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Geometry in Modern Architecture and Postmodern Architecture in Nepal

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Abstract
Geometry, as a science of measurement and properties of space has its origins in human observation and the need to measure land. In architecture, the study of geometry led to development of new mathematical tools which was made applicable to design of buildings. Modern architecture is a growing field with a number of sub-genres that have evolved over time. Classifications vary according to style and philosophy. One common characteristic among modern architects is the use of geometry not only for aesthetics but also for structure. This article sheds light on how geometry had a significant part in developing early Nepali modern architecture in terms of forming the formative notion in which the principles of plane and solid geometry are employed to establish architectural form. The objective of this research was to examine the use of different geometry in shaping early Nepali modern architecture in terms of determining the form in a given social political context. Qualitative research method was used to investigate he use of geometry context in selected buildings design in a given socio-political since 1950s.The method mainly included the study of drawings, documents and record along with literature review. The research highlights a initial notion from the Bauhaus movement that helped to define formal archetypal structures or formative concepts through which architecture may develop. The study concludes that the post 50s buildings were designed mainly by foreign trend architects with not only strong Bauhaus influence but also the history which acts as determinant or characteristic in buildings along with drawing from local architectural context.

Keywords
Geometry, modern context, shaping

1. Introduction

According to Jonner Kepler, Geometry is the archetype of the beauty of the world. Geometry (from the Ancient Greek: Geo- "Earth", Metron "Measurement" is a branch of mathematics concerned with questions of shape, size, relative position of figures, and properties of space [1]. Geometry plays a role in Architecture in many ways. It is a tool for Architect, it can be adopted to be imposed over the landscape and create monumental structures with the spirit of leaving an imprint. It can also emerge out of the conditions of being and conditions posed by the surroundings [2].

In Architecture Geometric ideas play a multifold role; as abstract ideas they belong in the category of ideal geometric their perfection can be imposed on the physical fabric of the world as a means for identifying place. They can even emerge, is a reaction to the landscape or constraints [3]. More so, This Geometric way of thinking can be traced from classical antiquity in the form of books and teachings all the way to a Modern context. This research will focus on how geometry is transformed into an architectural design language in such a way that it examines how the components of geometry combine to create a grammar of meaning for a complete architectural composition [1].

Geometry is a branch of mathematics that deals with shapes, forms, and measurements, and visual thinking predominates. Geometry invented by man. Human language is geometric and is used in many different ways. A visual dictionary of architecture as defined by Francis D.K. Geometry is a tool invented by people to perceive the outside World and represent the inside world. Different types of geometry, such as spherical and bin curves, have been found to be applied to reality for the 19th century [4]. Perspective,

Projection Geometry, Decomposition Shape, Trigonometry, Differential Geometry, Topology, Fractal Geometry, etc. are examples of additional types of geometry developed over time. Renaissance architect emphasized the percentage of views from the perspective of views as well as Alberti. Le Corbusier emphasized the modular ratio using the modular expression according to the gold relationship [1].

The necessity to define the relationship between history and design has been brought to light by the resurgence and growth of interest in architectural history and historic architectural examples.When we study history in the academic sense of understanding where we fit into a certain timeline or in the academic sense of understanding the past, we may end up knowing nothing more about the past as architects than names, dates, and recognized styles. If one can look through and outside of the layers of classical architecture, inside which architecture is frequently classified and presented, history may be a source of richness for architectural design.

In this work, a theory that goes beyond the present and discloses an architectural concept is sought after. Building inspection and analysis are the method used in this search. The development of theory to provide concepts for architectural design is the intended outcome [2].

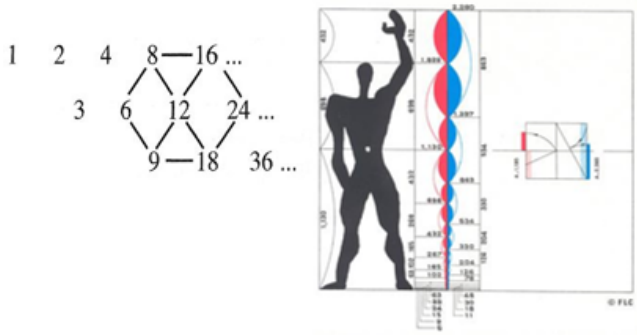

Figure 1: Alberti's system of musical proportions and Le Corbusier's The Modular

Today, the world is experiencing a huge shift in the way people live, think, and express themselves. This cultural phenomenon is known as postmodernism. While modernism was fairly rigid and focused on functionality, postmodernism introduced a more relaxed attitude, with an emphasis on self-expression and personal identity. In architecture, this new style has led to the use of non-traditional materials such as green windows, arches, domes, and even towers that are inspired by medieval or Gothic architecture.

Post modernism was movement in architecture started in between 50's and 60's. Change occurs due to the need and interest of people and post modernism is no exception. Post-Modernists aimed to add more human characteristics to architecture by drawing inspiration from the past.

This article explores the emergence of these new architectural styles in Nepal and how it came influence by precedent of architecture. The need of research demand for complex geometric in the light of modern geometric representatives raises questions about the relationship between geometry and architecture. Nepalese Modern Architecture has been unconsciously being inspired by works seen in surrounding, magazines of internet sources like arch daily without being aware about geometry behind the work of architecture.

2. Literature Review

A concept that may be used by a designer to shape or influence a design is known as a formative idea. The concepts give means to plan choices, establish order, and intentionally produce shape. Using various ordering strategies might lead to varying outcomes. Presenting examples of the idea's general manifestations allows for the definition and exploration of each notion [5]. To establish a formative notion in which constructed shape is determined using the principles of plane and solid geometry , the following quality requirements are used:

- Structure
- Natural Light
- Massing
- Plan to Section or Elevation
- Circulation to Use-space
- Unit to Whole
- Repetitive to Unique
- Symmetry and Balance
- Geometry
- Additive and Subtractive
- Hierarchy

2.1 Concept of Geometry

Architecture is shaped by the concept of geometry, which incorporates the principles of both solid and plane geometry to define created form. The recurrence of the fundamental geometries through multiplication, combination, subdivision and manipulation is recognized as the development of grids in this issue. Since the beginning of recorded architectural history, geometry has been employed as a design tool. Buildings' most prevalent determining factor or feature is geometry. It may be used on a wide variety of spatial or formal levels, including the usage of basic geometric forms, numerous form languages, proportional systems, and complicated forms produced by sophisticated geometric manipulations. The area of measurement and quantification where geometry may generate architectural forms is relative. This analysis's main considerations include size, position, shape, form, and proportion. Additionally, it focuses on how combinations, derivations, and manipulations of fundamental geometric configurations lead to consistent changes in geometry and form languages. Grids are scrutinized for their regularity, configuration, intricacy, consistency, and variety. All of the problems employed in the study can be strengthened by geometry, which is a prevalent characteristic of structures [5].

2.2 Massing

Massing refers to the aspect of a building's three-dimensional layout that is most perceptually dominating or frequently experienced. More than only a building's elevation or silhouette make up its mass. It represents how the structure appears to the eye as a whole. It is too restrictive to think of massing as only this, even though it may encapsulate, resemble, or occasionally mirror the shape or the elevation. For instance, on a structure's elevation, fenestration might not have any impact whatsoever on how big the building appears to be. Similar to the silhouette, it might not accurately depict useful differences in shape and be overly broad [5].

Massing, which is viewed as a byproduct of designing, can be the outcome of choices made on matters other than the three-dimensional arrangement. Massing may be viewed as a design concept that is related to ideas of context, collections, unit patterns, both primary and secondary elements, and single and multiple masses. Massing has the power to express circulation, define and articulate external spaces, accommodate sites, designate entrances, and stress the significance of architecture. As a problem in the analysis, massing can reinforce the concepts of the section to plan, plan to section, geometry, additive and subtractive, and hierarchy [5].

2.3 Bauhaus

Bauhaus architecture prioritized function above all else, with a core principle of "truth to materials". Many Bauhaus buildings are geometric, with flat roofs and streamlined facades. This was meant as a stark rebuke of industrialization, the coldness of mass production, and consumerism.

It is distinguished by its strict economic sensitivities, geometric design, and reverence for useful materials. It still has an impact on us now, as seen by how frequently historical components are incorporated into contemporary environments. Influenced architecture, typography, furniture, and weaving [6].

Figure 2: Bauhaus-Building Dessau

Bauhaus building is the important landmark of architectural history. The outside of the workshop wing is defined by the glass curtain wall hung ahead of the load-bearing framework, which also clearly displays the building materials. This design adheres to the idea of unadorned functionality [6].

Planning of Bauhaus consist of three connected wings or bridges. The majority of Bauhaus structures are cube-shaped, emphasizing straight angles, however others have rounded corners and balconies. Characteristic of the building depends upon Simple geometry, rectangular featuring the elimination of surface decoration and extensive use of glass. A focus on simple geometric forms such as the triangle, square and circle [6].

The plan, elevation, and section for the Bauhaus

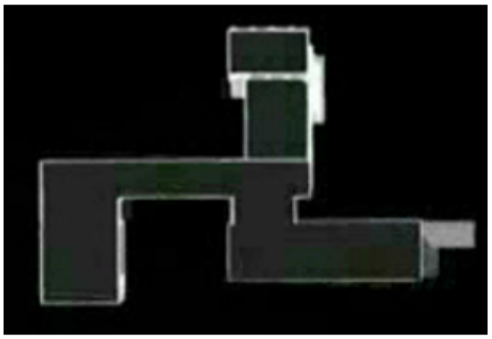

Figure 3: Top view of Bauhaus-Building Dessau

building are all rendered at the same scale in the study's analysis section. It aids in recognizing and outlining formal archetypal patterns or initial concepts from which architecture may develop. The drawings help, as abstractions that are intended to convey essential characteristics and relationships of the building. The drawings also display the precise physical characteristics that enable comparisons of the characteristics of buildings regardless of their design, kind, function, or period. The diagrams are created using the building's three-dimensional shape and space layouts [7].

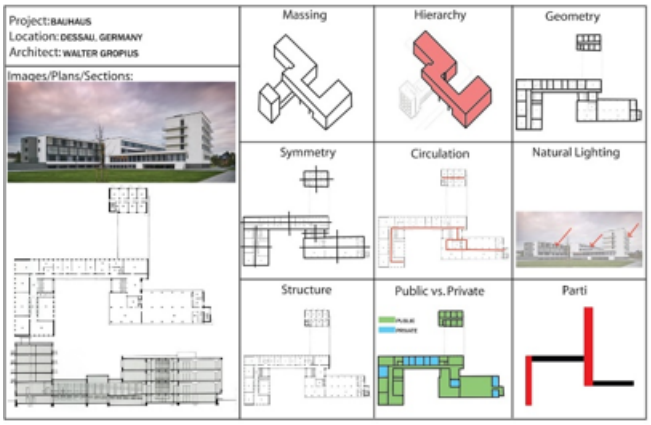

Figure 4: Precedents of Bauhaus Building, Analysis diagrams and Formative ideas

The basic geometric configurations that used to determine a building's form that include the square and rectangle as used in Bauhaus. Two adjacent squares with a shared side assist to identify the boundaries of the overall plan configuration and immediately determine the limits of the plans. Additionally, two squares were overlapped to produce a unique condition in the common region. Rectilinear grids occur in the Bauhaus which is coincident with structure.

The Bauhaus building's massing may also be used to convey circulation, stress importance in architecture, fit site, define and articulate outdoor areas, and meet site needs.

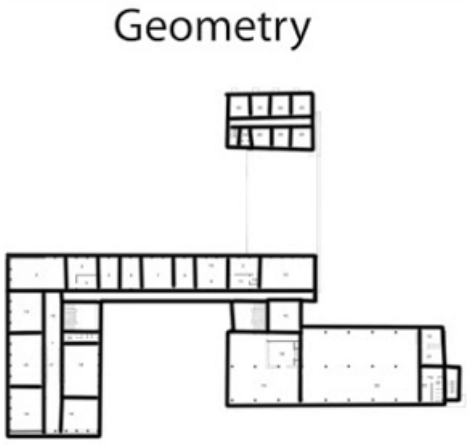

Figure 5: Geometric representation of Bauhaus Building

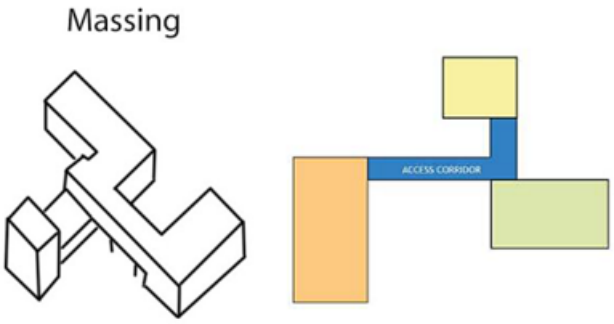

Figure 6: Massing representation of Bauhaus Building

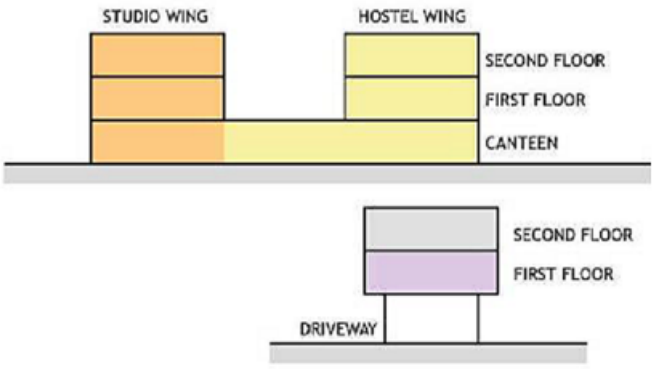

Figure 7: Massing elevation shape representation of Bauhaus Building

- Similar Functions housed in separate wings
- Corridors connecting different wings
- No central point in the layout

• Provides decent flexibility and expandability

• An outward looking complex

• Separate wings are designed as separate buildings housing specific functions

• Strong separation between wings imposes certain restrictions on planning flexibility

• Use of glass intended to create a feeling of lightness to structure

• Absence of ornamentation to the building was prevalent in practice during the period

3. Methodology

In this research, qualitative approach is used to explore, analyses and to understand the perceptions of use of geometry and the emergence of these new architectural styles in Nepal. A systematic qualitative research approach has been used to accomplish the goals of this research. There are three steps to the research methodology procedure. The literature review that starts the first step is done in order to create the research topics. It is followed by a preliminary map analysis of the building's structure, which gives rise to the notion for additional research into buildings and their comparable design concepts that can be found in many of the works of architects regardless of period, style, location, purpose, or kind of building. The commonalities can be categorized into overarching themes or formative concepts that may have been utilized to generate the architectural designs.

To compare and analyses the changes that have occurred over time that vary Nepali contemporary architecture and with valley honest context, carrying out documentation and survey analysis by studying the record of the drawing available.

A case study is a popular research technique in the social sciences. Case study research is chosen for the study because it calls for in-depth exploration of a particular person, organization, or event to examine the reason. An assessment of a person, organization, or event that is descriptive and exploratory is known as a case study. A case study investigation uses many sources of evidence, contains quantitative evidence, and gains from previously developed theoretical hypotheses.

4. Context of Study

Saraswati Sadan was designed by Bed Prasad Lohani in 1892. He was the country's first concrete building, Saraswati Sadan represents a turning point in contemporary architecture in Nepal. Reinforced concrete and reinforced brick concrete were among the brand-new, cutting-edge materials and technologies used in its construction. The main architectural structures were initially constructed between the 1940s and the 1960s, during the early modern period. These structures are highly inspired by architectural and engineering ideas that transcend beyond historicity and are mostly defined by the early usage of reinforced cement concrete. Are a good example of early modern architecture and contain aspects of "modern" architecture (Nepal 2020). It was developed by Bed Prasad Lohani, who brought concrete construction to Nepal. Experimented with a variety of elements in constructions, including domes, RCCs, and RBCs [8].

The constructions are clear, practical, and sound structurally. It represents a turning point in contemporary architecture in Nepal. It is constructed with cutting-edge technology and materials, such as reinforced concrete and reinforced brick concrete [8].

Figure 8: Saraswati Sadan in Kathmandu

Large spans have been achieved by using thick beams and strong walls. The balconies' free-floating cantilever look is achieved by using inverted beams as well. In the design, it has been experimented with levels and light. The structure has been equipped with clerestory windows and skylights to let in natural, diffused light [9].

The basic geometric configurations that used to determine a building's form that include the square,

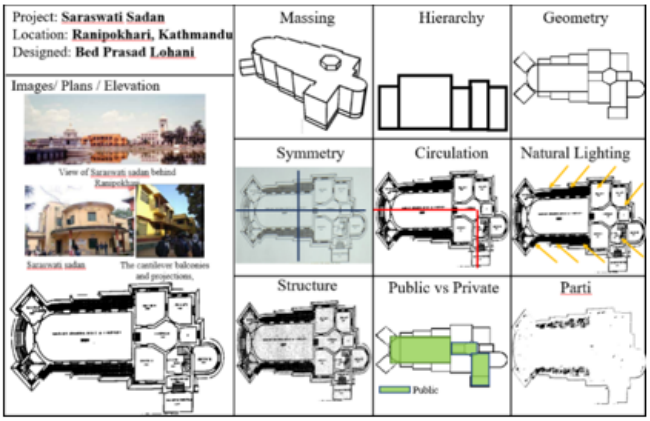

Figure 9: Precedents of Saraswati Sadan Building, Analysis diagrams and Formative ideas

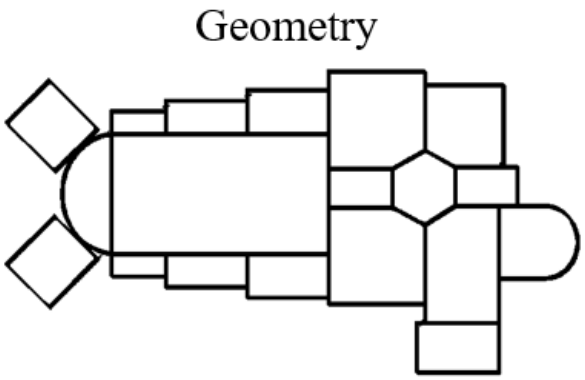

Figure 10: Geometric representation of Saraswati Sadan

rectangle, Semi circle, hexagon as used in Saraswati Sadan. To make each basic form as observable as an entire figure, more than two additional basic forms have also been joined. Although each form has been hinted, it is not necessary that it really exist. It is now feasible to identify a geometry within, next to, or overlapping another within the domain of combinations, such as in a rectangle, square, or semicircle. Because one geometry lies within another, the inner geometry was used to represent an item, a room, a courtyard, a predetermined area, or an inferred space.

The Saraswati Sadan building's massing might similarly define and articulate external spaces, fit site, designate entry, express circulation, and stress value in architecture. The visually dominant or most prevalent three-dimensional configuration of a structure is shown as its massing. It displays the perception of the structure as a whole. In many instances, the center space, although appearing to be dominant from the outside, functions as a hub for

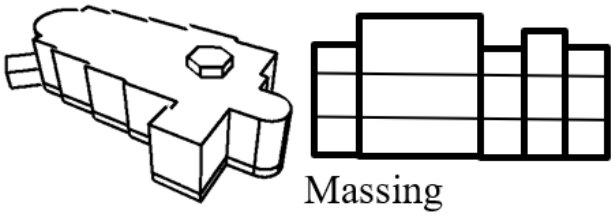

Figure 11: Massing representation of Saraswati Sadan

circulation and an organizer of surrounding areas. The notion of linear configurations, which separates circulation from user space, has been used to spine or corridor organisations. The exact geometric combination of the building's massing is a rectangle covered by a semicircle.

4.1 Comparison between Bauhaus and Saraswati Sadan

• Both buildings are the important landmark of architectural history

• Built using new and innovative materials and technology including reinforced concrete and reinforced brick concrete.

• Design is simple, functional, and structurally stable.Played with levels and light in the design.

• Use of Glass windows have been used in order to allow natural diffused light to enter the building.

• Absence of ornamentation

• Functionality predominates ornamentation and uses asymmetry and regularity versus symmetry

• characterized by geometric design, respect for practical material, and its severely economic sensibilities

• Continues to influence us today, where any modern environment often incorporates elements of the period. Influenced architecture, furniture, typography, and weaving

• Aim of Buildings constructed in different era help to gain independent access to the new innovations of crafts and industries

• Buildings are usually cubic, favor right angles, although some feature rounded corners and balconies

5. Analysis, Discussion and Findings

Geometry which is used for taking intangible concepts and ideas and establishing them in built environment by the use of the Geometric Principals in the buildings. Factual graphic information of Bauhaus and Saraswati Sadan represent a range of time, function and style which accompanied the detail analysis of the building.

Although the dominating patterns in this study have been established, that does not imply that there aren't any other patterns. The analysis of the buildings which represent the evolution of modern architecture investigate the formal and spatial characteristics of the buildings in each work in such a way that help to understand the building parti. Visual connection has been established by user and the environment in both the context study building.

Following are the key findings emerged from the Study:

• The fundamental principles of both solid and plane geometry, which are used to establish architectural form and include the square and rectangle, are embodied in the Bauhaus and Saraswati Sadan.

• Two squares were overlapped to produce a unique condition in the common region.

• Because of one geometry lies within another, the inner geometry was used to represent an item, a room, a courtyard, a predetermined area, or an inferred space.

• Building designs from different eras use massing to convey circulation, define and articulate external spaces, accommodate sites, and underline the importance of architecture.

• The notion of linear configurations, which separates circulation from user space in both the buildings.

6. Conclusion

This research paper helps to gather the idea about the use of different geometry, which has also been used as a design tool since the very beginnings of architectural design.

The study concludes that the post 50s buildings were designed mainly by foreign trend architects with not only strong Bauhaus Influence but also the history which acts as determinant or characteristic in buildings along with drawing from local architectural context. A formative notion aids in comprehending the idea that a designer may utilize to shape or impact a design. The concepts include strategies for planning choices, establishing order, and intentionally producing shape. The ideas cover methods for organizing decisions, creating order, and purposefully creating shape.

The diagrams highlight particular physical characteristics that enable a comparison of that characteristic between buildings regardless of style, kind, purpose, or time.

Finally, it serves as a new concept for future researchers of the field and for all architects. The use of various techniques of analysis that emphasize what is fundamentally the same, rather than different, in the way we think about architecture is also examined, and we want to explore archetypal notions that can aid in the production of architectural form.

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