narrow band saw was used to cut the outline of the design.
5. The human figure on top of the comb was curved with chisels and gouges.
6. The dents in the comb were also removed and smoothed using the flat file.
7. Various grades of paper were to sand the comb.
8. Sanding sealer was applied to the surface of the comb to seal pore spaces on the surface.
9. Mansion polish was applied and neutral polish was used to polish it.



Plate 25. Wooden comb

The wooden comb is a decorated wooden artifact which is produced from soft woods like Sese, Cedar and Afromosia. Treated laminated bamboo made of one to two year old culm has the softness properties that is measurable to the soft woods mentioned above, hence the success of this project.

The wooden comb was made using the method above. The major problem faced was the reaction of the harmattan weather on the laminated bamboo. Cracks developed during the carving process but this problem was overcome using the smooth sawdust with glue. The glue was mixed with the smooth sawdust and applied to the affected areas and later sanded to seal those openings on the surface of the work piece. The end product is the result in Plate 25.

4.3 DISCUSSION OF FINDINGS

The researcher found out that it is not advisable to use untreated bamboo to produce any artifact if the intention is to keep that particular artifact for a longer time because untreated bamboo deteriorates at a faster rate.

Preserved bamboos extend its life span and maintain its quality. It is therefore advisable to treat bamboo properly before it is used. It was also observed that durability can be increased with the careful choice of the species of the bamboo. It was observed that *Bambusa vulgaris* has compact grains which make it very strong and less resistant to termites attack than *Bambusa vulgaris* var *vitata*.

It was not easy harvesting mature bamboo culm from the central part of an unmanaged clump. They may become congested making the cutting of individual culm difficult.

One major advantage of bamboo is its ability to be worked on by using very simple hand tools. Comparing the grains of bamboo with other wood like sese, Odum and Mahogany, the grains of bamboo are stronger, compact and durable. Bamboo gives a better finishing surface by aesthetics.

The grains of bamboo runs in the same direction and the durability of the culms make carving along the grains or against the grains easier than wood.

One may find laminated bamboo carving difficult when the tools are not well sharpened. This is because much pressure has to be exerted on the gouges and chisels with the mallet which may cause cracks and openings in the laminated bamboo. The

laminated bamboo may also split open if the carving is done in the harmattan season as the weather may have adverse effect on it. It was also observed that a laminated bamboo made from one year old bamboo has the softness properties that sese and Afromosia has and can be used to carve into items that sese and Afromosia can be used to carve.

Finally it was observed that one needs patience to carve bamboo especially around the joints due to the brittleness of the joints.



CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.

5.1 Overview

This chapter deals with the summary, conclusions as well as recommendations for further research.

5.2 Summary

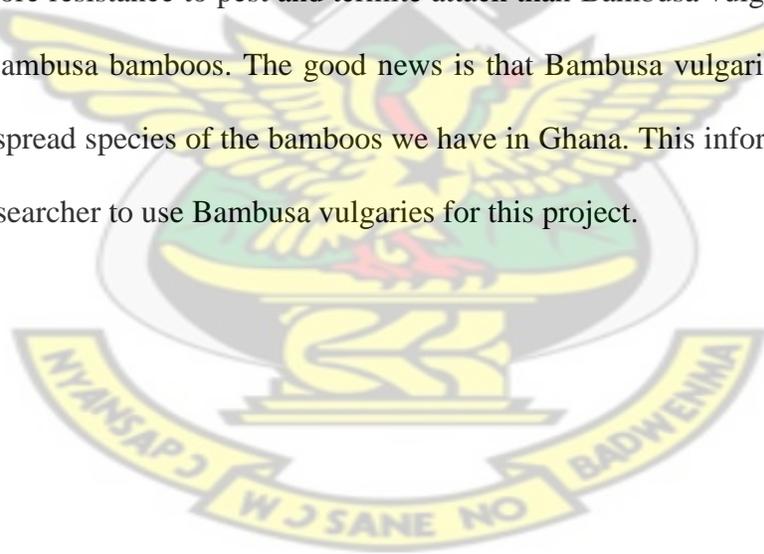
The problem was that most Ghanaians are not aware of the potentials of bamboo in the production of traditional Ghanaian artifacts. The research had therefore been geared towards producing selected traditional Ghanaian artifacts which were originally produced in wood with laminated bamboo made from *Bambusa vulgaris* in order to sensitize Ghanaians about what bamboo can do in the local art industry.

To achieve this, the following objectives were outlined for the project:

1. To study the production methods of selected traditional artifacts.
2. To process and laminate bamboo into boards and blocks for the production of the selected traditional artifacts.
3. To produce the selected traditional artifacts using the laminated bamboo boards and blocks
4. To write a report on the report.

To achieve these objectives, the researcher visited some bamboo craft centers, wood carving centers and bamboo industries to see at first hand the type of products being produced at these centers and industries.

There was scanty information on the topic, however, the researcher reviewed the available literature and conducted interviews on 160 respondents on the possibility of using treated laminated bamboo in producing traditional Ghanaian artifacts which were originally produced in local species of wood. The experimental and descriptive methods of research were adopted for this project. Experiments were conducted on some of the species of bamboo which we have in the country for this project. It came to light that *Bambusa Vulgaris* has more resistance to pest and termite attack than *Bambusa vulgaris varvitata* and *Bambusa* bamboos. The good news is that *Bambusa vulgaris* is the most wide spread species of the bamboos we have in Ghana. This information made the researcher to use *Bambusa vulgaris* for this project.



5.3 CONCLUSIONS

In conclusion, the writer wants to say that bamboo has been with us for a very long time but because of the lack of its technological know-how and for the fact that most Ghanaians consider bamboo as a threat to their farm lands, bamboo has been greatly underutilize.

A practical approach and creation of awareness of bamboo and its products would create a great job opportunities for the unemployed in the country. It will help children to develop better interest in producing artifacts from bamboo.

The revelation made by the researcher pose a great challenge to the teaching and learning of bamboo processing in our Junior High schools and Senior High schools in Ghana since the items exhibited by the researcher can be made by students of JHS and SHS levels. A major advantage of bamboo is its ability to be worked on with simple hand tools. The simple wood working tools which we are familiar with works perfectly on bamboo.

One important fact which should not be forgotten is the proper preservation of the bamboo for it to last longer.

5.4 RECOMMENDATIONS

1. The Forestry commission in collaboration with the Ministry of Education and the Ghana Information service should prepare documentaries or audio-visual materials on bamboo and its products. These documentaries should be played to basic schools, JHS, SHS and other tertiary institutions to sensitize them on the potentials of bamboo.
2. Ghanaians should be made aware through public education by the National Commission for Civic Education, that the use of bamboo goes beyond fencing, TV poles, erection of shed, yam barns etc. and that almost all items that are produced in wood could be produced in bamboo.
3. People staying along the Volta Lake and other water bodies in the country should be encouraged by their chiefs and opinion leaders to plant bamboo along the banks of the rivers and streams to prevent silting, evaporation and improve the quality of the water and to protect these water bodies.
4. More laminating machine should be developed to help in the lamination of the bamboo into boards. The Mechanical Engineering Department of the Kwame Nkrumah University of Science and Technology and local artisans at Kumasi magazine can help in this direction.
5. The Integrated Rural Art and Industry Department should organize proficiency courses in bamboo processing and make it available to all

JHS and SHS drop outs, and other interested persons. A recognized certificate of participation should be awarded to successful applicants at the end of the programme.

6. The government should exempt stakeholders who would like to venture into bamboo processing from paying tax for a period of time. This will make the bamboo industries attractive. This will allow more foreigners who have the knowledge in bamboo and its products to come and invest in these areas in the country.
7. Farmers should be encouraged to go into cultivation of bamboo to feed the few local bamboo industries we have in the country. This bamboo plantation will check rural-urban drift.
8. The National Youth Employment Programme should incorporate bamboo cultivation and usage in their programme so that the youth will be trained on bamboo cultivation and processing. This will go a long way to create the needed awareness of the potentials that are bound in bamboo to the Ghanaian populace.
9. Using bamboo to produce these traditional Ghanaian artifacts would pave the way for the local woodcarvers to have alternative material in the production of their works. This would give them hope for getting alternative raw materials for producing their works rather than relying on the existing raw materials which is depleting at a faster rate.

10. The presence of these plantations would encourage the establishment of local bamboo industries like paper and wine industries that would use these raw materials.
11. Good roads and electricity would be provided to the plantation sites and industries to open up those areas for viable economic activities to take place there.

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