

**TRANSFORMATIONS IN SIRIGU WALL PAINTING AND FRACTAL ART
SIMULATIONS**

By

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DECLARATION

I hereby declare that this submission is my own work towards the PhD 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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CHAPTER ONE

INTRODUCTION

Background to the study

Traditional wall painting is an old art practiced in many different parts of the world. This art form has existed since pre-historic times according to (Skira, 1950) and (Kissick, 1993).

In Africa, cave paintings exist in many countries such as “Egypt, Algeria, Libya, Zimbabwe and South Africa”, (Wilcox, 1984).

Traditional wall painting mostly by women can be found in many parts of Africa including Ghana, Southern Africa and Nigeria. These paintings are done mostly to enhance the appearance of the buildings and also serve other purposes as well.

“Wall painting has been practiced in Northern Ghana for centuries after the collapse of the Songhai Empire,” (Ross and Cole, 1977).

This thesis project focuses on Sirigu wall painting tradition. Sirigu is a small village in the Kassena Nankani District in the Upper East Region of Ghana. It is widely known for its magnificent traditional wall paintings. Other indigenous art forms such as pottery, basketry and straw work are produced by the people of this Kassena Nankani community.

The wall paintings depict traditional symbols and philosophical ideas. In Sirigu, the wall painting is known as *Bomborisi* and it is usually practised by women. During his first visit to Sirigu in 2002, the researcher was amazed at the beautiful mural paintings and other

artworks of this village. This experience and subsequent fieldwork in 2006 and 2009 enabled the researcher to adapt the traditional wall painting motifs and technique from Sirigu known as *Bomborisi* for this thesis project.

The researcher has since 2006, been preoccupied with the study of *Bomborisi* of Sirigu through various transformations for idiomatic expression. Knowledge is fast increasing and technology is being applied in transforming existing art forms.

The study of the traditional *Bomborisi* motifs has led the researcher into a new mathematical simulation technique which can be applied to art. This is what scholars call “fractals” (Kolman and Hill, 2005). Contemporary digital art provides different genres and techniques and Fractal Art is one of the approaches.

The study of fractals required new knowledge from experts hence the researcher attended a lecture about Fractal Art and Geometry by Andrzej Gutek of the Mathematics Department of the Tennessee Technological University, U.S.A. at K.N.U.S.T. in August, 2008.

In May 2009, he also attended Fractal Art and Geometry workshop at K.N.U.S.T. by Dr. F. T. Oduro of the Mathematics Department and Duvar Hetherford of the Grambling State University, U.S.A. The researcher acquired new knowledge about Sirigu *Bomborisi* and fractals through fieldwork, workshops and library studies for the thesis research.

Problem Statement:

Research work by Ross and Cole (1977), Clark-Courtney (1990), Cowhey (1996), and Haverkort (2007) have examined and provided ethnographic information about the nature of Sirigu wall painting. Eglash (1999) and Brett (2008) have also documented aspects of Sirigu architecture and culture as having fractal characteristics.

Even though fractal art is virtually unknown in contemporary Ghanaian visual art expressions, ironically, it is widely used in traditional African arts and culture such as *Bomborisi* according to ethno-mathematicians. There is no documentation on *Bomborisi* wall painting motifs using fractal art simulations in Ghana.

The *Bomborisi* painting motifs have some fractal characteristics and for this reason current studies are required to explore and appropriate these motifs into fractal art transformations and simulations in the studio art based research.

Research Questions

1. What is the nature and characteristics of the Sirigu wall painting tradition?
2. To what extent has *Bomborisi* been transformed in Sirigu and beyond?
3. Is there any link between Sirigu *Bomborisi* motifs and contemporary geometric concepts such as fractals?
4. How can these emerging fractal concepts be applied manually and manipulated digitally in studio research?
5. In what way will the results of the thesis project be made available to the public?

Objectives:

- To find out and document the nature of Sirigu *Bomborisi* wall painting that reflects transformations.
- To explore *Bomborisi* wall painting motifs through fractal art simulation technique to serve as the basis for evolving transformations in the academic studio setting.

Delimitations:

The scope of the research work covered *Bomborisi* wall painting within and beyond Sirigu by Sirigu women artists. Subsequently, the studio practice work of the thesis was limited to fractal art simulations in the form of computer generated images preceded by manual manipulations.

Importance of Study:

1. The Sirigu *Bomborisi* wall painting is expected to serve as a useful resource material for stylistic development in painting through the process of manual and digital transformations based on conventional methods and application of fractal art and geometry techniques.
2. The outcome of this project will help preserve and transmit the intrinsic cultural idioms of the Sirigu wall painting tradition to academia, many more individuals and society at large.

Definition of Terms:

Agurinuuse/Sukuukomakoma: school children holding hands.

Akunyena-nii: name of a cattle raider with the herd moving along a straight path.

Am: dawadawa pod extract, used as fixative.

Ameziazuva: hat/cap.

Ampua: bark of tree extract as fixative or varnish.

Apiligeta: image that indicates the negative space that exists between the woman's face and the veil as she lifts it over her head.

Baare: building structure behind the main court yard.

Baasi: lizard

Bangole: sleeping place.

Bomborisi: the local word or terminology for wall decoration in Sirigu community.

Bunto: smaller plants that have slimy properties when mixed with water and added to the colours as varnish.

Burima: shea-butter residue-protective varnish.

Canvas Painting: *Bomborisi Tanne*

Danga: cooking area.

Deyanga-Bopaka: workshop area.

Diyanga / Danga: kitchen.

Dogolongo: walking stick/Bishop's staff.

Eebga: crocodile.

Kugpela: white earth/limestone.

Kugsabla: black stones ground and moulded into balls.

Kumpio: calabash arranged in the order of a pyramid.

Laasi: calabash.

Lungae: traditional drums.

Naafo: cow.

Nankam: language spoken in Sirigu

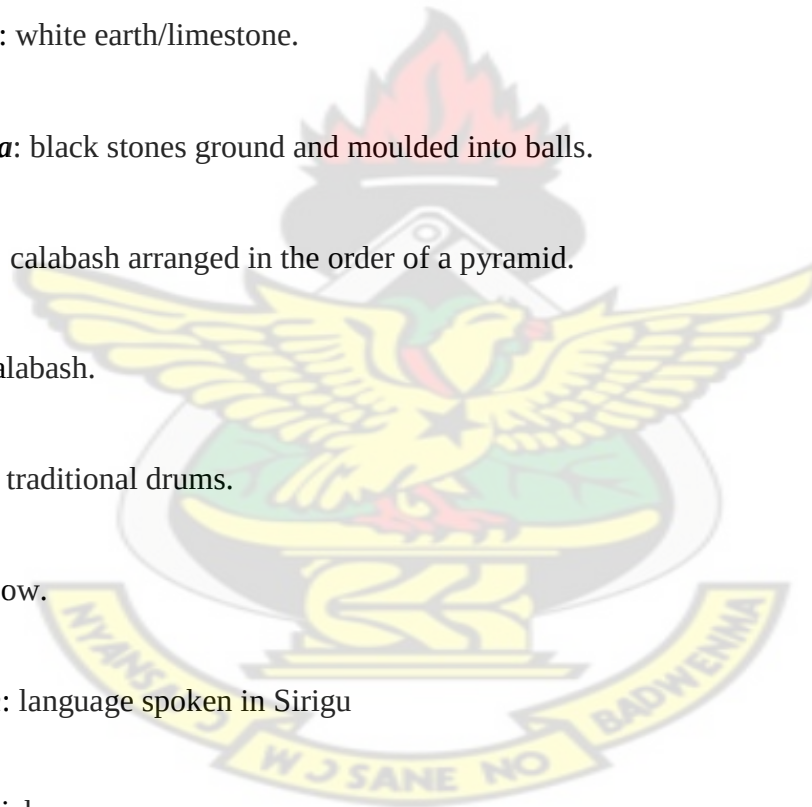
Niila: chicken.

Nunkuobro: feather of a guinea fowl.

Pisko: domestic sheep/goat.

Sasigas: white stone for painting on wall.

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Waafo: python.

Wanne: halved calabash used to hold water or grains.

Wanzagsi: broken calabash.

Weefo: horse.

YagimbasaWanzagsi: pieces of calabash used for modelling pots.

Yoka: fish net.

Zaalenga: calabash net.

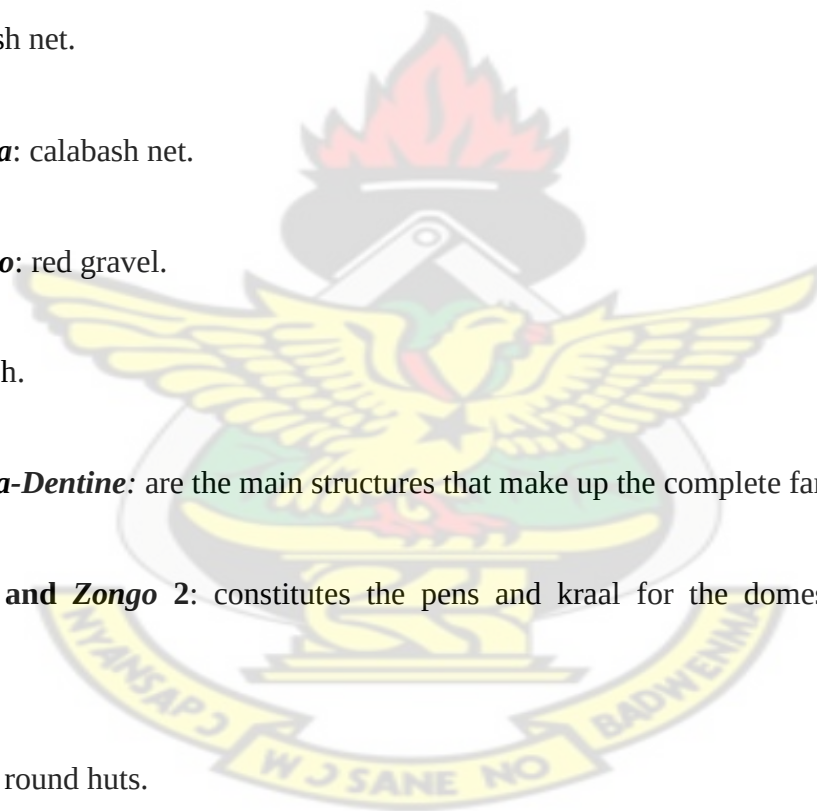
Zigmolgo: red gravel.

Ziifo: fish.

Zinzaaka-Dentine: are the main structures that make up the complete family house.

Zongo1 and Zongo 2: constitutes the pens and kraal for the domestic cattle and other animals.

Zuvaka: round huts.



FRACTAL FORMATIONS

Chaos: a state of complete and thorough disorder and confusion.

C.G.I.: computer generated images

Ethno-mathematics: unconscious social process and practice that emphasize the possibilities for intentionality in mathematical patterns.

Fractal: a pattern usually produced by a computer that is made by repeating the shape many times in smaller and smaller sizes.

Infinity: a point at an infinite distance away.

Iteration: a process of going through a certain set of instruction repeatedly.

Recursion: frequent or repeated forever in the same order/predetermined sequence of similar processes.

Scaling: To increase or decrease the amount or size of something.

Self-similarity: Almost the same or likeness.

Simulacrum: something that looks like somebody/something else that is made to look like somebody/something else.

Simulation; a situation in which a particular set of conditions is created artificially in order to study, experience something that could exist in reality: The act of pretending that something is real when it is not: the simulation of genuine concern.

Symmetry: exact likeness in size, shape, form, etc., between the opposite sides of something.

Transformation: a complete change in appearance, form or character.

Translation: the process of changing something into a different form.

Research Methodology:

Prior to the beginning of this project work, the researcher had the opportunity to participate in an experiential field work at Sirigu with students of the University of Georgia Ghana Study Abroad Program in the year 2002. This gave the researcher the chance to observe the Sirigu *Bomborisi* wall painting at first hand and participate in the execution of *Bomborisi*.

- Two subsequent site visits were made to Sirigu in 2007 and 2009 during the thesis research period to collect data through observation, interviews and photography.

- The thesis project involved the use of qualitative research method. The researcher observed the nature of a number of *Bomborisi* wall paintings in Sirigu and photographed them to serve as illustrations for the thesis work. He also interviewed the oldest living *Bomborisi* painter, Akanvole Agombire, and others in her household, who provided the data needed. Subsequent field work was also done at the Catholic Cathedral in Navrongo, Tiedar Restaurant in Bolgatanga and the Golden Tulip Hotel in Accra to observe and photograph the *Bomborisi* on the walls of the open air restaurant painted by the Sirigu women painters in 2003.

- In order to determine the nature of earlier transformations in wall painting, literature review was conducted covering materials from Sirigu *Bomborisi* in recent times. Some of the

books reviewed were: Arts of Ghana by Ross and Cole, African Fractals: Modern computing and Indigenous Designs by Ron Eglash.

- The data obtained was analyzed descriptively to unearth knowledge about transformations in *Bomborisi* which contributed material for the studio art exploration.

Facilities used for the Research:

Buildings with Traditional Paintings at Sirigu, Painting Studio, KNUST, Main Library, KNUST, Ashanti Library, Kumasi, College of Art and Social Science Library, KNUST, British Council Library, Kumasi, British Council Library, Accra, Internet Service, KNUST, I. C. T. Centre, KNUST, Ghana National Museums and Monuments Board, Accra, Ghana National Tourist Board Offices in Accra/Kumasi, Centre for National Culture, Bolgatanga, Sirigu Women's Centre, Sirigu.

Arrangement of Text:

Chapter One covers the Introduction which includes the Background of the Study, Problem Statement, Research Questions, Objectives, Justification of Objectives, Research Methodology, Delimitations and Definition of Terms.

Chapter Two deals with Review of Related Literature.

Chapter Three deals with Research Methodology.

Chapter Four deals with Exploration into Fractal Painting.

Chapter Five deals with the Summary, Results, Conclusions and Recommendations.

Appendices of assorted material are at the tail end.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter on review of related literature is in two sections: 1. Review of *Bomborisi* Traditions in Sirigu village and beyond; followed by 2. Review of fractal art formations and simulations.

Bomborisi Traditions in Sirigu Village and Beyond

Background:

Sirigu town is situated in the North sub-Savannah belt of Ghana. It is part of the larger Kassena Nankani District with Navrongo as its administrative capital in the Upper East Region of Ghana. It is about 35 miles northwest of Bolgatanga, the Upper East Regional Capital. “Sirigu is part of the northern boundary between Ghana and Burkina Faso” (Morro, 1991, p.6). The town is primarily known for its traditional architecture, pottery, straw products and wall paintings. Sirigu can be reached through Kandega and Mirigu villages with few visible extinct wall decorations.

Being located in a Sahelian territory of Ghana, one would have thought that Sirigu may have been influenced by Islamic faith but interestingly enough; the population is largely made up of Christians as many of the inhabitants are Catholics. Considerable

number of people in the Sirigu rural area are either “animists or atheists” (Morro, 1991, p.7).

The people are hospitable and interactive. They are polygamous and marry at early ages. They practice patrilineal system of inheritance and live in small family units sharing many things in common. Their cultural practices bind them together and are clearly seen in their architectural and traditional mode of living.

Sirigu Architecture

Sirigu architecture is characterized by separate buildings of a compound connected by high mud walls. Moving into the interior of the walls, “one is greeted by a big open space area that serves as a transitional link between the communal world and the privacy of the domestic space” (Norman, 1997, p.7). The adobe walls are connected to form one complete building which accommodates all members of the household. This possibly bonds each family member to another making the complete patrilineal wedge of the entire home.

The compounds are interlinked by low mud brick walls in the interior and by high walls on the exterior. Haverkort (2007), describes the outer wall as, “an enclosure that chains the rooms together.” p.8. Typically, the ground plan of a small family compound is circular, but as it grows with the addition of more members, the interior becomes more spacious.

Norman (1997), reveals that, “most quarters of the compound in this polygamous society are used by and designated to the women of the Sirigu family.” p.8. The

structural forms and their functions provide their traditional identification as *Bangole* sleeping place, *Danga* cooking area, *bo-o-lodge* –*Deyanga-Bopaka* workshop area and *Zinzaaka-Dentine* forms the main structures that make up the complete family house. Behind the main courtyard are *Baare 1*, *Baare 2*, *Baare 3*, *Zongo 1* and *Zongo 2* which constitutes the pens, coops and kraals for the domestic animals. The *Diyanga / Danga* kitchen, *Bo-o-lodge* and *Bopaka* form three distinct areas that together, emphasises the Sirigu woman's importance "as both mother and provider in the home" (Norman, 1997, p.8) thus designating a larger part of the compound as her space of control.

For many years the traditional settlements will continue to reflect the way of life of the people who inhabit them. "Each building consists of several chambers, passageways, stairways, granaries and animal pens" (Ross and Cole, 1977, p. 237). Indeed from a distance, one observes built clusters of either rectangular or round structures with conical thatched roofs and flat terraces.

Traditionally, the wall paintings found on the buildings in Sirigu are typical of Nankani architecture. Both the buildings and the paintings are made from earth and plant materials. This approach to the construction of buildings in the area is possibly the most appropriate traditional technology of regular maintenance. It is done to insulate the inhabitants from the harsh weather conditions of heat during the day and extreme cold dry harmattan conditions at certain times of the year. (Ross and Cole, 1977)

In Sirigu, the maintenance of the compound is a reflection of the man and his "ability to provide" (Cowhey, 1996, p.5). If a man has suffered low harvest, for example, he may not have the means to repair the structure of the compound. The final

maintenance further goes to glorify the man when the women have completed the decorations on the walls. A well decorated adobe wall is a credit to the man, though he may not have personally touched the wall by participating in the painting. It goes again to show that he is a responsible family man. Painting the walls improves the overall appearance, and beauty is added to the image of the compound in the eyes of the community. A well-maintained and decorated compound shows that the house owner is capable of providing for his family and also attends to the needs of the house structure. It also shows the worth and value of the woman in the household.

In Nankani culture, “a woman is a reflection of her husband” (Morro, 1991, p.6). “The man receives the praise because he has a wife who can produce the object of admiration” (Clark-Courtney, 1990, p.7). (Ross and Cole, 1977, p.238) mentioned that “when men have built a compound, women take over to finish it.”

They further compared *Bomborisi* in the Kassena Nankani area as possessing significant difference between the *Bomborisi* of Navrongo and Sirigu. It was revealed that the Navrongo wall painting colour scheme was limited to black and white tones while the *Bomborisi* of Sirigu involved red, brown, black and white tones.

Sirigu Wall Painting

The Navrongo people are the Kassenas and the Sirigu people are the Nankanis. The wall painting in Sirigu is called *Bomborisi*. *Bomborisi* tradition is a widely known art form in the Kassena Nankani territory which is still being practiced today by the women

of Sirigu. The *Bomborisi* traditional wall painting comes with various techniques and motifs which are usually employed to create different kinds of effects.

In most of them, relief patterns are combined with flat coloured patterns which are intended to enhance the beauty of the painted walls. Sometimes animals and other objects are represented in both relief and totemic references. Refer to Figs. 1-3, pp.16-17.



Fig: 1 The *wanzagsi* painted home near Sirigu, copy by Morro Issahaku, 1991.



Fig: 2 Low and high relief motifs done on the inside walls at Sirigu, copy by Michael Nyarkoh, 2007.



Fig: 3 Decorated round wall with thatched roof, copy by Michael Nyarkoh, 2007.

Eglash (1999) and Simms (2005) have mentioned that fractal simulation characteristics exist in African traditional knowledge systems. Sirigu architecture and *Bomborisi* wall motifs reflect some fractal characteristics. It is as a result of this serendipity of new knowledge that the researcher attempts to do an in-depth review of fractal art simulations related to *Bomborisi* for the 2nd part of this chapter.

Fractal Art and Fractal Formations and Simulations

Background: Fractal and Fractal Art

Many authors have written about fractal geometry. They include Kolman and Hill (2005), “Introduction to Linear Algebra an Applied 1st Course 8”, “Chaos and Fractals” Burton (1990), “Fractal Geometry and Ghanaian Art Project Report” Simms (2005), “A Better Way to Compress Images” Barnsley and Sloan(1988), “Exploring the Boundary Between Creation and Discovery” Keller(1991) and “African Fractals” Eglash (1999).

The word, fractal, is derived from the Latin word *fractus* that roughly translates as “irregular fragment” (Kolman and Hill, 2005, p.539). Fractal is a geometric pattern that is repeated at ever smaller scales to produce irregular shapes and texture that cannot be represented by classical geometry. Fractal art is still in its beginning stages of development as a separate and accepted art form. “Only since the 1990’s have computers and fractal programs advanced enough to make fractal image exploration practical” (Kolman and Hill, 2005, p.537). Fractal art is relatively very recent.

Repetition of the constructive steps makes geometric shape fragmented and perhaps reasonably rough. This, when divided into parts, appears as a reduced duplicate

of the original. “Such sets, curves, figures or surfaces are called fractals” (Kolman and Hill, 2005, p.538). The Mathematics of fractals was first systematically studied by Benoit Mandelbrot. “George Cantor and Benoit Mandelbrot are pioneers of the fractal geometry theory” (Kolman and Hill, 2005, p.539).

“Mangbetu ivory sculpture is a classic example of fractal scaling”, according to Eglash, (1999) p.81. It is based on complex geometric aesthetic of 45-degree angle. Creating this 45-degree angle technique with the scaling properties of the ivory carving can reveal its underlying fractal structure. Three striking features of heads in profile are revealed. Each piece of head is bigger than the one above it facing the opposite direction. Each head has two lines around. It is formed under the jaw and by the hair. These lines meet at about 90 degrees. There is an irregularity as the left side shows a different angle about 20 degrees from the upright. See fig. 4, p.20.



Fig: 4 Mangbetu Ivory Sculpture, picture courtesy of Eglash, 1999.

Examples of fractals in mathematics include;

Cantor Set

George Cantor (1883) published accounts of points in the interval $[0, 1]$. This set is constructed by repeating a very simple principle indefinitely, each time deleting a middle third of an interval. This set is today called “Cantor Point–Set or Cantor’s Dust” (Kolman and Hill, 2005, p.538).

Parts of the Cantor’s set appear to be a reduced copy of the whole shape. Such sets, curves, figures or surfaces are called fractals. Cantor’s set is also referred to as Cantor’s Fractal.

Eglash (1999) wrote that Cantor’s set is

“constructed starting with the line segment representing the interval $[0, 1]$ (including the end points), we omit the middle third. The result is two line segments $[0, \frac{1}{3}]$ and $[\frac{2}{3}, 1]$. The progression of each of these segments with the middle third omitted, it produces a four line segment of eight endpoints. It often will be left with points known as Cantor’s set.”

By continuing this process we end up with the Cantor’s set. See fig. 5, p.21.

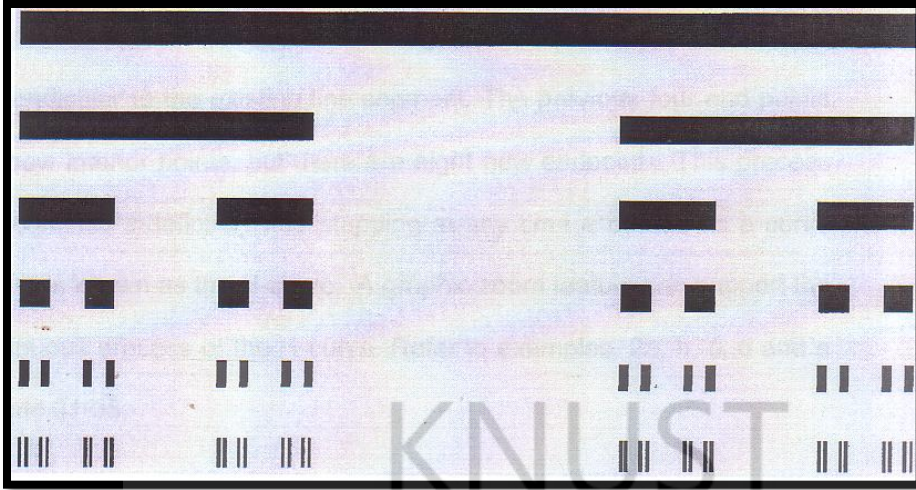


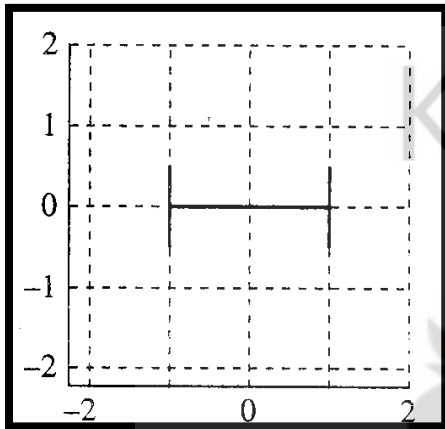
Fig: 5

“Steps leading to the construction of the Cantor’s Set” image courtesy of Eglash 1999.

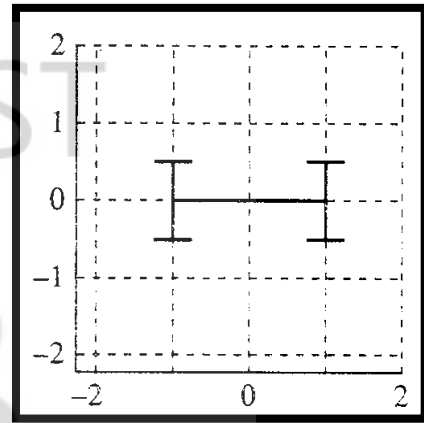
H-Curve

Kolman and Hill (2005) agree with Eglash (1999)’s earlier assertion that H-Curve is constructed by starting a line segment along the x-axis from $x = -1$ to $x = 1$. Two end points are obtained by drawing a line segment one-half as long having its midpoint at an end point and perpendicular to the existing line segment. The initial endpoint becomes interior points of four new endpoints. A one-half line segment is drawn with the segment before it having its mid-point at an end point vertical to the existing line segment. The preceding four end points will have inner points, with eight new endpoints. Continuous

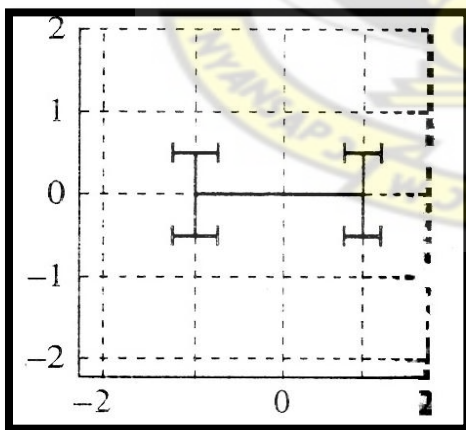
progression indefinitely, a section occurs as a curve called H-curve. Refer to examples in figs. 6 a-e, pp.23.



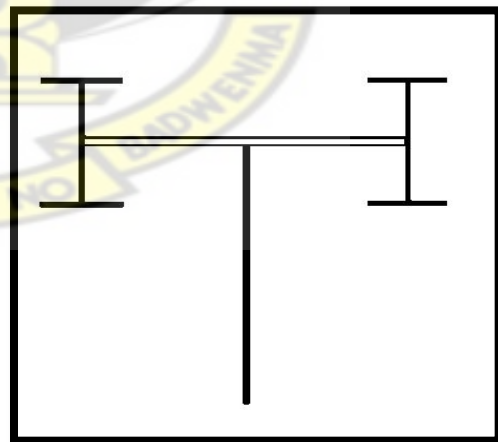
Step a.



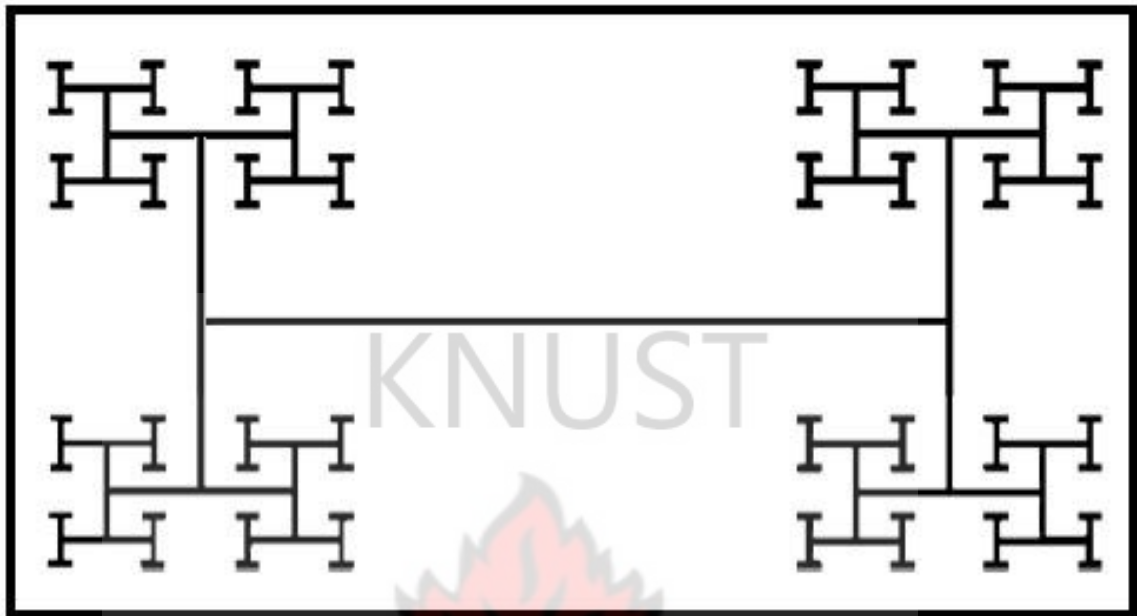
Step b.



Step c.



Step d.



Step e.

Fig: 6

“Steps leading to the construction of the H-Curve”

Koch Curve

Quoting Eglash (1999),

Koch curve is constructed removing the middle third of a line segment and replacing it with an equilateral triangle and by removing the base. The direction is repeated on succeeding line segment to the fourth step. The initial line segment is 1 unit in length, then the 4 segments in Step 1 are $\frac{1}{3}$ of a unit, the 16 segments in Step 2 are $\frac{1}{9}$ of a unit and so on. At each step a line segment is scaled down by a factor of 3.

This implies that self-similarity is factored into construction process of the Koch curve. Constructing the process repeatedly, infinitely and frequently generates a curve

that would be tremendously rough that does not have a line tangent at any point. See examples a, b and c for steps 1-4 in fig. 7, p.24-25.

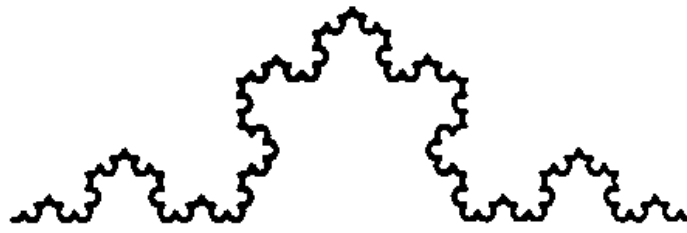
Step a



Step b



Step c



Step d

Fig: 7a-d

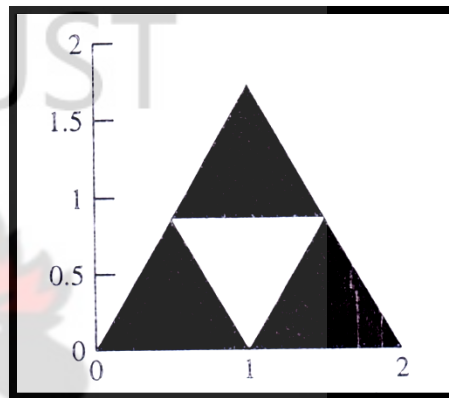
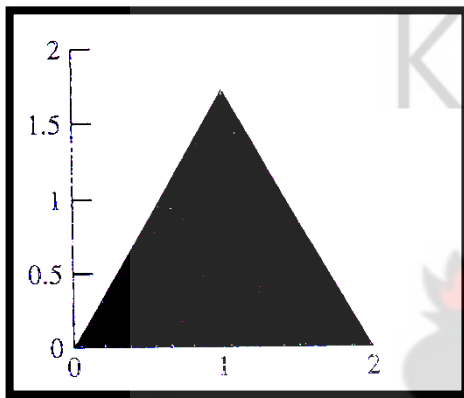
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“Steps leading to the construction of the Koch-Curve”

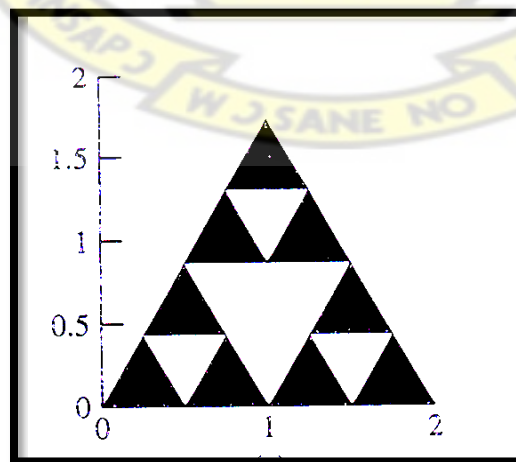
Sierpinski’s Triangle or Gasket

Sierpinski’s Triangle or Gasket is a prominent mathematical fractal. This fractal is formed by an initial equilateral triangle and then the triangle created by the mid-points of the sides is cut out. Subsequently, the central triangle created in each of the three triangles is removed. This process is repeated to obtain the fractal. According to (Kolman and Hill (2005), “the preceding steps are conceptually easy, but careful thought is needed to determine the *affine* transformations required to produce them.” p.538. In this instance, the middle triangle is constructed by connecting the mid-points at the sides of the initial equilateral triangle. The three triangles produced are $\frac{1}{2}$ the size of the sides of the original triangle. Hence there is a reduction by $\frac{1}{2}$. This implies that self-similarity is built infinitely in the construction process.

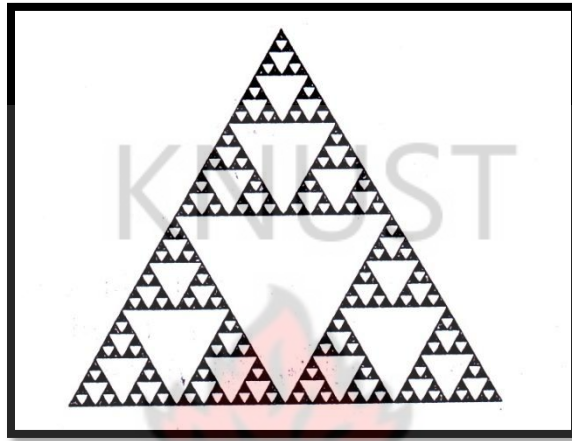
Constructing the process repeatedly infinitely generates a complex filling of a given space at any point with ever smaller equilateral triangle referred to as Sierpinski Triangle or Gasket. See examples a-d in fig. 44a-d, pp.26-27.



Step a. Step b.



Step c.



Step d.

Fig: 8a-d

“Steps leading to the construction of the Sierpinski’s Triangle/Gasket”

Constructing a Fractal

The constructed fractal examples according to Kolman and Hill (2005), “are considered true fractals in contrast to curves or surfaces in real world such as coastlines, trees, coral reefs, clouds or the surface of metal plate.” p.537. Natural objects in this sense are viewed only over a finite array of scales and therefore do not have infinitely repeated constructive steps as those described in the previous examples. This invariably proves that as the artist tools are varied in representing natural objects, true fractals are

the mathematician's tool that can be used to provide models for physical objects or phenomena.

This has improved the technique for modelling the geometry of nature that was not previously available to mathematicians.

Affine transformations seem simple enough; they map line segments to line segments. However the simplicity of the process does not mean that the repetitions of it will lead to simple patterns. In fact, it is surprising that a wide variety of complex patterns are as a result of repeated applications of *affine* transformations. It was this type of mathematical observation that laid the foundation for the new areas of mathematics called **fractal geometry and chaos theory**. Fractal occurs when a figure appears self-similar as the scale changes. The term self-similar is used to describe figures composed of infinite repetitions of the same shape that is, the figures composed of smaller objects that are similar to the whole. For example a tree is made up of branches, limbs and twigs. Viewed at different scales each of these has similar shape or appearance. (Kolman and Hill, 2005, p.539).

Recursion

One of the ways to generate a fractal is by recursion. Fractals described in the previous sections were obtained by this process. In mathematics this process is carried to infinity.

In generating the Cantor set or Koch curve, for example, we stop once the lines become too tiny to print. “In fact, any physically existing object will only be fractal within a particular range of scales,” (Eglish, 1999, p.113).

Scaling

Scaling is another element of fractal construction. To have ‘scaling shape’ means that consideration of same pattern within the range at different scales is achieved. Enlarging a tiny section will create a pattern that looks similar to the original image, and its reduction will result in something that looks like a tiny path or shadow of the real image.

Self-Similarity

Self-similarity is another determining element of fractal. Mathematicians make a distinction between statistical self-similarities, and exact self-similarities. In the Koch curve for example, a precise imitation of the original may well be found within any section of itself.

The acacia tree branch is a typical example of natural fractals model. Acacia trees have branch parts that contain tiny image of the whole (see fig. 9).

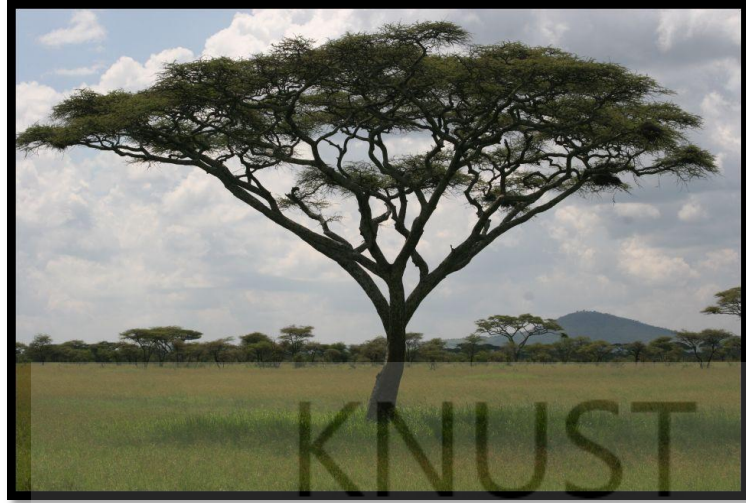


Fig. 9. Acacia (Acumulifolis) tree with fractal branch pattern, Google image retrieved 20/10/2011.

Infinity

Infinity is also an essential component in the construction of fractal. In order to obtain a fractal, as in the previous section, we repeated the steps infinitely many times. Infinity can be represented “symbolically and/or typically by spiral” (Eglash, 1999, p.82). The same concepts are combined with infinity and fractals in contemporary Western mathematics.

The most striking image for infinity is snail shells. The Balubas according to Eglash, for example, “use spiral land snails and the Jola use the spiral end of the sea snail, which forms the drinking cup that can only be used by the Chief.” By this way, one consumes the infinite life that exists in the spiral formed within the shell showing a

symbol of eternity. A corn-row hair style is a typical example of this scaling pattern. Its simulation is shown in fig 10, p.31.

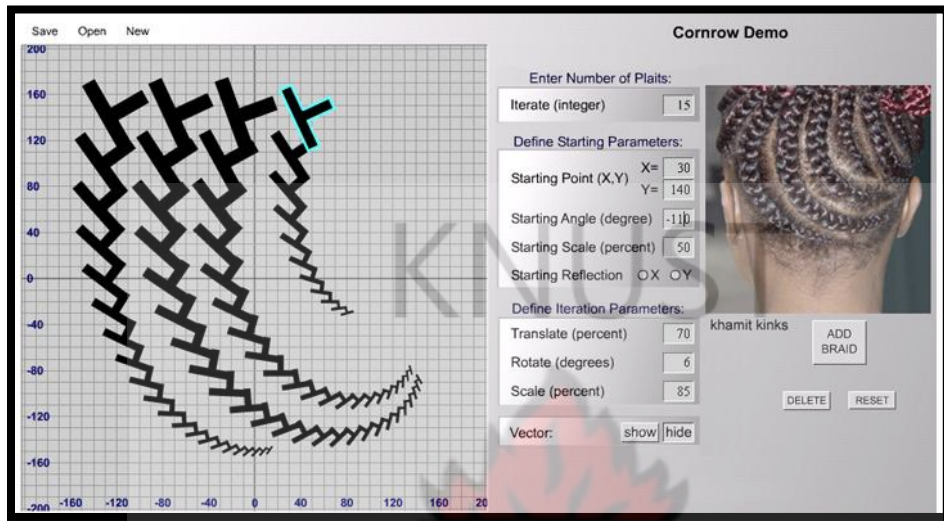


Fig: 10

Corn row fractals showing infinity patterns

The concept of infinity is classically a positive African association to invoke prosperity without end. It is a process without end which fits into Aristotle's desire to communicate icons to infinite modes. But the spiritual element of these icons, demand additional requirement: the icons are essentially to convey the sensibilities of drawing on the power of infinity itself. Snail shells are often used because of the scaling properties of their logarithmic spirals; one can see the potential for the spirals to continue despite its containment in a finite space.

Comparatively, the infinity icon in the Nankani architecture is the coils of a relief serpent of infinite length, sculpted into the house walls as found in fig.2 p.17. It is linked

to the African classical infinite concept based on snail shell having a geometric length without end. The conscious creation of this infinity concept is more than in the case of snail shells, because one cannot see the infinite coils of the snake. The Nankani representation of fractal art is seen in the imitation of the snake by coiling the motifs back on itself indefinitely. A recursive process is a typical illustration of the *kumpio* and the *zaalenga Bomborisi* that symbolize this idea of infinity.

Fractals Dimension

Dimension is linked with whole numbers as well as one-dimensional line, and two-dimensional plane, but the theory of measurement that governs fractals allow dimensions to be fractions. African designs that are strictly Euclidean abound and even these may occur in *fractalized* versions. Fractals in African culture have five essential components that are useful means to examine African designs and knowledge systems as fractal geometry. Scaling and Self-Similarity are descriptive characteristics to explore fractal properties in African designs. African architectural forms are some of the clearest illustrations of indigenous self-similar designs.

Fractals in Architecture, Settlements, Nature, and Art.

Indigenous African Architecture

Fractals exist in settlements, Architecture, Nature, and Art. African architecture often provides excellent examples of cultural design themes. These structural designs

have direct bearing on our social concepts which are part of our lives, our built environment, one in which we live, work or play. The Sirigu architectural paintings as observed by the researcher reveal such social concepts. They are mostly expressed in the motifs used in the traditional wall paintings and other art articles.

Egash (1999) mentions that at first glance, African architecture varies as there is great diversity among the many cultures of Africa. He quotes Gardi (1973), to the effect that “fractal architecture can be found in every corner of the African continent.” p.20). He limits fractals to some selected traditional architectural forms in Africa. Fractal geometry provides wide array of shapes in mathematics which has been noted in traditional African architecture by its outstanding repeated presence.

Settlements

A computer-generated fractal model for example shows the different cultural diversity in comparing aerial photographs of architectural plan of African settlements. The fractal simulation in self-similar characteristics of the physical structure helps in the understanding of the subject as in aspects of local and cultural implication of the structure. African designers used iteration techniques and provide a fundamental building construction structure through fractal graphics to show how the patterns appear graphically.

Examples of simulated fractals of traditional African architecture include settlement of selected African cultures. Most circular homes in Africa show the Mokoulek centralized type. The Songhai village of Labbezange in Mali for example,

shows features of grouped but separate circular household. Fractal geometry is based on symmetry between different scales feature of circular structures in scaling symmetry.

Egash (1997) mentions earlier studies in Songhai that the rectangular buildings seen in Labbezanga are due to Islamic influence and that the original structure will have been completely circular. A graphical illustration of the photos of Songhai architecture is shown as fractal dimension like the computer generated fractal of Labbezanga. These circular settlements are commonly found in inland West Africa and there are significant similarities in Burkina Faso and Northern Ghana settlements. The scaling representation of each settlement is beautifully constructed by the Nankani societies as in fig. 11, p.35.

Norman (1997) states that, “historically, the people migrated from nearby Burkina Faso to their present place. They represent two groups of people, namely the Nankense and Kassena.” p.5

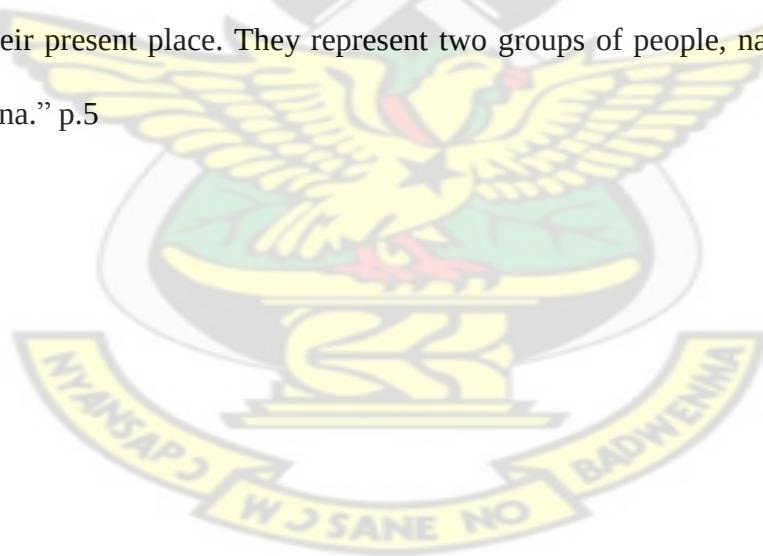




Fig: 11

A clay model of Nankani home, picture by Michael Nyarkoh, 2007

Nature and Art

The outer limits of the compound are social context coded as male and the successive enclosures as female, the woman's circular cooking area *dego* around the circular fireplace have the scaling stack pile of pots. Similar to the Kotoko women, the Nankani women also insulate the walls using cow dung for plastering and decorating. Recurrent image of a triangle in these wall designs represent the *zaalenga*, a nested stack

of calabashes. They are circular bowls carved from gourds that are kept in the kitchen by each woman. Since these calabashes are stacked from large to small in sisal rope casing, a triangle is formed. The associated triangular decorations are represented as abstract scaling circles.

The *kumpio* is represented as a shrine for her soul in the tiniest container of a woman's *zaalenga*. When she dies her pots along with the *zaalenga* is smashed and her soul is released to eternity. The concept eternity symbolically represented by the coils of a snake is connected with well-being. The infinite length created into the walls of these settlements is known in fractal terms as spirals as linear or logarithmic spiral. The Archimedes linear spiral has even space between each revolution. Only a finite number of turns can fit in this finite space. In the logarithmic spiral, there is an increasing distance between each revolution as infinite number of turns can fit in this finite space. The snake symbol, however, is a receptacle of the principles elaborated above.

“Dozens of self-similar scaling- the Nankani fractals span three orders or magnitude which is comparable to the resolutions of most computer screens” (Egash, 1999, p.33). These scaling circles are not unconscious accidentals but the artists have made conscious use of the scaling in their social symbolism. The most important representation is that which is connected with child birth. When a child is brought forth, it must stay in the innermost enclosure of the woman's *dego* until the child can crawl out unaided. The succeeding social spacing of each entrance is a rite of passage which begins with the biological entrance of the child from the womb. Each of these connected chambers is handed down as the next iterated stage of birth of life.

The *zaalenga* is symbolic of the entire structure and its annihilation in the event of death, establishes the journey in reverse from the circles of the largest calabash to the tiny *Kumpio* holding the soul of the matured adult to the eternal abode of ancestors who reside in the earth's womb. This is an awakening system to the scaling circles of the Nankani tradition and it is a recursion that emphasises infinity. See fig. 12, p.37.



Fig: 12

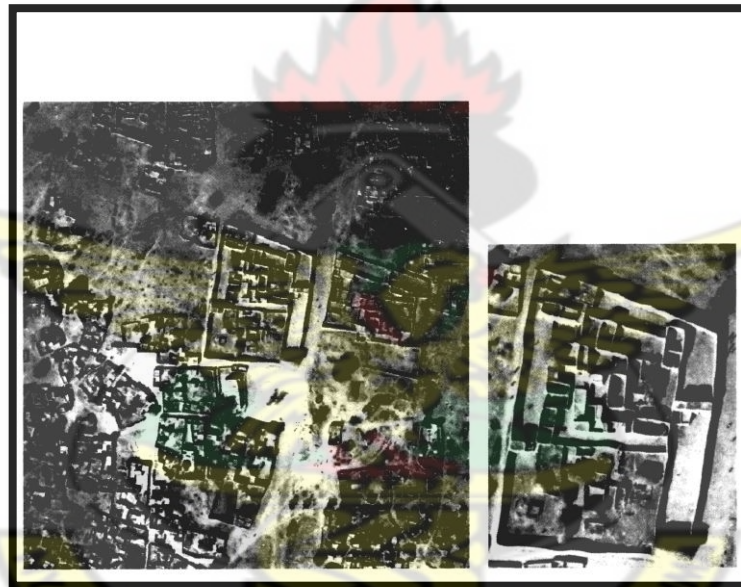
Zaalenga calabash stack pile-Kumpio

Simulated Settlements

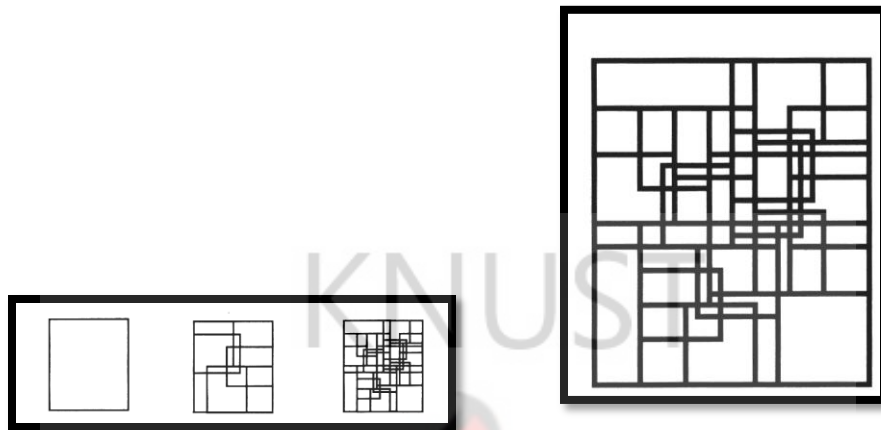
Simulated settlement photographed by Eglash as good example of fractal architectural geometry in Africa can be found in the following communities in figs. 13-16, (pp.38-42).

a. Lognie-Birni in Cameroun, b. Ba-lia settlement in Southern Zambia

c. Mokoulek in Cameroun, d. Aerial view of the village of Labbezanga in Mali.



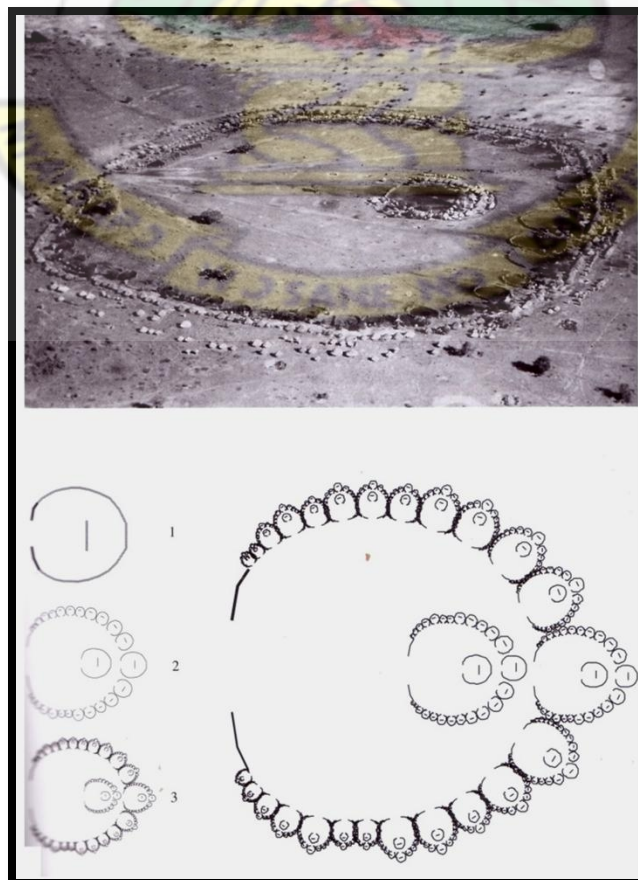
Aerial View



Fractal generation of the aerial view

Fig: 13

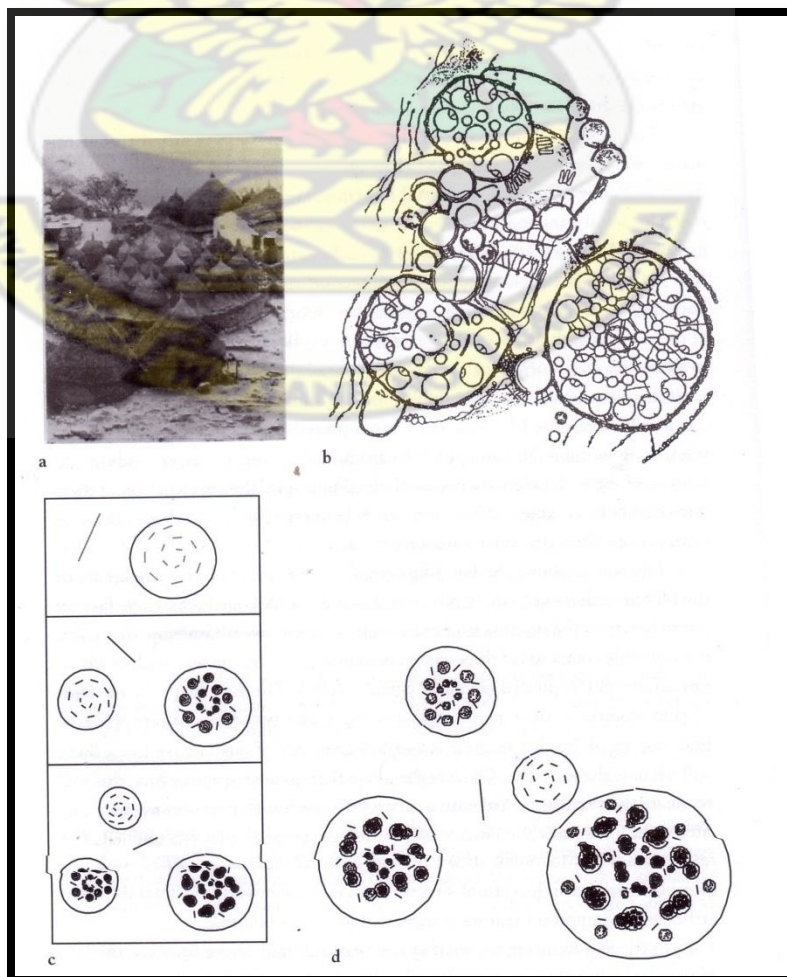
a. Lognie-Birni in Cameroun courtesy of R. Eglash, 1999.



KNUST

Fig: 14

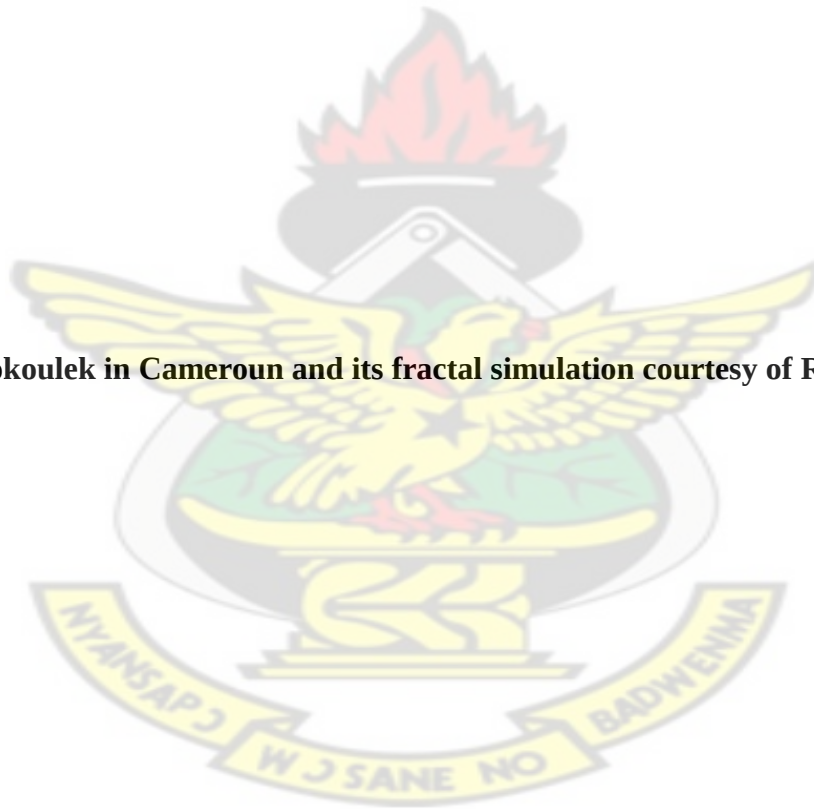
- b. Ba-ila settlement in Southern Zambia showing the fractal simulation below courtesy R. Eglash, 1999.**



KNUST

Fig: 15

- c. **Mokoulek in Cameroun and its fractal simulation courtesy of R. Eglash, 1999.**



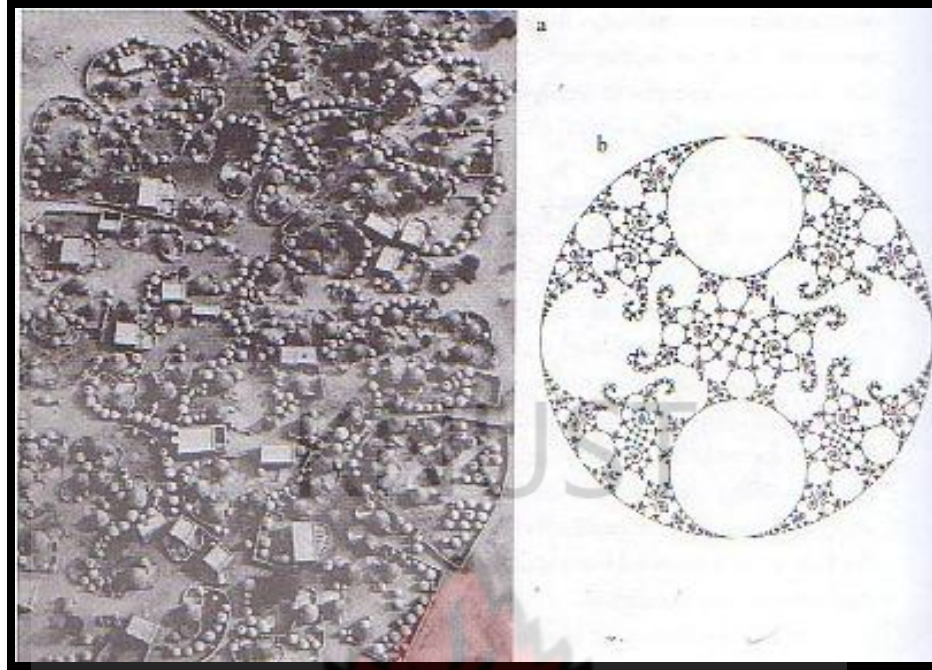


Fig: 16

d. Aerial and fractal view of Labbezanga village in Mali, courtesy of R. Eglash, 1999.

Fractal Aesthetics

Eglash (1999) has stated that, “designs are based on nature from conscious and artificial designs” (p.48). The intention according to Eglash is “intuitive inspiration and others are more self-conscious application of rules and principles”. There exist variations from rules of self-consciousness and the principle that inspires the result. This African fractal simulated architecture in figs.13-16, pp.38-42 however, does not appear to be related to anything aside the artist’s visual or aesthetic intuition. The remarkable

structural appearance does not provide initial meanings particularly to the geometric forms of the figures. Some professional mathematicians report that the creative idea occurs as pure intentions as it flashes in geometric thinking of an artisan. This goes to prove that aesthetic pattern clearly qualify as intentional design.

For now, African representation of nature shows that artisans have gone past simple form. The misconception that African fractals are rarely the result of imitating natural forms is a reminder that they are not due to “primitives living close to nature” (Eglash 1999). African fractals are representations of nature, and they are obviously a self-conscious idea, not a mimetic reflection.

In addition to the need for bottom-up authority, some researchers such as Ross and Cole, and Norman, have established the crucial role of women in the development of art, especially, in gender division of labour in rural African society. While much of this study has focused on women in bearing the brunt of the economic change, many of these practices like Sirigu women’s wall painting which continues even today, confirms that women’s indigenous knowledge systems is a significant resource in recent approaches to art development.

Combining traditional knowledge systems and mathematical graphic simulations fractal imitations of the African designs is simulated. By correlating the equation parameters it resulted in fantastic computer generated patterns as exhibited by the researcher. See figs. 29-33, pp.54-64.

The formation of some traditional design bears similar characteristics as computer generated fractal simulations which indicate various levels of iterations as global scaling symmetry, Eglash (1999). Research has revealed that concentric circles and square formations are observed from above the Mexican pyramids. They were found to reveal Euclidean characteristic than fractal. They scale to have an infinite number scaled to one point as found in figs.17-18, p.45.

This is linked to advance these theories located in the simulated paintings in the thesis project. Simulations of multiple concentric shapes in the painting in plate 12 are represented in transparent overlaps. The various designs in the painting mentioned above are shown with variegated circular forms. They are depicted as fractal simulations based on linear forms as in Native American architecture. Plate 12, however, depicts simulations of the *Bomborisi waafo*-python relief motif as found in fig.2, p.17. Similar images of concentric patterns have been applied in the fractal generated design in plate 21, p.185.

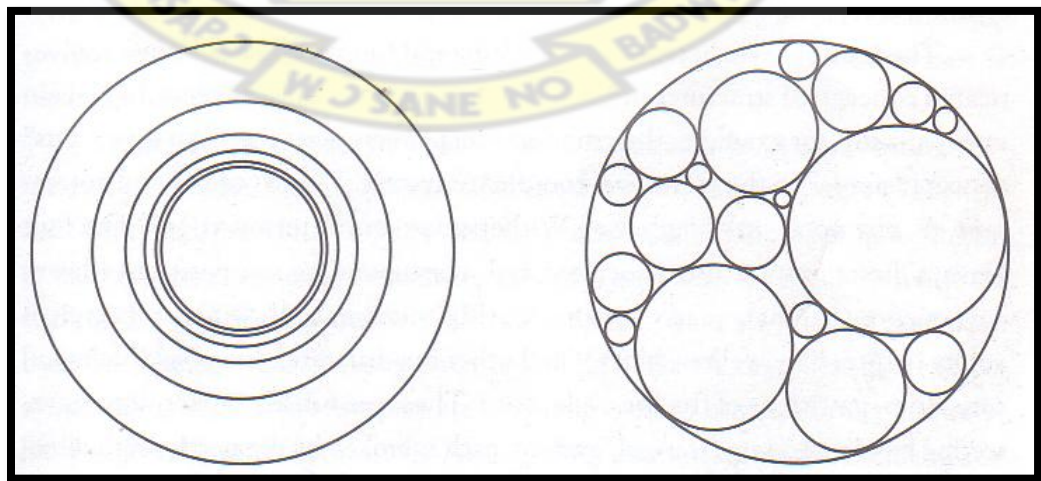


Fig: 17

Non-linear Concentric Circles

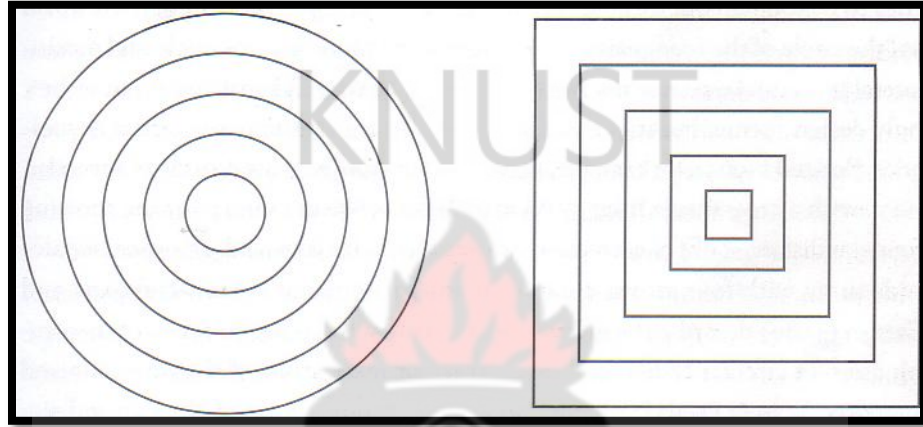


Fig: 18

Linear Concentric Circles/Squares (one point scale forms)

Fractal Designs from Nature

Brett (2007), introductory remarks reveal that “Fractals involve any process that repeats a structure but on different scales” (p.3). Fractal-like structures occur in nature. By considering the fern plant in fig. 19, p.46 as a whole; the entire leaf has a triangular shape. Each stem on the leaf is arranged in a triangular shape but smaller than the whole. On each stem is a tiny leaf that is triangular. The same pattern can be seen when looking at a head structure of broccoli as in fig 20, p.47.



Fig: 19

Fern plant fractal



a



b

fig. 20a-b

Broccoli fractal

Fractal Simulationists' Works

Figures 21-28, pp.48-53 represent sets of “global scaling symmetry,” as digital fractals simulations created by six (6) professional fractal simulationists. Fractal art is a digital medium- computer that allows many contemporary artists to integrate complex fractal elements in their own art designs. Fractal simulations of identifiable contemporary artists’ works have been reported by Parke (2003). She also discusses her own fractal simulated designs alongside other works by Kerry Mitchell, Robert Williams and Mark Townsend.

Park (2003), in a report on “Fractal Art: A Comparison of Styles” has mentioned in the abstract that,

Where algorithmic art objectively shows the geometric or mathematical structure in an aesthetically pleasing way, some fractal artists now dare to go a step further by using fractal elements to create works of art that appeal subjectively to viewers' feelings and emotions. Fractals are geometric representations of certain specialized mathematical formulas. The fractal's shapes, colours, and textures are all controlled by these formulas, which are, in turn, controlled by the artist's manipulation of their parameters (p.1).

The resultant digital manipulations of the four individual fractal simulations are represented as follows in figs.21-24, 48-50.

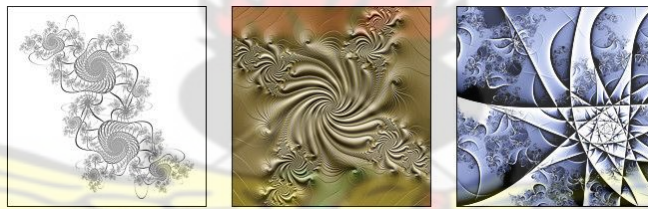


Fig. 21

**A set of three fractal simulation designs by Kerry Mitchell (2000),
Photograph by courtesy of Janet Parke (2003)**

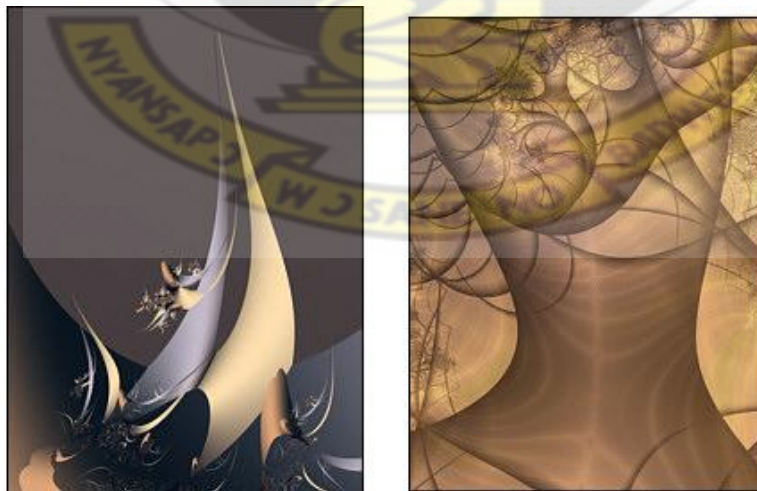


Fig. 22

A set of two fractal simulation designs by Robert Williams (1999)

Photograph by courtesy of Janet Parke (2003)



Fig. 23

Three fractal designs by Janet Parke (2000), Photograph by courtesy of Janet Parke (2003)

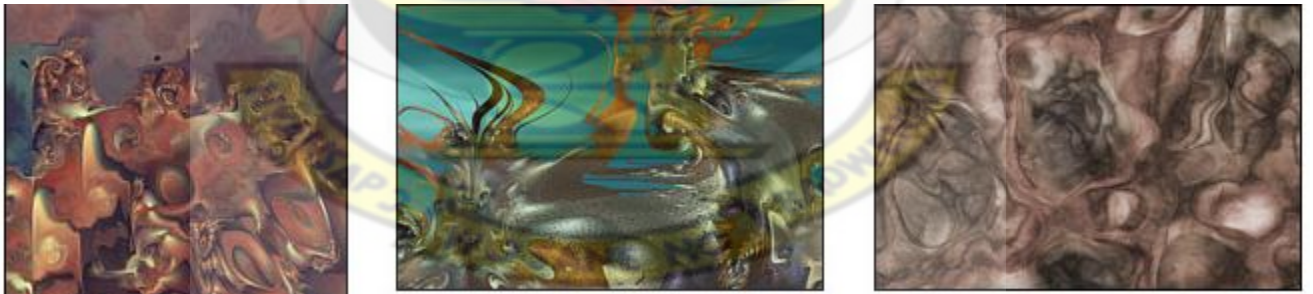


Fig. 24

A set of three fractal simulation designs by Mark Townsend (2001). Photograph by courtesy of Janet Parke (2003).

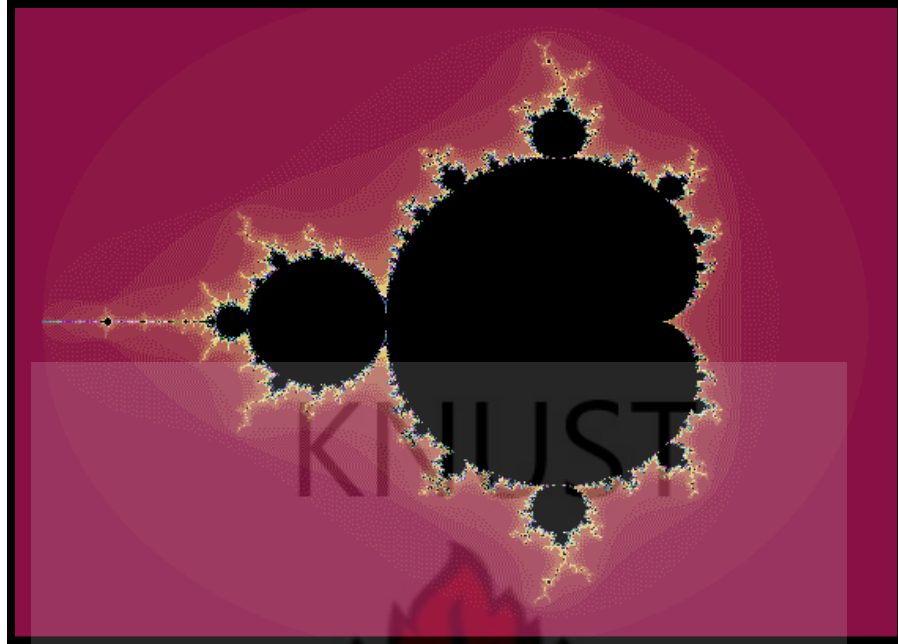
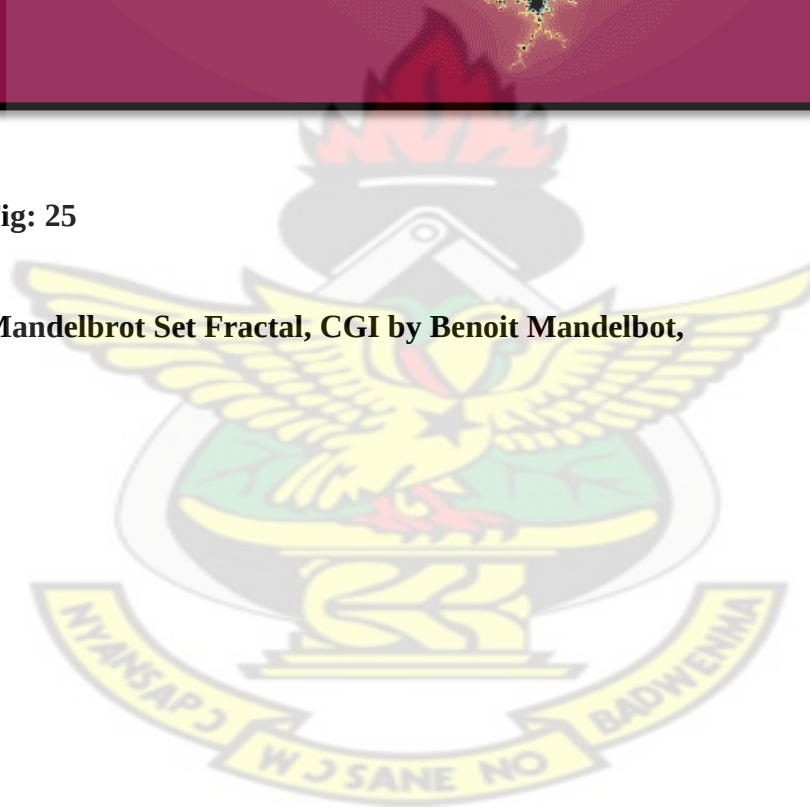


Fig: 25

Mandelbrot Set Fractal, CGI by Benoit Mandelbot,



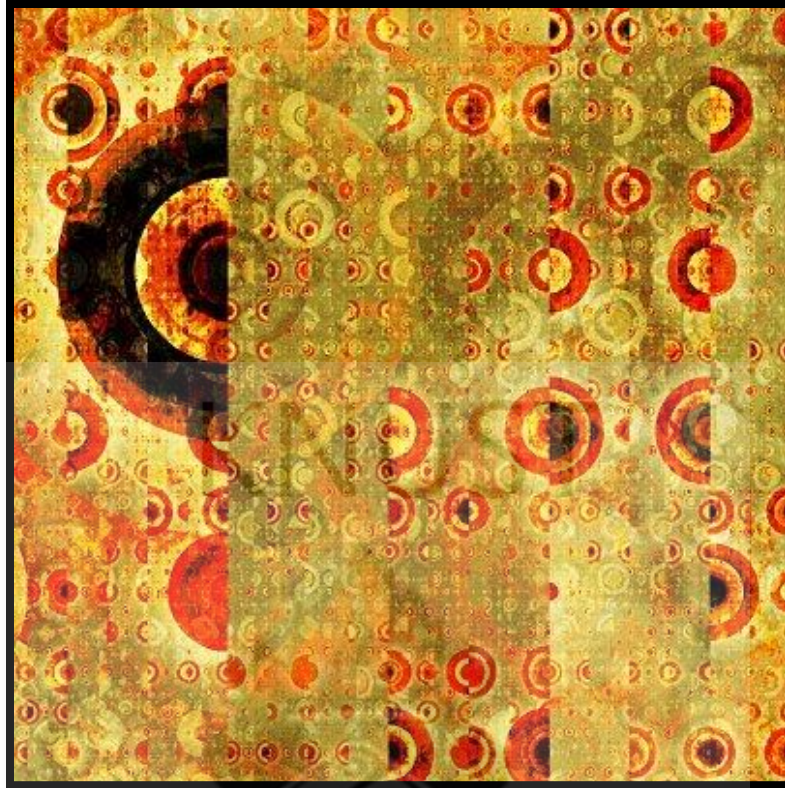


Fig. 26

Ohello Fractal, CGI by Kelly Deitrich

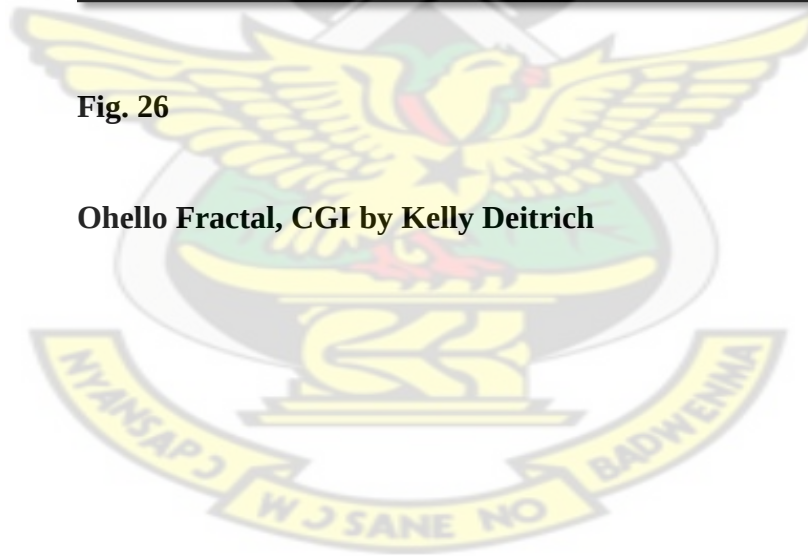




Fig. 27

Light Ship Fractal, CGI by Kelly Deitrich

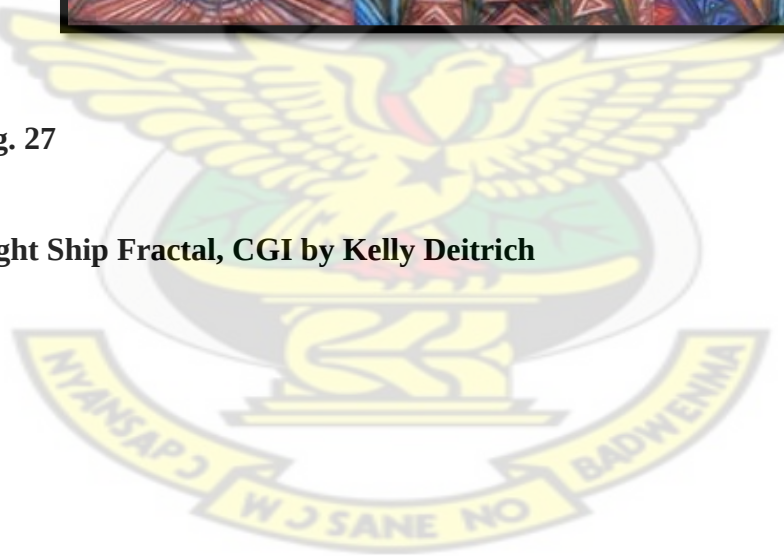




Fig: 28

Night 20% Moon Fractal, CGI by Kelly Deitrich

Some of the available computer fractal generating programs includes:

1. Apophysis - open source software for Microsoft Windows based systems
2. Electric Sheep - open source distributed computing software
3. Fractint - freeware with available source code
4. Sterling - Freeware software for Microsoft Windows based systems
5. SpangFract - For Mac OS

Fractal Paintings: Five Simulated Transformations

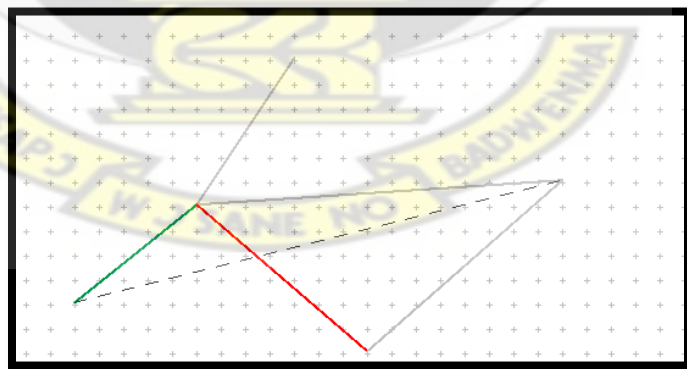
Graphic Simulated Fractal Technique

Transformations were effected with the computer to generate graphic images using fractal art technique run by Matlab/JAVA application software.

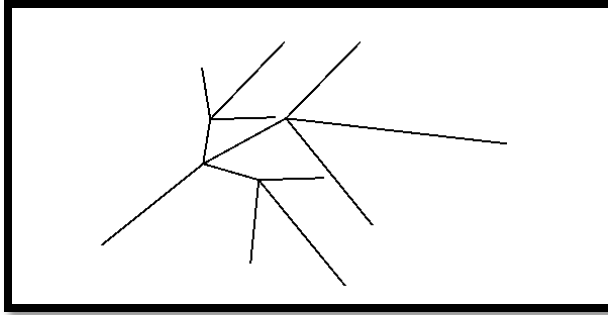
The following fractal graphical simulations were generated for various iterations of a fern plant, Nankani home, *wafo* (snake), *wangzasi* (broken pieces of calabash) and *zaalenga* (calabash stack pile) *Bomborisi* motifs using Matlab/JAVA Application Software for figs: 29-33 by the researcher.

This set of five experimental paintings is as a result of computer generated images to effect simulated transformations. Graphical sequence of the C.G.I. experimental paintings is as follows:

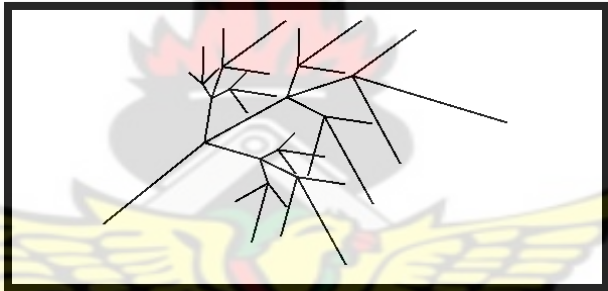
Fern Fractal



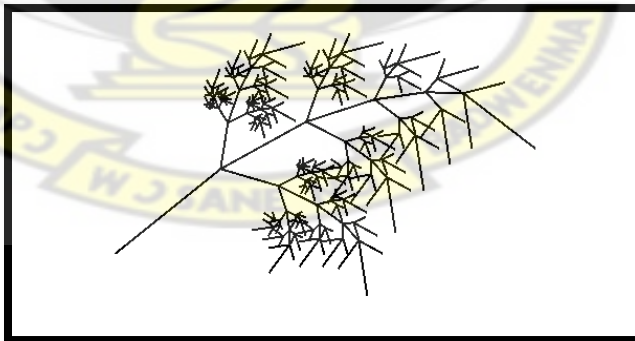
a. Initial iteration



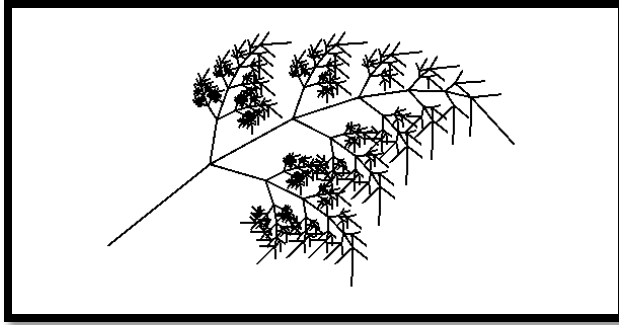
b. Second iteration



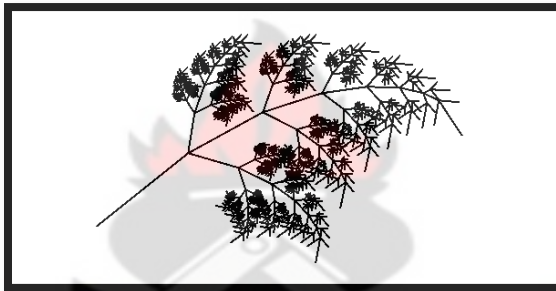
c. Third iteration



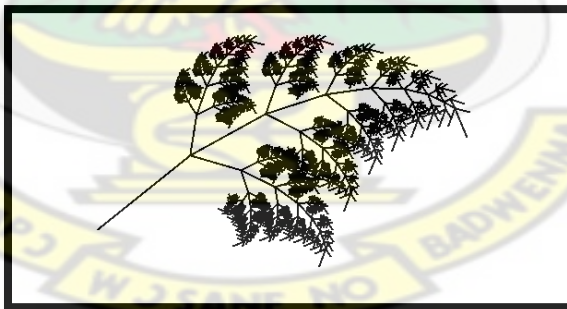
d. Fourth iteration



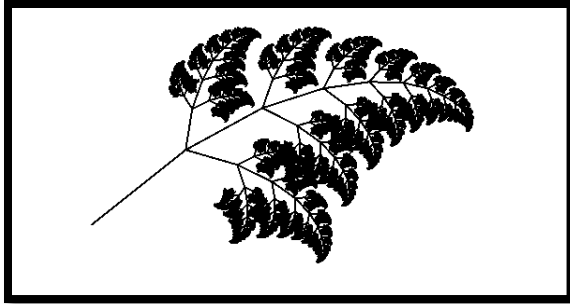
e. Fifth iteration



f. Sixth iteration



g. Seventh iteration

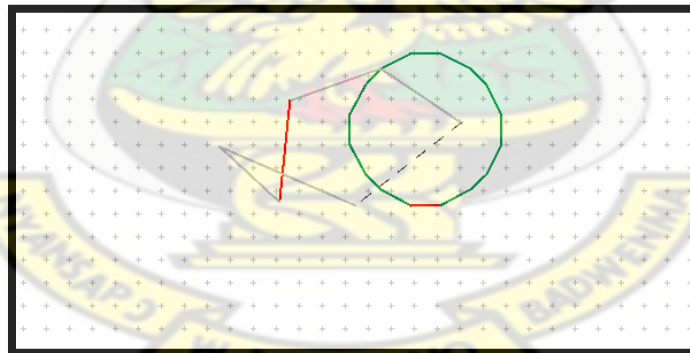


h. Eighth iteration

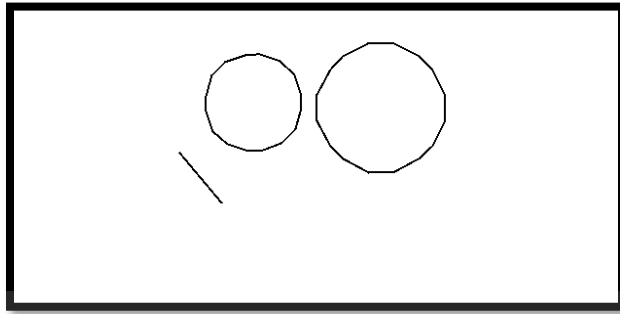
Fig: 29 a, b, c, d, e, f, g, h

Fern plant iteration: Mathlab/JAVA CGI. by Michael Nyarkoh

Nankani Home Fractal



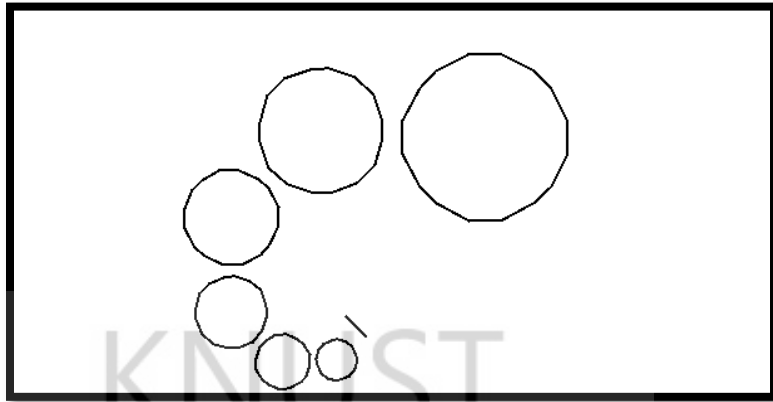
a. Initial demo



b. Second iteration



c. Third iteration

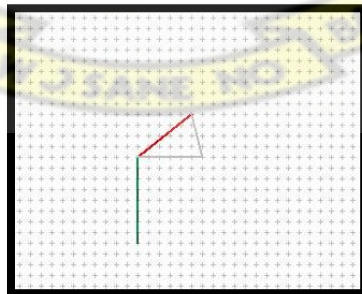


e. Sixth iteration

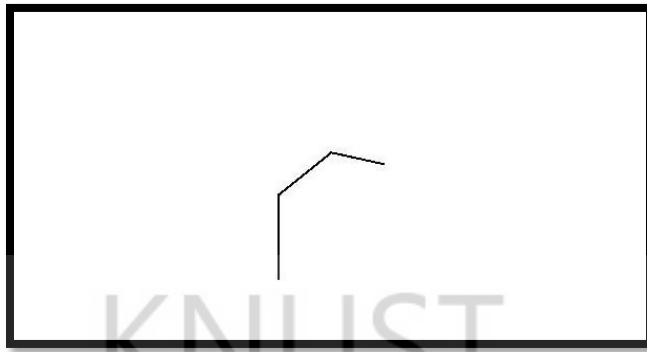
Fig: 30

Nankani Home iteration: Mathlab/JAVA CGI. by Michael Nyarkoh

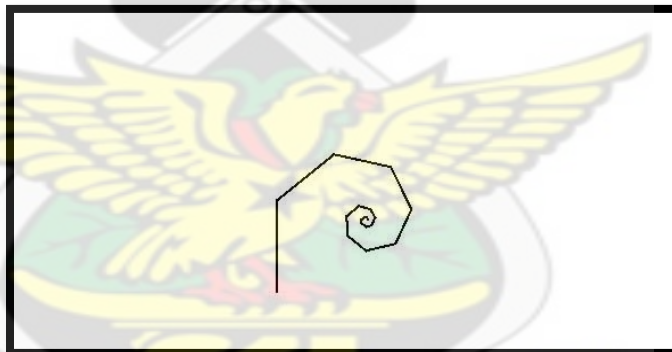
Spiral Formation



a. Initial demo



b. Second iteration

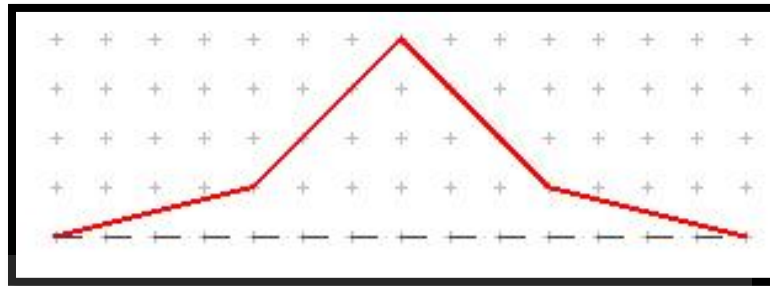


c. Ninth iteration

Fig: 31

Spiral Simulation: Mathlab/JAVA GI. by Michael Nyarkoh, 2009.

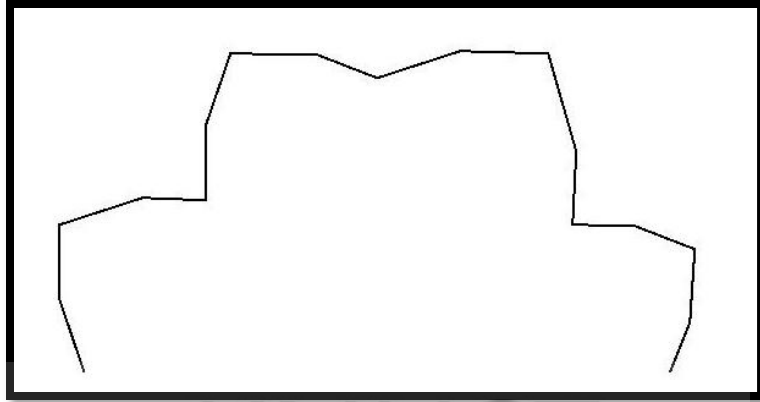
Wangzasi Triangular Fractal



a. Initial demo



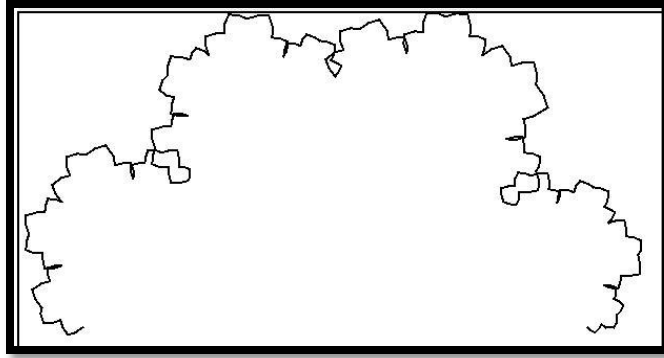
b. Second iteration



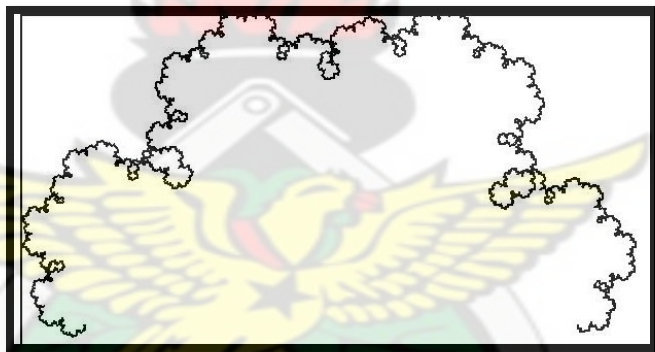
c. Third iteration



d. Fourth iteration



e. Fifth iteration



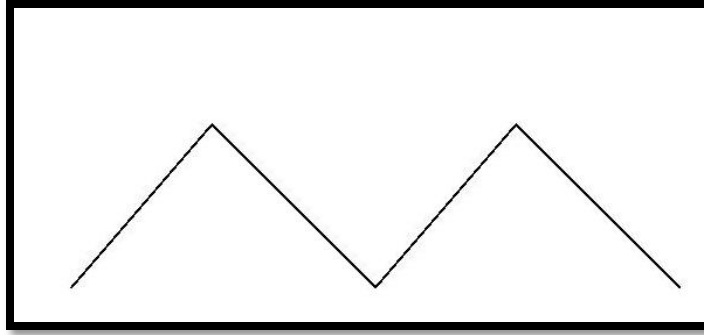
f. Ninth iteration

Fig: 32a-f

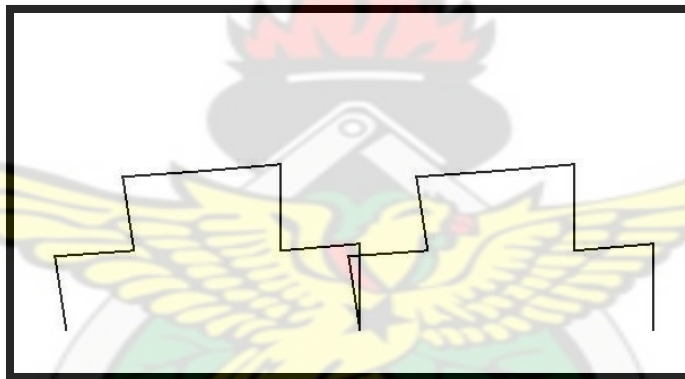
Wangzasi triangular fractal simulation

Mathlab/JAVA GI. by Michael Nyarkoh, 2009

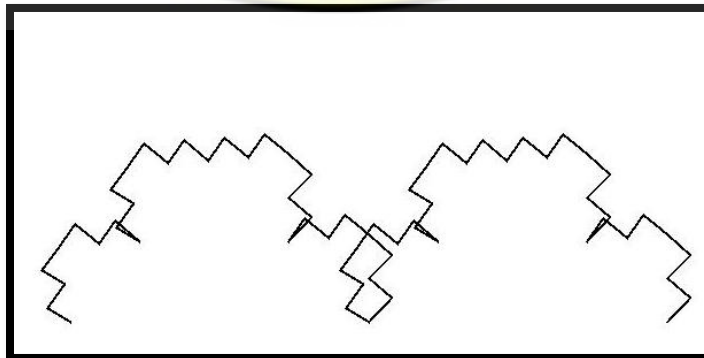
Zaalenga Fractal



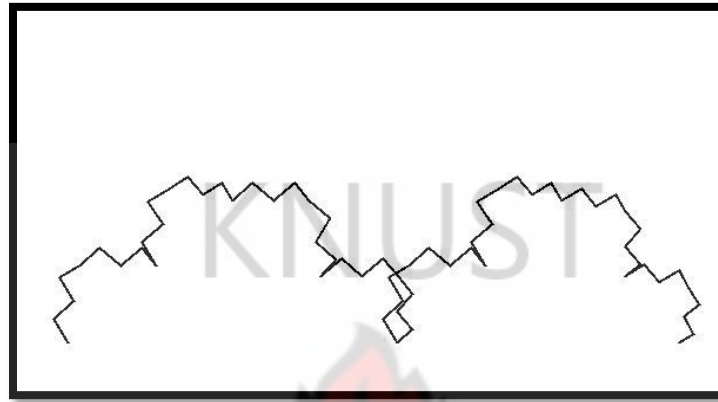
a. Initial demo



b. Second iteration



c. Third iteration



d. Fourth iteration

Figs: 33a-d

Zaalenga fractal: Mathlab/JAVA G.I. by Michael Nyarkoh, 2009.

Transformation by Simulation

Transformation seeks to make a dialogue between current scholars, theorists, and writers within a wider array of disciplines and practices like Eglash's African fractal designs and *Bomborisi* wall painting techniques alongside Walter Benjamin's ideas especially on art, and representation in the context of alteration from collective to universal culture.

This thesis on Sirigu wall painting symbols is transformed into mathematical fractal characteristics as a contemporary art project. It is possible by re-evaluating of an existing art tradition which is analogous to the Benjaminian transformation from “cult or ritual value” to “exchange or exhibition value” Encyclopaedia (2011).

The research focuses on the effort Benjamin concepts conceive about transformations in relation to what the researcher espouses as *Bomborisi* transformation. The second is the variety of concepts, terms of engagement, and interpretations. The researcher however extrapolates transformed fractal concepts.

Dictionary Com.LLC (2011) has defined fractals as “representation of highly complex mathematical process, which is bounded by a set of rules” such as scaling, recursion, iteration, etc. for this thesis. Fractal operating procedures and its relationships are specified, alongside other variables such as computer generated images (CGI). The interaction of these phenomena will create new situations and new rules, which will further evolve as the simulation.

Baudrillard defines simulation as “technical mediation replacing the natural thing” (Dictionary.Com.LLC, 2011). “The act of simulating something generally entails representing certain key characteristics or behaviours of a selected physical or abstract system” (Wikipedia Foundation Inc., 2009).

Baudrillard encapsulates that,

“Simulacra and Simulation, introduced the concept that reality or the principle of the "real" is short-circuited by the inter-changeability of signs

in an era whose communicative and semantic acts are dominated by electronic media and digital technologies” Encyclopaedia (2011).

In relating the *Simulacra and Simulation* to contemporary art world which influenced Baudrillard’s claims that our present “society has replaced all reality and meaning with symbols and signs, and that human experience is a simulation of reality” (Dictionary. Com.LLC, 2011)

It is therefore claimed that “the object of symbolism of culture and media that create perceived reality, its shared existence becomes legible”. Baudrillard and Eglash affirm that fractal simulation which is based on African traditional knowledge systems in the sign-order on the four (4) stages of the simulacra. The first stage is a faithful image or copy, linking what Baudrillard called "the sacramental order," (Walter, Ennings, Doherty, 2008).

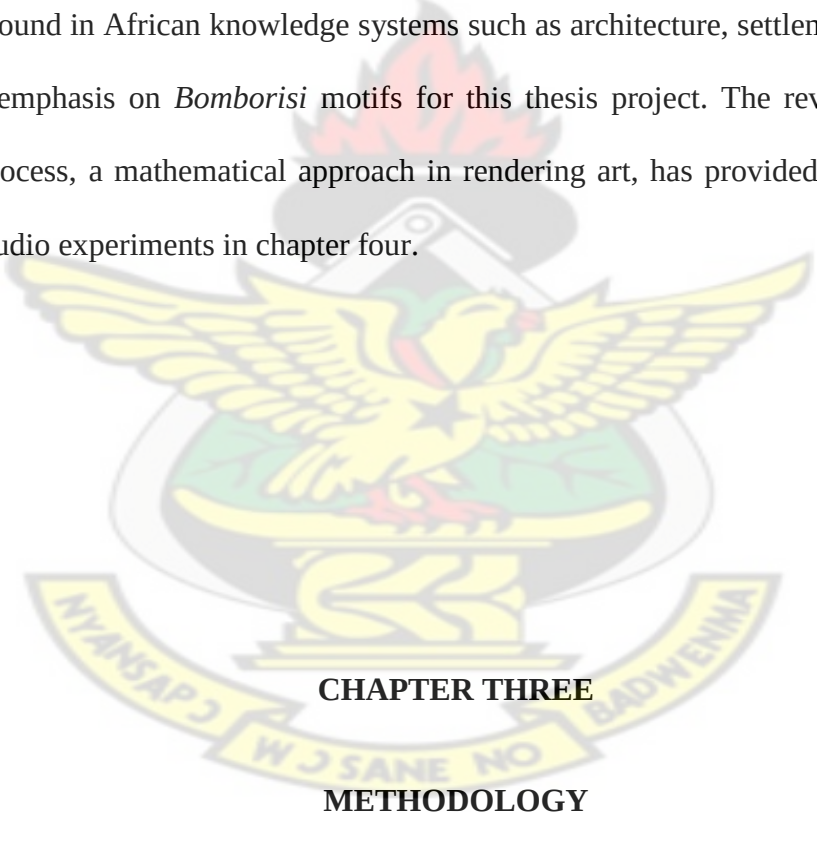
The second stage is perversion of reality, this is where we believe the sign to be an unfaithful copy, which "masks and denatures" reality as an "evil appearance - it is of the order of malfeasance". Here, signs and images do not faithfully show us reality, but can hint at the existence of something real which the sign itself is incapable of encapsulating.

The third stage masks the absence of a profound reality, where the simulacrum *pretends* to be a faithful copy, but it is a copy with no original. Signs and images claim to represent something real, but no representation is taking place and arbitrary images are merely suggested as things to which they have no relationship. Baudrillard calls this the "order of sorcery.

The fourth stage is pure simulation, in which the simulacrum has no relationship to any reality whatsoever. Here, signs merely reflect other signs and any claim to reality on the part of images or signs are only of the order of other such claims (Bovill 1996, p.15-38).

Baudrillard refers to “simulacra” in this phenomenon as the "precession of simulacra". The simulacra in Baudrillard’s concepts of culture and media symbolism, is to eventually create perceived reality and legitimizes its existence. Baudrillard’s, "precession of simulacra" (Walter, Ennings, Doherty, 2008).

Computers and fractal programs have advanced enough to make fractal image exploration practical. George Cantor and Benoit Mandelbrot and currently Ron Eglash have systematically studied Mathematics of fractals geometry theories. Fractals forms also are found in African knowledge systems such as architecture, settlements, nature and art with emphasis on *Bomborisi* motifs for this thesis project. The review of classical fractal process, a mathematical approach in rendering art, has provided the background for the studio experiments in chapter four.



CHAPTER THREE

METHODOLOGY

Research Design and Pictorial Transformations Observed at Sirigu, Navrongo, Bolgatanga and Accra.

Research Design:

The Sage Encyclopaedia of Qualitative Research Methods (2008) explains action research as a fluid methodology distinctively appropriate to researching and piloting exploratory practice with the aim of stirring up development. According Zimmerman (1998), action research is also used to develop a new approach to solving a difficulty by being keenly involved in direct application in the studio setting.

Qualitative research methods were used for the thesis. The formulation of problem to be investigated was sought for. A critical thought process and definition of problem to be investigated was decided.

Data collected from the fieldwork were further explored through studio art experiments as discussed in the next chapter. The researcher developed personal ideas based on *Bomborisi* motifs and fractal art simulations and produced paintings with attributes of Sirigu women wall painting motifs. Research instruments in the form of literature review, questionnaires, interviews, digital and audio recording items were prepared and used for the study.

The research begun by personal observation and direct participation in *Bomborisi* wall painting rituals and documentation of the various processes of the wall painting: from the acquisition of materials and assembling of tools to the preparation of the wall surface and the rendition of the wall decoration. To be able to do this, a thorough search was done to answer the following questions:

- What are the characteristics of the Sirigu wall painting?
- To what extent has *Bomborisi* been transformed in the village setting and beyond?

- Is there any link between Sirigu *Bomborisi* motifs and contemporary geometric concepts such as fractals?
- What are some of the direct and indirect relationships between the geometric concepts of fractals and Sirigu wall painting?
- To what extent can the emergent fractal concepts be carried out in the studio setting using electronic medium?
- What type of exhibition will be the outcome of the thesis project?

In making such schematic investigations, knowledge about Sirigu wall painting among Nankanis became important source of reference and background. Fortunately written accounts by Ross and Cole, Haverkort, Norman as well as preliminary fieldwork survey by the researcher provided the needed data for the paintings. Eglash (1999) touching on African fractal art simulations inspired the researcher on the foundation, classification, and transformation of paintings to explore *Bomborisi* motifs and their simulations through studio experiments.

As a result, the initial step to the research data analysis was identifying common traditions existing in Nankani culture and its bearing on the symbols used in the wall painting. The next area was to research into the *Bomborisi* and find out how selected geometric motifs in the village setting can be used in studio experiments. Enquiry was made into the making of *Bomborisi* and answers sought for.

The final project was executed using fractal art characteristics such as iterations, translation, transformation, reflections, scaling, recursion, Cantor Set, Sierpinski's triangle and other fractal characteristics based on *Bomborisi* geometric symbols such as cattle

path-*Akunyena-nii*, crocodile-*Eebga*, calabash net-*Zaalenga*, and broken calabash-*Wanzagsi* motifs among others.

The final experimental paintings reflected transformation of *Bomborisi* motifs into a manual and computer generated fractal paintings with titles such as *Pisko Wanzagsi*, *X Bomborisi*, *The Soul of Akanvole* and *Hypercomplex Waafo*, *Dynamic Yoka*, *Complex Newton Cowry*, *Anyemi* and *Zinzira Akunyena-nii Conurbation*.

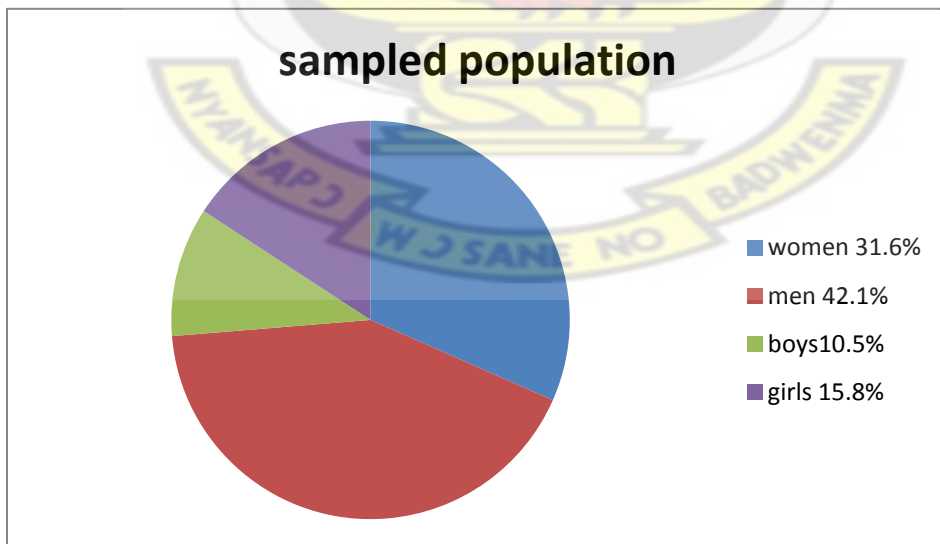


Fig. 34 Sampled Population Chart Representing Members of Akanvole's House at Sirigu.

This chart represents the distribution in percentage terms of respondents in the house of Akanvole.

The population of this project was made up of artists including women, men, girls and boys. The researcher considered data related to *Bomborisi* (women wall painting culture) on one side and selected motifs on the other side.

The population was therefore divided into four distinctive categories; women, men, boys and girls. The researcher sampled individual views and ideas on *Bomborisi* tradition which he assumed answers for the research questions for his project.

To reinforce the researcher's desire in using purposive and cluster sampling techniques for the fieldwork data situated within the key objective by selecting a segment of a universe that the results may, or could be, extended to the total population.

Considering the diverse nature of the population, the researcher sampled special cases to make a careful observation of the variables within each of the various population groups. The aim of the sampling of cases was to achieve representativeness rather than comparability. However a certain degree of comparability surfaced in the researcher's decision on using fractal geometry characteristics for selecting the motifs.

Criteria for the Sampling:

Category A: *Bomborisi* artists works classified as transformations. The builders with majority being men, the painters with majority being women are involved in the *Bomborisi* through generational inheritance, marriage or acquaintance.

Category B: Selected members of SWOPA and SIBA.

1. *Bomborisi* motifs were sampled.
2. The transformation within Sirigu painting motifs and other artworks belonging to (SWOPA and SIBA) members.
3. The transformation beyond Sirigu must belong to (SWOPA) members.

Justification for the Criteria for the Sampling

Category A: The entire household of Madam Akanvole Agombire the only surviving pioneer of *Bomborisi* was selected as representative unit. Since information required from respondents of this category are mainly about Sirigu wall painting tradition, the artists mostly women provided most of the information.

Category B: The motifs selected must be geometric in character to be simulated as a fractal.

Research Tools/Instruments

Various institutional and research libraries were visited for information on the topic. These included buildings with traditional paintings at Sirigu, Ghana National Museums and Monuments Board, Accra, Ghana National Tourist Board Offices in Accra/Kumasi, Centre for National Culture, Bolgatanga, Sirigu Women's Centre, Sirigu. Others include British

Council Library, Kumasi, British Council Library, Accra, Main Library, KNUST, Ashanti Library, Kumasi, College of Art and Social Sciences Library, KNUST, Internet Service, KNUST, Painting Studio, KNUST.

In addition to the libraries, the internet has been accessed for supportive institutional, personal/private, commercial and academic as well as on-line library sites for relevant information needed for the research project. This was done by making notes, printing out essential reports, journals, periodicals and electronic books for the thesis.

Questionnaire

The questionnaire was designed for those in category A which is made up of women, men, boys and girls. This was meant for those who build the walls and those who decorate them. Questions were sought for answers on the history and general information about *Bomborisi* by the Kassena Nankanni people of Sirigu. The question covers the history, acquisition and preparation of materials, tools and the painting ritual involved in the *Bomborisi* tradition. Personal information about the artists, their hopes, expectations and ritual practices associated with *Bomborisi* was sought for.

In totality, inquiry was made up of both open and close ended questions to allow respondents to agree or disagree with the researcher's assumptions as well as to allow for independent opinion to be expressed.

Administration of Questionnaires:

The questionnaire was designed, tested and administered by the researcher. Research assistants were sought for to help those in categories A and B respondents, who

could not read in order to facilitate translations, since the researcher could not communicate in *Nankam*.

Interviews:

Initial interviews conducted in some of the research locations were instrumental in the designing of the questionnaires. These interviews were mainly with the entire household of Madam Akanvole Agombire and other individual active SWOPA members in Sirigu. The medium of expression was Twi and English. Final detailed interview were conducted in Sirigu, precisely, in the house of Akanvole.

Participant Observation:

The researcher was once involved in the mortar preparation, plastering, drawing, creation of relief symbols and decoration on the buon-fresco surface in Sirigu. This helped the researcher to identify the assemblage of materials and tools for *Bomborisi*.

***Bomborisi*:**

Originally, the creation of *Bomborisi* or (wall painting) is part of the larger and necessary fresco plastering process on buildings in Sirigu. The designs are derived from various sources including natural and traditional elements such as broken calabash and fishnets. The paintings are created on both exterior and interior walls. The materials and tools used in painting the walls are all derived from the Sirigu local area and beyond. Painting pigments are obtained from special stones. The dominant colours of the stones are *zigmolgo*, *kugsabla* and *Kugpela* representing red, black and white respectively.

Traditionally, earth and cow dung are mixed together with water to plaster the earthen walls. The painting is done while the surface is still wet like buon fresco painting. The ground (white kaolin or limestone) is mixed into the consistency of paint and applied first to the wet walls. The red and black stones are ground into powder and mixed with water before application with a straw broom, which is dipped into the paint and applied directly to the wall. The white kaolin stone is sometimes used to draw directly onto the wet wall like pastel.

Painting is done directly on the wet surface already mentioned above. The stones are inserted into incised marks. Other conventional brushes and brooms are also used to make the decorations. The women sometimes prefer to paint with the white stone – *sasigas* directly onto the plaster. Sometimes a local plant residue -*bunto* is added as a lubricant.

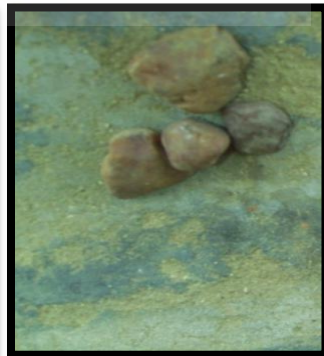
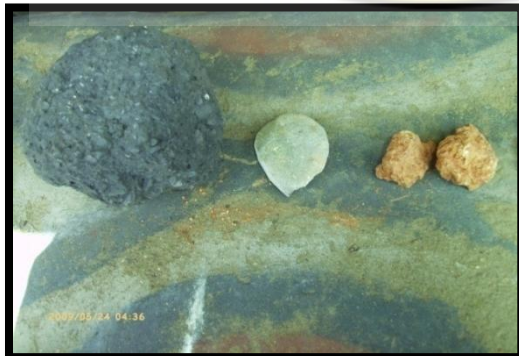
Organic and earth pigments are the materials used. The rudimentary tools used to prepare the plaster and the applications of paint are derived from implements used in everyday household activities by the women. The paint is mixed in a clay pot called *laasi*. The artists are mostly women who use simple painting tools like the guinea fowl feathers -*nunkuobro*, sticks, fingers, and any other available material that come handy.



a. White clay



b. Dawadawa pod and Zinzira fruit, Ampua fixatives



c. various stones used as pigments for *Bomborisi*

Fig: 35

Materials used for *Bomborisi*. Photograph by Michael Nyarkoh

Preparation of Surface for Plastering:

Cow-dung is mixed with sand and water into a mortar consistency. The mixture of soil, sand, water and cow-dung is usually used for interior plastering. Sand is used on the exterior part of the building because of its durability. Cow-dung is soaked in water, then sieved to remove pebbles, stones and unwanted materials.

Kaolin (which is sometimes used as decoration tool) is usually obtained inexpensively from the local market. Limestone is obtained locally in clay form and sometimes is processed into hard stone state or ground into a powder and then formed into oval shapes. Figs. 35a, b and c, p.77-78, show some of the materials used for wall painting.

Cow-dung and sand are mixed into mortar consistency by using the bare hand and other implements. This activity of mortar preparation is thoroughly done with calculated amounts of sand and cow-dung. Women use their bare hands, feet, and hoes to accomplish this task. Interestingly, the plastering is done with the bare hands in applying and smoothening to an even surface. See fig. 36, p.80. For the exterior wall, three layers of plaster are applied. Relief forms are created while the plaster is still wet for the interior walls. As the form begins to take shape, fingers and the palm are meticulously applied to give volume to the relief.

The surface is allowed to almost dry before smoothening it with the white stone or kaolin-*sasigas*. The smoothening process is done carefully and this is considered to be the most essential component of the art form. In *Bomborisi*, a beautiful painting is valued primarily by its design and colour, as well as the smoothness or finesse of the surface. The ‘paint’ is finally prepared and sprayed onto the surface wall using the tips of an old straw-like brush.

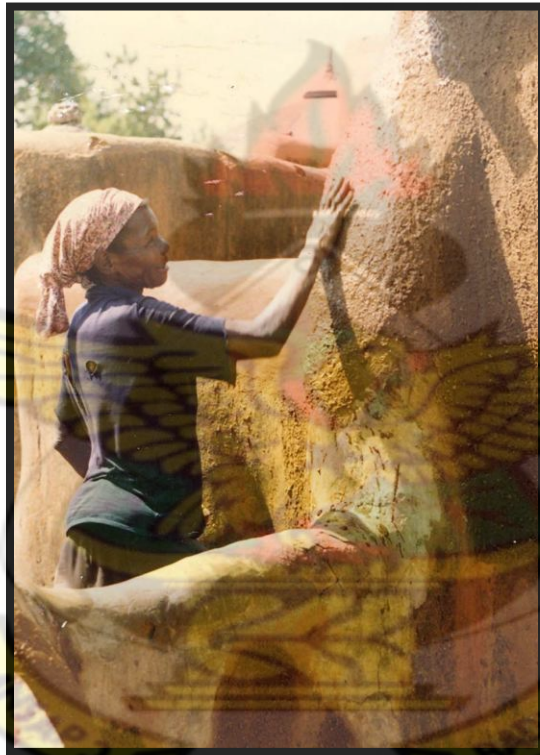


Fig: 36

A woman plastering a wall with her bare hand. Photograph by Michael Nyarkoh, 2002

Painting Process:

The artists begin the painting process starting from the top of the building downwards because of the drippings of the paint. Fig. 37, p.82, shows women painting cattle foot path *Akunyena-nii* motif. The painter starts working a section of the wall, creating one design at a time. She works freehand to produce designs from her imagination.

The black earth – *kugsabla* and white earth pigment -*Kugpela* symbol of power and purity, are applied many times to highlight the black and white designs respectively, when plaster is still wet. Most authors state that earth pigment is red. The researcher, however, found that the *Bomborisi* painters know and use it as red, but in actual fact, *zigmolgo* and *gare* are dark brown and light brown tones respectively. The first white base coat, when applied over wet plaster surface, gives a yellow hue but turns into a nice white colour appearance as it dries in buon fresco effect. Several layers of *kugpela* are applied to assume a bright finish.

When the painting procedure is complete, dry empty *dawadawa* pods are boiled and processed as *bunto* varnish for protection against the weather. When the boiled water cools and the painting is completely dry, the varnish is applied with the ends of an old straw broom which is sprayed or splashed evenly across the surface.

About three base coats are applied dulling the white colours when it is painted unto the wall, establishing a yellow-white finish. When applied well, however, the painting is able to withstand the weather up to three years.

In recent times, painters have introduced coal-tar (bitumen) which is black for plastering the exterior walls of the building which is able to endure the weather for up to five years. The coal-tar technique is slightly different in process. It is added to the fetched sand, water and mixed thoroughly for plastering in the same traditional approach.

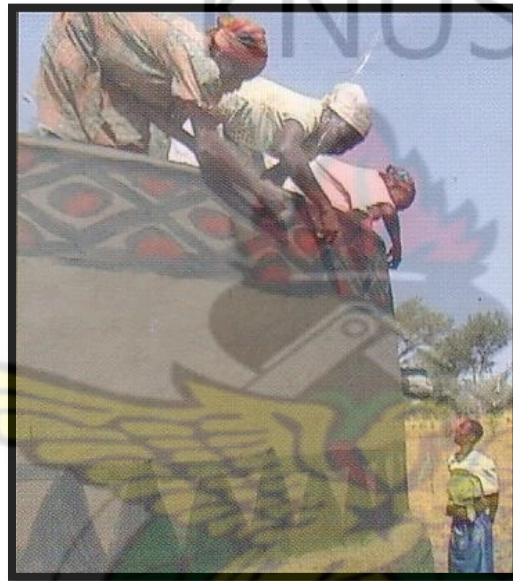


Fig: 37

Sirigu women decorating a traditional wall during communal labour. *Akunyena-nii* motif is at the top and the bottom part has the *wanzagsi* motif. Photograph by Haverkort 2007.

The designs are rendered in contours with highly expressed geometric forms, which reflect the generic life of the women in the community. An image considered as

beautiful is taken from the surroundings and with a play on negative and positive spacing, is given abstract definition. The motif must still be an identifiable image to the woman for merit. Some early designs in the villages have been given several names. Other images have in turn been interpreted through different designs. However, one should be aware that variations do exist as a result of its transformation.

As mentioned before, compositionally, there is commonality in the border designs that tend to be the most consistent among the painters. There are three specific designs that are prominently used in this manner and seldom used on other parts of the building. Two of these designs are usually used along the top of a building. They are called *wanzagsi* and *akunyena-nii*.

The *wanzagsi* design represents the broken calabash using a series of triangles spaced horizontally in a line form. They are depicted both as upright and inverted. *Akunyena-nii* is named after a cattle raider in Burkina Faso. The design was created through the image of the cows entering a pen in a straight line with the other smaller cows pushed on either side. It is represented as a series of diamonds, one placed next to the other. Circles are placed in the centre of each diamond, with half circles placed above and below.

A common lower border design is *amezia-zuvaka* hat or cap. The design itself is a double row of half circles; one placed on top of the other. This image is taken from the traditional woven hats characteristic of the Northern people. Although very simple in form, this image can clearly be seen in the total design.

Divided sections are found across the rest of the building, each designated by a certain motif. *Zaalenga* or calabash net is one of the most popular motifs. A woven calabash net usually hangs in a woman's sleeping quarters which shows her importance and how she is revered in the community. As a highly individualized motif, it is associated with a specific female rendition. It is expressed in many forms, but usually a variation of connected triangles or diamonds.

Another interesting motif commonly used by the women is *apiligyeta*. This image indicates the negative space that exists between the woman's face and the veil as she lifts it over her head. It is shown by connecting vertical and diagonal lines to shape them into triangular forms. Variations exist here as well, sometimes blending with the designs of the *tanne* image.

Tanne is the weave of the local cloth used to make the traditional smocks. *Tanne* is usually represented by either criss-crossed diagonal lines in a visually imperfect image or as *tangolima* or crooked weave. This is shown usually as a series of zig-zagged straight or curved lines.

One of the favourite motifs among the women is *sukuu komakoma*, meaning school children. The image features children standing shoulder to shoulder linking hands with one another. The design drawn from this is a "W" divided by a vertical line through the centre specifically called *agurinuuse* which clearly expresses the unity existing between them.

Yoka (fishnet) is an unusual design found in the dry northern regions. It is said to have originated from the traditional fishing culture. It is depicted in several patterns, most simply as a series of criss-crossed lines. *Agame yoka*, or lying fishnet, is shown as a series of connected inverted triangles.

A wooden ladder is used to access the roofs of many of the compounds. This is called *dongo* and is represented by quarter and full triangles connected into intriguing forms. The designs in contour representing, the *zaalenga* and *dongo* are the same. However, it is the addition of colour that distinguishes the images from each other.

Symbolic Images/Motifs

Relief motifs used are much less abstract. With a high amount of stylization, they give beautiful variation to the images they reflect. Most of these images are zoomorphic (animal forms). The python, or *waafo*, is an animal often depicted in coiled form and stretched out lengthways across the painting surface. This image is rarely individualized.

Two other popular motifs are the crocodile-*Eebga*, and the mythical two headed crocodile that exist in the Paga pond. It has a long cylindrical body with the arms and legs folded in “V” shapes.

The ever-present cow is the *akunyena-nii* motif represented either as flat back or hump-back. Cowry shells are frequently used as eyes for the animals.

The “Bishop’s staff” with cross has replaced the traditional walking stick *dogolongo* motif. The Bishop’s staff reflects God’s presence in the household. The

walking stick can still be seen as a symbol of respect and authority. This example is exhibited in most of the art works of the women of Sirigu.

These are some of the designed motifs used to represent the visual images seen and loved by the women artists. From what they see as beautiful and important, transformed imagery of unique forms and colour scheme has evolved. The designs themselves are highly geometric, a clear representation of image reserved for the relief forms in traditional Sirigu architecture and pottery.

Akanvole Agombire – the famous female wall painter of Sirigu.

In Sirigu, ninety five year old Akanvole Agombire, is shown making a basketry production fig.38, p.89. She is the leading active traditional wall painter. As the oldest survivor, she led a pioneering group of seven women painters to actively be engaged with *Bomborisi*. They were Adumpoka, Atigisama, Aloobase, Akansaah, Asokiwine and Abisika. She has passed on the *Bomborisi* culture to her daughters, Ayampoka Kayora, Tampugre Agombire, Atuliya Aniah, and many other women in her community.

As an active member and leader of SWOPA, she has participated in every commissioned wall decorating projects executed by the Sirigu women association in Ghana and beyond and through this she has contributed a lot to expand the frontiers of traditional painting and craft by women. She was instrumental for the mural paintings at the Golden Tulip Hotel in Accra and Tiedar Hotel in Bolgatanga.

She was a member of the team that first decorated the walls inside the Navrongo Catholic Cathedral. She has participated in many other local and international exhibitions

by SWOPA. She produces other craft such as straw and clay products alongside canvas painting. According to her, the cowries attached to the relief painted animal are believed to enable the eyes to see and overcome evil happenings around. She also interprets this traditional myth of the cowries as a form of protection by the animal concerned believed to provide maximum protection to the household. With age and time she has vigorously pursued the painting tradition. Today she still assumes the leadership role in SWOPA. Refer to fig. 38-39, pp.87-88.

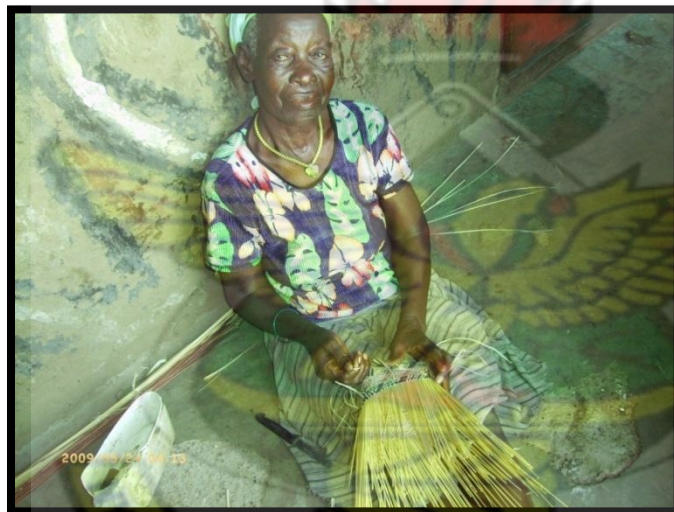


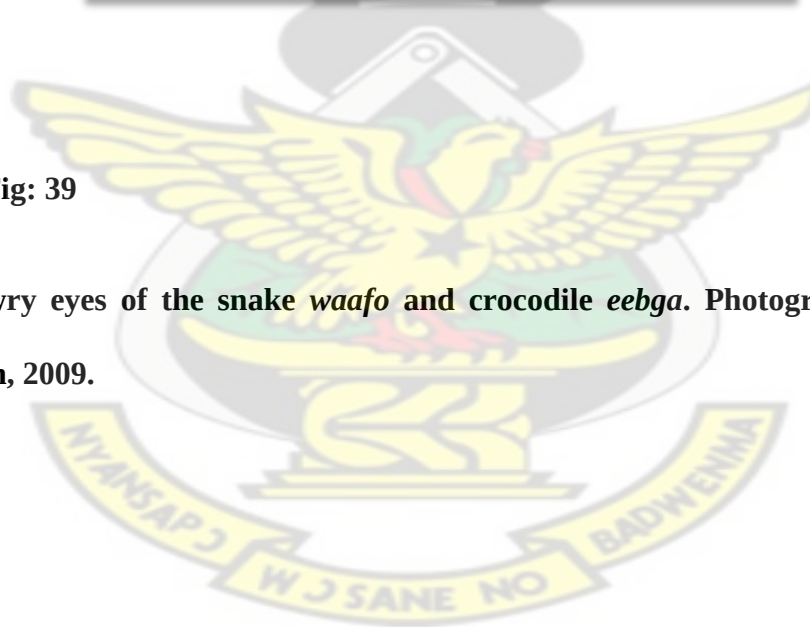
Fig: 38

Sirigu woman, Akanvole, making straw basket. Photograph by Michael Nyarkoh, 2009.



Fig: 39

The cowry eyes of the snake *waafo* and crocodile *eebga*. Photograph by Michael Nyarkoh, 2009.



Pictorial Transformations Observed at Sirigu, Navrongo, Bolgatanga and Accra.

Recent Developments in the Sirigu Art, (S.W.O.P.A):

Recent developments in Sirigu include the Organization of a Craftswomen Association, Sirigu Women's Organization for Pottery and Art (S.W.O.P.A.). It is part of a community based ecotourism project at Sirigu in the Kasenna Nankani District. S.W.O.P.A. is the brainchild of Melanie Akasiise (the founder). See fig.44, p.94. The European Union (E.U.), Government of Ghana (G.O.G.) through (The Ministry of Trade and Industry) and A.T.A.G. (Aid to Artisan in Ghana) a non- governmental organization contributed to put up an art centre for S.W.O.P.A. in Sirigu. Fig.40, p.90, shows mural paintings at the entrance of the S.W.O.P.A. Centre depicting cattle path-*akunyena-nii*, broken calabash-*wanzagsi*, halved calabash-*wanne*, chicken-*niila*, crocodile-*eebga* motifs and some figurines. Figs. 41-42 pp.91-92, depict pieces of broken calabash-*wanzagsi*, school children holding hands-*sukuu komakoma* motifs on the external and seating wall of the workshop respectively. Figs. 43-44, pp.93-94, displays the cattle path-*akunyena-nii* motif at the top, broken calabash-*wanzagsi* and school children holding hands-*sukuu komakoma* or *agurinuuse* motifs at the centre and hat- *Amezia Zuvaka* motif located at the base of the gallery and guest house buildings at the centre respectively. The association is financially supported by agencies like the Danish Government Fund, A.T.A.G. and I.C.C.O. (Daily Graphic Saturday, August 2, 2008). The association has transformed itself and most importantly helped the women by arousing their interest in competitive traditional industry. See figs. 46-52, pp. 96-102.



Fig: 40

Entrance of the Women Centre at Sirigu is painted with *Akunyena-nii*, *Agurinuuse*, *Zaalenga* and figurine motifs. Photograph by Michael Nyarkoh, 2009.



Fig: 41

Workshop shed, painted with *Agurinuuse* and *Wanzagsi* motifs. Photograph by Michael Nyarkoh, 2009.

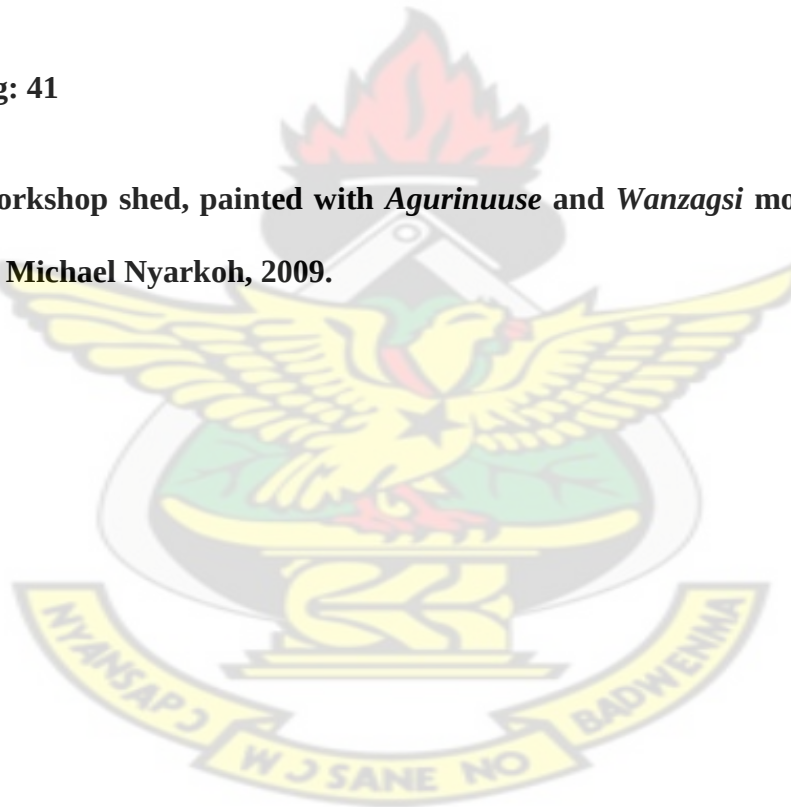




Fig: 42

Seating area of the shed *Agurinuuse* and *Wanzagsi* motifs. Photograph by Michael Nyarkoh, 2009.

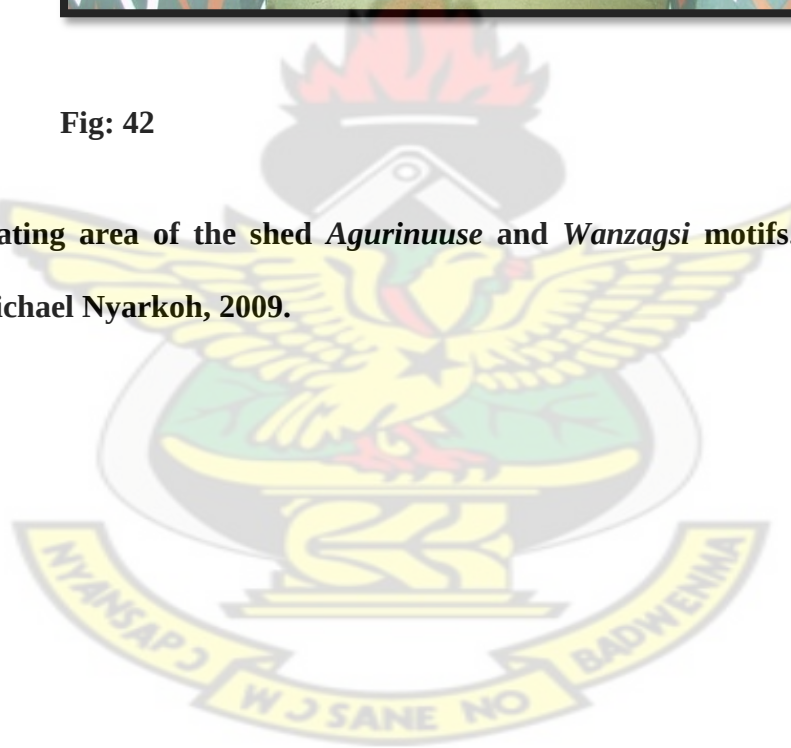




Fig: 43

Painted building at the women centre painted with Akunyena-nii, *Agurinuuse Amezia Zuvaka* and *Zaalega* motifs.

Photograph by Michael Nyarkoh, 2009.

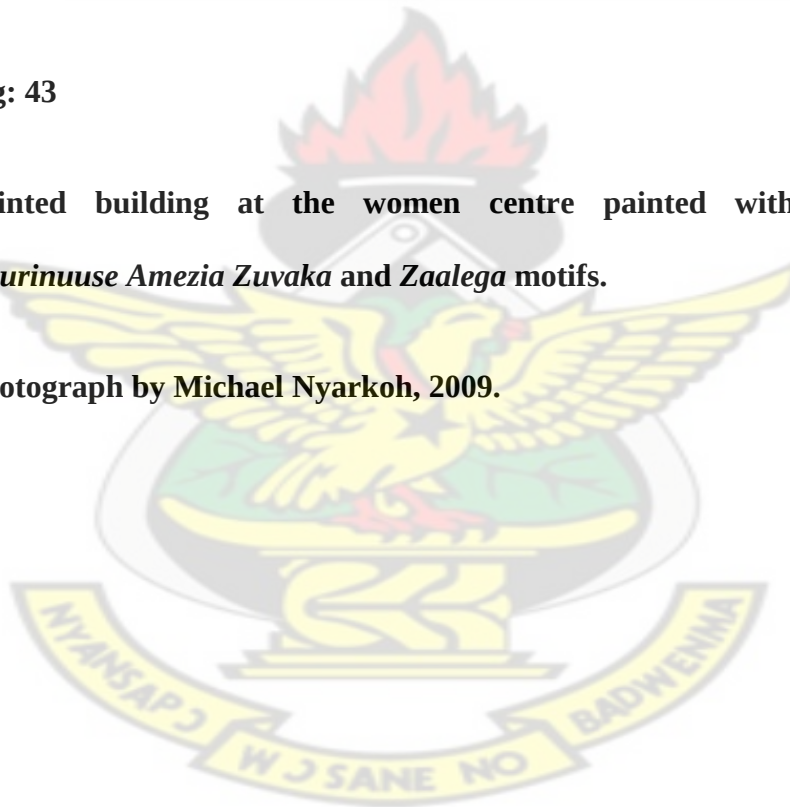




Fig: 44

**One of the guest houses at the women centre *Akunyena-nii*,
Agurinuuse, Amezia Zuvaka and *Wanzagsi* motif.**

Photograph by Michael Nyarkoh, 2009.

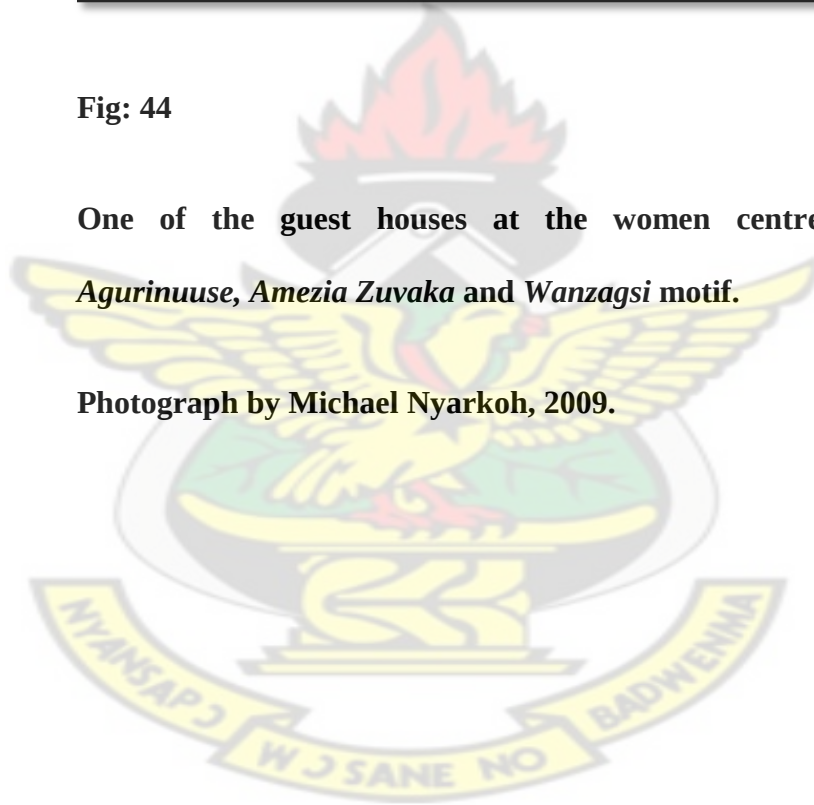




Fig: 45

Mme Melanie Akasiise founder of S.W.O.P.A., copy by Haverkort, 2007.



a.b.

Pots decorated with *Zaalenga* and *Tanne* motifs



c.

d.

Fig: 46

Assorted ceramic wares from Sirigu at the S.W.O.P.A. shop. Photograph by Michael Nyarkoh, 2009.



a. *Agurinuuse* designed baskets



- b. **Wangzasi designed basket**

Fig: 47

Baskets made by S.W.O.P.A. Photograph by Michael Nyarkoh, 2007.

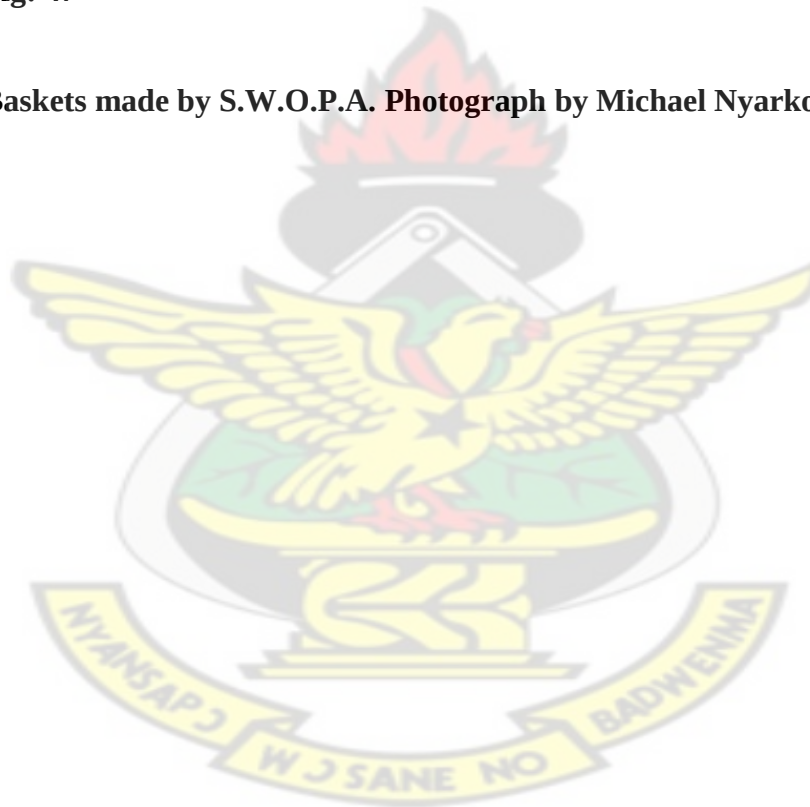




Fig: 48

A monument in honour of Mr. Kofi Annan former UN General Secretary located at the SWOPA centre. It is painted with *Akunyena-nii, Zaalenga, Amezia Zuvaka* and *Wanzagsi* motif. Photograph by Michael Nyarkoh, 2009.



Fig: 49

Two of the paintings, acrylic on canvas, used in the “Wall to Wall” exhibition in 2007 and 2008 in Europe. They have been painted with *ziifo* (fish), *naafo* (cattle), (*waafu*) python and *weefu* (horse) motifs. It also have *Zaalenga*, *Wanzagsi*, *Agurinuuse*, *Tanne* and *Amezia Zuvaka* motifs, copy by Haverkort, 2007.



a.



b.



c.

Fig: 50

S.W.O.P.A. *Bomborisi* acrylic on canvas, paintings with *ziifo* (fish) and *Eebga* crocodile motifs. It also has *Zaalenga*, *Wanzagsi*, *Agurinuuse*, *Tanne*, *Yoka* and *Amezia Zuvaka* motifs. Photograph by Michael Nyarkoh 2009.



a. Fishes *ziifo* is a composition of transformed *Akunyena-nii*, *Yoka*, *Zaalenga* and *Agurinuuse* motifs.



Fig: 51

b. "Fighting in unity" is acrylic on canvas painting with *Naafu* (cow) and *Eebga* (crocodile) motifs. They also have *Zaalenga*, *Wanzagsi*, *Agurinuuse*, and *Amezia Zuvaka*, motifs. Photograph by Michael Nyarkoh 2009.



Fig: 52a

Sirigu women busily painting on canvas, copy by Haverkort 2007.



Fig: 52b

Faces of some of the S.W.O.P.A. members, copy by Haverkort, 2007.

Recent Developments in Building Structures

The wall painting tradition at Sirigu is faced with grave problems and challenges therefore innovation is very vital for the sustenance of this important art heritage. Permanent settlements are now built with concrete materials in and around the Kassena Nankana District including Sirigu. There is much evidence of transformation in the architectural landscape today as many of the round houses have gradually given way to rectangular cement block structures with corrugated iron sheet roofs. Figure 54, p.104 shows recently constructed cement structure decorated with Sirigu motifs. Figure 53, p.104 shows the undecorated earthen wall and fig. 56, p.106 shows a combination of rectangular and round concrete structure recently built near Sirigu.

The area is continually faced with flooding that destroys the earthen wall homes. Recent floods particularly in 2008 destroyed most earthen built homes. Introduction of electricity and its associated comfort may have influenced the change from thatched roof to iron sheets structures. It is also known that thatched straw roof is often eaten by termites and does not last long enough. Figure 55, p.105 has both cement and earthen wall decorated with totemic relief features.



Fig: 53

A typical Sirigu traditional settlement home, made of earth with corrugated iron roofs. Photograph by Michael Nyarkoh, 2009.



Fig: 54

Rectangular concrete structure with corrugated roofing sheets, in Sirigu, the walls are decorated by Elias, Ferreol Aburipoore and Asampana Ayandoor (all male) with *Tanne* and *Zaalenga* motifs. Photograph by Michael Nyarkoh 2009.



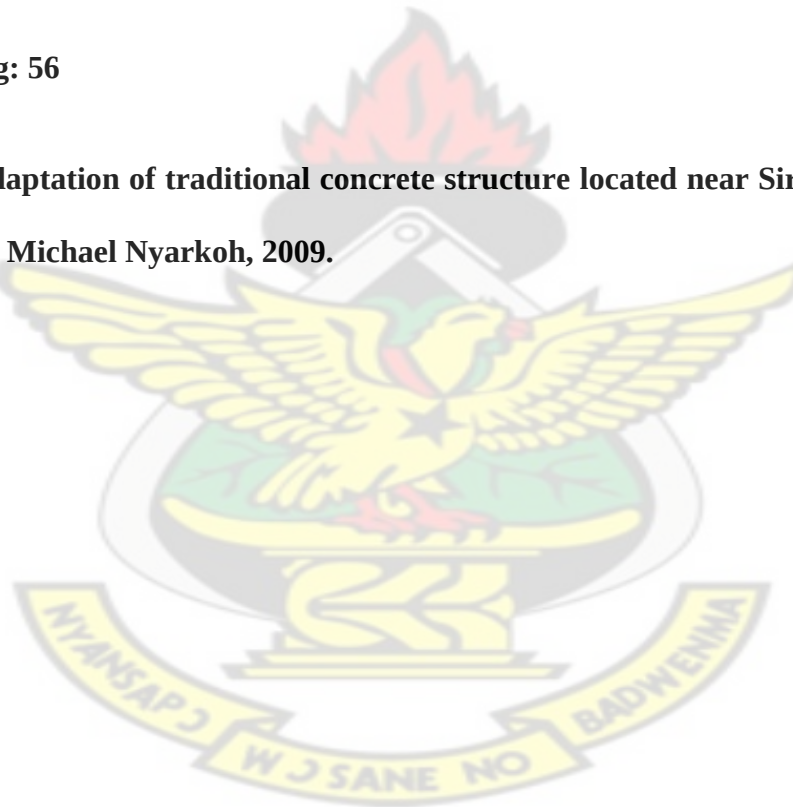
Fig: 55

Internal wall area and staircase with circular and iron rectangular roofs in Sirigu, aspects of these designs were rendered by Elias and Ferreol Aburipoore and all males with *Naafo*(cow) and *Waafo* (snake), featuring *Zaalenga*, *Wanzagsi Akunyena-nii* relief motifs. Photograph by Michael Nyarkoh 2009.



Fig: 56

Adaptation of traditional concrete structure located near Sirigu. Photograph by Michael Nyarkoh, 2009.



Navrongo Cathedral: Our Lady of Seven Sorrows

The Cathedral was the first chapel to be built in Northern Ghana. The first missionary workers were Oscar Marie, Jean Marie and Eugene Gar. They arrived in 1906 and constructed the first three traditional round shelters in Ghana in 1907 as a place of worship. Only one still remains today in Navrongo see fig.57, p.108. The two others have collapsed as a result of excessive flooding. The main cathedral was built from 1920-1928 using traditional earthen materials. The interior decorations were initiated by Rev. Father Paul Kizito Aveyere. The interior decorations were painted by traditional women painters from Sirigu in 1973 according to the church's history as it was told by the assistant curator, Miss. Ayera, to the researcher.

The lower parts of the walls were painted using domestic animal motifs. They include sheep, cattle, goats, birds, snakes and crocodiles. On the pillars, images represented are fruits, millet, other vegetation, a Bishop's staff, Christ, Angels guarding people into the cathedral, the hat of the Bishop, a priest giving communion and a statue Mary, mother of Jesus with the seven sorrows (in the form of seven swords piercing her heart). Refer to fig. 58 p.109. The symbols on the pillars were also executed by the Sirigu women. Colours used are brown *dawadawa* concentrate extract, black earth and white kaolin. In recent renovations acrylic and enamel white and black paints have been used in the painting. Some of the triangular designs have also been incised by texturing.

In recent times, male painters mostly the children of Akanvole, were employed to paint over some of the triangular pillar designs in the church. The most recent paintings were done during the Centenary celebration of the church in 2006. See figs. 58 - 62, pp.109-113.



Fig:57

The only surviving earthen Cathedral built in 1907 at Navrongo. Photograph by Michael Nyarkoh, 2009.

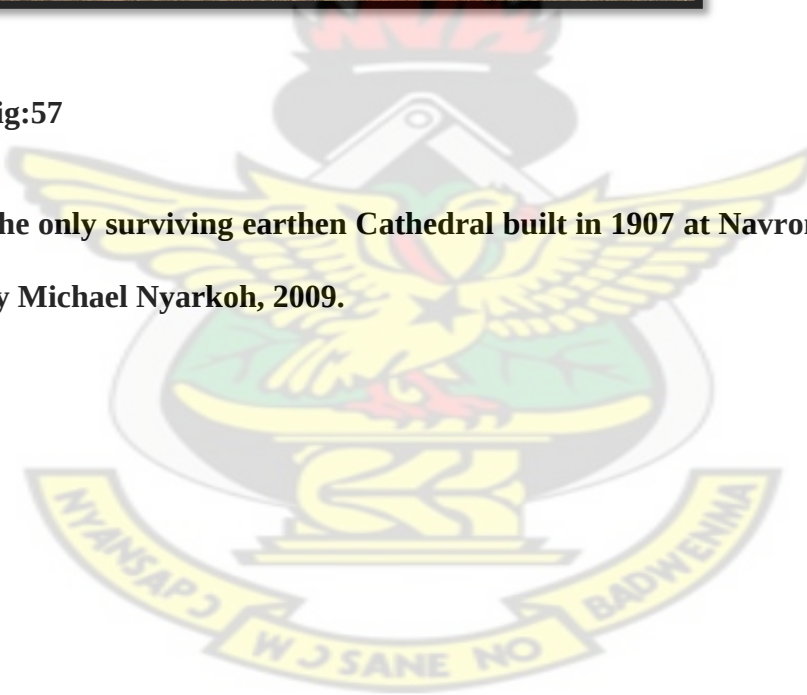




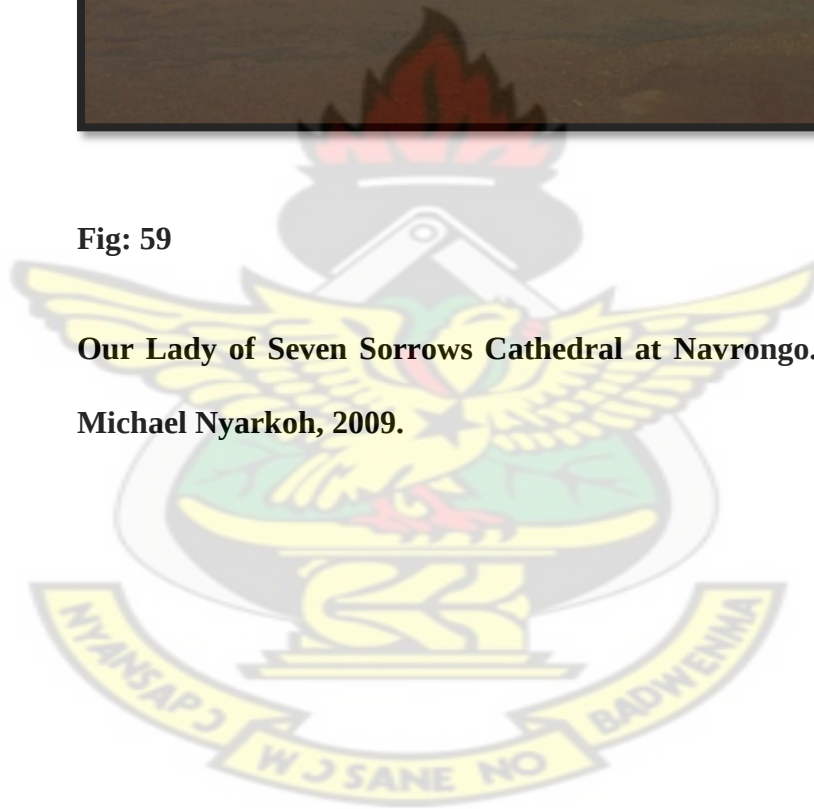
Fig: 58

The concrete statue with seven sorrows of Mary symbolized in the form of seven sets of swords piercing the heart in the Cathedral at Navrongo. It has been embellished with enamel paint. Photograph by Michael Nyarkoh, 2009.



Fig: 59

Our Lady of Seven Sorrows Cathedral at Navrongo. Photograph by Michael Nyarkoh, 2009.





a. Fruit

b. Bishop's cap

c. Pounding millet



d. Bishop's staff

e. Wangzasi

f. Guarding Angel

Fig: 60

The designed pillars featuring *Bomborisi* motifs using enamel, acrylic and earth pigments at the Cathedral in Navrongo. Photograph by Michael Nyarkoh, 2009.



a. Wangzasi and Tanne motif



b.

Relief Crocodile-eebga and Snake-waafo motifs

Fig: 61

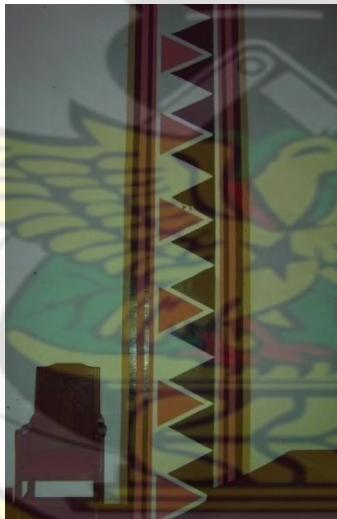
The designed pillars with incised *Bomborisi* motifs features *Agurinuuse*, *yoka* and *zaalenga*, using natural earth pigment at the Cathedral in Navrongo. Photograph by Michael Nyarkoh, 2009.



a. Speaker case



b. Triangular strips inside the Cathedral



c. Detail of the triangular strip design

Fig: 62

Triangular simulations of *Wanzagsi* and *Zaalenga* motif inside the Cathedral at Navrongo. Photograph by Michael Nyarkoh, 2009.

BOLGATANGA

TEIDAR RESTAURANT:

In 2005, S.W.O.P.A. was commissioned to paint the walls of Tiedar Restaurant in Bolgatanga, the administrative capital of the Upper East Region. The medium used for the wall painting was acrylic and enamel. *Bomborisi zaalenga* and *wangzasi* (pieces of broken calabash), *zuvaka* (round hut) and *agurinuusi* (school children holding hands) motifs are represented on the cement painted walls as depicted in figs. 63-66, pp.114-116.

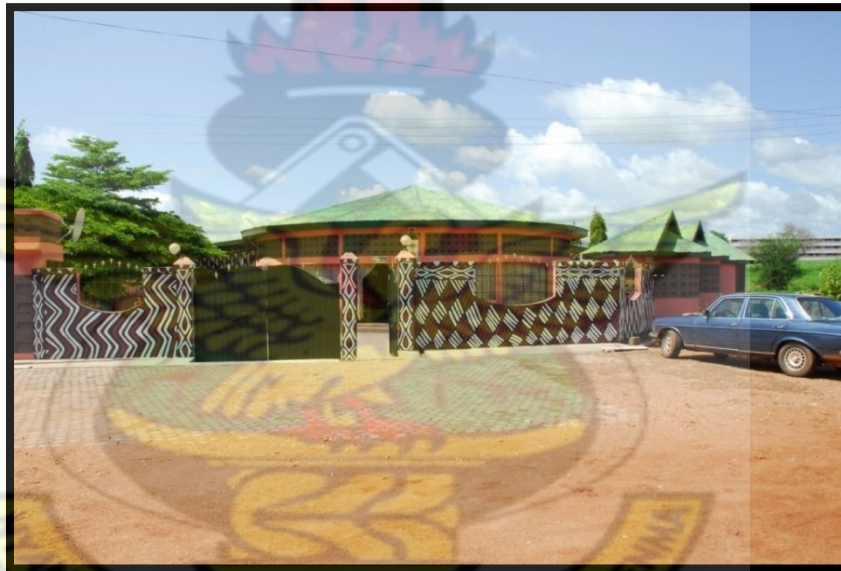


Fig: 63

Entrance of the Tiedar Restaurant at Bolgatanga featuring *Zaalenga*, *Wanzagsi Akunyena-nii* and *Tanne* motifs, copy, courtesy Carol Ventura, 2008.



Fig: 64

Bomborisi Akunyena-nii, Zaalenga and Wanzagsi motifs painted at the bar, copy, courtesy Carol Ventura, 2008.



Fig. 65

Zaalenga and Zuvaka paintings inside the chalets at Tiedar Restaurant, copy, courtesy of Carol Ventura, 2008.



Fig. 66

Outside wall painted with *Zaalenga* motif, copy, courtesy of Carol Ventura, 2008.

GOLDEN TULIP RESTAURANT, ACCRA

The Sirigu women artists (S.W.O.P.A.) were commissioned to produce *Bomborisi* designs on the restaurant walls of the Golden Tulip Hotel, Accra in 2003. The researcher visited Golden Tulip Hotel in Accra to observe and photograph the *Bomborisi* on the walls of the open air restaurant painted by the Sirigu women painters in 2008. Refer to figs. 67-70, pp.117-120.



Fig: 67

Bomborisi featuring *Agurinuuse* and *Akunyena-nii* among other motifs are found inside the outdoor restaurant at Golden Tulip Hotel in Accra. Photograph by Michael Nyarkoh 2009.



Fig: 68

Detail of *Eebga* (crocodile) motif with *Agurinuuse Akunyena-nii* and *Zuvaka* motifs are painted on the external walls at the Golden Tulip Hotel restaurant in Accra. Photograph by Michael Nyarkoh 2009.

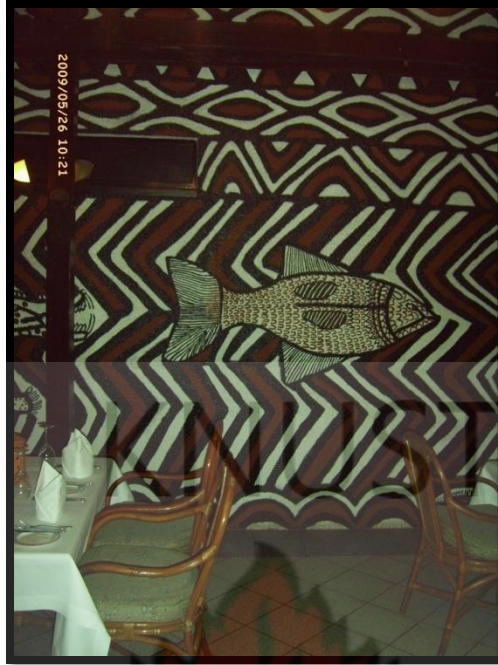


Fig: 69

Ziifo (fish) motif with Tanne, Wanzagsi, Agurinuuse, Akunyena-nii and Amezia Zuvaka motifs is featured on the external walls at the Golden Tulip Hotel restaurant in Accra. Photograph by Michael Nyarkoh, 2009.

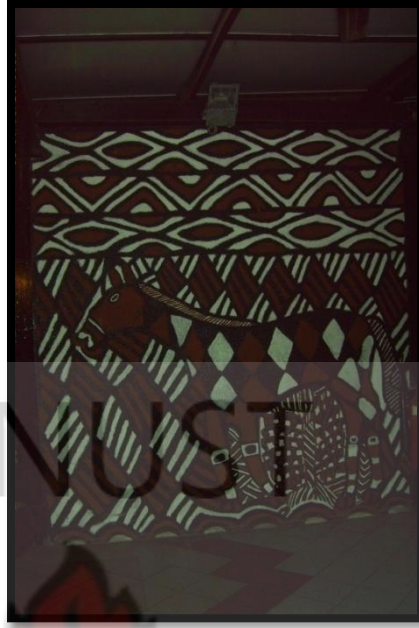


Fig: 70

Weefo (horse) motif features, Tanne, Zaalenga, Wanzagsi, Agurinuuse, Akunyena-nii and Amezia Zuvaka motifs decorated on the external walls at the Golden Tulip Hotel restaurant in Accra, photograph by Michael Nyarkoh 2009.

Role and Contribution by (SIBA) Men Artists in Sirigu

In the past, men were not allowed by tradition to be directly involved in *Bomborisi*. Men constructed the homes and walls over which the women painted. A cursory survey indicates that men in recent times have directly been involved in *Bomborisi*. Elias Agombire Aburipoori and Asampana Ayandoor, the children of Akanvole, were first introduced to *Bomborisi* in the early 1970s. In 2003, Sirigu Builders Association (S.I.B.A.) with men as members was formed. Today many other young men currently participate in the wall decoration using contemporary painting materials and techniques as in fig. 54-55, p.104-105.

The rendition of motifs on the walls and their meanings in Sirigu and the general procedure for making *Bomborisi* the transposition of the motifs on other crafts and the transformation within and beyond Sirigu are discussed in Chapter Three.

The photographs of *Bomborisi* motifs and their transformations through simulations in fractal characteristics in the form of experimentations were made analyzed and discussed in Chapter Four.

CHAPTER FOUR

EXPLORATION INTO *BOMBORISI* FRACTAL PAINTING

Introduction

Sirigu wall painting motifs and colour schemes from the village settings were manipulated in a number of academic studio art experiments by applying conventional painting techniques manually as shown in plates 1-18, respectively.

Further *Bomborisi* transformations were effected digitally by using fractal art techniques as shown in plates 19-22. They are represented and categorised in this chapter as:

Experimental Paintings 1-5 were the first set of five paintings done manually by using poster colour on cardboard to effect fractal geometric transformations as represented in plates 1- 5.

Experimental Fractal Painting 1-5 were the second set of five experimental paintings done manually by using poster colour on cardboard to effect transformations as represented in plates 6-10,

Fractal Painting 1-8 were the third set of eight categories of advanced experimentations that converted *Bomborisi* geometric designs into fractal compositions manually using acrylic on plywood to effect fractal transformations as shown in plates 11-18, respectively.

Fractal Paintings 1-10 which show computer generated images using *Fractint* Application run on C++ Software constituted the fourth set of ten experimental fractal geometric works that effected transformations are represented in plates 19- 38.

Bomborisi Fractal Transformations 1-10 is the fifth set of computer-generated fractal experiments in plates 29-38, respectively. They were created using Adobe Photoshop 7.0 Application software. The designed fractals show combinations of selected manual and digital experimentations found in the previous second, third and fourth sets respectively. They are intended to portray and represent digital transformation of the *Bomborisi* fractals in the author's new kind of fractal technique.

The experiments in the studio setting covered five different sets of transformations as presented below:

First Set of Fractal Paintings: Five Experiments

The first set of five (5) experimental paintings was done manually with poster colour on cardboard to effect the transformations represented in plates 1-5 respectively.

Analysis of the first set of five (5) experimental paintings is as follows:

Experimental Painting 1:

Researcher: Michael Nyarkoh

Plate 1: *The Crocodile Bond*

Size: 51cm X 38cm

Medium: Poster on Cardboard

The Crocodile Bond in plate 1, p.127 is the first transformed painting by the researcher using poster colour on cardboard. It is a representation of the crocodile motif with similar rendition as the crocodile-*eebga* symbol used in *Bomborisi* and represented in fig. 61, p.112 as found inside the Catholic Cathedral at Navrongo.

It is a crocodile-*eebga* motif with the mouth open and placed over four different motifs located in the middle section of the composition. The composition also has a pinkish red sun located in the top left corner of the painting.

The motifs were done in horizontal stripes across the lower half section of the composition. The first motif is *zaalenga* (halved calabash for storing water and grain). A plain lemon coloured strip is placed under the first motif, after this is *sukuu komakoma/agurinuuse* (school children holding hands) motif which is represented here as a zigzag.

The fourth motif is a *lungae* (hourly). Thick black lines were made to join the motifs together. These patterns form the background of the painting. The striking design of the crocodile stretches over the four geometric motifs. The crocodile, together with the

first and the last motifs, were painted with brown, black and white. The third motif of the *sukuu komakoma* is in black.

The concentration of brown is found in the upper and lower jaws of the *eebga* crocodile stretching through the trunk to the legs. However, its mid-section from the opened mouth is composed of two separate zigzag and broken pieces of calabash motifs. The upper black and white zigzags lie between the *wangzasi* (broken pieces of calabash) motifs. This *wangzasi* design has the heads of the *sukuu komakoma* motif. The crocodile's tail is surrounded by designs from the *bonkeka zuvaka* (round huts). They were painted in brown, black and white tones. Between the rounded brown and white larger *zuvaka* motif is the thin black line separating them.

The *sukuu komakoma* design runs through the crocodile to express harmony. The mid-section of the crocodile's tail has some of the above motifs appearing in a continuous transparent manner.

The right leg stretches to cover the second *zaalenga* (broken calabash) motif in the white area. The lower feet also fall directly into the *dondo* motif through the lower area of *sukuu komakoma* motif. The tail, however, stretches through the lemon, black and white tones of *sukuu komakoma* and across the *lungae* (hourly) motif.

Below the tail end is the unpainted white area of the composition. The different motifs are separated by black lines. These act as dividing borders for the different motifs. The *dondo* zigzag designs of black, brown and white triangles were combined with either the white and black or white and brown colours to provide harmony and contrast. The

feet of the crocodile has suggested claws painted in black colour almost covering the entire feet. The teeth are indicated as black zigzag forms. The tail, however, is rounded and bulky, giving balance to the sun at the top left area of the crocodile.

The crocodile in the painting symbolizes the protection of the people of northern Ghana. This icon has been created with fierce open jaws, extended claws and bare teeth as if to devour its prey. In the painting, the fusion of the crocodile-*eebga* and the background motifs reinforces the spiritual protective nature of the crocodile.

The reddish sun and lemon stripe represent support for life. The *agurinuuse* stripe dominated by white and partially under the crocodile represents the pond in which the crocodile resides and the hourly-*lungae* (*dondo* local drum) striped (dominated by brown at the lower part of the painting) represents the bare land on one side of the pool. The green stripe in the middle indicates grassy land with the broken calabash-*wangzasi* striped bordering it at the top representing bare land area on the other side of the pool. The bare white area represents the sky with the circular reddish circle representing the sun.

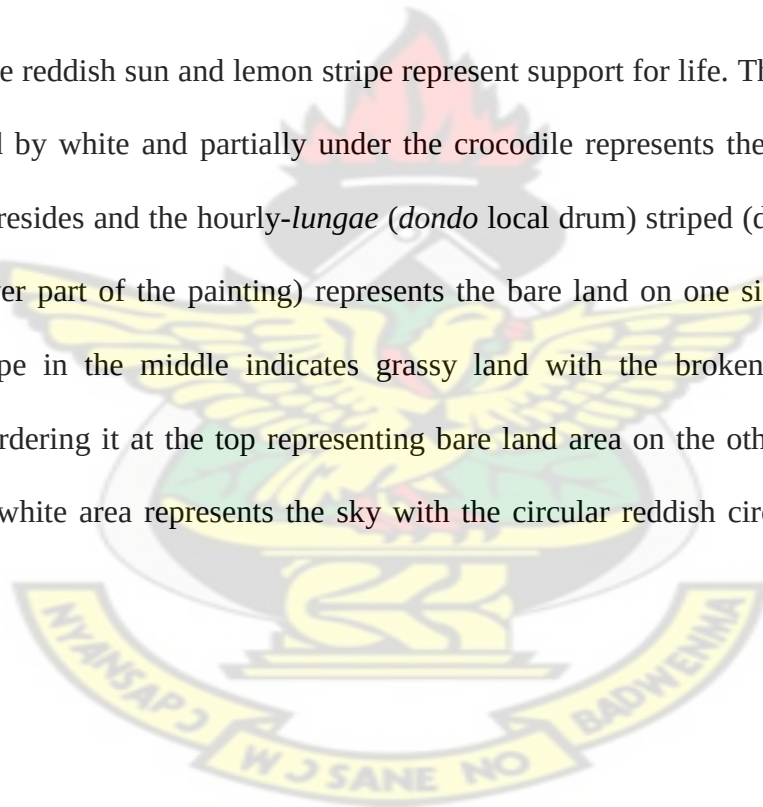




Plate 1

The Crocodile Bond: Size: 51cm X 38cm, Medium: Poster on Cardboard by Michael Nyarkoh, 2009.

Researcher: Michael Nyarkoh

Plate 2: *Pisko Wangzasi*

Size: 51cm X 38cm

Medium: Poster on Cardboard

Pisko Wangzasi in plate 2, p.130 is a totemic representation of a domestic animal usually a goat or a sheep. The outline of the animal was filled in with four different motifs which merge into the background of multiple designs that include *zaalenga*, *akunyena-nii*, *wangzasi* and *zuvaka*. The legs of the animal extend into a plain white foreground.

The calabash net-*zaalenga* motif (which has net-like features) dominates the painting. This motif stretches from the topmost area through the left and central portion of the composition. The middle section has broken calabash-*wanzagsi* motif placed towards the far upper right side below the *zaalenga* motif. The extension of the *zaalenga* motif is followed by similar but smaller ones. The last motif in the composition is the curvilinear snake-*waafu*, in motion. It stretches from the left to the right area in black, brown and white coloured strips.

The feet or legs of the domestic animal have evolved into stele. The main body area was done using four smaller motifs. The topmost motif is the broken calabash and the middle motif is the round hut-*bonkeka* *zuvaka* in broad white and brown colours. This serves as the abode for all the prominent known motifs in *Bomborisi*. Below this is cattle

path-*Akunyena-nii*, followed by smaller *wanzagsi* motifs. The tail is painted in black. The head is abstracted and located in between the upper area of the forelegs.

The totemic rendition of the domestic animal is an innovation of traditional Sirigu painting. The plain foreground in the composition reflects long draughts and bare ground cover around the totemic goat. This totemic painting represents the self-similarity of *Bomborisi*. It reflects a single Sirigu family producing the same stock, bearing the identical genes lying in infinite and unpredictable chaos.





Plate 2

Pisko Wangzasi: Size: 51cm X 38cm, Medium:

Poster on Cardboard by Michael Nyarkoh, 2009.

Experimental Painting 3

Researcher: Michael Nyarkoh

Plate 3: *Sierpinski Eebga*

Size: 51cm X 38cm

Medium: Poster on Cardboard

Sierpinski Eebga in plate 3, p.133 features an abstracted crocodile-*eebga* motif on a white background. The painting reveals the back view with the head towards the upper area of the composition. It has a stripe of abstracted cattle path-*akunyena-nii* across the midsection of the composition, through the crocodile. The backside of the crocodile has six strips of assorted motifs. These motifs begin from the forelegs and shoulder area to the hind section.

Three Sierpinski's gaskets were placed one over the *akunyena-nii* motif and two below. These motifs are adaptations of fractal translated effects. The feet of the crocodile were rendered in black and white outline. Each of the claws has been abstracted into short upright poles. The head has a sharp protruding V-shaped black mouth painted with the brown eyes.

The motifs in the painting include broken pieces of calabash-*wangzasi*, calabash net-*zaalenga*, round huts *zuvaka*, curved movement, hourly, *lungae* and halved calabash-*wanne* for carrying grain or water. Variation is created by including the triangular Sierpinski's gaskets. The back of the crocodile-*eebga*, which has the rectangular shape, is filled in with *Bomborisi* motifs.

The tail, in outline, restores harmony with the fore limbs of the crocodile. In “Sierpinski *Eebga*”, Sierpinski’s gaskets were combined to create a new kind of crocodile motif by the researcher. The three Sierpinski gaskets are ignited to seemingly propel the crocodile to fly like a butterfly.

Sierpinski’s Bomborisi is based on similar characteristics as the fractal simulated design found in steps a-d in fig. 8, pp.27-28. The simulated black and white rendered triangles found here are represented to its fourth iterations. They depict fractal iterated version of three triangles and the *Sierpinski’s Eye* in plate 20, p.182 however is an advanced fractal representation of the similar abstracted computer generated image based on the *Sierpinski’s Gasket*.





Plate 3

Sierpinski Eebga, Size: 51cm X 38cm, Medium:

Poster on Cardboard by Michael Nyarkoh, 2009.

Experimental Painting 4

Researcher: Michael Nyarkoh

Plate 4: *Wise Staff*

Size: 51cm X 38cm

Medium: Poster on Cardboard

WiseStaff in plate 4, p.136 is based on five motifs: *wanne*, *zaalenga*, *wangzasi*, *zuvaka* and the Bishop's or (old-man's staff). The staffs are located on the left and right. The uppermost motif border has been rendered with fish net-*yoka* in black and brown.

Two old man's staffs frame the left and right sides, creating balance within the composition. Various motifs are arranged along the black and white serpentine lines and three horizontal lines. The motifs from the top to the bottom are abstracted broken calabash-*wangzasi*, calabash net-*zaalenga*, strips-*tana*, hat-*Amezia-zuvaka* and halved calabash-*wanne*.

The prominent brown, black and white coloured shapes show balance and harmony within the bounds of the old man's staffs. Placed in bands across in variegated form, the motifs enter the white curvilinear and horizontal lines together with the staffs to form a shelf-like structure.

The painting emphasizes the prominent old-man's staff-*dogolongo* motifs in *Bomborisi*. This motif represents old age, a sign of wisdom and knowledge. Old-age is inherent in the staffs and the motifs evoke wisdom.

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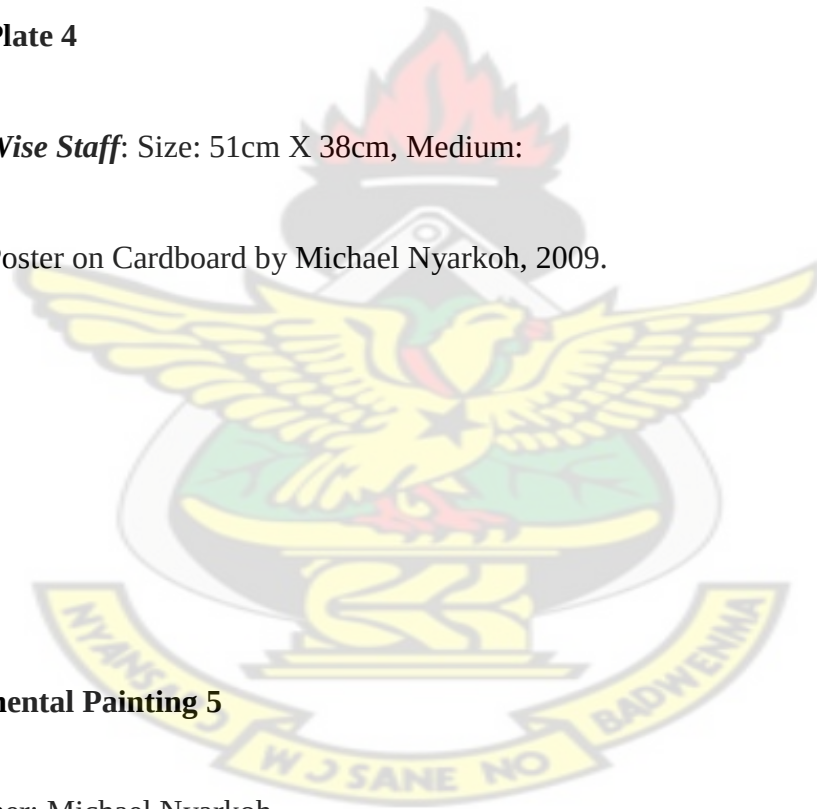


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Plate 4

Wise Staff: Size: 51cm X 38cm, Medium:

Poster on Cardboard by Michael Nyarkoh, 2009.



Experimental Painting 5

Researcher: Michael Nyarkoh

Plate 5: *Weefo Chaos*

Size: 51cm X 38cm

Medium: Poster on Cardboard

Weefo Chaos in plate 5, p.139 is an abstracted horse with an elongated neck. Located facing left, it is a combination of round huts-*bonkeka-zuvaka* and halved calabash-*wanne* motifs which have been used as patterns to fill the outline of the horse.

The middle part of the horse-*weefo* has abstracted Koch curve characteristics that start from the saddle and continues at the hind hip to the tail section. The neck begins with a series of black, brown and white tones in succession. It is followed by dark colour extending to the torso.

The belly, however, has intricate motifs of round hut-*zuvaka*, halved calabash-*wanne* and cattle path-*akunyena-nii*. The midsection of the horse in shape reveals broken calabash in curvilinear form and fishnet-*yoka* motif. A white stripe divides the last halved calabash-*wanne* motif. The two left feet represent the brown and black hourly-*lungae* motif. Attached to the right legs are decorations of calabash net-*zaalenga* motifs for the left limbs.

The entire composition is rendered in brown, black and white, which reflects new *Bomborisi* technique. The head and tail, with predicted chaotic fractal elements is created along the diagonal extensions of calabash net *zaalenga* and round hut-*zuvaka* loops across the stomach area give asymmetric balance to the horse-*weefo*. The closeness of the designs makes the horse-*weefo* compact and solid, contrasting the fluid strips of inclined broken calabash and round hut motifs. Life is difficult but it takes the swift horse-*weefo* to perfect a chaotic start to achieve confident ending. It is an abstracted representation of the horse-*weefo* symbol used in *Bomborisi*. The *Pisko Wangzasi* in plate 2 shows an abstract painting of similar totemic representation found in *Bomborisi*. It is rendered like

the image found in fig.70, p.120 which has been executed in enamel paint on concrete walls at the Golden Tulip Hotel in Accra.

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Plate 5

Weefo Chaos: Size: 51cm X 38cm, Medium:

Poster on Cardboard by Michael Nyarkoh, 2009.

Second Set of Fractal Paintings: Five Experiments

The second set of five (5) experimental paintings of fractal geometric forms were done manually with poster colour on cardboard to effect transformations. They are in plates 6-10, respectively. Analysis of the experimental paintings of the second set is as follows:

Experimental Fractal Painting 1

Researcher: Michael Nyarkoh

Plate 6: *Shadows of the Midnight Ray*

Size: 51cm X 21cm

Medium: Poster on Cardboard

Shadows of the Midnight Ray in plate 6, p.142 features three crescent designs over triangular pointer depicted in reducing fractal scale. *Bomborisi* motifs were used for the recursive fractal geometric form.

The motifs were rendered in fractal reflections. The inner designs were produced using triangular motifs. These motifs are reflected in three reduced scales of succession to represent the crescent shapes. They are aesthetically arranged with the largest on the right and the smallest on the left side of the composition. A tapered straight bar pierces the base area of the three crescent forms.

The colours are based on recent *Bomborisi* technique combining multiple colours in addition to traditional white, red, brown and black tones. They are portrayed in multiple renditions of blue and red with black tones.

This is followed by seemingly merging crescent forms. The connecting tapered bar line has been painted in colourful triangular calabash net-*zaalenga* and fish net-*yoka* motifs. It is harmonized by reflecting the tones from the loops above and braced on the railing in a chain process to infinity. The symbiosis created by the interconnected shapes shows commonality in representation of rapidly dwindling crescent moons.

The illuminated colourful triangles are wedged into each other in compact rhythm with subtle gentle and gradation of multi coloured tones. The entire design represents fractal self-similarity. In this painting fractal geometry has been explored simulating woven repeated designs by using *Bomborisi* motifs.

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Plate 6

Shadows of the Midnight Ray: Size: 51cm X 21cm, Medium:

Poster on Cardboard by Michael Nyarkoh, 2009.

Experimental Fractal Painting 2

Researcher: Michael Nyarkoh

Plate 7: *Bomborisi Koch Curve*

Size: 38cm X 26cm

Medium: Poster on Cardboard

Bomborisi Koch Curve in Plate 7, p.144 shows the arrangement of broken calabash-*wangzasi* and cattle path-*akunyena-nii* motifs on each side of the composition. A bigger triangle (with interior motifs) surrounds each of the four Koch curves. Each of the Koch curves is attached to the triangular broken calabash-*wangzasi* motifs. The composition shows a colourful wedge of triangular forms projected with the tip pointing towards the centre.

On each side of the pink Koch curve are four red, green, brown and blue triangles, which are viewed projecting from the sides into the centre of the composition. Within each of these shapes are repeated scaled patterns. It begins with small inner dark blue, followed by light coloured tones of green to match the darker green and top lemon green colours with tints of blue, surrounding the Koch curve fractal simulation at the top and bottom.

The final image reveals a fractal generation of iterated scaling. At the base is the cattle path-*akunyena-nii* design, painted in light blue, which serves as a platform for the Koch curve. To be heard and be seen by all, one needs the other to advance such heights to be visible. In reaching out to the voiceless, unreachable and invisibles, the Koch curves in the painting make *Bomborisi* reachable and visible.



Plate 7

Bomborisi Koch Curve: Size: 38cm X 26cm, Medium: Poster on Cardboard

by Michael Nyarkoh, 2009.

Experimental Fractal Painting 3

Researcher: Michael Nyarkoh

Plate 8: *Cantor's Bomborisi*

Size: 42cm X 38cm

Medium: Poster on Cardboard

Cantor's Bomborisi in plate 8, p.147 was purposely designed to suit *Bomborisi* walls decorations pattern. The painting is a combination of the four most important motifs used in *Bomborisi*; the calabash net-*zaalenga*, fish net-*yoka*, pieces of halved calabash-*wanne* and hourly-*lungae* motifs. The composition is made up of six segments.

The broken calabash-*wangzasi* motif was rendered in white, pink and ochre in the first segment above the green, pink, brown and orange fishnet-*yoka* fishnet motif in the second segment. The largest design rendered is the calabash net-*zaalenga* motif, found at the centre of the composition. This motif was painted in black pink and ochre. Under this segment is a zigzag *yoka* motif, painted in blue, green, orange, pink and brown. The contrasting zigzags (made up of triangles) typify currently transformed *Bomborisi* technique.

Another broken calabash-*wangzasi* design (like the first segment) has been painted with hard edge black outlined triangles. The final bottom segment is rendered in hourly-*lungae* motif. The *yoka* fishnet motifs found in the three segments have light blue halved calabash-*wanne* motifs interspersed and placed in opposite directions.

As the Cantors set scales to infinity so are the segmented bands on a quest to find the same kind of arrangement as seen in pottery and basketry. The answer to the quest is seemingly infinite as *Bomborisi*.

Plate 8

Cantor's Bomborisi: Size: 42cm X 38cm, Medium:

Poster on Cardboard by Michael Nyarkoh, 2009.

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Experimental Fractal Painting 4

Researcher: Michael Nyarkoh

Plate 9: X *Bomborisi*

Size: 51cm X 38cm

Medium: Poster on Cardboard

Plate 9, p.150 shows X *Bomborisi* which features cattle path-*akunyena-nii*, broken calabash-*wangzasi*, feminine kind of broken calabash-*yagimbasa wangzasi* and halved calabash-*wanne* motifs. The motifs have been composed to depict a stretched X-shape. They stretch into infinite scaling range towards the four corners of the painting.

Each pattern scales from the centre and reduces in size into the tapering to the corners. The design is boldly painted in traditional *Bomborisi* colours of brown, white and black. The left and opposite sides of the “X” shape have both broken calabash-*wangzasi* and halved-*wanne* motifs. The feminine kind of broken calabash-*Yagimbasa*

wangzasi and halved-*wanne* motifs in thin black strips emanating from the centre make up the design for the top and bottom sides. The rays of lines that converge at the sides have been rendered to create a spider web. They were painted in brown, black and white tones. Each segment with painted patterns is scaled, and separated with straight black lines that meet at the sides.

The compactness of the central designs provides adequate hold that support the heavy weight exerted by the “X” form. The extensions create depth in the varied geometric patterns. The white triangular web-like designs on both sides of the painting projects the space between the lines. The rays in the form of black lines merging from the sides strengthen the strings to hold the “X” form together. The “X” arm design is not only limited to *Bomborisi*, it is depicted as a simulation of a stool with the edges marked by sharp wavy brown, black and white lines. Harmony is created in the use of lines and triangles elaborated in white and brown and dark outlines.

These motifs have been explored to bring about such nuances of the old tradition. The uniqueness is expressed in the modulation of the elements and balance is created by the manipulation of the triangular motifs.

The entire painting depicts an exploration of cattle path-*akunyena-nii*, broken calabash-*wangzasi*, feminine kind of broken calabash-*yagimbasa wangzasi* and halved-*wanne* motifs for fractal scaling and translation in *Bomborisi* transformation. The painting therefore requires a drop of infinite idea to make a bounce with repeated scaled transformed “Xs”.

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Plate: 9

X Bomborisi: Size: 51cm X 38cm, Medium:

Poster on Cardboard by Michael Nyarkoh, 2009.

Experimental Fractal Painting 5

Researcher: Michael Nyarkoh

Plate 10: *Sierpinski's Bomborisi*

Size: 38cm X 50cm

Medium: Poster on Cardboard

Sierpinski's Bomborisi painting in plate 10, p.153 is composed of three Sierpinski's triangles filled with *Bomborisi* motifs and colours. The motifs used are round huts-*bonkeka zuvaka* and broken calabashes *wangzasi* to generate this fractal imagery. Two points of Sierpinski's triangle points upwards and one point downwards.

The triangles show a pyramidal resemblance on each side and a reflection of the middle pyramid itself. They are portrayed to fuse the two motifs of the round hut-*bonkeka zuvaka* and feminine kind of broken calabash-*yagimbasa wangsazi* that have been expressed in a mosaic pattern.

They are typical fractal compositions with a series of variegated triangular shapes that have been rendered in white, brown and black. The pyramidal triangles depict typical Nankani architectural design.

The harmony is revealed in the modulation of the different triangular shapes. The black painted triangular shapes form the background. The white and brown shapes lying in between the white triangles create a bridge of steps. There is bilateral symmetry in the picture plane.

Sierpinski's triangles with feminine kind of broken calabash-*yagimbasa wangsazi* and round hut-*bonkeka zuvaka* motifs have been well explored as *Bomborisi* fractal self-similarity simulations. The form unites three Sierpinski's gaskets reflected as pyramidal *Bomborisi* peaks.

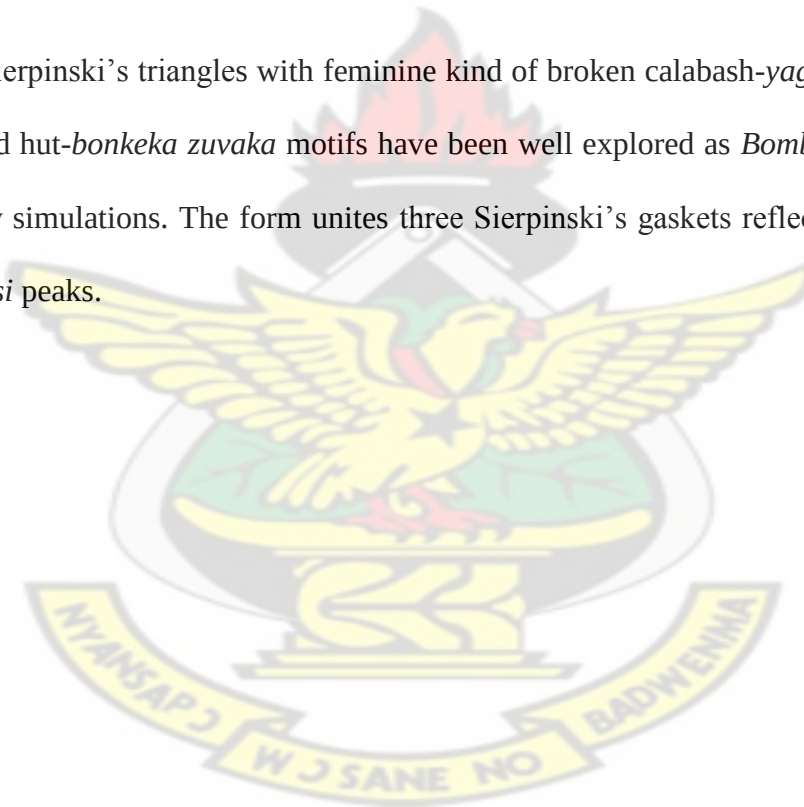


plate: 10

Sierpinski's Bomborisi: Size: 38cm X 50cm, Medium:

Poster on Cardboard by Michael Nyarkoh, 2009.

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Third Set of Fractal Paintings: Eight Advanced Experiments

The third set of eight categories of advanced experimentations places *Bomborisi* geometric designs into fractal compositions using acrylic on plywood to effect transformations are in plates 11- 18, respectively. The third set of eight experimental paintings was done manually with acrylic colour on plywood to effect the transformations.

Analysis of the third set experimental paintings is as follows:

Fractal Painting 1

Researcher: Michael Nyarkoh

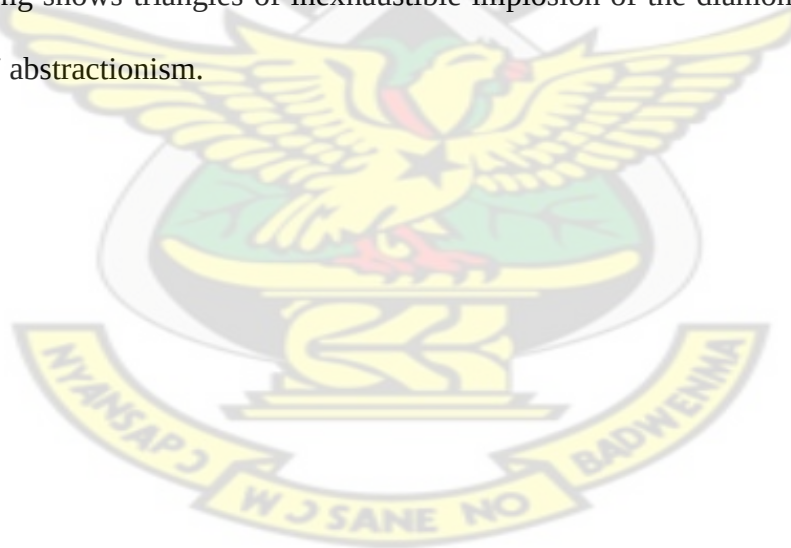
Plate 11: *Bomborisi Gem*

Size: 4ft X 8ft

Medium: Acrylic on plywood.

Bomborisi Gem in plate 11, p.156 features a colourful array of variegated triangles arranged in an intriguing manner. The central part of the composition consists of hexagonal formation of different brightly coloured triangles. It is surrounded by similar scaled reflections of cattle crossing a path-*akunyena-nii* and calabash net-*zaalenga* designs. The motifs were painted with brown, orange, gray, light blue and yellow.

The central part is also portrayed in brightly painted hexagonal gem-like shapes. Harmony is revealed in the triangular motifs found in the gem as it reflects the surrounding colours in the painting. The entire composition depicts fractal recursive, translated and reflected transformational attributes of fractal geometry. Depth is achieved by the rendition of the scaling of broad to tiny triangular shapes in the entire painting. The painting shows triangles of inexhaustible implosion of the diamond gem typified in *Bomborisi* abstractionism.



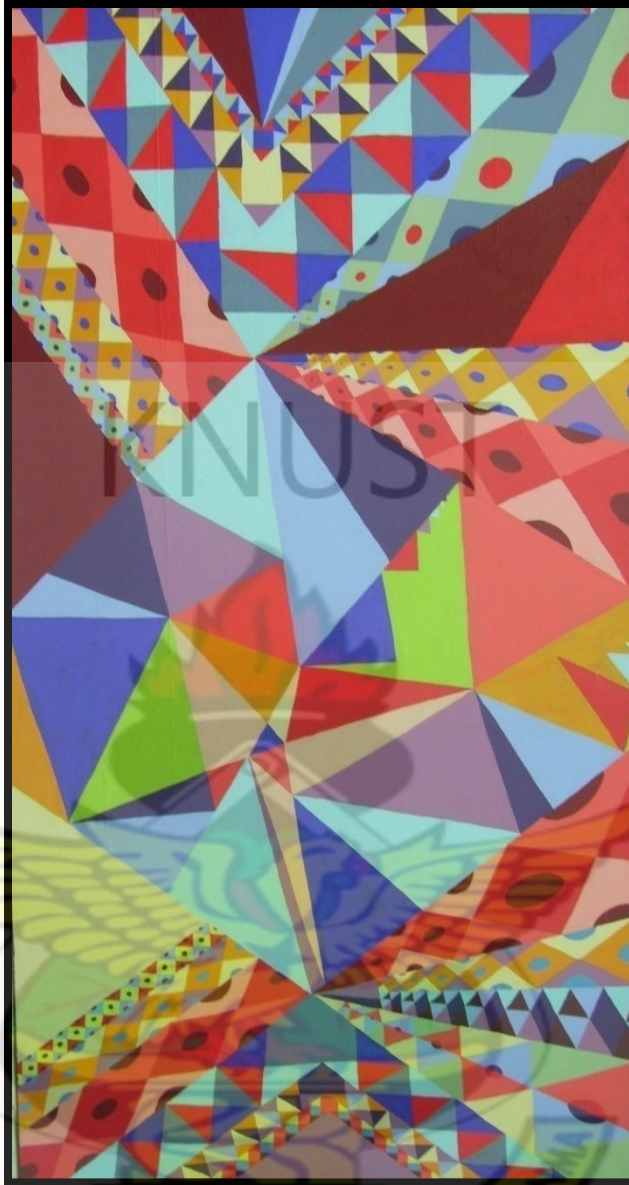


Plate 11

Bomborisi Gem: Size: 4ft X 8ft, Medium:

Acrylic on plywood by Michael Nyarkoh, 2009

Fractal Painting 2

Researcher: Michael Nyarkoh

Plate 12: *Concentric Bomborisi*

Size: 4ft X 8ft

Medium: Acrylic on plywood.

Concentric Bomborisi in plate 12, p.159 shows transformed *Bomborisi* red, orange, yellow, violet, blue and green concentric circles. They have been rendered in a continuously overlapping pattern and were painted over a white undercoat, revealing transparency in the secondary hues.

Different concentric circles cover the entire painting surface in transparencies. The largest is located at the top and covers a third of canvas. They have been rendered in mauve, yellow, orange, light and dark blue colours. Within this bigger design are a number of transparent concentric circles of mid-range to the smallest circular range.

Balance is achieved by making two reduced versions of the previous circles. They are located directly below to the left side and overlap into light blue tones in the bigger circle above. Around these circles are much smaller orange and brown concentric circles. The placements of the circles have been abstracted and they reflect combinations of different circular tones below. The rendition shows an overall pattern of concentric forms.

The exposed background and circular overlaps create depth. Harmony is created by the representation of different shapes and variegated tonal hues in the entire composition. The pattern created reveals concentric *Bomborisi* python-*waafo* and round hut-*zuvaka* architectural simulations. Concentric python-*waafo* motif circles were explored to reveal a blend the traditional motifs used in *Bomborisi* for simulation of Sirigu round hut architecture into organic fractals.

The painting titled *Concentric Bomborisi* also represents linear concentric images. The circles of similar sizes represented in the painting have been rendered in the same hues as represented in fig.26. Multiple of concentric shapes in the painting are represented in transparent overlaps. The various designs in the painting mentioned above are shown with variegated circular forms. They are depicted as non-linear fractal simulations based on Native American architectural form as fractal simulated painting. It depicts simulations of the *Bomborisi waafo* python relief motif in fig.2, p.17. The painting is based on the python motif that has been recreated as computer generated image in plate.20, p.182.





Plate 12

Concentric Bomborisi: Size: 4ft X 8ft, Medium:

Acrylic on plywood by Michael Nyarkoh, 2009.

Fractal Painting 3

Researcher: Michael Nyarkoh

Plate 13: *Soul of Akanvole*

Size: 4ft x 8ft

Medium: Acrylic on plywood.

Soul of Akanvole in plate 13, p.162 is a remarkable colourful rendition of *Bomborisi* curvilinear forms. Abstracted calabash net-*zaalenga*, hut-*zuvaka*, and cattle path-*akunyena-nii* motifs cover the entire surface of the composition. Three different segmented partitions make up the entire composition. The top strip was painted in broad diagonals of school children holding hands-*agurinuuse* and calabash net-*zaalenga* motifs. It was rendered in lemon, yellow, light green, dark green, light blue, orange, brown and black colours. The lower triangles were painted in very dark tones.

The middle part features juxtaposed calabash net-*zaalenga*, school children holding hands-*agurinuuse* and cattle path-*akunyena-nii* curved motifs. It scales to infinity from the right side and is attached to the left corner of the top strip of school children holding hands-*agurinuuse* (zigzag) motifs.

The centre is characterized by variegated *Bomborisi* motifs in fractal scaling renditions. The lemon curvilinear plane below the first zigzag strip symbolizes a calabash net-*zaalenga*. The four horizontal strips at the bottom are iterated cattle path-*akunyena-nii* and translated fish net-*yoka* motifs. They provide solid ground as support for all the designs above.

The soul of the *Bomborisi* potter Akanvole which resides in the pot, is broken into smaller calabash net-*zaalenga* triangles to free her soul when she goes to the other world. This painting represents continuous release of the calabash net-*zaalenga* which is the shrine of her soul.

The calabash net-*zaalenga*, *fish net-yoka*, round hut-*zuvaka* and cattle path-*akunyena-nii* has been explored into various aspects of variegated fractal dimensions. It is the traditional intuitive intellect that simulates various aspects of the calabash net-*zaalenga* design into recurrent fractals. This has become an internalized system and inevitably resurfaced unconsciously in the cattle path-*akunyena-nii*. The great soul of Akanvole is a result of the harmonious marriage of intellect and intuition personified in cattle path-*akunyena-nii* and calabash net-*zaalenga*.

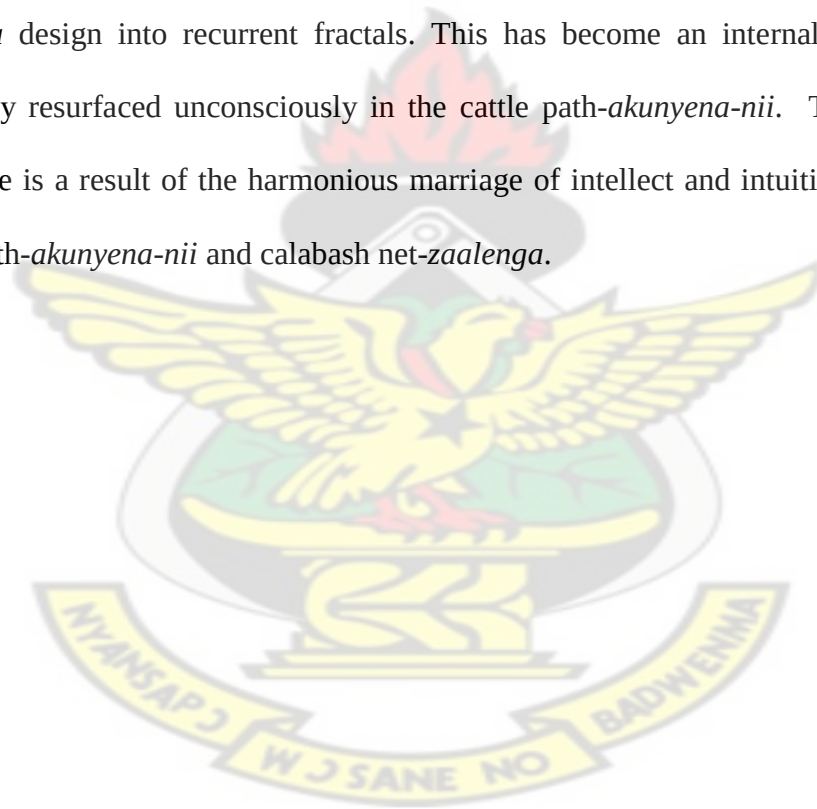




Plate 13

Soul of Akanvole: Size: 4ft X 8ft, Medium:

Acrylic on plywood by Michael Nyarkoh, 2009.

Fractal Painting 4

Researcher: Michael Nyarkoh

Plate 14: *Tana Koch Curve*

Size: 4ft X 8ft

Medium: Poster and Acrylic on Plywood.

Tana Koch Curve painting in plate 14, p.165, shows pieces of broken calabash-*wangzasi* and zigzag strips-*tanne* motifs as two designs juxtaposed different colourful. The triangular and zigzag shapes have been done using the same pattern for each design. The motifs were rendered and pointed in opposite vertical directions. They cover the entire painting surface.

The first motif from right to left has been done in brown, cream, light yellow and black colours. This design begins from the bottom and tapers at the top right corner.

The second design was painted in dark blue, mauve, orange, red, yellow grey, light blue and coffee. It is rendered similarly as the initial right design, starting from the top and tapering at the bottom. The two motifs are repeated to form three set in the entire composition.

The inversions created by the designs create harmony. The colourful white and yellow triangles give volume and depth in the strips-*tanne* and broken calabash-*wangzasi* motifs that have been used to create Koch curve fractals.

Tana Koch Curve explores the evocative and lyrical possibilities of line derived from strips-*tanne* and broken calabash *wangzasi* motifs, which are spontaneously attached by leaning with a breathtaking vitality and freshness that defy description in repetition. Extensive depth and height is projected as each motif gives a piercing strike into infinite space representing six unending pylons. They are rendered to symbolize fractal Koch curve simulation.

Tana Koch Curve has been rendered in similar representation as the Mangbetu ivory sculpture simulation found in fig. 4, p.20. The design in plate 38 which is based on elaborate geometric aesthetic of 45 degrees angle has been simulated showing single profile of the Mangbetu ivory sculpture. It has been depicted inclined 25 degrees for the six of three upright and its inverted form. They are rendered to represent painted designs of six Mangbetu simulated forms using *Bomborisi* motifs.

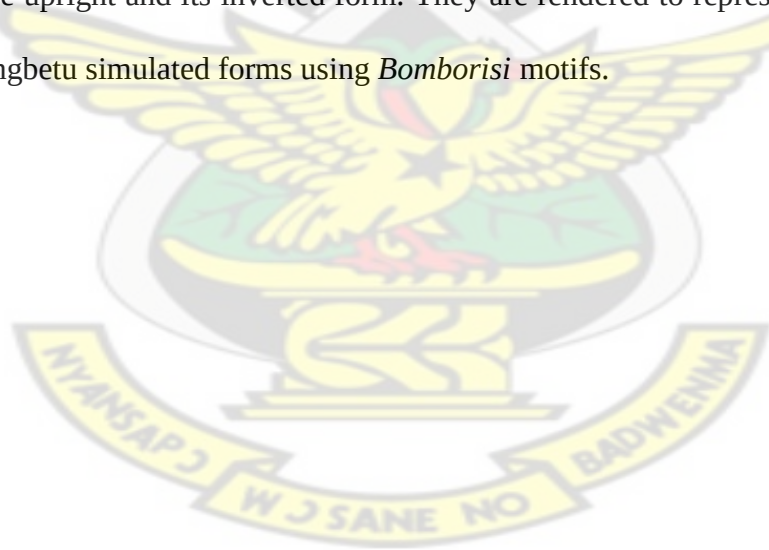




Plate 14

TanaKochCurve: Size: 4ft X 8ft, Medium:

Poster and Acrylic on Plywood by Michael Nyarkoh, 2009.

Fractal Painting 5

Researcher: Michael Nyarkoh

Plate 15: *Hourly Lungae Local Drum Gasket*

Size: 4ft X 8ft

Medium: Poster and Acrylic on Plywood.

Hourly Lungae Local Drum Gasket painting in plate 15, p.167 shows a general range of triangular designs. It is done in segmented spaces and covers the entire surface. The painting projects rich bluish and orange tones which cover the entire composition. The composition is divided into five visible segments with triangular motifs overlapping in transparency mode through the various separated segments.

The uppermost area has triangles abstracted into forms of Sierpinski's gaskets. Attached are two light bluish and yellowish Koch curve designs. The bottom side has bigger triangular patterns that point towards the centre of the composition. The segment found at the centre depicts irregular triangular shapes. Shades of blue and orange tones of the Koch curve design are placed in the segment above. The subsequent segments have been rendered using variegated shapes of the Sierpinski's triangle and Koch curve designs. The hourly-lungae and broken calabash-wangzasi motifs were extrapolated composed and textured into fractal chaotic transformation. The painting vividly portrays honesty, which restores creative instincts in *Bomborisi* that are clearly channeled towards a reflection of current fractal transformations.

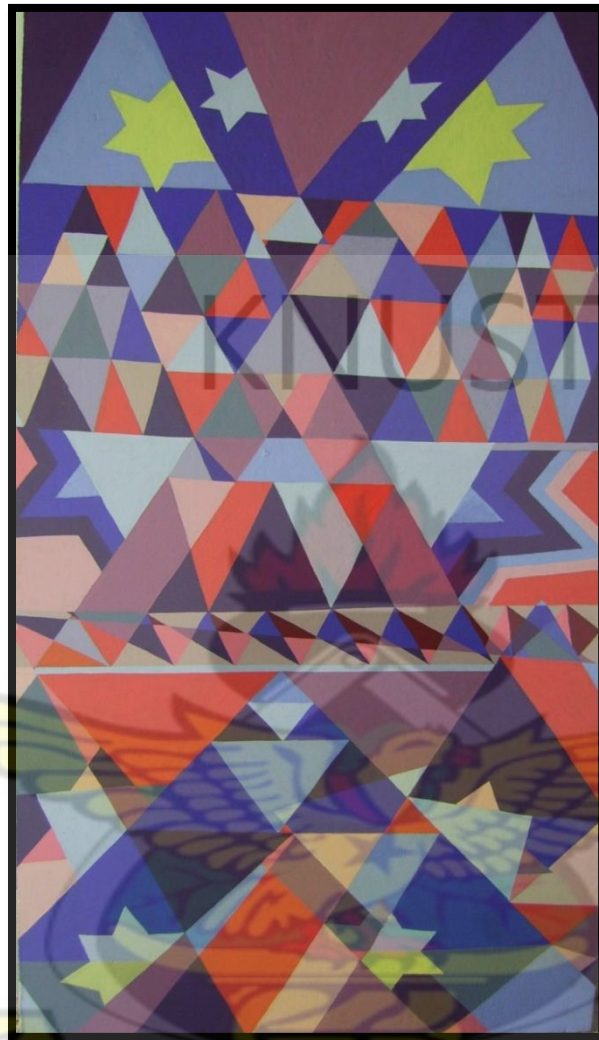


Plate 15

Hourly Lungae -Local Drum Gasket: Size: 4ft X 8ft, Medium:

Poster and Acrylic on Plywood by Michael Nyarkoh

Fractal Painting 6

Researcher: Michael Nyarkoh

Plate 16: *Wanne Concentric Circles*

Size: 4ft X 8ft

Medium: Acrylic and Poster on Plywood.

Wanne Concentric Circles in plate 16, p.170 combines a *Bomborisi* python and bluish tones of concentric circles. The two bigger designs have *Bomborisi* brown, black and white tones as well as the bluish colour tones. The centre, of each spiral which is the starting point, is done in brown, black and white of halved calabash-*wanne* fish net designs. This is followed by the bluish tones after one and a half revolutions. They are rendered in broken calabash-*wangzasi* and cattle path-*akunyena-nii* motifs abstractions. This continues after similar spiral revolutions, then followed again with *Bomborisi* painted in halved calabash-*wanne* and around these is semi-circular movements.

The motif on the right side is bigger than the other set, with the middle circle being the smallest. The circular larger movement forms the background patterns. Current transformed *Bomborisi* technique of applying variegated tones has been explored.

The concentric motifs were rendered in pink, red, orange, red, lemon green, green and blue. The smallest concentric circles have semi-circular designs painted in blue tones while the biggest concentric circles have blue tones along the central area as the brown *Bomborisi* renditions also have white colours.

The design show linear concentric fractal movement. The rendition is vigorous, tight and fluid in vibrant consistency. The blue tones radiate persistent flow as the underlying designs provide depth and volume.

Similarly the *Wanne Concentric Circles* painting in this section have been rendered based on the simulated linear concentric circles and Mokoulek architecture represented in fig. 15, p.41 and plate 12, p.159 respectively. The image also represents fractal spiral composition of selected variegated triangular *Bomborisi* motifs. The fractal simulations in both designs have the fractal scaling representation of reduced iterations of the initial bigger forms.

It is designed to show circular movement of traditional round huts-zuvaka. The *Bomborisi* python-waafa motif has been translated and simulated in fractal recursions and linear scaling. Rotational motions were explored in the circular motion to depict the life cycle with the stacked pile of calabashes in the Nankani home. It is interpreted that a Sirigu woman's shrine- calabash net-*zaalenga* is broken up into smaller pieces as it disperses the soul into multiple entries in the next world when she dies.



Plate: 16

Wanne Concentric Circles: Size: 4ft X 8ft, Medium:

Acrylic and Poster on Plywood by Michael Nyarkoh, 2009.

Fractal Painting 7

Researcher: Michael Nyarkoh

Plate 17: *Wanne Cowry*

Size: 4ft X 8ft

Medium: Poster and Acrylic on Plywood.

Wanne Cowry in plate 17, p.173 features triangular halved calabash-*wanne*. They have been portrayed to cover the entire painting surface in rotational movement. It is painted in multiple tones of red, light yellow, tints of white, shades of grey and blue, violet, orange, brown greenish blue colours.

Each triangle and concentric circle is laid juxtaposed. The larger triangles are repeated along the opposite fringes of the painting. It is, however, merged into two transparent strips with the smallest triangles constituting the interior middle area of the painting surface. The cluster of triangles over-lapping transparent is found at the centre in abstracted rectangle. The design shows abstracted cowry shell within which many smaller triangles overlap. The upper triangles are reduced transformation tips at the middle central end. The lower designs are repeated in opposite version of the former.

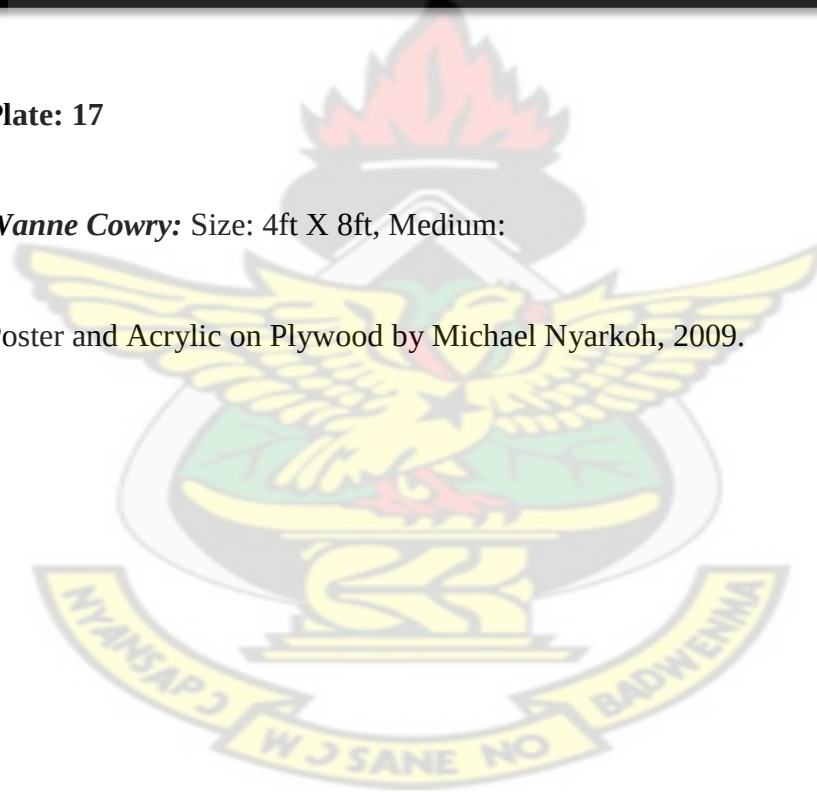
The hues are variegated into moderate bright secondary tones. This radiates a shine of soft appeal. The application of paint has been gently distributed to provide an even distribution of colours to harmonize. This is intended to gracefully merge the triangular halved calabash-*wanne* motif for cohesion. The motifs placed along the fringes with large triangles support and protect the inner fragile smaller triangles. The designs were rendered with the halved calabash-*wanne* motif to create an abstract oyster shell design as *Bomborisi* transformed cowry.



Plate: 17

Wanne Cowry: Size: 4ft X 8ft, Medium:

Poster and Acrylic on Plywood by Michael Nyarkoh, 2009.



Fractal Painting 8

Researcher: Michael Nyarkoh

Plate 18: *Akunyena-nii iterations*

Size: 4ft X 8ft

Medium: Poster and Acrylic on Plywood

Akunyena-nii iterations in plate 18, p.176 shows a direct fractal rendition of an iterated *akunyena-nii* symbol. The painting was rendered to cover the entire surface. The background is pink, green and its tint.

Red, violet, green and blue triangles combine to form the outer square and diamond patterns. Hues of black, violet, yellow and orange were used for the inner smaller squares. Two green tones were used to divide each stretch of design, rendered in a serpentine order.

The painting has big coloured motifs interlaced with smaller dark image reflections (the motifs were rendered at the right upper corner side and reflected is located at the lower left side area of the painting surface in rotation). The biggest symbol indicates a single square design is first followed by three reduced ones and then a third smaller motif is done in succession in diagonal segmentation.

Five motifs are represented in the centre. A second representation generated in dark tones has been depicted as shadows of the initial bigger design. This has been iterated in reduced scale towards the centre. They are done in each space to conform to fractal iterations which rotate along individual paths that are revealed in repeated self-similarity.

These foot steps are designed to unify buoyancy, joy and harmony is separated by gentle foot marks that represent by visible cattle-*naafo* feet.

The painting assumes a wavy green and blue fractal rendition in translation, enlargement and infinite scaled form. The final appeal vibrates to energize bold cattle crossing a path-*akunyena-nii*, elegant python-*waafo* and cattle-*naafo* path motifs.

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Plate 18

Akunyena-nii iteration: Size: 4ft X 8ft, Medium:

Poster and Acrylic on Plywood by Michael Nyarkoh, 2009.

Fourth set of Fractal Paintings: Ten Computer-Generated Geometric Designs.

The fourth set of experimental paintings done on a computer are ten computer generated fractal geometric designs to effect transformations from plates 19-28, respectively using *Fractint* Application run on C++ Windows Version Winfract software.

Analysis of the fourth set of computer generated fractal experimentations is as follows:

Fractal 1

Researcher: Michael Nyarkoh

Plate 19: *Sierpinski Eye*

Parameter path: S.Guess

Maximum iteration 150

Image corner values:

X min. = -0.899999976158, X max. = 1.700000047684

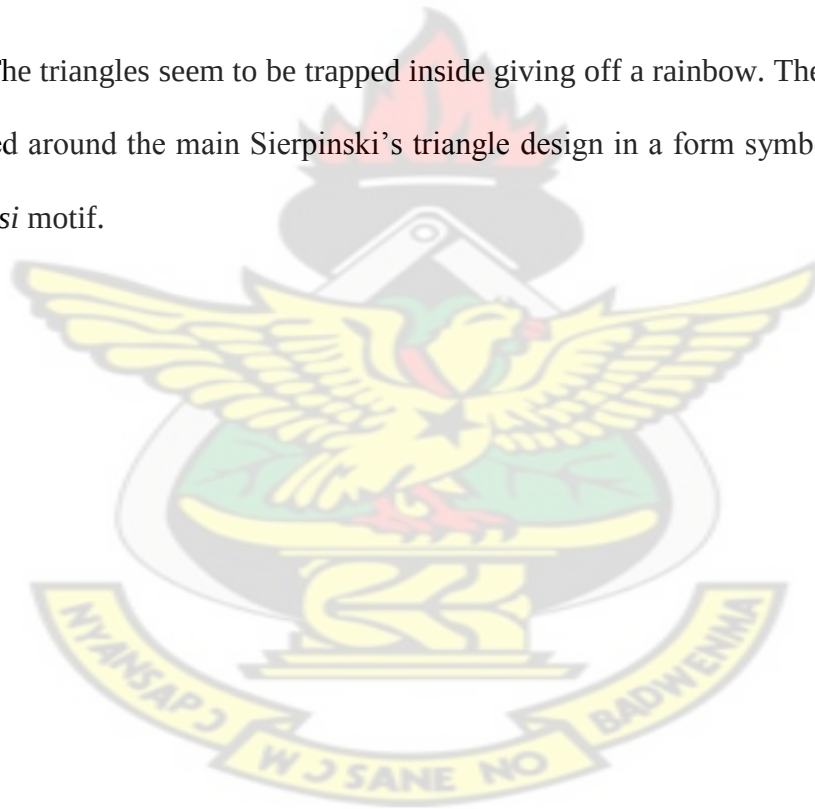
Y min. = -0.899999976158, Y max. = 1.700000047684

Sierpinski Eye fractal painting in plate 19, p.179, shows a typical Sierpinski's triangle in the centre. The central larger triangle has four visible horizontal bands of colours. Arranged from top to bottom are purple, cyan, beige, off-white and light blue. It is surrounded by series of generated triangles, rendered without the colours of initial top segment. The scaling sequence makes the colour resolution blurred and dark as it

approaches infinity. The final effect features visible triangles viewed and rendered with a dark background.

The Sierpinski's triangle is placed inside a series of generated curvilinear external outlines with zigzag patterns. It was done in red with bright yellow at the extreme top right corner. This is followed by a set order of reduced generated violet, cyan, pink, light-yellow and light-blue hues around the triangle. They are rendered in the fourth iteration along the range towards the centre.

The triangles seem to be trapped inside giving off a rainbow. These external tones are placed around the main Sierpinski's triangle design in a form symbolic of the cowry *Bomborisi* motif.



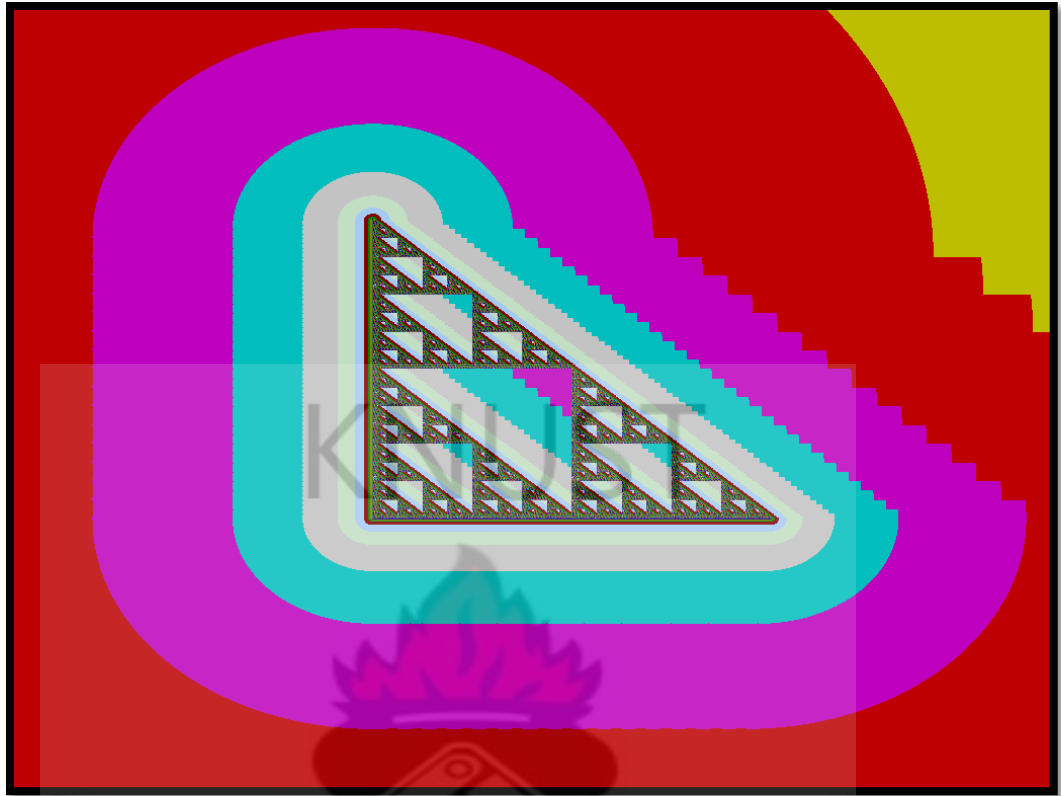


Plate: 19

Sierpinski Eye: Parameter path: S/Guess, Maximum iteration 150,

Image corner values: X min. = -0.899999976158, X max. = 1.700000047684,

Y min. = -0.899999976158, Y max. = 1.700000047684, C.G.I.by Michael Nyarkoh,
2009.

Fractal 2

Researcher: Michael Nyarkoh

Plate 20: *Circle Waafo*

Parameter path:

S. Guess, magnification= 20000.000000,

Xmin = -200000000000, Xmax. = 200000000000

Ymin. = -1.500000000000, Ymax. = 1.500000000000

Maximum iter: 200

Circle Waafo fractal painting in plate 20, p.182 shows a myriad of concentric circles. The visible tones are yellow, blue green and violet. Within the circles are transparent concentric circles and outside the circle are iterated smaller ones. The design depicts linear concentric scaling iterated to infinity. The circles are generated into tiny rings visible by the colour content. The yellow tones are separated by blue rings.

The spiral formation shows transparencies revealing scaled visible circular forms beneath. They are joined together to form a constellation. They also reflect ripples of different magnitude as the effect of droplets in still pool. The scaling effect is visibly enhanced by the resonance created as the motion is directly forced into the central larger concentric form. The general view is gray - violet organic patterns of the *waafo* (python) motif. Energy is absorbed and reflected back from the central bigger concentric ripple image.

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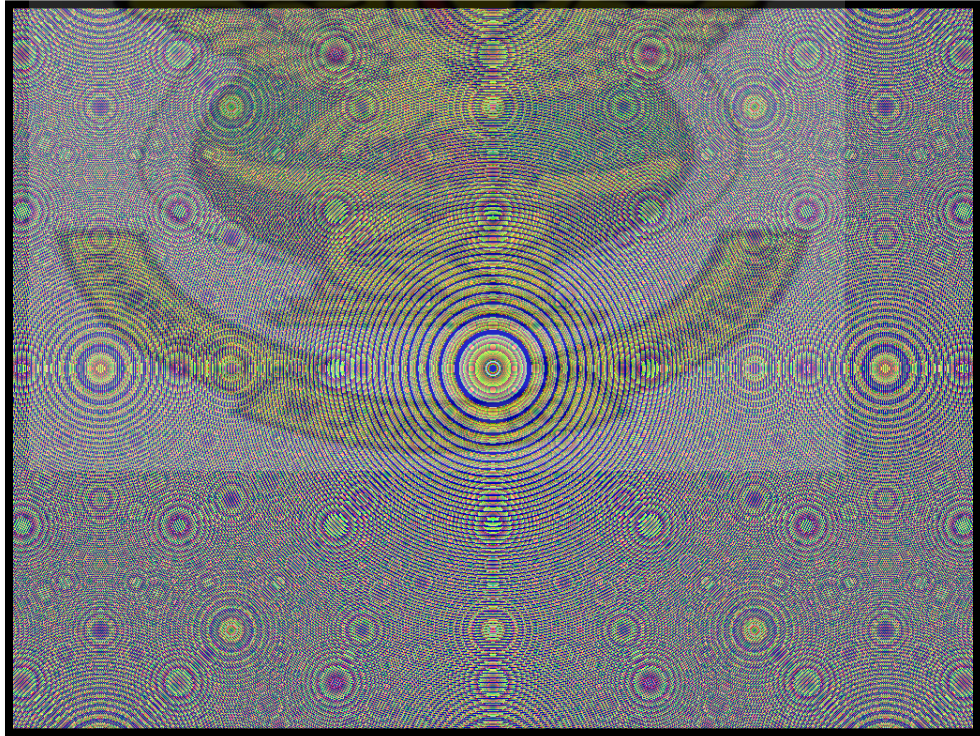


Plate: 20

CircleWaafo: Parameter path: S/Guess, magnification= 20000.000000,

Xmin = -2000000000000, Xmax. = 2000000000000

Ymin. = -1.500000000000, Ymax. = 1.500000000000, Maximum iter: 200,

CGI.by Michael Nyarkoh

Fractal 3

Researcher: Michael Nyarkoh

Plate 21: *Lambdafn Triangular Concentric Circle*

Parameter path:

Real part of parameter = 1.000000

Imaginary part of parameter = 1.400000

First function = ident.

S. Guess, real

Image Corner values:

$X_{min} = -4.000000000000$, $X_{max.} = 4.000000000000$

$Y_{min} = -3.000000000000$, $Y_{max.} = 3.000000000000$

Maximum iter: 200

Lambdafrn Triangular Concentric Circle fractal painting in plate 21, p.185 shows concentric truncated computer generated images. They are created in self-similarity. The composition represents a reflection and enlargement in a zoom-out rendition. It is also based on the concentric idea as in plate 12, p.159. In this painting, concentric circles are represented by series of triangles. They have been scaled to infinity in reduction sequence. These triangular images are shown in variegated colour representation. The triangular forms are scaled into a colourful central pin-hole view that recedes into an unending tunnel. The initial hues are red, green, yellow and blue. This is followed in order by violet, cyan and gray tones in the next ring. The subsequent circular motions are rendered in red, crimson, gray and very dark gray.

The movement of the geometric concentric motion reveals an interlocking effect. Harmony is created by merging generated shapes in a continuous circular rotation. The triangles flow along the interlocking circular formation with red, light pink to yellow tones in the middle. This is balanced with the gray and light green reflections illumination inside the tunnel.

It also portrays three dimensional soft textures. The flow of the design into the inner dark smaller core symbolizes a broken calabash-*wangzasi* that is energized by the graceful illumination of light reflected within the colourful tunnel.

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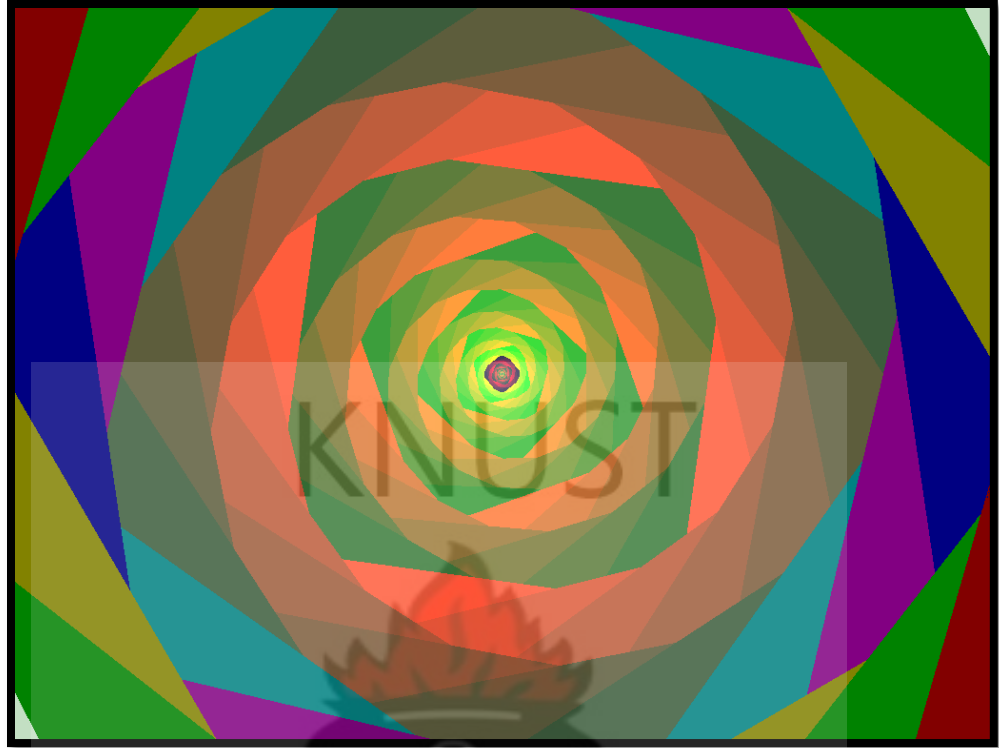


Plate: 21

Lambdafn triangular concentric circle: Parameter path:

Real part of parameter = 1.000000, Imaginary part of parameter = 1.4000000

First function = ident., S/Guess, real Image Corner values:

Xmin = -4.000000000000, Xmax. = 4.000000000000

Ymin = -3.000000000000, Y max. = 3.000000000000, Maximum iter: 200

C.G.I. by Michael Nyarkoh, 2009.

Fractal 4

Researcher: Michael Nyarkoh

Plate 22: *Sierpinski Kente*

Parameter path: Tesseral, image

Image Corner values:

Xmin = -4.00000000000, Xmax. = 4.00000000000

Ymin = -3.00000000000, Y max. = 3.00000000000

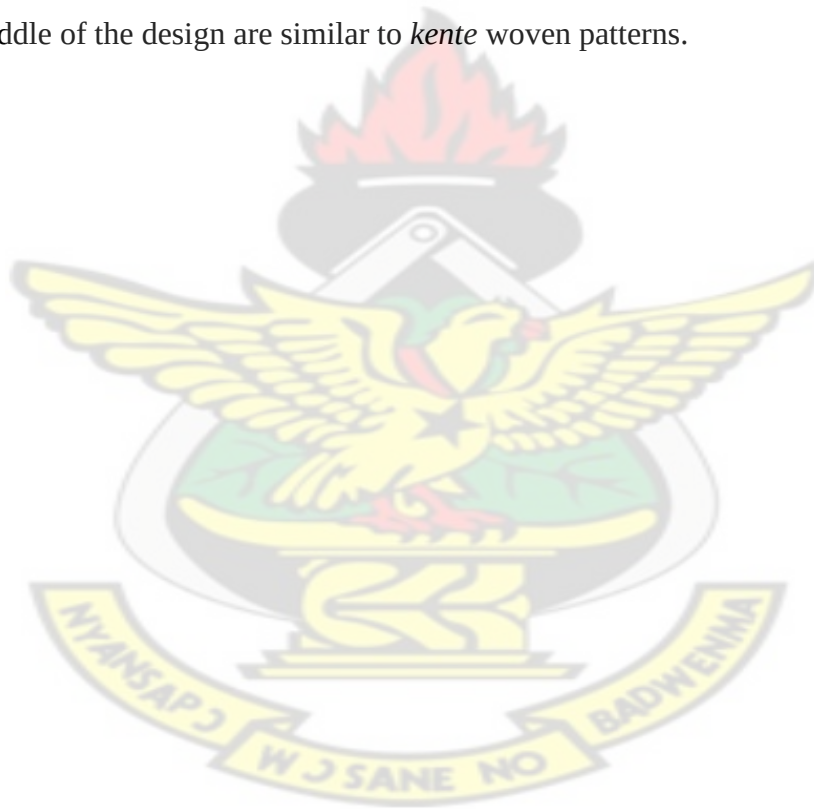
Iterations: 20

Sierpinski Kente in plate 22, p.188 shows a colourful spectrum of Sierpinski's triangles in the middle, rendered into three separate bands. A curvilinear scaled profile is reflected in the central topmost black area, joined to the top corner of the middle triangle. This is extended towards the lower right end of the triangle. The mid right section is done in rectangular form inclined to the right. Each rectangular form has zigzag ends attached to the rectangular forms. They have been conspicuously rendered into a fourth iterated visible image. The represented in an array of iterations visible as it moves into the interior.

Colourful rectangular forms are beyond the triangle at the centre. These are placed vertically. They are also scaled and attached to the triangle at the left vertical side. Below this is a third band, represented as rainbow illumination. It is designed with semi

curvilinear reflections of the topmost designs. They are done in reduced scaling towards the base side of the Sierpinski's triangle on both sides of the composition.

The third and subsequent iteration is joined with a strip of straight line extensions of the first blue colour. Colour perspective is created as the strip of lines get closer to the triangle. The distance between them is rendered in dark tones. This bonds the bigger inner circular "O" with the surrounding shapes. The entire composition has been rendered in a semi-transparent manner. Colours, curves, lines, zigzag, strips and the smaller bands at the middle of the design are similar to *kente* woven patterns.



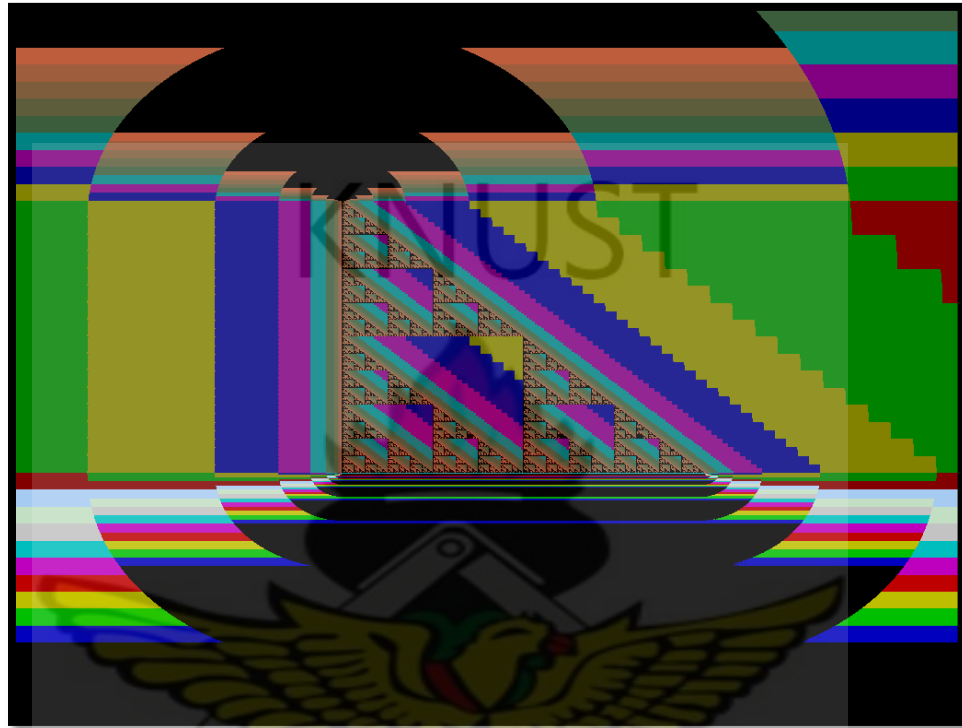


Plate: 22

SierpinskiKente: Parameter path: Tesseral, image corner values:

Xmin = -4.000000000000, Xmax. = 4.000000000000 Ymin = -3.00000000000,

Y max. = 3.000000000000, Iterations: 20 GI. by Michael Nyarkoh, 2009.

Researcher: Michael Nyarkoh

Plate 23: *Sq(1fn) Bonkeka-Zuvaka*

Floating pt. math.

Basic option

Passes: tesseral

Imag

Image Corner values:

Xmin = -4.000000000000, Xmax. = 4.000000000000

Ymin = -3.000000000000, Y max. = 3.000000000000

Maximum iteration: 20

Sq(1fn) Bonkeka-Zuvaka GI.in plate 23, p.191 shows eight sets of black and rainbow arch forms. The black arches are broad and directed towards the center. The central area has two parts. The first black interior is represented in a reduced scaling circular pattern. The second part is represented by concentricrainbow pattern.

The black arches are separated by brightly coloured arches, created in white, blue, red and violet reflections. Each curved arch is reflected on the opposite side. Iterated concentric designs inside the composition are show scaling into a second black circle

repeated to form others. Beyond are two identical iterated arches done to portray an opposite reflection of the arches.

The arches are rendered with a Shaman-like effect are similar to shells like the cowry and the oysters. The entire setting is a simulation of a Sirigu traditional round hut- *bonkeka zuvaka* design. The connection of the arches to the interior circular traditional hut walls is symbolic of the natural state of the spider's web.



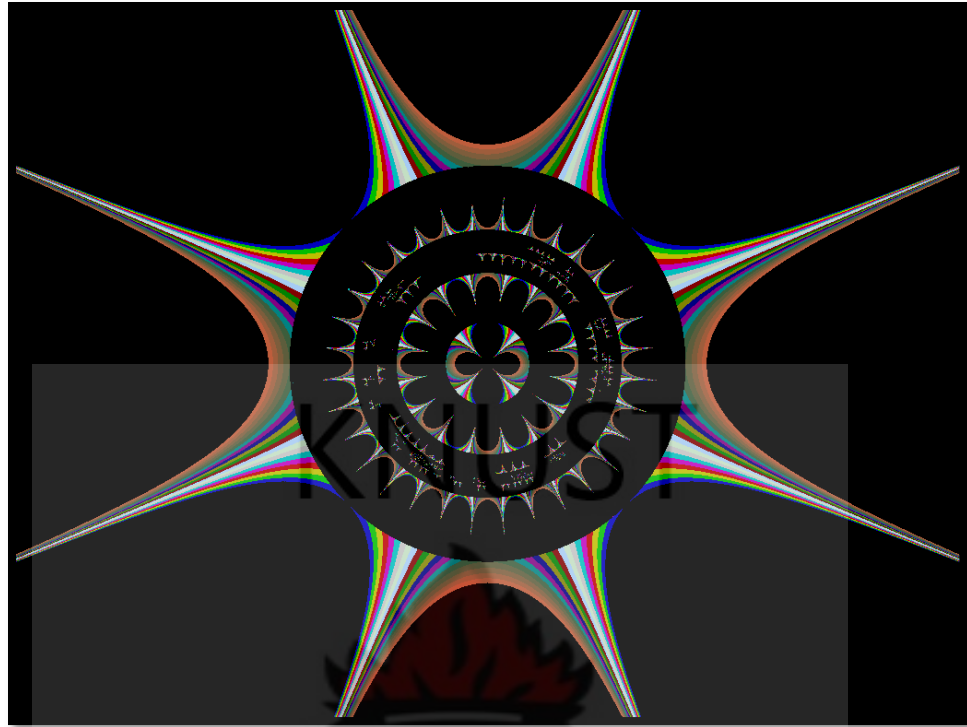


Plate: 23

Sq(1fn) Bonkeka Zuvaka: Floating pt. math., Basic option, Passes: tesseral,

Image Corner values: Xmin = -4.000000000000, Xmax. = 4.000000000000

Ymin = -3.000000000000, Y max. = 3.000000000000, Maximum iteration: 20,

C.G.I. by Michael Nyarkoh, 2009.

Fratat 6

Researcher: Michael Nyarkoh

Plate 24: *Sqrfn Amezia Zuvaka*

Floating pt. math.

Basic option

Passes: S. Guess

Real

Image Corner values:

Xmin = -4.000000000000, Xmax. = 4.000000000000

Ymin = -3.000000000000, Y max. = 3.000000000000

Maximum iteration: 20

Sqrfn Amezia Zuvaka in plate 24, p.194, shows rainbow coloured curvilinear patterns. A separate curvilinear arch is attached on each side of the composition. It is rendered in pink to light blue tones and is represented as joined strands of violet, blue, yellow, green, red and tinted blue and brighter pink, cyan, violet, red, yellow, green and blue colours separated by a white strip. A series of pinkish-blue and black tones are placed on the outer left and right ends. The intensity is increased at dividing halves placed in the top and bottom of the composition.

The middle area is marked by a continuous arch. Black background arches are iterated into infinitely generated concentric circles. The iteration is generated into a

visible fifth zoom out scale. The central arch of linear concentric scaling opens into a larger black mid-point. The overall fractal design depicts a rainbow curvilinear representation set on the hat-*Amezia zuvaka* motif. The rainbow is seen as a sign of joy as it brings rain after a severe long drought.

KNUST





Plate: 24

Sqrfn Amezia Zuvaka: Floating pt. math., Basic option, Passes: S/Guess,

Real Image Corner values: $X_{min} = -4.000000000000$, $X_{max} = 4.000000000000$

$Y_{min} = -3.000000000000$, $Y_{max} = 3.000000000000$, Maximum iteration: 20

C.G.I. by Michael Nyarkoh, 2009.

Fractal 7

Researcher: Michael Nyarkoh

Plate 25: *Complex Newton Cowry and Zinzira in Akunyena-nii Conurbation*

Real part of degree: 3.000000

Imag part of degree: 0.000000

Real part of degree: 1.000000

Maximum iteration: 200

Basic option: Imag – colour – S. Guess

Image Corner values:

Xmin = -4.000000000000, Xmax. = 4.000000000000

Ymin = -3.000000000000, Y max. = 3.000000000000

Complex Newton Cowry and Zinzira in Akunyena-nii Conurbation fractal painting in plate 25, p.197, show three basic curvilinear designs. They are rendered in brightly coloured white, pink, cyan, royal purple, violet, red, yellow and green colours. The three main designs are joined and directly attracted towards the centre. Each curvilinear representation is separated by wavy bands that are also separated by a circular representation enclosed in a series of joined bands.

The bands have similar iterative and recursive patterns. They show the bright tints of the initial set of tones with violet, cyan and light pink colours. The pattern is bold, unspotted, fluid and soft, showing a wavy trend as the pith closes in at the centre. The

smaller circular shapes represent a star-like formation generated in red and green yellowish and dark blue tones.

They are done in continuous wavy strands of open bean husk-*zinzira* representation. These shapes are placed in a ring with an infinite scaled pattern to form a distinct conurbation.

KNUST



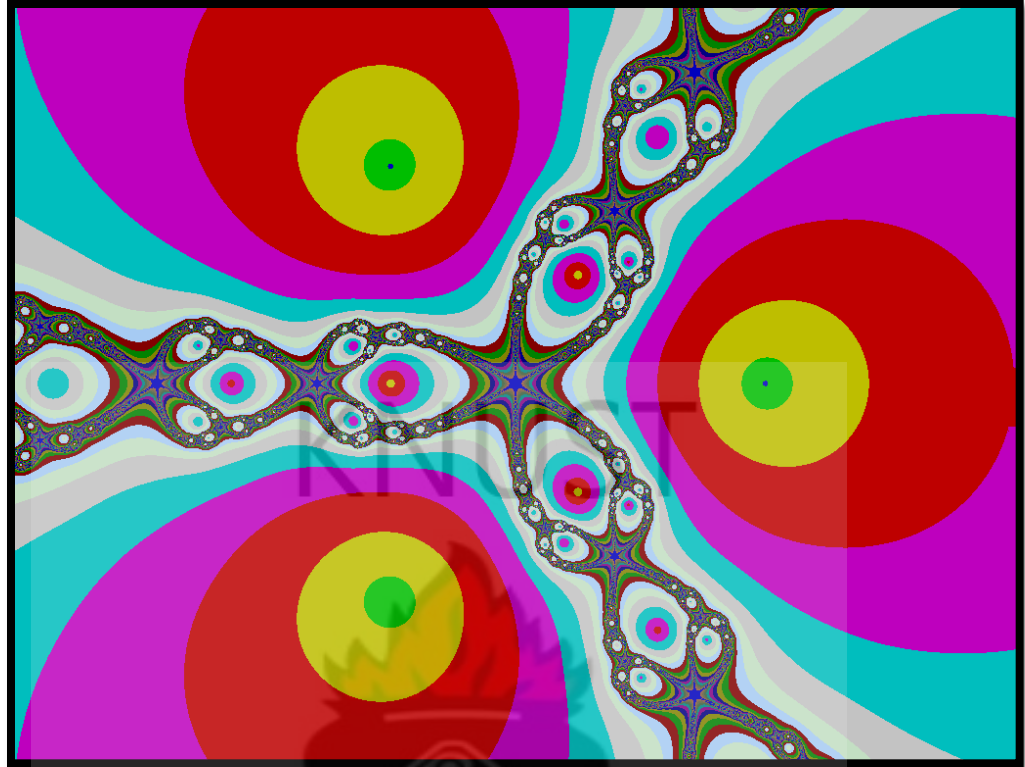


Plate: 25

Complex Newton Cowry and Zinzira Akunyena-nii Conurbation: Real part of degree: 3.000000, Image part of degree: 0.000000, Real part of degree: 1.000000, Maximum iteration: 200, Basic option: Image – colour – S/Guess, Image Corner values:

Xmin = -4.000000000000, Xmax. = 4.000000000000, Ymin = -3.000000000000,

Y max. = 3.000000000000, GI. by Michael Nyarkoh, 2009.

Researcher: Michael Nyarkoh

Plate 26: *Hypercomplex Waafo*

Fractal formula

1st function-ident.

Basic option - S.Guess,

Xmin = -2.000000000000, Xmax. = 2.000000000000

Ymin = -1.5.00000000000, Y max. = 1.5.000000000000

Maximum iteration: 20

Hypercomplex Waafo is the fractal representation in plate 26, p.200 features a linear concentric design. It is rendered in a perfect iterated form. Red, violet, cyan, pink, white and light-blue is the first set of tones. Brown, green, yellow dark blue, violet, cyan constitute the second set and dull greenish-pink flows into much brighter tones to form the third set of colours.

The inner central infinite area is depicted as black. This is represented as a single drop of circular pattern. The design is refreshed in cosmic form, which radiates and reflects the energy of the infinite centre. The progression is swift as it moves rapidly towards the mid dark area. Contrast is created as the sharp brown separate a shade of the colours below and the bright colours above. The black central pith is depicted as

absorbing all the spectral resolutions. The final design is characteristic of the *Bomborisi* coiled python-*waaf*o motif.

The painting is a computer generated fractal image also based on simulated linear concentric circle found in fig. 18, p.45. In this painting the spaces in each ring has been painted in different hues.

KNUST



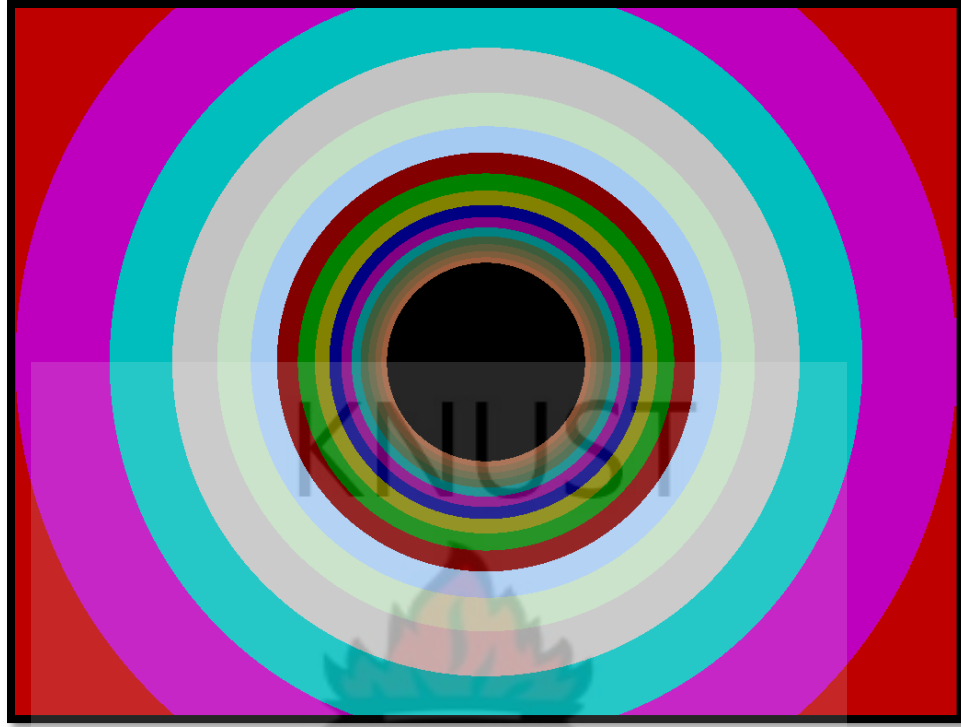


Plate: 26

Hypercomplex Waafu: Fractal formula, 1st function-ident., Basic option –
 S/Guess, Xmin = -2.000000000000, Xmax. = 2.000000000000, Ymin = -
 1.5.00000000000, Y max. = 1.5.000000000000, Maximum iteration: 20, GI. By
 Michael Nyarkoh, 2009.

Fractal 9

Researcher: Michael Nyarkoh

Plate 27: *Barnsleyj1 Spiral Bomborisi Home*

Real parameter 0.60000

Imaginary parameter: 1.1

Xmin = -2.00000000000, Xmax. = 2.00000000000

Ymin = -1.5.00000000000, Y max. = 1.5.00000000000

Basic options

Max

Iter: 10; Inside colour: - 20; Outside colour:- 20

Fill colour: 1

Barnsley1 Spiral Bomborisi Home plate 27, p.203 represents organic life. It shows four full and two halved iterated spiral motifs. The rendition is a reflection and also shows a self-similarity pattern in the range formation. The fractal design is rendered in brown, green, blue, violet, white, and cyan colours. The motifs have been each iterated to form a parent-tree and branches effect. They are scaled to cover the entire background design. A recursive and iterated generation is visible at the ninth generation. The lower motifs spin to the right while the top motifs reflect towards the left side of the composition. They are depicted into the sixth fractal generation. The first parent spiral is generated into an infinite iterated pattern on a brownish green background. The colours are natural and earthy, a representation of a fractal simulated circular *Bomborisi* home.

KNUST



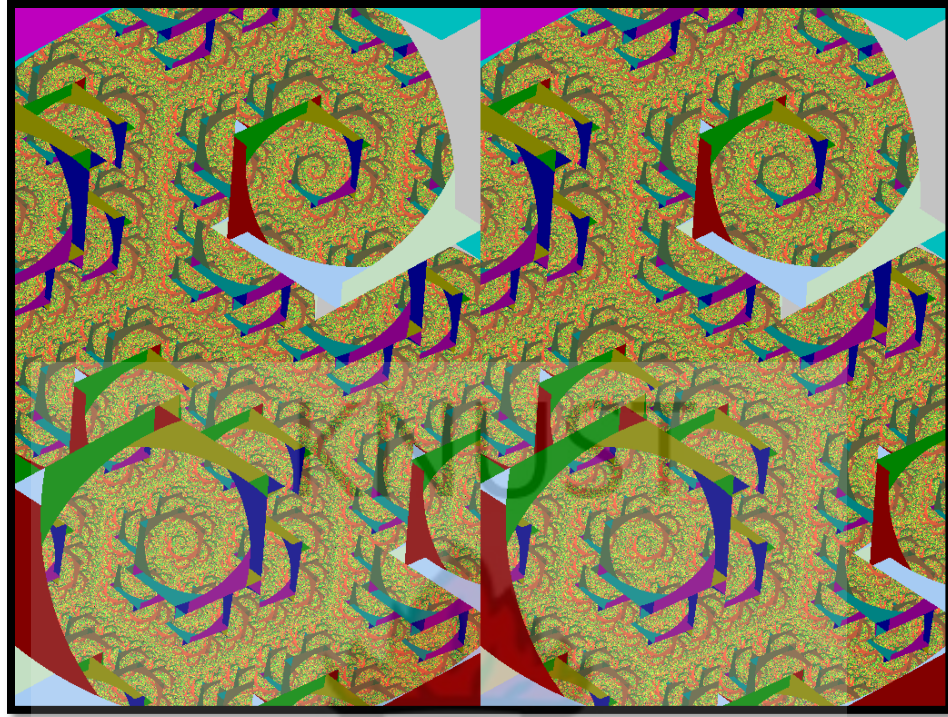


Plate: 27

Barnsleyj1 Spiral Bomborisi Home: Real parameter 0.60000

Imaginary parameter: 1.1, Xmin = -2.000000000000, Xmax. = 2.000000000000

Ymin = -1.5.000000000000, Y max. = 1.5.000000000000, Basic options, Max Iter:

10, Inside colour: - 20; Outside colour:- 20, Fill colour: 1 GI. By Michael

Nyarkoh, 2009.

Researcher: Michael Nyarkoh

Plate 28: *DynamicYoka*

+ # of intervals [<0 = connect: 50.000000

Time step:[,0= Euler: 0.1000000

a : 1.000000

b: 3.000000

First function: ident

Basic Option

S. Guess – Maxit

Maximum iter: 20

Xmin= - 20.000000000000, X max= 20.000000000000

Ymin= - 20.000000000000, Ymax= 20.000000000000

Dynamic Yoka in plate 28, p.206, is a fractal composition that represents a dark grill spread. It also depicts recursions of squares with concentric and curvilinear patterns. The composition gives off royal multiple tones. The larger inner interior of the patterns is painted from an inclining diagonal that was from the top left to the lower right.

The design reveals visible curvilinear patterns on each corner of variegated iterated concentric formations. The fractal design depicts geometric symbiosis with Sirigu traditional fishnet-*yoka* and calabash net-*zaalenga* motifs.

KNUST



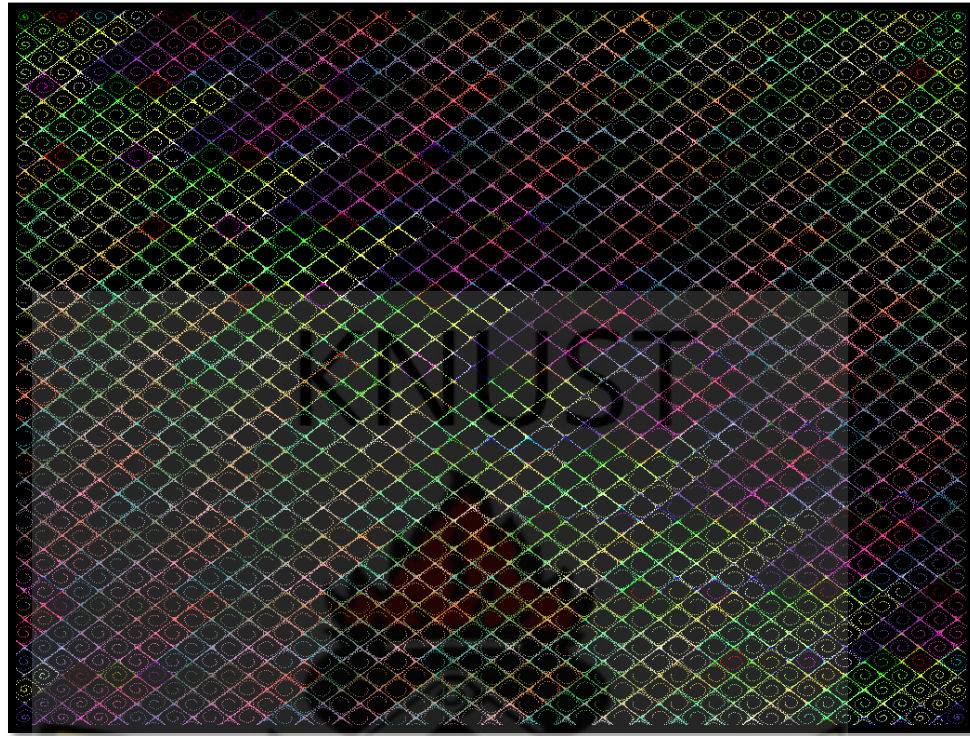


Plate: 28

Dynamic Yoka: +# of intervals [<0 = connect: 50.000000,

Time step:[,0= Euler: 0.1000000, a : 1.000000, b: 3.000000, First function: ident,

Basic Option, S/Guess – Maxit, Maximum iter: 20 Xmin= - 20.0000000000000, X

max= 20.0000000000000, Ymin= - 20.0000000000000, Ymax= 20.0000000000000,

GI. by Michael Nyarkoh, 2009.

The fifth set of computer-generated fractal experimentations are rendered as fractal formations based on the previous selected experimentations and represented as ***Bomborisi Fractal Transformations***¹⁻¹⁰ as in plates: 29-36, respectively. They were created using Adobe Photoshop 7.0 Application software.

This fifth set of *Bomborisi* fractals shows combinations of selected manual and digital experimentations found in the previous second, third and fourth sets. This set of fractal geometric forms has been appropriated and named, ***Bomborisi Fractal Transformations***. They are intended to portray and represent digital ideas of the *Bomborisi* fractals into the author's new kind of fractal technique. This technique is simulated into the paintings to be adapted, shared and used by individuals to extend the inexhaustible *Bomborisi*.

It defines one's own conceptual wall to take the fractal simulated paintings. These were digitally created unlike the traditional or manual experimental renditions previously done. They also show further manipulations of the computer-generated fractals into *Bomborisi Fractal Transformations* that reveals a new virtual wall painting. They are represented as repetitive, recursive, scaling, iterative, translative, chaotic and transformative fractal paintings.

The final fractal result is very fulfilling. It reveals nothing more than an inner intent, satisfying an inner ego, with an endless finite delight.

Bomborisi Conceptualism¹

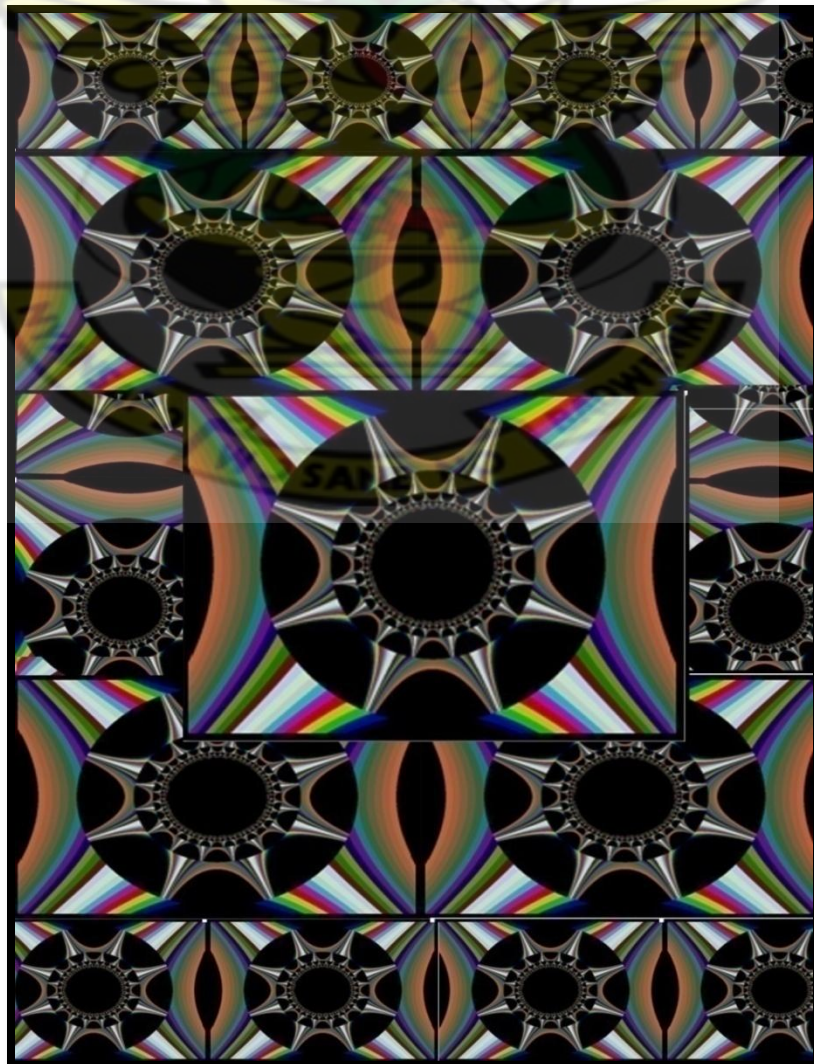
Plate: 29

Title: *X*

Researcher: Michael Nyarkoh

Medium: Computer Generated

X painting in plate 29, p. 209, is a digitally abstracted representation of circular and curvilinear reflections of *sqrfn amezia zuvaka* in plate 23, p.191, are shown as fractal translations. They also reflect transformed “X”, which represent all types of walls. They were created on various walls to symbolise classiness and modishness as pertains in Sirigu to a shared complement.



KNUST



Plate 29

X: Medium: C.G.I. by Michael Nyarkoh, 2009.

Bomborisi Conceptualism2

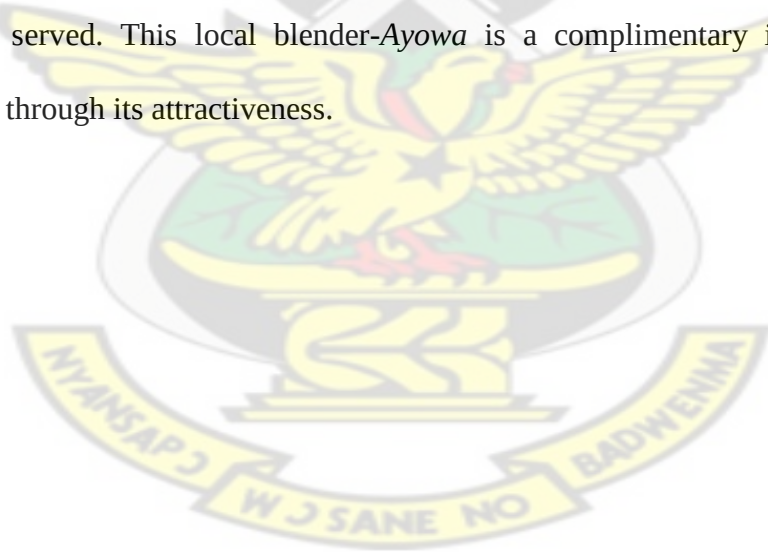
Plate: 30

Title: *Ayowa*

Researcher: Michael Nyarkoh

Medium: Computer Generated

Ayowa painting in plate 30, p.211, shows reflections of the concentric *Bomborisi* design *Hypercomplex Waafo* in plate 26, p.200. It is portrayed in an array of selected *Ayowa* dining plate placed on a revolving table that, as it turns, the warm red and cyan and light toned plates with delicacies are picked ready, to be served. It reflects the various tastes and preferences of the individual. When the table turns and revolves, the individual is readily served. This local blender-*Ayowa* is a complimentary item to satisfy the individual through its attractiveness.



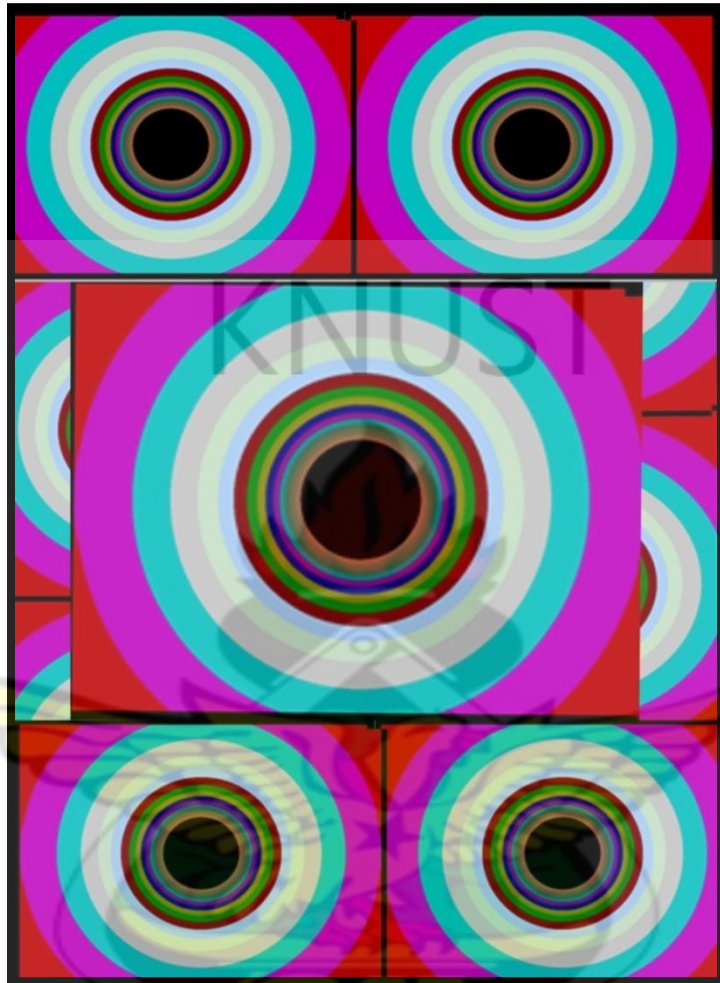


Plate: 30

Ayowa: C.G.I. by Michael Nyarkoh, 2009.

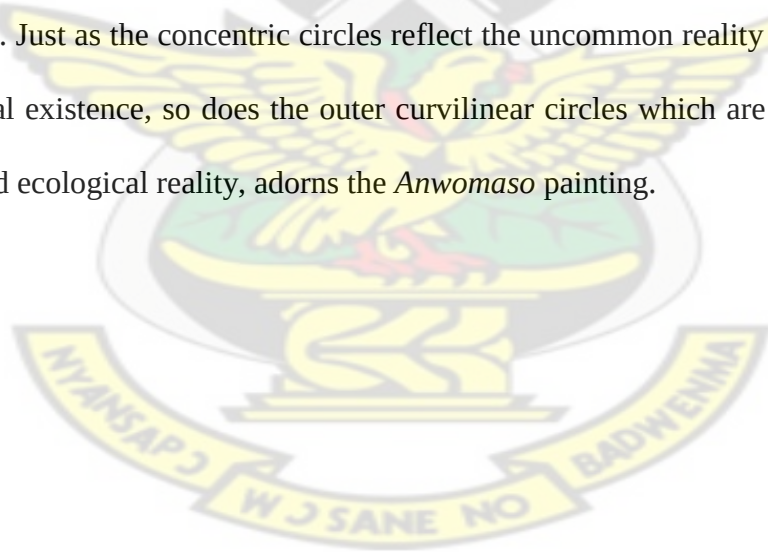
Plate: 31

Title: *Anwomaso*

Researcher: Michael Nyarkoh

Medium: Computer Generated

Anwomaso painting in plate 31, p.213 is a digital fractal geometric organic representation based on Lambdafn triangular concentric circle plate 21, p.185. This grow outwards from the core of those elements such as line, triangle, square and circle, that are universal to the concentric circle represented treated on the wall of a building at *Anwomaso* village. The painting contains reflections of the everyday world as seen by the researcher. Just as the concentric circles reflect the uncommon reality and ritual reality of the cultural existence, so does the outer curvilinear circles which are in contact with the human and ecological reality, adorns the *Anwomaso* painting.



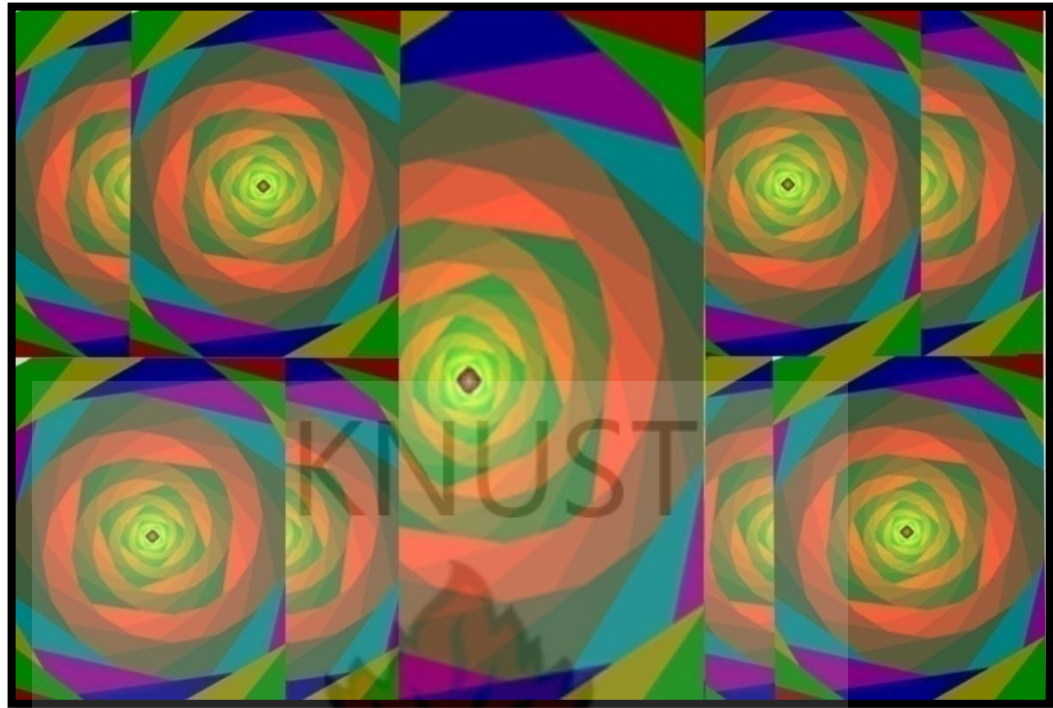
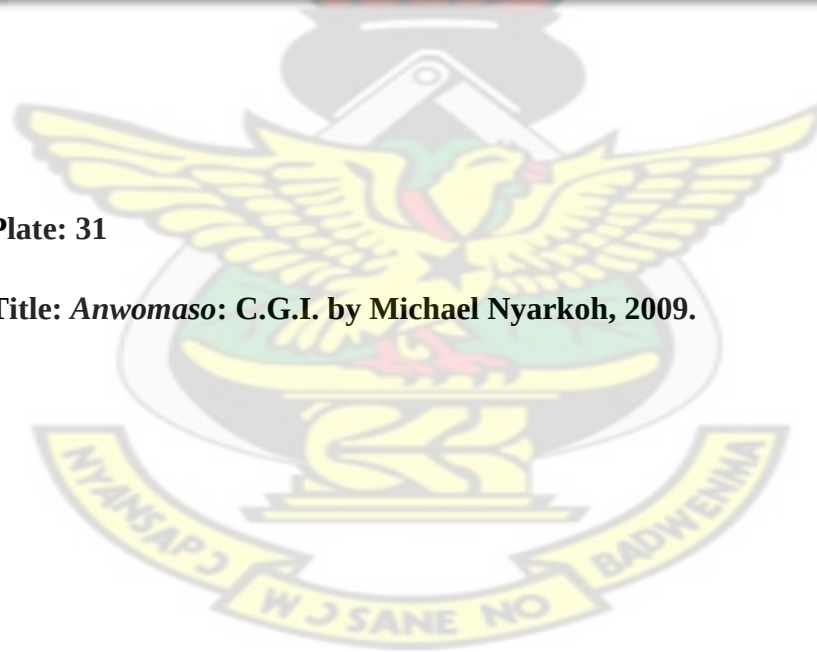


Plate: 31

Title: *Anwomaso*: C.G.I. by Michael Nyarkoh, 2009.



Bomborisi Conceptualism4

Plate: 32

Title: *Kosua*

Researcher: Michael Nyarkoh

Medium: Computer Generated Image

Kosua painting in plate 32, p.215, which is based on Complex Newton Cowry and *Zinzira Akunyena-nii* conurbation plate 25, p.197 is a digital representation of my kind of fractal designed wall. In essence, this painting provides a forum for coming to terms with life and putting it into perspective. *Kosua* is literary and visually an essential means of giving voice to the silences in those intimate areas that shape such walls.

Closely linked with this is the exploration of "touch" in human interaction with fractals. There is, within this context, a preoccupation that gives form to the fluidity of contact, separation, distance, love, and the emotional undercurrents that arises in this painted design. In navigating these wavy and fractal flows, the researcher is continually challenged to explore my inner emotional experience in search for that unique egg-*kosua* with pure yellow and white fluid which is represented in the beautiful mosaic of life that is reflected in the *Kosua* image.

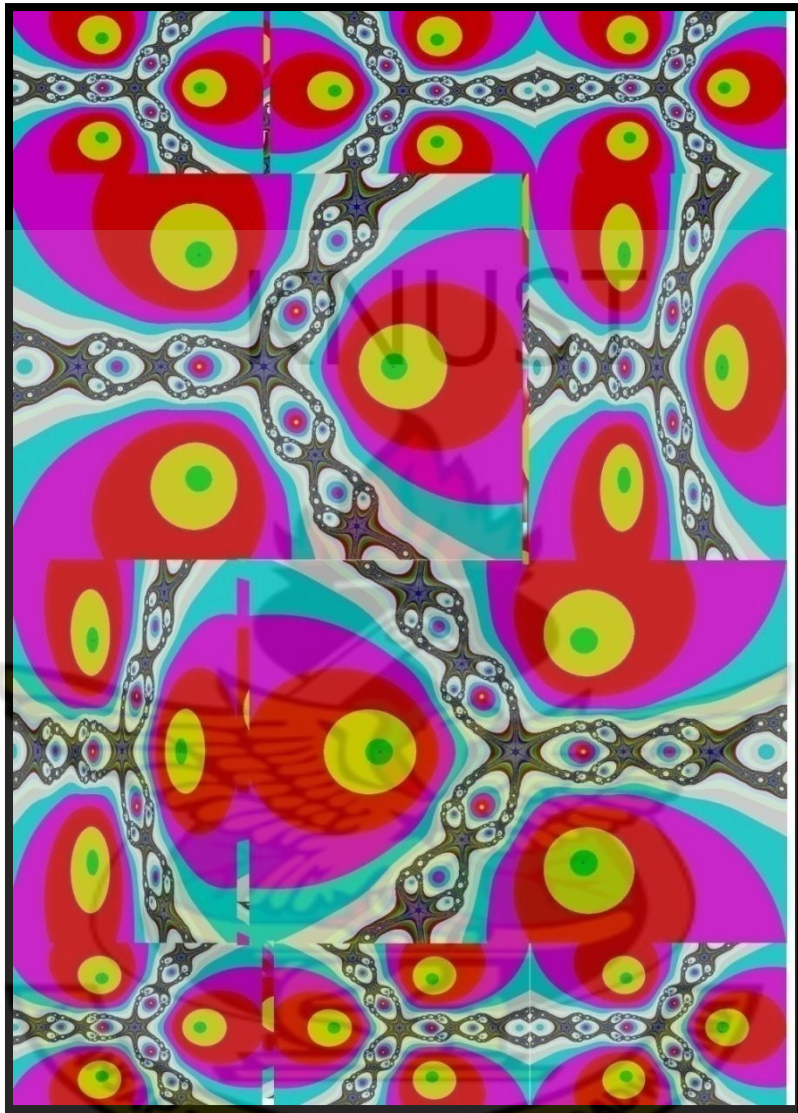


Plate: 32

Kosua: C.G.I. by Michael Nyarkoh, 2009.

Bomborisi Conceptualism⁵

Plate: 33

Title: *Maame Serwaah*

Researcher: Michael Nyarkoh

Medium: Computer Generated

Plate 33, p.217, with title *Maame Serwaah*, which is based on “Soul of Akanvole” plate 13, p.164, shows a complex textural detail effect of green and warm tones. It is a fractal reflection by transforming through simulation of plate 13. The lines and geometric forms are represented in a chaotic manner arranged to give a facial to *Maame Serwaah*. It is characteristic of young *Maame Serwaah*, who reflects the colour green and warm tones which make her energetic, sophisticated, lovely, variegated, complex and pretty. She represents a colourful mosaic of life.



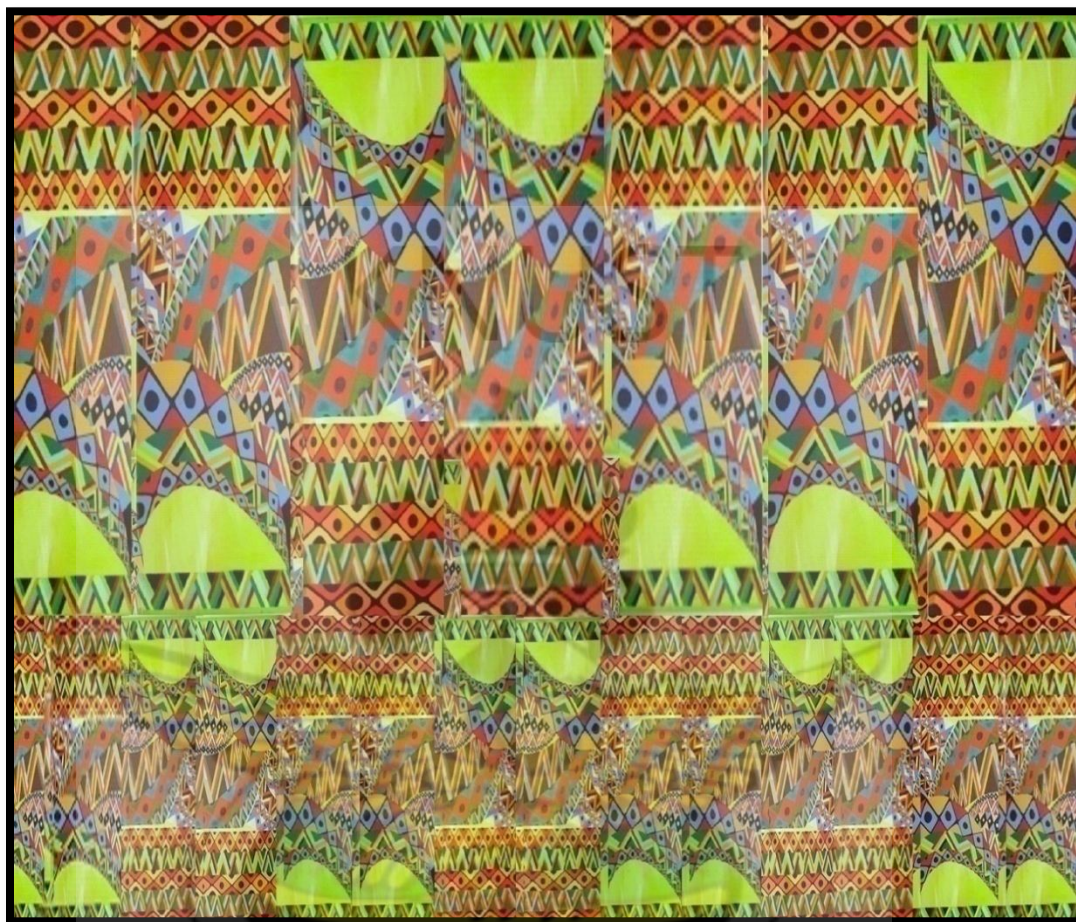


Plate: 33

Maame Serwaah: C.G.I. by Michael Nyarkoh, 2009.

Bomborisi Conceptualism 6

Plate: 34

Title: *Booban*

Researcher: Michael Nyarkoh

Medium: Computer Generated

Booban in plate 34, p.219, which is based on *Wanne* Cowry fond in plate 17, p.173, shows a composition with a strong linear and triangular *Bomborisi* calabash quality. The painting imagery contrasts between positive and negative space; its images appearing in the form of abstracted constellations. The painting's lyrical qualities express harmony and brevity. It represents freedom and spontaneity. The complex triangular elements reveal a pride of heritage.

Booban generally refers to images of everyday life at *Booban* village. It is created to adorn the walls during ceremonial occasions and important events. The researcher used similar intricate triangular images to add beauty to the walls of buildings and compounds at *Booban* village.

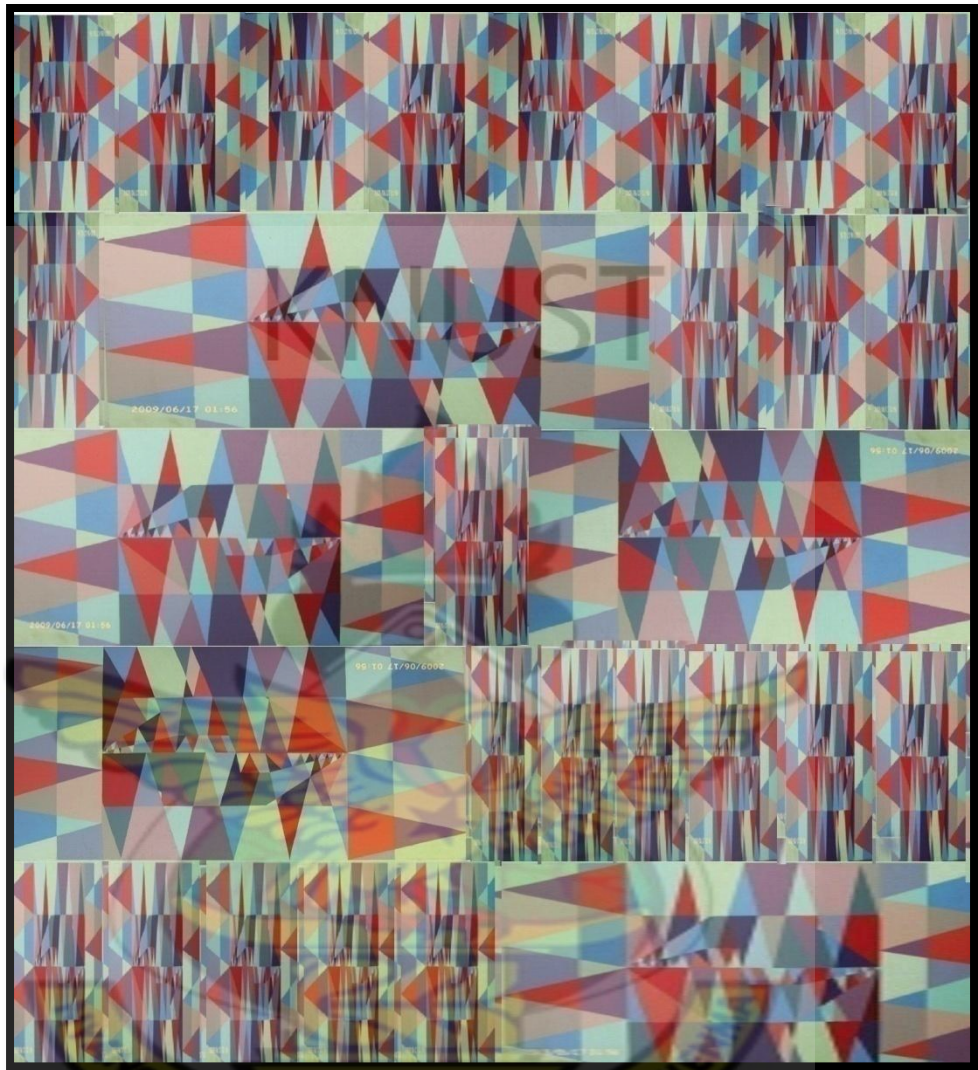


Plate: 34

BoobanWall: C.G.I. by Michael Nyarkoh, 2009.

Plate: 35

Title: *Ntoma*

Researcher: Michael Nyarkoh

Medium: Computer Generated

Ntoma painting in plate 35, p.221, which is based on Cantor's *Bomborisi* plate 8, p.147, represents fractal arrangements found in textile garments. The geometric design showcases threads gathered to create intricate fabric, which is vigorous yet tender. Its glamour is manifested in the warm *Ntoma* design. It reveals pride and abundant enchantment. It is portrayed to conceal the untouched fabric with the *Ntoma*.





Plate: 35

Ntoma: C.G.I. by Michael Nyarkoh, 2009.

Bomborisi Conceptualism 8

Plate: 36

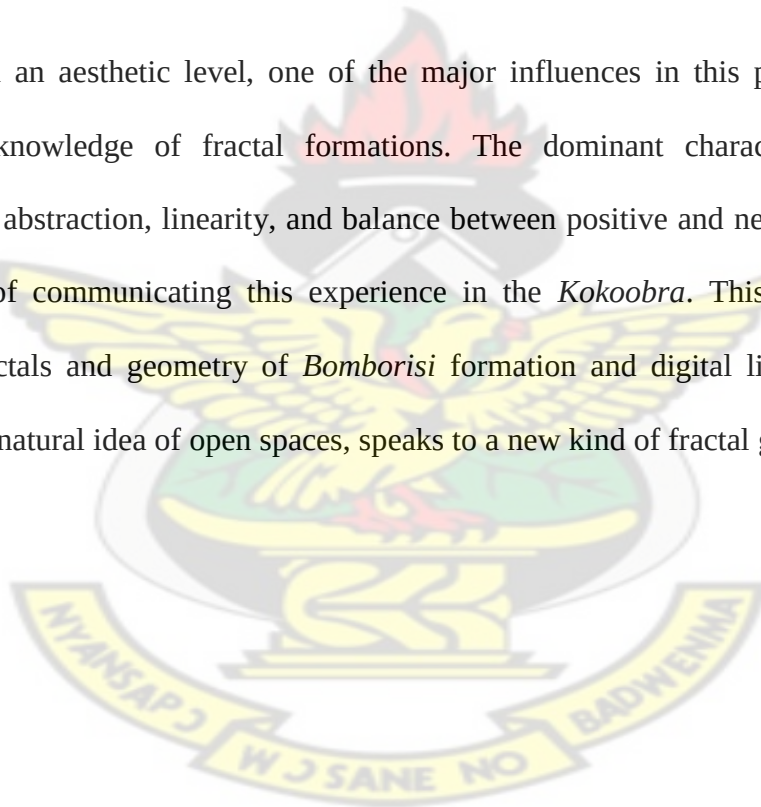
Title: *Kokoobra*

Researcher: Michael Nyarkoh

Medium: Computer Generated Image

This painting titled *Kokoobra* in plate 36, p.223, which is based on *Tana Koch* Curve plate 14, p.165, reveals and communicates the parallel forces of emotion in human life; its undercurrents and the often imperceptible threads it weaves around our lives.

On an aesthetic level, one of the major influences in this painting has been a growing knowledge of fractal formations. The dominant characteristics of fractal geometric abstraction, linearity, and balance between positive and negative spaces are at the core of communicating this experience in the *Kokoobra*. This visual expression, where fractals and geometry of *Bomborisi* formation and digital line work create the unspoken natural idea of open spaces, speaks to a new kind of fractal generated image.



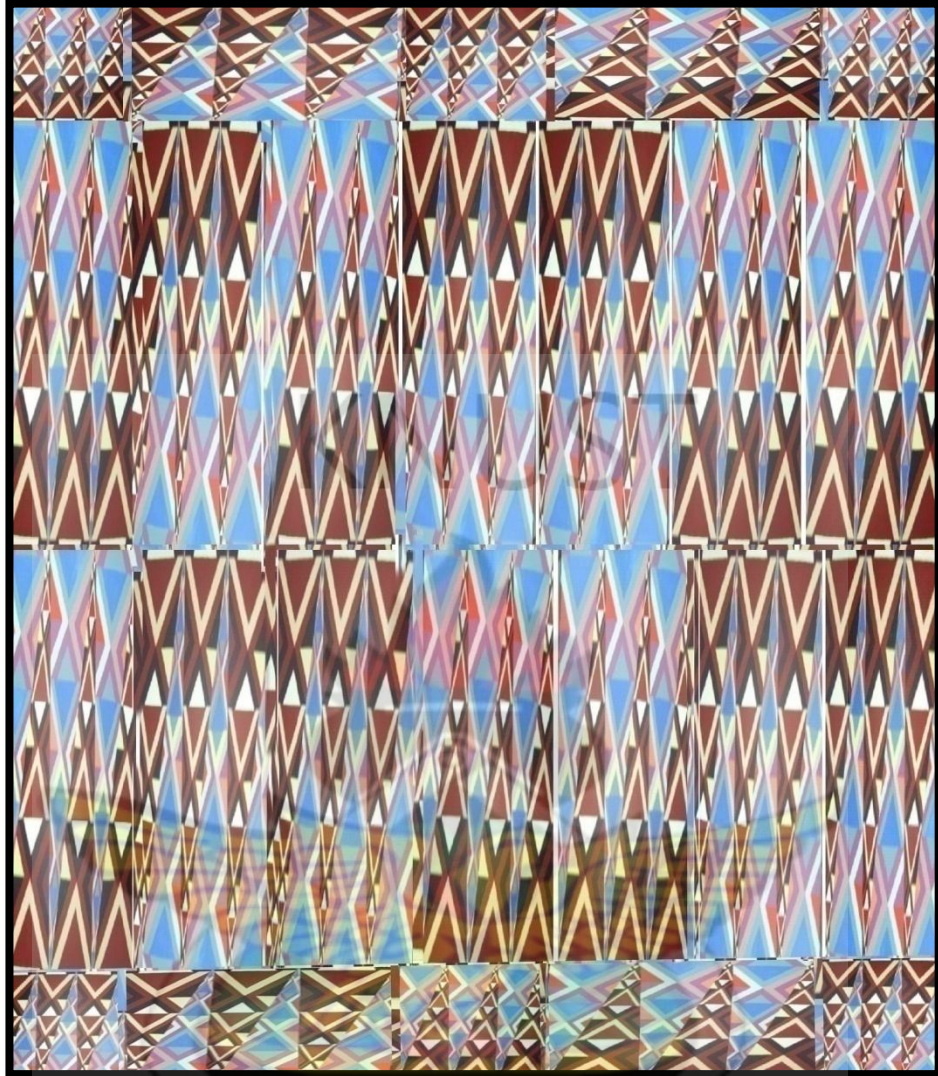


Plate 36

Kokoobra: C.G.I. by Michael Nyarkoh, 2009.

Plate: 37

Title: *Denkyembuo*

Researcher: Michael Nyarkoh

Medium: Computer Generated

Dekeyembuo painting in plate 37, p.225, which is based on *Bomborisi Gem* found in plate 11, p.156, expresses a dialogue between chaos, iterations, scaling and transformations in fractals. At the core of the creative fractal work in these triangular shapes lays the elemental bond they share, a bond that is located in conversations with *Dekeyembuo*. As a result, the variegated triangles exist on several shared levels. The painting responds to a personal need to create fractals from emotions and the experiences from which they evolve.

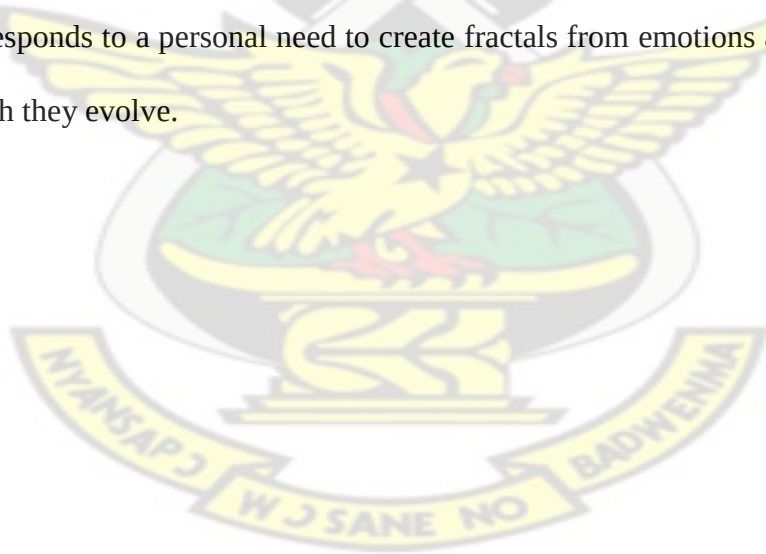




Plate 37

Dekyembuo: C.G.I. by Michael Nyarkoh, 2009.

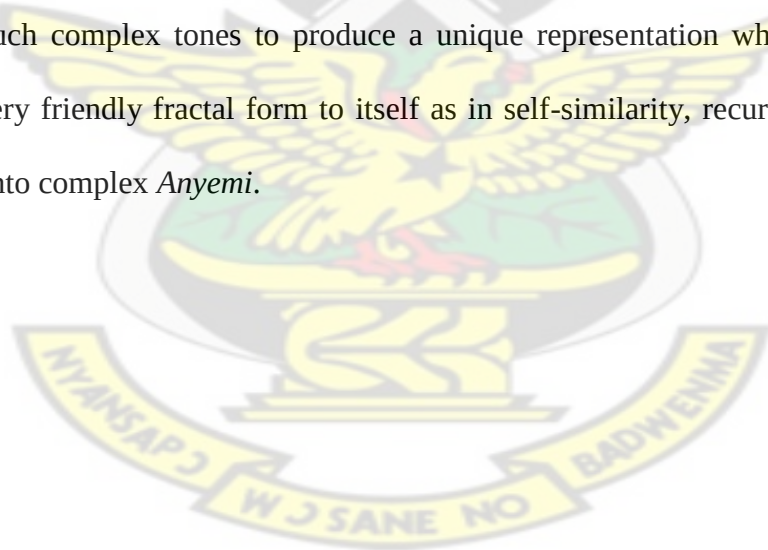
Plate: 38

Title: *Anyemi*

Researcher: Michael Nyarkoh

Medium: Computer Generated

Anyemi is the final single set of fractal simulated painting in plate 38, p.227. It reflects all of the fractal resolutions of the previous sixth fractal transformations. It reflects *Anyemi*, literary referring to a pal, friend or brother. It also shows complex transformations of fractal images that reflect variegated induced tones. These tones are manifested in the characteristic friendly hues that are projected to the wall. The wall absorbs such complex tones to produce a unique representation which is translated to attract every friendly fractal form to itself as in self-similarity, recursion and chaos and advance into complex *Anyemi*.



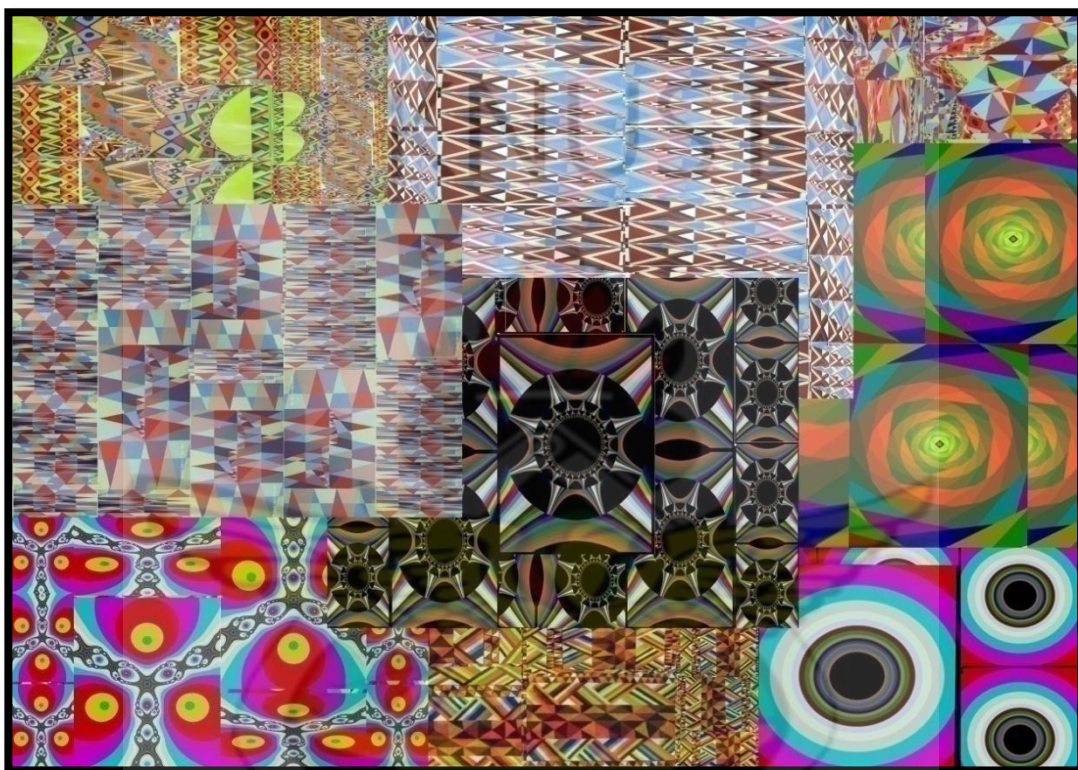


Plate: 38

Anyemi: C.G.I. by Michael Nyarkoh, 2009.

CHAPTER FIVE

SUMMARY OF RESULTS, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY OF RESULTS:

The title of this thesis is “Transformations in Sirigu Wall Painting and Fractal Art Simulations”. The first chapter introduces the background of the study, the statement of the problem, and specific objectives to find out the nature of the transformations in Sirigu wall painting. The delimitations, importance of the study, definition of terms, the research methodology, to research facilities and the arrangement of texts are also included in this chapter.

The second chapter covers review of related literature through library study. The researcher gained knowledge in fractal art which involves the use of geometry. The generation of fractal images have gone through pioneering stages by ethno-mathematicians, such as Ron Eglash, Benoit Mandelbrot and Brett Sims to mention a few. They have formulated theories like scaling, self- similarity, recursion, iteration, translation, reflection, transformation and chaos etc.

African Fractals: Modern Computing and Indigenous Designs by Ron Eglash discussed the fractal nature of the Nankani home, which includes those found in Sirigu. In respect to *Bomborisi*, Eglash mentioned that, the smallest container in a woman’s set of utensils which is the “calabash net-*zaalenga-kumpio* is a shrine for her soul”.

The third chapter covered the research methodology and the field work review which enabled the researcher to do an in-depth study of wall painting in Sirigu referred to as *Bomborisi*. This involved the acquisition of knowledge concerning the materials, tools

and methods used in the execution of the *Bomborisi*. Knowledge of the geometric, symbolic *Bomborisi* motifs such as pieces of broken calabash-*wanzagsi* and python-*waafo* was also acquired.

The fourth chapter covered a series of experiments to effect transformations by manipulating *Bomborisi* motifs manually using conventional acrylic and poster colour techniques. This was followed by manually integrating *Bomborisi* motifs with fractal art elements. The computer was used to digitally simulate *Bomborisi* motifs in order to generate enhanced fractal art characteristics of translation, reflection, chaos, self-similarity, scaling and others. Finally, some selected manual experimental paintings were further manipulated digitally into fractal conceptualism.

Major Findings from the Field

The researcher sought for the nature of transformations in Sirigu wall painting. The researcher identified four prominent developments in the *Bomborisi* transformations by the Sirigu women artists. This was classified under the original nature of the *Bomborisi* and its transformation in the village setting in Sirigu as well as subsequent transformations beyond Sirigu.

The original nature of architecture in Sirigu takes the form of earthen walls providing support for the *Bomborisi* painting using natural earth colours such as brown, red, black and white as pigment.

The associated *Bomborisi* motifs are dominated by geometric patterns with selected totemic images. Some of the geometric motifs are known as cattle path-

Akunyena-nii, calabash net-*Zaalenga* and broken pieces of calabash-*wanzagsi*. The totemic images include cow-*Naafo*, python-*Waafo* and crocodile-*Eebga*.

The second transformed nature of *Bomborisi* in Sirigu has been discovered in new architectural structures. Most of the earthen walls have been replaced with cement block walls, which have brought about the use of acrylic, emulsion and enamel as the new painting media.

Despite the change in the support and medium, the original *Bomborisi* motifs have been maintained alongside new motifs such as fish-*Ziifo*, strips-*Tanne* and traces of vegetation.

The third transformation involves painting on canvas. The Sirigu women have transposed *Bomborisi* on canvas using a combination of the original and new motifs side by side with acrylic and enamel media.

The fourth transformation involves recent paintings by Sirigu women beyond the borders of Sirigu.

The women have created *Bomborisi* on walls of buildings like the Catholic Cathedral in Navrongo, Tiedar Restaurant in Bolgatanga and The Golden Tulip Hotel in Accra. The Catholic Cathedral earthen walls have *Bomborisi* decorations using a combination of local earth pigments and enamel paint.

The dominant images of *Bomborisi* in the Cathedral were derived from a combination of traditional *Bomborisi* motifs and Christian Biblical iconography. Some of

the prominent images represented include Christ, Angels, *dogolongo*, *Wangzasi*, *Waafo* and *Eebga*.

The open air restaurant walls of the Golden Tulip Hotel have *Bomborisi* rendered creatively on them by Sirigu women artists. The medium used is mainly acrylic and enamel paint. There is evidence of typical *Bomborisi* motifs and totemic images. Prominent among them are *Wangzasi*, *Akunyena-nii*, *Weefo*, *Ziifo* and *Niila* painted in the *Bomborisi* colour scheme.

They are located in the bar area, the chalets, the walls and the entrance of the restaurant. The motifs used include school children holding hands-*agurinuuse*, calabash net-*zaalenga* and broken pieces of calabash- *wangzasi* and motifs respectively. They have been rendered using acrylic and enamel pigments on already plastered concrete wall.

In addition, exhibition of *Bomborisi* paintings on canvas by Sirigu women have been held at the Golden Tulip in Accra with sponsorship from the Danish Government. Similar exhibitions have also been held in the Netherlands under the caption “Wall to Wall” by World Art Foundation and Goethe Institute.

Studio Art Experiments

Following the field work experience, time was spent in doing studio art experimentations and analysis for the thesis project by applying conventional manual painting techniques and new computer generated fractal art techniques as exhibited in plates 1-38, pp.127-227.

The reproduction of *Bomborisi* fractals for this thesis detaches the experimental paintings from the domain of Sirigu tradition. By making many reproductions it substitutes a multiplicity of copies for a computer mediated fractal existence.

The first, second and third sets of paintings were manually painted by exploring with Sirigu *Bomborisi* symbols. The experiments set the tone for transformations in recreating *Bomborisi* designs using conventional materials and tools for the studio paintings. Fractal characteristics such as self-similarity, chaos and Seirpinski's triangle in *Bomborisi* were combined with the Sirigu motifs to produce semi-abstract simulations.

The second set of five experiments shows transformations that reflect further abstracted fractal simulations by combining Koch curve, Cantor's dust and Seirpinski's triangle and *Bomborisi* motifs for the transformation. This set defined a further experimental transformation of fractal characteristics such as translation, scaling and iteration. The colour scheme reflected Sirigu wall painting of dominant red, black and white tones. This was a deliberate attempt to incorporate original traditional characteristics to the transformed studio fractal experiments.

The third set of transformation also provided greater exposition on fractal elements such as concentric circle transformations, scaling, and reflections among others. The colour scheme for this set was very much detached from the original to the researcher's interest and personal content. These compositions were simulated manually to assert abstracted fractal identity in the paintings using acrylic on board.

The fourth set involved ten geometric computer generated images. They were obtained by making a mathematical in-put with numerical digits to produce the final colourful fractal images. The abstracted images were extremely dematerialised and very much detached from previous experiments and also from the original Sirigu *Bomborisi* realm.

The fifth set of fractal images are further simulations based on the previous computer generated fractals in the fourth set. It was possible to recreate them into mosaic images by using Photoshop 7.0 software.

These sets of paintings were done by combining selected manual and computer generated images in the previous third and fourth sets to create a complex fractal design. The resultant image portrayed images that reflected the researcher's personal transformations.

These experiments allowed the individual to adapt *Bomborisi* tradition which is located in collective authorships for exploration. The original motifs have been found to contain some fractal characteristics. The studio work exploited selected geometric motifs and it was possible to appropriate the results by dematerialising and decoding the simulated works with hybridity of codes. In a walk through the project experimental journey, the paintings reveal concerted attempts to relate the experiment with the transformations found in Sirigu wall painting and beyond. It unlocks the location of *Bomborisi* to a multiplicity of copies which can be displayed on the net to many more individuals and could also be detached for other mediated functions.

It was also observed that further transformations can be extended to other known traditional symbols such as *kente* designs as well as *adinkra* motifs for similar simulations and transformations.

CONCLUSIONS

With reference to the topic on “Transformations in Sirigu Wall Painting and Fractal Art Simulations”, the fieldwork component of the research work gave the researcher the opportunity to examine the nature of transformations in the Sirigu *Bomborisi* wall painting tradition.

It became obvious that within Sirigu, four major transformations can be observed which take the form of *Bomborisi* painting with earth pigments on earthen walls, a mixture of earth pigment and synthetic paint on earthen walls, *Bomborisi* painting with synthetic paints on cement block walls and canvas paintings.

It was also observed that other transformations involving *Bomborisi* painting by the Sirigu women artists can be found beyond the boundaries of Sirigu itself in places like the Catholic Cathedral in Navrongo, Tiedar Restaurant in Bolgatanga and the Golden Tulip Hotel in Accra.

Through this project, the researcher has acquired new knowledge in fractal art and geometry techniques (through Library research and personal contacts with experts in fractal art and geometry) which made it possible for the researcher to appropriate and simulate *Bomborisi* motifs into new fractal images by using computer Software

Applications such as Matlab run on JAVA, C++ Windows Version-(Winfract) and Adobe Photoshop 7.0 Applications.

The researcher has also become conversant with some fractal formations such the Sierpinski's Triangle or Gasket, the Cantor's Dust and the Koch Curve. He has enriched his knowledge and artistic skill through fractal generated simulations such as iteration, translation, recursion, reflection, scaling and chaos.

In spite of acquiring information on fractal simulationists' works in the form of digital painting and designs, the researcher has developed much interest in fractal art with special reference to painting.

These are as a result of studio art experiments manually rendered to precede computer generated images not as a mathematician or computer scientist's approach but as manipulations of fractal art elements.

The outcome of this research project will help preserve, transform and transmit *Bomborisi* culture to many individuals and society. This project which covers the work of Sirigu women will also contribute to the socio-economic development of the people through eco-tourism.

RECOMMENDATIONS

Ross and Cole (1977) provided information on the nature of wall painting in the Kassena Nankani area in the Northern part of Ghana, which covers Navrongo and Sirigu respectively. From recent observation by the researcher, it appears that the wall painting

tradition has possibly been lost in Navrongo requiring Sirigu women to be engaged to maintain the *Bomborisi* in the Navrongo Catholic Cathedral earlier on painted by them. This shows that with age and time the wall painting tradition in Sirigu might also fade away. Conservation efforts should be made seriously enforced.

Fortunately, the Sirigu Women's Organization for Pottery and Art (S.W.O.P.A.), with the help of agencies such as Aid to Artisans-Ghana (A.T.A.G.) and the Government of Ghana are preserving the *Bomborisi* tradition through transformation efforts by transferring the *Bomborisi* wall painting ideas to canvas and by encouraging production of other artworks such pottery and straw products with *Bomborisi* motifs for the local and international market.

It is therefore recommended that the current developments in Sirigu should be emulated and replicated in other villages such as Zorko, Mirigu and Kandega with the support of Government and other Non-Governmental Organizations (NGOs) in order to preserve the *Bomborisi* tradition.

Eglash (1999), observed the fractal characteristics of the Nankani home with some associated objects like the "Woman's *Zaalenga*" (calabash stack pile) and identified their pattern of arrangement as a recursive fractal formation. Eglash used fractal art techniques to simulate the circular structure of the "Nankani Home". The researcher studied the nature of the *Bomborisi* motifs on the Nankani Home at Sirigu and transformed them into fractal formations in iteration, recursion, chaos, translation, scaling, self-similarity and reflection. He also used a combination of the *Bomborisi*

motifs, Sierpinski's Gasket and Koch Curve formations for other transformations through experimentation.

It is therefore recommended that similar transformations using other traditional geometric motifs found in Ghana should be studied by applying fractal art and geometry techniques so that new forms of painting would be evolved.

Through the study, the researcher became aware of other complex fractal formations in 3D, Motion and Zoom but did not make use of them due to limited time to carry out more experimental work.

It is therefore recommended that these other fractal formations should be given more consideration in future research work.

The researcher limited the thesis experimentations to selected Sirigu *Bomborisi* motifs, but there are other motifs such as chicken-*Niila*, lizard-*baasi*, fish-*Ziifo* and cow-*Naafo* which are zoomorphic in nature.

It is therefore recommended that more attention should be given to these other *Bomborisi* motifs in future research.

There is a growing interest in fractal art and geometry techniques in painting since the introduction of the PhD. Painting and Sculpture programmes in the Department of Painting and Sculpture at KNUST, Kumasi. It will be useful if this knowledge is introduced to other art institutions of learning in the country.

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REFERENCE

- Bovill (2006). Accessed 8/07/2009, from <http://www.google.com.gh/imgres?imgurl=http://fusionanomaly.net/fractals.jpg&imgrefurl=http://fusionanomaly.net/fractals.html&h=450&w=600&sz=46&tbnid=PA8YYHpx2ay>.
- Bovill (2006). Accessed 12/07/2008, from http://books.google.com.gh/books?id=w5ptaiGsac4C&dq=fractal+geometry+art&printsec=frontcover&source=in&hl=en&ei=w2CNSqP1IMvFlAev5pTCDA&sa=X&oi=book_result&ct=result&resnum=12#v.
- Bovill (1996). Accessed 23/04/2009, from <http://books.google.com.gh/books?q=fractal+geometry+art&source=in&ei=w2CNSq>.
- Brett, A. S. (2008). Fractal Geometry and Ghanaian Art Project Report, (Spring 2007 - Fall 2008), USA.

Collins English Dictionary - Complete & Unabridged (2009).10th Edition,

Courtney- Clark, M. (1990). African Canvas, Rizzoli International Publications, Inc., New York

Cowhey A. C, (1996). Traditional Mural Arts of Sirigu: Forms, Symbolism and Processes, Independent Study Project Report

Daily Graphic (August 2, 2008). Cultural Fund Awards SWOPA and 8 Others, Graphic Corporation, Ghana.

Eglash, R. (1999). African Fractals: Modern Computing and Indigenous Designs, Rutgers University Press, New Brunswick, New Jersey and London

Eglash, R. (1993). Inferring Representation Type from Spectral Estimates of Fractal Dimension in Communication Wavelengths, Journal of Social and Evolutionary Structures, USA

Eglash, R. (1995). African Influences in Cybernetics in the Cyborg Handbook, Routledge, NY

Eglash, R. and Broadwell, P. (1989), Fractal Geometry in Traditional African Architecture, Dynamics Newsletter, USA

Eglash, R. (1999). 20/08/2009, from <http://www.csdt.rpi.edu/african/afactal/afbook.htm>.

Eglash, R. (1999). Accessed 20/08/09, from http://www.csdt.rpi.edu/african/African_Fractals/index.html.

Eglash, R. (1989). Accessed 14/03/08, from <http://www.rpi.edu/~eglash/eglash.htm>.

Eglash, R. Renselaer Polytechnic Institute (2003). Accessed 2/08/09 from <http://www.rpi.edu/~eglash/csdt.html>.

Eglash, Renselaer Polytechnic Institute (2003). Accessed 4/07/2008, from http://www.ccd.rpi.edu/eglash/csdt/african/cornrow_curves/.

Eglash, Renselaer Polytechnic Institute (2003). Accessed 7/10/2007, from <http://www.rpi.edu/eglash/csdt/african/archi/fractal/afar>.

Dictionary. Com.LLC (2011). Accessed 7/11/11, from <http://dictionary.reference.com/browse/simulation>

Encyclopaedia (2011). Accessed 3/12/11, from <http://en.wikipedia.org/wiki/Postmodernism>[http://en.wikipedia.org/wiki/Conceptual art](http://en.wikipedia.org/wiki/Conceptual_art).

Encyclopaedia (2008). Accessed 8/08/2008, from [En.wikipedia.org/wiki/fractal](http://en.wikipedia.org/wiki/fractal).

Google image(2011). 4/06/12, from http://www.google.com.gh/search?q=acacia+tree+fractal&hl=en&prmd=imvns&source=lnms&tbm=isch&ei=X77MT-a8PMLMsgbhrpnuBg&sa=X&oi=mode_link&ct=mode&cd=2&ved=0CDgQAUoAQ&biw=1366&bih=661.

Haverkort, B. (2007). [“Wall to Wall” Art artist of Sirigu Ghana](#), World Art Foundation, Elsteren 11 5855 AS Well, The Netherlands.

Jones (1997-1999). Accessed 24/07/2008, from <http://www.fractalus.com/ifl/>.

Kerlinger, F. N. (1973). Foundations of Behavioural Research, New York: Holt Rinehart and Winston.

Kissick, J. (1993). Art Context and Criticism , Brown and Benchmarkpp.38-42, 363-366

Kolman, E. B. & Hill, D. R. (2005). Introduction to Linear Algebra an Applied 1st Course 8, Pearson Prentice Hall, Upper Salle, New Jersey, USA.

Kumekpor, T. K. B. (2002). Research Methods and Techniques of Social Research. SonLife Printing Press and Services, Adenta, Accra

Mandelbrot, B. (1982). The Fractal Geometry of Nature, San Francisco: W.H. Freeman.

Mandelbrot, B. (1981). Scalebound or Scaling Shapes: A Useful Distinction in the Visual Arts and in the Natural Sciences, Leonardo, USA.

McGraw-Hill Science and Technology Encyclopaedia, (2005). Accessed 20/08/09, from <http://www.answers.com/topic/fractal>.

Mitchell (2000-2012). Accessed 20/08/09, from <http://www.abm-enterprises.net/fractal-geometry.html>.

Morro, I. (1991). Traditional Wall Painting of the Navrongo District, M.A Thesis, KNUST, Kumasi, Ghana

Norman, C. (1997). Mural Art of Sirigu, Independent Study Project Report, USA

Nosro1 (2010) Accessed 7/07/2008, from
http://www.youtube.com/watch?v=G_GBwuYuOOs

Otto, G. O. (2002). Art Fundamentals: Theory and Practice , McGraw Hill Companies, New York

Patrzalek (2012). Accessed 7/08/2009, from <http://www.fractal.org/Bewustzijns-Besturings-Model/Fractals-Useful-Beauty.htm>.

Raedschelders (2009). Accessed 23/08/2009, from <http://classes.yale.edu/fractals/>.

Ross, D. H. and Cole, H. M. (1977). The Arts of Ghana, Museum of Cultural History, Los Angeles University of California

Skira, A. (1980). Lascaux. World Publishing Company, Ohio

Walter, Ennings, Doherty (2008), Accessed 11/12/12, from
http://books.google.com.gh/books?hl=en&lr=&id=dI1U8cRGXpIC&oi=fnd&pg=PA1&dq=the+work+of+art+in+the+age+of+its+technological+reproducibility&ots=NMDcpCDfk&sig=vIs8dYg5_YIaLlppwbv0mhyYwIc&redir_esc=y#v=onepage&q=the%20work%20of%20art%20in%20the%20age%20of%20its%20technological%20reproducibility&f=false

Wilcox, A. R. (1984). Rock Art of Africa, Winterton: Drakensberg Publications

Wikipedia Foundation Inc., (2009). Accessed 20/08/2009, from
<http://en.wikipedia.org/wiki/Fractal>,

Zimmerman, E. (1998). Authentic Assessment Research in Art Education. In S. La Pierre and E. Zimmerman (Eds), Research Methods and Methodologies for Art Education.

Reston, VA: National Art Education Association

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APPENDICES

Appendix A: Sirigu Motifs

Appendix B: Navrongo Chapel chart done by Sirigu women painters.

Appendix C: Questionnaire.

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