DISCOVERING GEOMETRIC INTERSECTIONS IN TRADITIONAL BUILDINGS IN MINNA: RELEVANCE TO CONTEMPORARY DESIGN

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ABSTRACT

The contemporary thrust of sustainable forms of African traditional architecture rest on the use of analogies and metaphors. Even though analogies and metaphors pay more attention to the exterior outlines of formal appearances, while de-emphasizing intrinsic geometric intersections. In a course like descriptive geometry where geometric intersections are taught with relevance to industry based examples, the consequence of such less introspective approach to African architectural form is a reflection of the relegation and inexistence of traditional building illustrations. This study therefore set out to explore geometric intersections among traditional buildings in Minna; with a view to exude their numerous contemporary potentials. Case studies were randomly conducted among traditional buildings within Minna, and their traditional geometric intersections were indentified and matched with suggestive contemporary relationships. It found that geometric intersections in traditional architecture hinge their contemporary relevance on building construction; and can be sustained as first principles in particularly areas such as space frame nodes, design of building enclosures, composite construction and rare of all prefabrication.

Key words: ***descriptive geometry, geometric intersections, sustainable form, and traditional architecture***

1.0 INTRODUCTION

Exercises around rediscovery, renaissance, rebirth and regeneration have become a major preoccupation of the African continent today (Mhlaba, 2007). This comes with the consciousness that like any other regional architecture, African architecture has been subject to constant change: in which case, its enduring elements can be considered sustainable. In African architecture, particularly that which refers to the indigenous people of the continent, space planning relative to form have endured qualitatively through centuries (Mhlaba, ibid). Form being the lesser of both elements in African architecture, notwithstanding, is primarily a bequest of socio-cultural and climatic factors (Rapoport, 1969, p.83). Some of which, have been geometrically exploited by architects through analogies and metaphors to the extent that the geometric accent of African architecture has prevailed symbolically and aesthetically in contemporary designs. Few examples include the Dominican Catholic Church by Demas Nwoko (Asojo, 2001); Hassan Fathy's sustainable architecture in Egypt (Tassel, 2007); Northern Cape Provincial Government Complex by Silva architects (Joubert, 2007) and Gabriel Fagan's heterotrophic designs (Barker, 2010).

Formal analogies and metaphors however are concerned with scales, proportions and appearances of outmost exterior building components that primal traditional building form represents. In addition to being detached from underdeveloped materials such as thatch and mud, analogies and metaphors pay little attention to the intrinsic intersections existing between building parts. Yet, it is inappropriate to neglect any part of available knowledge in African Architecture (Olufikayo, 2007, p.1). In descriptive geometry where geometric intersection is taught, the consequence of such less introspective approach to African architectural form is a reflection of the relegation and inexistence of traditional illustrations in courses like descriptive geometry. By extension it underscores architects' rational application of African architectural forms when traditional conceptual frameworks used in design studios result in weak contemporary designs. There is therefore the need to enumerate traditional geometric intersections and their corresponding relevance to contemporary design.

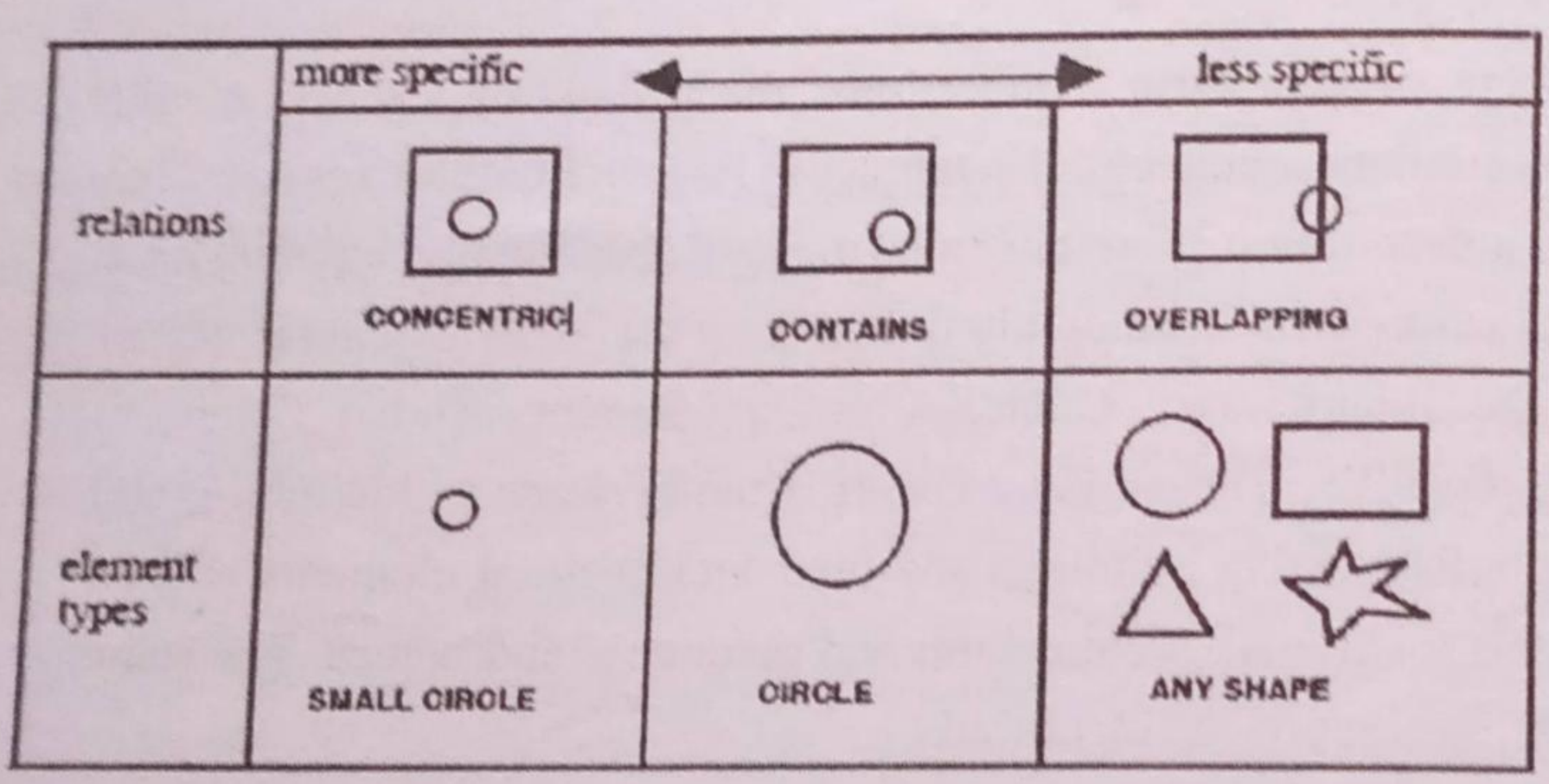
This study therefore set out to explore geometric intersections in traditional architecture in Minna. The fundamental objective is to exude various contemporary potentials of traditional geometric intersections. This objective will be achieved by considering the following questions. What is geometric intersection and to what extent are they relevant to architectural form? What valuable lessons can be acquired and transferred into contemporary architectural designs?

Beginning with the concept of geometric intersections, the pattern of discussion will comparatively incorporate germane architectural examples in form of literature review. This will flow in concert with a description of architectural form. Subsequently, existing case studies of traditional architecture will be randomly drawn from seven distinct areas within Minna, viz: Kpakungu to GidanKwano; GidanKwano to Maizube; Tudun Fulani to Maikunkele; Boss and AngwanBiri; Dutsen Kura Gwari; Kuta&Gwada to Maitumbi; and Chanchaga to Tagwai Dam.Respective buildings and their architectural elements will be identified according to their traditional, architectural and geometric and names. The same will apply to the geometric intersections so identified.

2.0 THE CONCEPT OF GEOMETRIC INTERSECTIONS

Geometric intersections emanate as a point or line where two geometric forms, such as lines, surfaces or solids meet or cross each other: and it is possible in any of five ways, viz: intersection of two lines; a line and a plane; two planes; plane and solid and two solids (Bertloine&Wiebe 2003, p.597). Within a course like descriptive geometry, it represents a convergence of several topics including auxiliary views and true lengths. It is geared towards reinforcing the understanding of solid developments: whose main objective is directed at the assemblage of outer surfaces of geometric forms and by extension architectural forms. The concept of geometric intersection reinforces the point that graphics is used to support industries. For instance, in industries such as automobile, aircraft and petrochemicals; it seeks to know the implication of intersecting orthogonal and non-orthogonal shapes or

The foregoing implication is made more apparent in a brief description of architectural form. According to (Coenders&Wagemans 2004, p.4-5) form in its broadest sense is the representation of appearance of a structure: by extension, it includes a definition of shape or geometric principle that represents both the physical outline of a structure and its non physical aspects. Semper (1986, p.2) as quoted in Barker (2010, p.28) described architecture as being defined by four elements, the roof, the mound, the hearth, and the woven wall. According to Plowright (2007, p.1)it is impossible to isolate a column, a wall, or a brick and call it architecture states because architecture is holistic and by implication transcends its individual parts. He adds that, architecture as an emergent system relies on the interaction between its elements. Additionally, the findings in Gross & Do (1996, p.46), on drawing analogies to support creativity in architecture are apparent: the more intersections exist

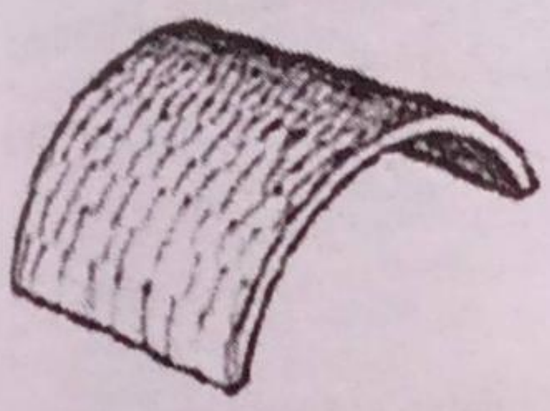


between elements, the more the degree of flexibility of forms (fig 1).

Fig 1: A hierarchy of spatial relations and element types enables flexible matching Gross & Do (1996)

2.1 Architectural Examples of Geometric Intersections

In building construction, the groin vaults of early Roman architecture, typify flexibility of two intersecting barrels. Geometric intersection makes it possible for the then emergent architecture to have openings on all four sides: thereby increasing ventilation lighting options. Needless to say they were relatively more aesthetical, yet more intricate in construction requirements. The same principle of two intersecting barrels result in a geometric variant of groin vaults; typifying the canopy shape of the tarpaulin car parks that surfaced in Nigeria not less than a decade ago (Figs 2 & 3).



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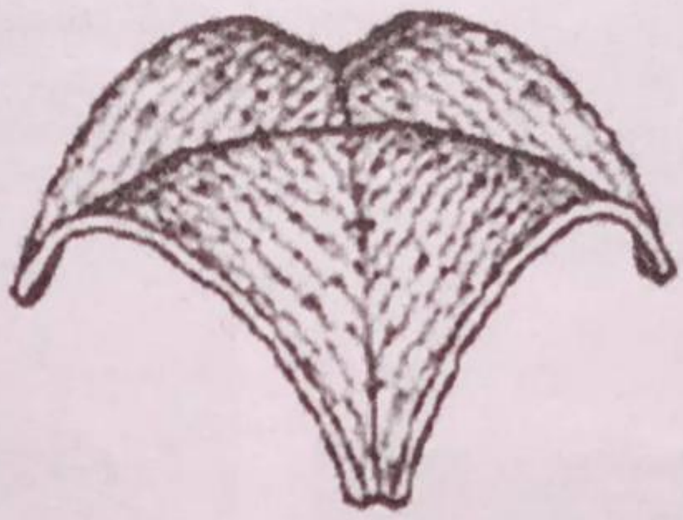
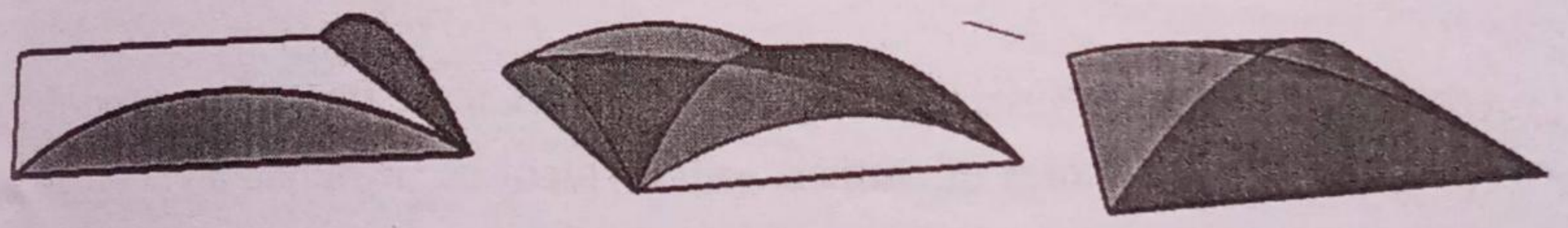


Translation of barrel vaults in early Roman architecture into Groin vaults via geometric intersection. Dooley (2004, p.362)

Fig 3: Schematic drawing of tarpaulin car porch, representing a variant of two intersecting barrels.



Also, in a unique way, the slightly changing, yet sustainable shapes, patterns and roof forms typical of explicit Malay traditional architecture (Ahmad, 2005, p. 3); rest on the geometric intersections of its structural members (Fig 4). Their contemporary validity is evidenced by the intersection of two truncated pyramids with a triangular prism (Fig 5).

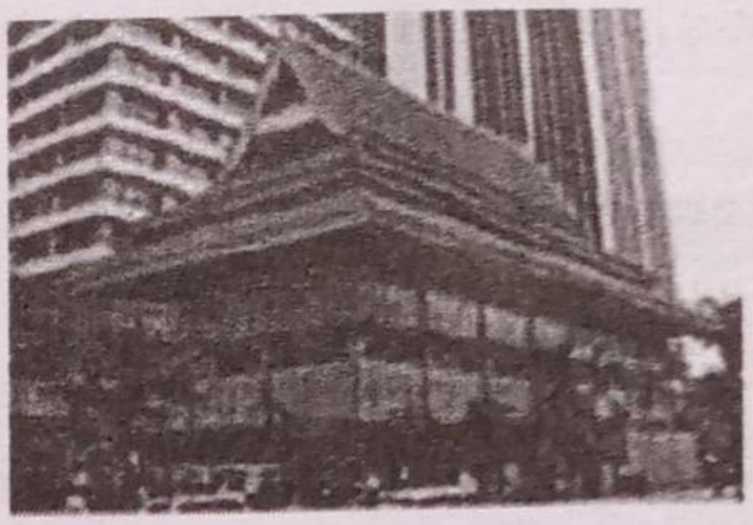


Fig 4: Sustainable ro
Malay traditional arc
Ahmad (2005)
Fig 5: Contemporary
traditional roof depic
intersections in the E
the Bumiputra

The Yagua dwelling in Peru is another typical example of the intersection of the Papago ceremonial arbour in Ramada and an archetype of the Uru dwelling. All of which are found in South America (Fig 6).

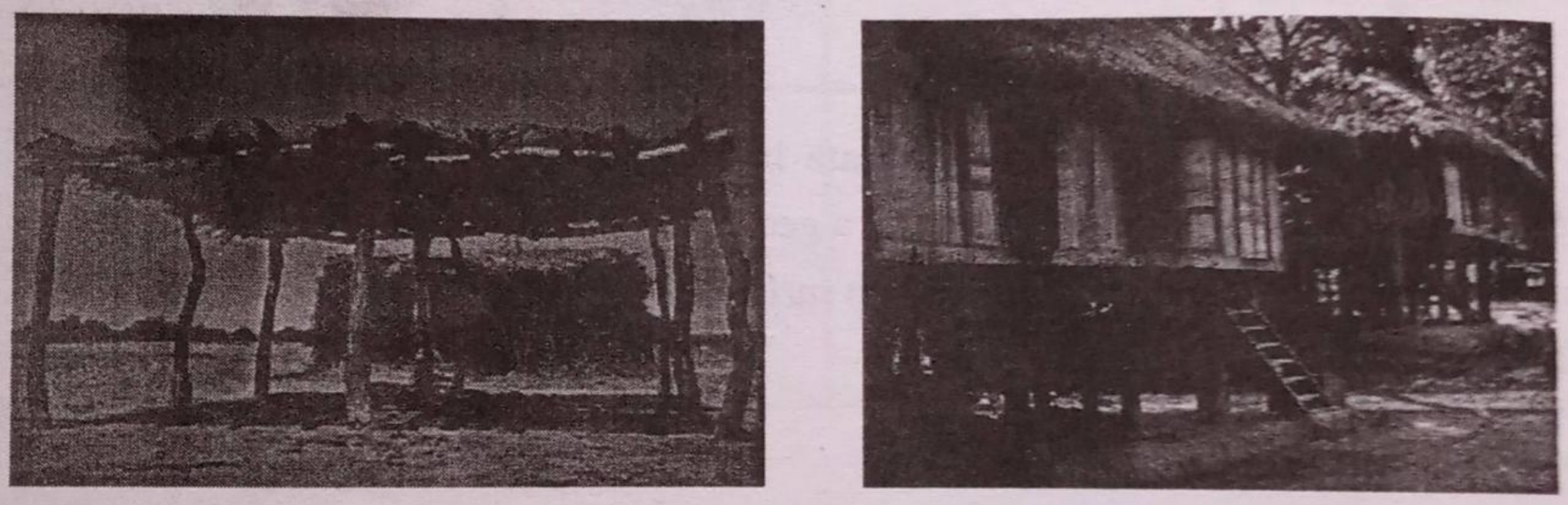
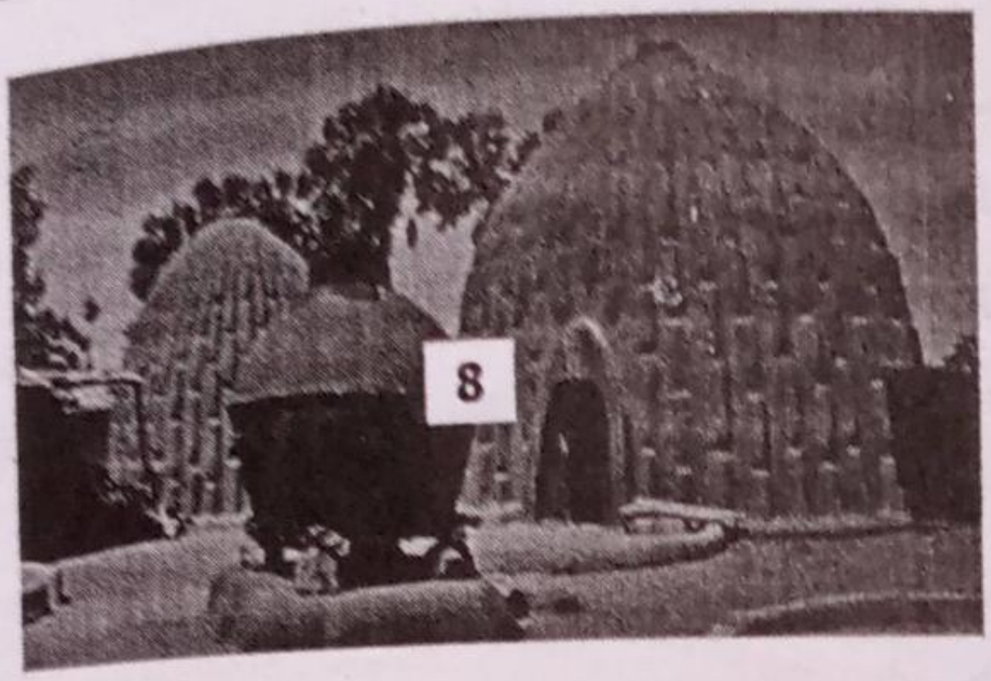


Fig 6: Yagua dwelling in Peru showing intersection of Papago and Uru dwelling. (House form and culture, 2008)

Specific to African architecture, Prussin (1974, p.187) posits that "the softly rounded, curvilinear surfaces and rough textures of earthen walls typical of savannah architecture eliminate the harsh, irritating contrasts between light and dark created by perpendicular intersecting planes, and convert it to softly graded shade and shadow" (Figs 7, 8 & 9).



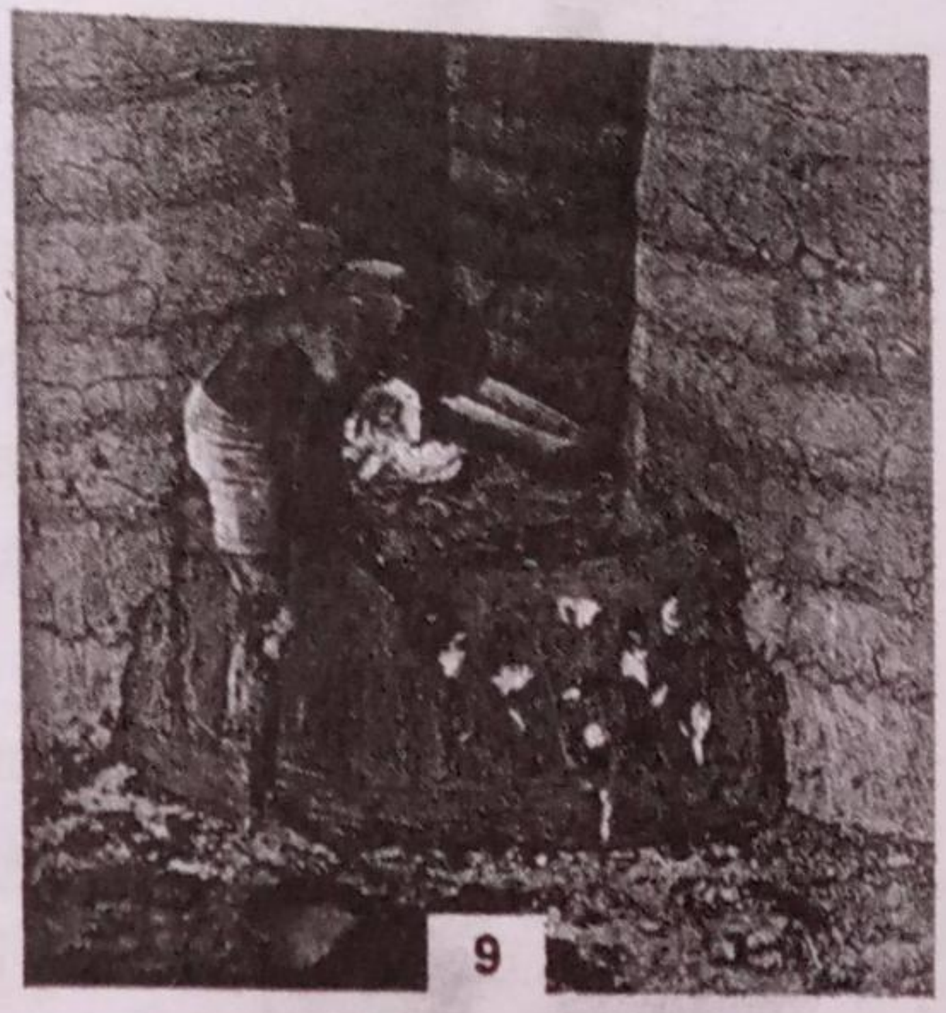


Fig 7: A Tallensi compound at Tongo in Ghana, showing geometric intersections of rounded huts with cylindrical walls. Prussin (1974)

Fig 8: Musugu housing in Cameroon, showing elaborate entrance intersecting with the domed dwelling. Prussin (1974)

Fig 9: Batammaliba, Africa male joining wall and observing the principle of intersections. House form

A contemporary example that draws extensively from the rich cultural history similar to the foregoing example was described in Joubert (2007). The independent architectural character of the geometries and enclosures ascribed to the complex is plausibly and possibly appreciated wholly, safe for the potentials of unique geometric intersections (Fig 10).

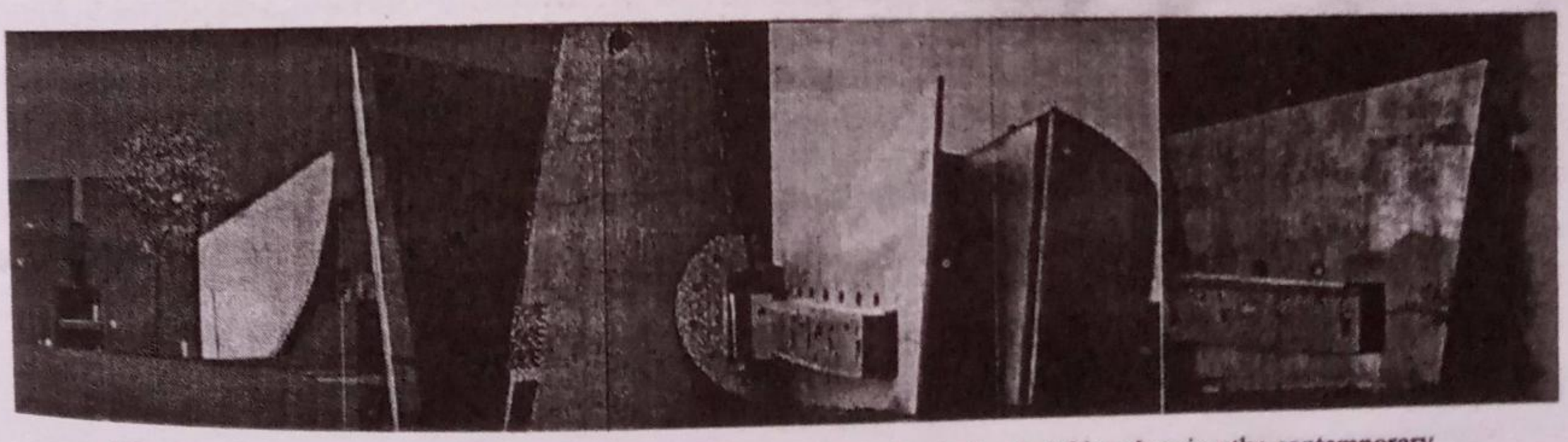


Fig 10: Views of the Northern Cape provincial Government Complex in South Africa showing the contemporary potential of geometric intersections to harmonize independent forms of architectural character. Joubert (2007)

It is therefore deducible that a potent formal clout accompanies geometric intersections. Essentially, the concept of geometric intersections transcend physical space: they emerge as a bridge between physical (material) and non physical (immaterial) aspects of architectural form and by so doing, support the generative processes that underlie the emergence of architectural form into a cognizant whole. Whether the issue be syntheses of domestic architectural forms (Barker, 2010), building responses to climate (Ahmad, 2005; Prussin 1974; Rapoport, 1969) or quest for identity (Joubert, 2007); hardly can substantial descriptions be made about roofs and enclosure components in African architecture without the accent of geometric intersections being felt. For a long time though, the shaping forces of traditional geometric intersections have to most intent been overlooked or rather described superficially, with little attempt to uncover and consolidate their generative, functional, structural and aesthetical essence contemporarily. This, of course is inadequate, though architects are by nature visually inclined.

3.0 PRESENTATION OF CASE STUDIES

A cross section of the domiciled tribes within the areas surveyed in Minnaare mainly Gbagyi, but interspersed with Hausas and Fulanis. Except for the unique shapes of granaries that serve as a complement to their occupation, the bulk of formal compositions retained the character of round huts and rectangular building forms.Their predominant occupation is agriculture: farming, followed by cattle rearing. Fundamentally, the architectural elements and their geometric intersections withinthe seven distinct sub-divisions explored in Minna, barely reflected any significant variations among each other. Therefore the findings of traditional geometric intersections were unified and reported indistinctly as follows: pictures; architectural elements and description of intersections.

Table 1: Geometric Intersections in Traditional Architecture in Minna

1. Interior component of the roof

2. Exterior component of the roof

Architectural Elements

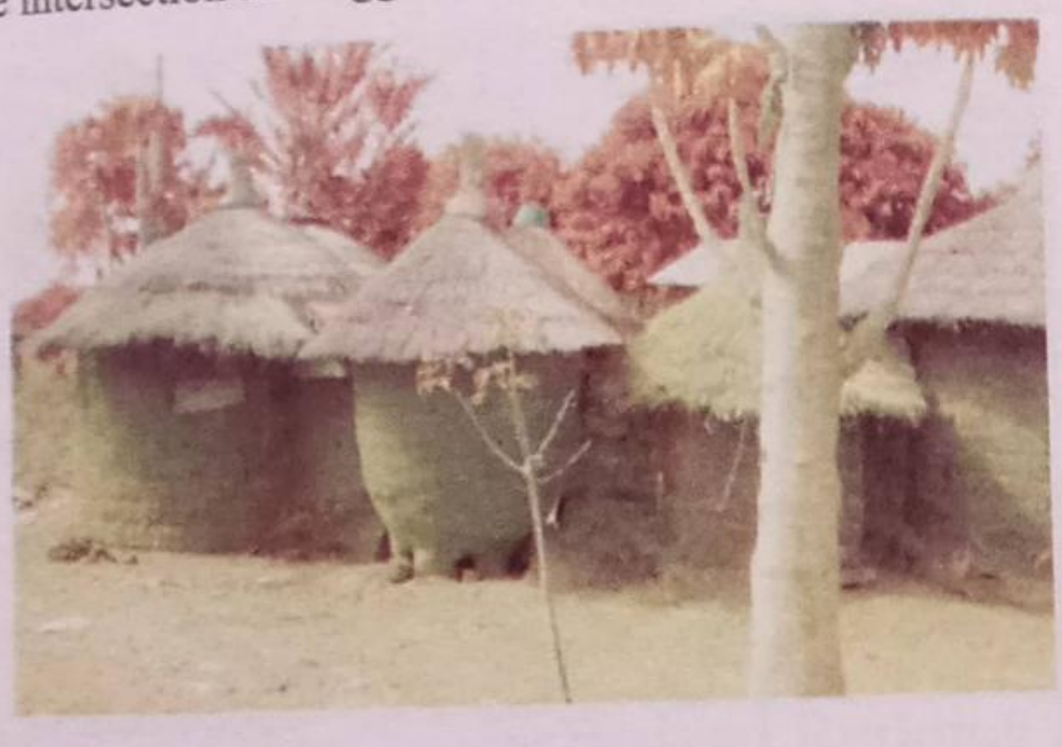
Interior and exterior components of traditional Gbagyi roof components comprising linear materials; Roof cap (Kpakakuta) and Roof (Kpaka).

Description of Geometric Intersections

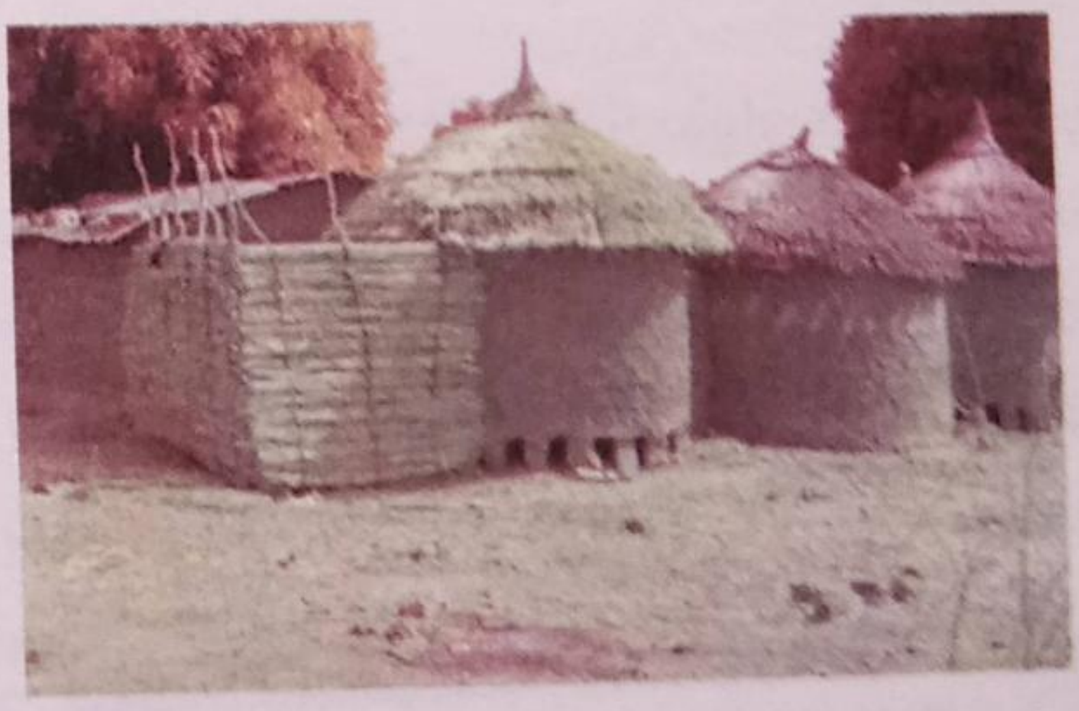
The identifiable geometries are basically cylindrical wooden bars and cones.

1. Intersection occurred as the wooden bars converge at an apex (that is, literarily intersection of lines).
2. Intersection occurred between the base of a cone (roof cap) and the frustum of a cone (roof) (that is, intersection of two solids).

The intersection are suggestive of nodal connections of space frames technology



3 Traditional compounds (kpinmi)



4. Traditional compound (Kpinmi)

Architectural Elements

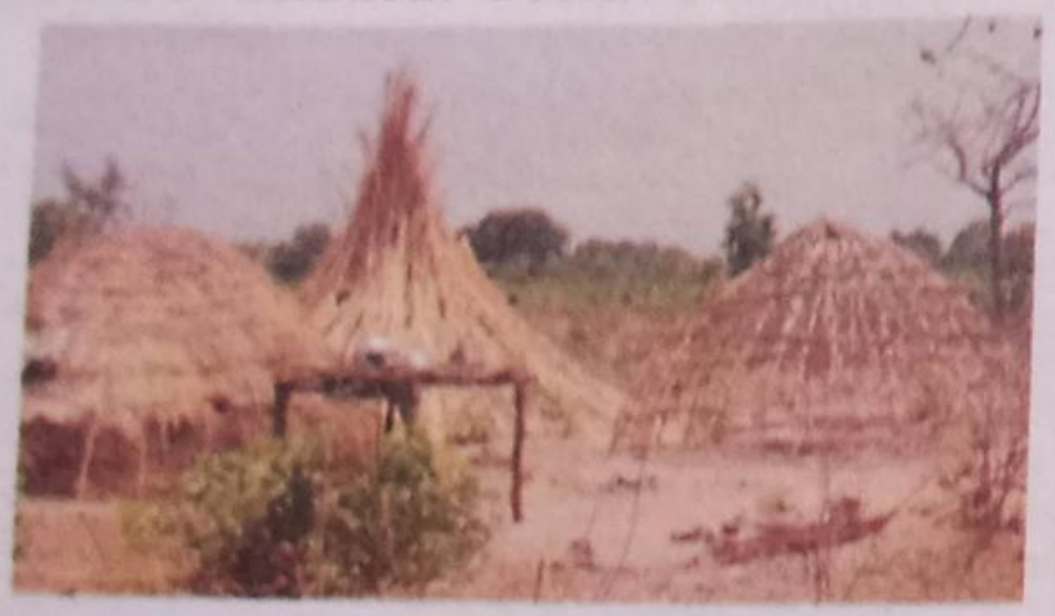
They comprise rooms (dagba), store/silo/granary (rumbu) and convenience.

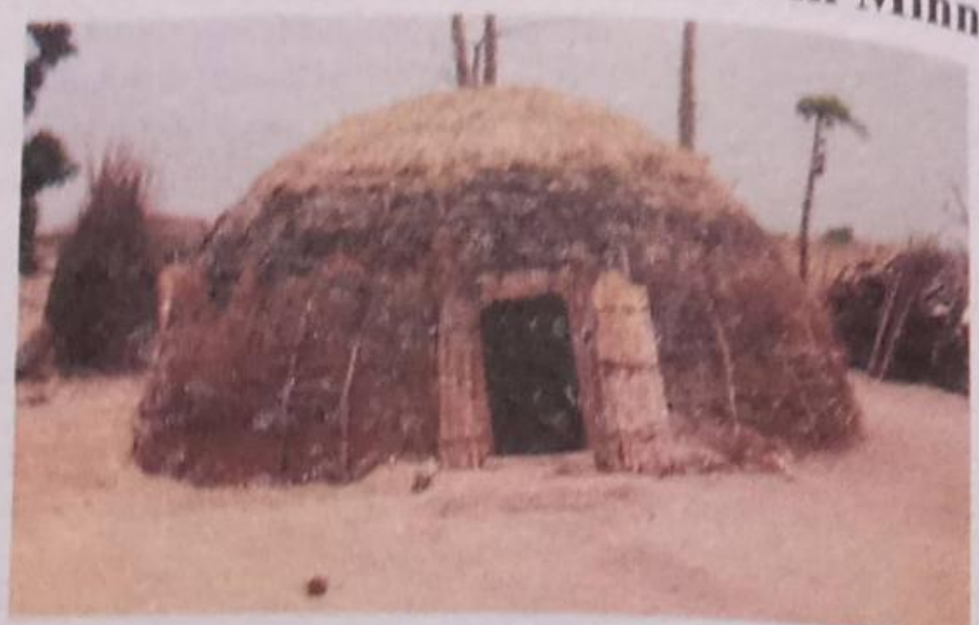
Description of Geometric Intersections

The identifiable geometries are hollow cylinders, cuboids, cones, frustum of cones and linearized materials.

1. Intersections occurred between cylinders, cuboids, cones and its frustum. (That is intersection of solids).
2. The major intersections occurred between linear materials and hollow cylinders with heterogeneous materials. (That is intersection of planes and solids).

The intersecting geometries are suggestive of supporting conceptualization of free form building enclosures





5. Structure of farm shelter6. Covered farm shelter

Architectural Elements

The structure comprises linear materials, waiting to be covered with straw

Description of Geometric Intersections

The identifiable geometries are arches and a dome.

5. The major intersection occurred at an apex where the curve linear materials converge. (Literarily, that is, intersection of lines, but in reality, intersection of solids).

The intersecting structures are suggestive of supporting domes and minimal structures

7uncompleted traditional silo/granary (rumbu)

8. Completed traditional silo/granary (rumbu)

Architectural Elements

They are basically composed of store/silo/granary (rumbu).

Description of Geometric Intersections

The identifiable geometries include cones and frustum of cones.

7. The geometries are constructed separately and intersected
8. The intersections occur between cones and frustum of cones. (that is, intersection of solids)

The intersecting structures are suggestive of supporting prefabrication technology

Source: Author's field work, 2011

4.0 DISCUSSIONSAND CONCLUSION

Evidently, without geometric intersections there can be no real synthesis as well as harmony between the formal elements that constitute architecture. Traditionally, the convergence of roof members; the chain of connected individual building units and the assemblage of pre-finished roofs on erected walls all together lend credence to this. Unlike in descriptive geometry where geometric intersections can be described strictly as a point; in reality, the range of possible geometric intersections transcends points, because building materials and architectural components have varying thicknesses. Therefore, only two of the five possible extant of geometric intersections are possible in architecture (that is - intersection of planes and solids and intersection of solids). Within this narrower range of real and possible geometric intersections there exists a catalogue of lessons from traditional geometric intersections which serve as models that represent first principles for contemporary designs and hinge their support on sections of the construction industry.

Firstly, the convergence of roof members at a given apex suggests a principle akin to nodal joints of space frames technology. Secondly, traditionally clustered settlements are easily defined and distinguished from dispersed settlements, owing to the relevance of geometric intersections. This supports as well as suggests the conceptualization of free from building enclosures. Instead of detached rounded Gbagyi huts that are trivialized as been stringed together, typifying adorning beads and pendants of African women, a different concept fo building enclosures can be derived.Building enclosures therefore must not of necessity b constrained to orthogonal and banal compositions; rather a contemporary archetype of suc free form idea is manifested in the curtain wall system. In addition, the catenation of rotun and bulbous forms conjures an aesthetical aura that conveys with it an element of ensuir mass of complexity. While complexity remains a huge divide in matching tradition analogies with contemporary architecture, the posture of clustering buildings by intersecti their forms is germane to the concept of massing building shapes within urban domai Thirdly, the incorporation of heterogeneous materials such as cereal stalk and round mud

huts, also convey relevance of traditional geometric intersections to composite construction. Lastly, the docile geometry of the silo or granary defies Euclidean description. Drawing fromPrussin(1995, p.195) an example of the Dogon granary is believed to embody the concrete ordering of the world: it serves as a model for the definition of geometric volume, representing the realization of an ideal. He adds that the sustenance and continuity of life depend upon the successful construction of a granary; therefore it is imbued with meaning of the highest order. In descending order, the granary's form can best be described as a seamless intersection of an upright cone (roof), an inverted frustum of a cone (upper part of the wall) and a cylinder at the base. This rare geometric intersection represents a high social-cultural and formal order. As a high formal order with undevelopable surfaces, it bears contemporarily on the concept of undevelopable surfaces. This again falls into the category of free form architecture. But more significantly, because its elements can be contrived distinctly and then assembled at their various intersections, geometric intersections can engender the idea of prefabrication as well.

The rediscovery of geometric intersections in traditional architecture despite the advancements of contemporary architectural form is not an attempt to regress the creativity of architects; particularly architect students. Quite the contrary, each geometric intersection pointed out in this study provides a potent basis to idealize geometric forms in contemporary architectural design with particular relevance to building construction. Unlike analogies which introduce general meaning to architectural form, geometric intersections are more specific in their significance. As a strategy for sustainable form, it is expected that the rich knowledge of contemporary building construction and techniques can be submerged in descriptive geometry via traditional geometric intersections. Further research is therefore required in translating the chosen examples in this study to clean line graphics in order to communicate traditional geometric intersection in comprehensible geometric language.

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