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THE USE Of MODULAR NETWORKS IN ARCHITECTURAL CONSTRUCTION METHODS

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Abstract:

Network and modular thought provide practical and effective solutions to many methodological problems that confront architectural design curricula and its professional practice. Hence, architectural research is supported in designing complex architectural formations, academically through students of architecture schools and professionally through practicing designers. The research achieves this by extracting an initial system that contains a theoretical structure and an applied mechanism for the use of modular networks.
Research documents their conceptual references by historically documenting everything related to the concept of network thinking, modular design mechanisms, and systems of formation and formation.The research monitors with opinion questionnaires the local position academically and professionally and records the degrees of conceptual awareness of the modular networks, then analyzes them and shows its significant indicators and links them to the problems of network and modular design and their shortcomings and negatives. Its efficiency and the extent of interaction of architecture students and architectural designers with its stages and steps, Finally, the research extracts its conceptual definition, proposes the theoretical structure of the modular network concept and the final formulation of its applied research mechanism, and clarifies and supports the theoretical approach and application interaction.
Keywords: Modular Networks, Architectural Construction Methods.

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Introduction:

The research records by observing the local architectural product a negative repetition and unconscious borrowing of reference models for buildings with similar functions, and the use of traditional design networks or individual improvisation without networks. The research links this to the architectural education system's lack of application of guiding mechanisms or general design methodology systems, in addition to the lack of awareness of each of the design thought of the modular network.

The nature of modular thought with its design networks relied in its history on experimentation and the accumulation of subjective experiences, beginning with classical architects and even modern architects, so it did not develop theoretically, but rather directed towards a direct applied direction.

Research aims:

The research aims to reach an initial system for designing with modular networks that provide solutions to the problems of their local application, correct their theoretical concepts and contain their Western experience, through theoretical support and practical testing that increase the qualitative (not quantitative) capabilities of architecture students and professional practitioners. From the theoretical point of view, the research attempts to formulate a reference structure that organizes the thought of network and modular design based on reviving the historical concept and showing its organizational capabilities and benefits. Unconventional and accommodating solutions for those inputs.

Research Methodology:

The research achieves its objectives through methodological axes, which are:

The focus of critical analysis: the extrapolation and inference of the global experience in dealing with network thought and modular application and its activation locally through comparison and critical containment and not following it and imitating it as it is with its negatives and contradictions, then delving into revealing what is related to the capabilities and capabilities of modular design and network systems, and focusing on its positives and theoretical and applied benefits.

Conceptual Monitoring Axis: In it, the negatives of using modular networks in the architectural design process are monitored and measured, and what is lacking in conceptual premises that pave the way for their applications and exit from them with indicators directed to assess the local modular position in the fields of architectural education and professional practice, and they are translated into research needs and requirements.

The default axis: It begins with the assumptions of the network concept to confirm the architectural relationship between the nature of networks and the needs of modular thought for formation and formation. Then he tries, with the hypotheses of the modular concept, to study the dual modular nature and its design role, its conceptual basis, its quantitative qualities and its capabilities in controlling and coordinating the components of the architectural product, and studies the relationship between repetitive modular formations and their availability for artistic aesthetics and how they work with the principles of multiplication and cumulative addition.

Finally, in the application of modular networks, he attempts to relate the history of engineering systems and rational design methods to the role of grid systems and modular units in functional and spatial design.

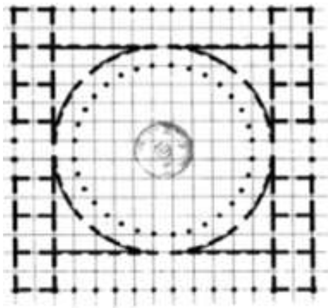
Experimentation and testing axis: it explores ways to deal with modular thought and its networks, and after preliminary testing mechanisms and prepares them for applied interaction in the form of exercises to activate these modular networks and experiment with their translation into the design process inputs.

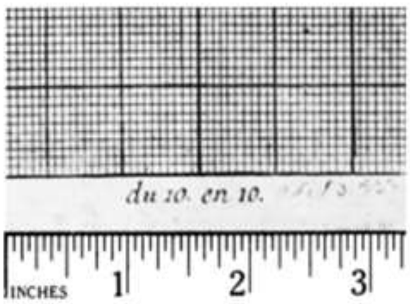
Network and Modules in Architecture:

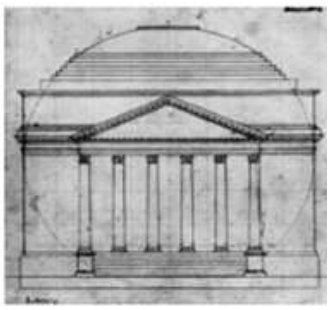
Network concept in design:

Network positioning systems are divided into the central cosmic position in which the shapes are organized and divided around a point center, and the perpendicular kartist position, in which the longitudinal and linear forms extend on both sides of the central axes.

The architectural function of the grid was observed when Thomas Gerson drew his geometric designs on square paper. Using pencil and intersection-coordinate paper, with decimal division (Figure 2) and allowing himself a degree of freedom for his designs and lines. The function of squares paper was multiplied in the form of graph paper, which was an important original for the modular system, as it was the basis for the Durand theory relied on in the horizontal projection. But (Jefferson) and (Durand) did not use square paper lines as axes for structural columns, but as an easy and simplified means of measuring dimensions and calculating distances.



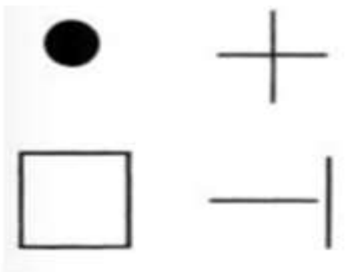


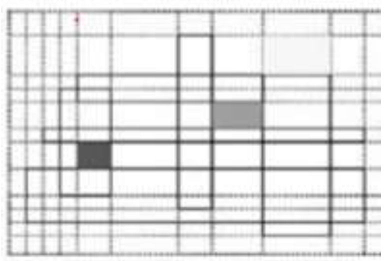


(Figure 3). (Figure 2). (Figure 1).

The design network is defined from a functional perspective as an overlay of two or more linear systems, and as a container system for horizontally and vertically arranged lines on which the points representing the coordinates intersect, but it differs from squares paper in its relative references and compatibility with solutions to design problems (Fig. 4). The network is divided into four partial forms: (coordinates/intersections/modules/lines), of which two components were made: (point basis) and it includes the coordinates and their intersections (Figure 5).

Domain domain basis: It includes both the module and the font as constitutive

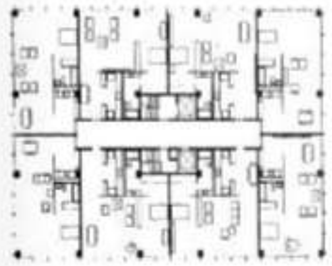




(Figure 4). (Figure 5).

And when the design grid is used with skill and sensitivity, it leads to an accurate and refined production, but when it is used by an experienced designer or with the control of creation over the creative side, it produces filter designs and strict visual character (Figure 7).

The formal layout of the design network is affected by the function and the idea, so it is very diverse and shaped, and it is an industry and a solitary innovation that will be specialized in the determinants and criteria of each building. (Paul Rand) has described the real role of the network that it begins when it is used to solve the architectural function, as it works as a fabric of straight paths directed within the horizontal planes (Fig. 8).



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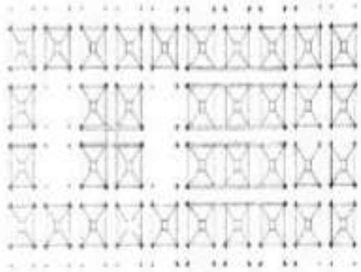

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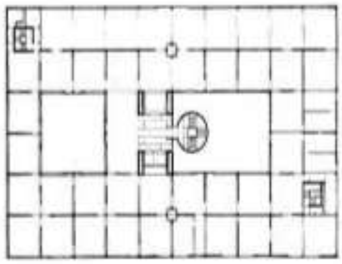

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(Fig. 8). **(Figure 7).** **(Figure 6).**

The concept of the modular network:

The idea of the modular grid is old and original in the history of architectural design. Since ancient times, architecture was modular, with grid designs, and it was solid and built on heavy load-bearing walls with small openings and limited spaces (Fig. 9). But in the modern era, the solid elements, the spaces opened, the lightness of the building materials increased, the openings increased, and the interest in space increased, as the standard unit (modidol) was formed from a space element (Fig. 10). The modular entrance is one of the auxiliary means for organizing and coordinating building spaces, its components and materials, and structuring the structure in a logical manner and with high efficiency.

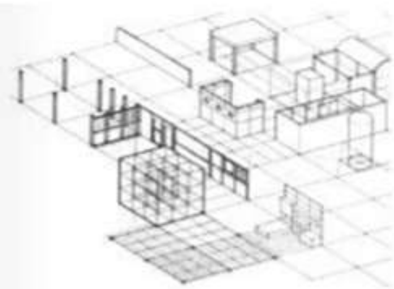


Figure 9

Figure 10

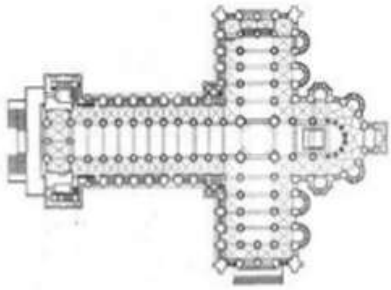


Figure 11

Methodological mechanisms of network and modular design:

Modern analytical systems appeared that study lattice and structural engineering and reveal the geometric and modular units in them, in addition to the rational formation system developed by the theorist (Durand) in which he presented his analogical and strict vision of network and modular applications. The American Organization for Standardization also presented its integrated module system, which specializes in the implementation of repetitive buildings in short periods of time.

The research chose the Durand system to review its modular grid idea, where it used grid paper, so the horizontal planes became more diverse in their structures and aggregates, and explicitly relied on the modular grids, in which the piles of columns were efficiently distributed over the parts of the building. The simple and clear module, which was applied with the principle of cumulative addition in which modules are combined, stacked and combined during the design process (Fig. 17). In Durand's approach, he formulated his module formation by methods and sequential composition plans that have work steps and graphs that start with defining the axes of the architectural situation, then dividing the sub-networks, and installing walls and columns on their lines and at their intersections, then the building with its final formation (Fig. 18). But the fault of that approach is that the course of the design idea was not clear or paved for the spatial formulation, where the two-dimensional modular formations were long, and limited in their design solutions and aesthetics, despite what Durand achieved of rationality based on logic and scalability.When designing with networks, it is recommended to develop an action plan that begins with the objectives to be achieved and the determinants of it, and to realize the precise measures of the design requirements, then filter the design idea, and link it with the network and modular systems, for guidance only without imposing specific solutions.

2- Modular concept in design:

A module is a unit that is formed from a part or from separate parts that make up a modular configuration or system with an aggregative system.In terms of dimensions, the module is a quantitative and volumetric unit that is used as a parameter for dimensional coordination. As for its numerical origins, it was historically a common standard unit for all arithmetic operations expressed by the radius of the column. Medieval builders used to adhere to a verbal description in the implementation of their buildings without engineering drawings or written text descriptions.

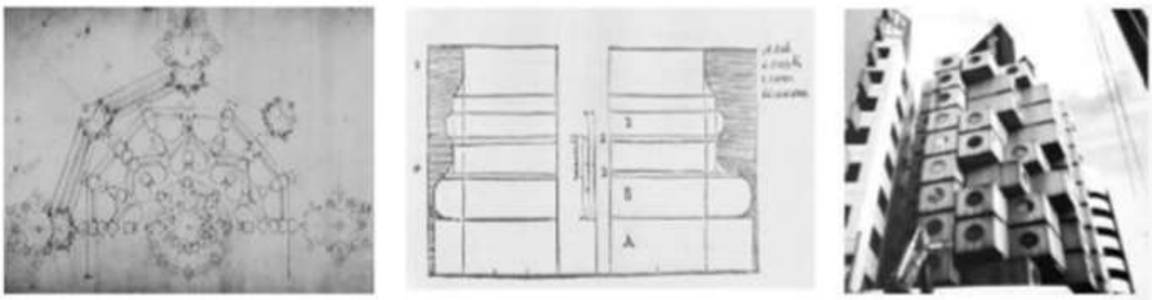


Figure 12

In the faucet designs, the modular system is formed by using the square as a module, then multiplying it and dividing it to produce a coordinate lattice of square intersections on which the building parts are distributed with its structural complexities.The archaeological manuscripts showed the square models, codes that were formed for the cathedrals and their horizontal planes with their side aisle and buttress. It was divided into sub-modules that govern and guide the builders as a comparative reference for the architectural relationships and overlays. The modular geometric system was working with added and successive values, ie successively and overlapping steps and dimensional values (Fig. 12). The modular networks have linked the design lines of the horizontal planes and their interfaces, and they are characterized by being logical, rational, reproducible and have relatively flexible formation principles, but at the same time they are governed by the fixed laws of their geometric development. dense network partition .Where the network and modular design spread, and the modular network did not remain just a medium for transmitting designs with their standard details and activation in space, but rather it became a standard with a dimensional value guiding proportions and measurements.

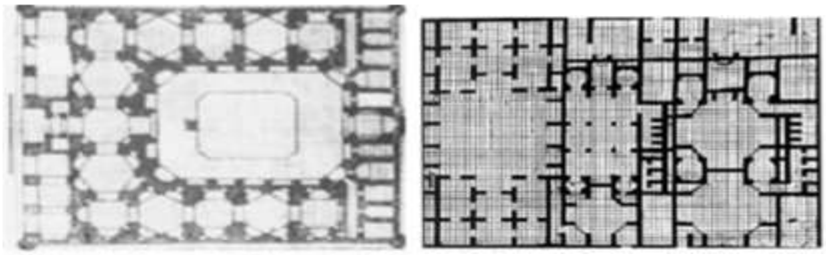


Figure 13

The interest in the module and its design revolve continued in organizing the aesthetic and structural ratios, and the focus in the modern era was on the micro-modular unit in coordinating it with building materials and standardizing it as a common volumetric unit and adding to the product an economic and aesthetic value that appears in the form of compatible complications and with less coordination effort. The architect dealt with the aesthetics inherent in the concept of modularity and shows its connection to the ideal geometric formation, and stressed that it provides some aesthetic effects and pure and ideal relations between the integrated and multiplied parts.

Research assumes:

Through its hypotheses, the research establishes theoretical relationships and applied organizations. He tries to prove it based on the documented references, then presents his vision of activating it within the framework of both the theoretic structure and the proposed applied mechanism, and these hypotheses are:

The first hypothesis: The spatial nature of the design network is consistent with the modular applications.

Proving the first hypothesis through references: The spatial nature of the network paves the way for the work of modular systems within the network configuration, as it expresses numerical and quantitative values and is linked to flat models and their repetitive areas. It is also used to confirm continuity and extension along the network axes.

The spatial foundation provides a typical background for rational and logical design, and supports spatial applications associated with constructions and engineering systems.

The second hypothesis: The design role of the modular unit depends on its dual nature.

Proving the hypothesis through references: The stereotyped module is the basic unit and standard unification tool that determines the sizes and specifications of the building elements. As for the volumetric spatial nature, it fits the functional role and links the parts of the design with its relative relationships and plastic overlays.

The third hypothesis: the combination of modular systems and rational thought provides the aesthetics of geometry and ideal relationships.

Proving the hypothesis: The modular square system dominated the complex formations in the Middle Ages as a key to the aesthetics of architecture. When the modularity is linked to the geometrical formation, there are aesthetic effects and perfect relationships between the structural parts.

The fourth hypothesis: modal thought works through generative complications and cumulative additions.

Proving the hypothesis: The geometric systems were established and were historically associated with the generative module according to the concept of cumulative addition, in which the module formations are combined and stacked and combined to prepare and produce the module formation. The design with multiples of the modular parts is considered a basis for modular generation in which the module is divided into sub-modules that guide the designer as a comparative reference for the architectural relationships and overlays.

Assessment of architectural awareness of network and modular thought.

The research uses opinion questionnaires to explore the degrees of conceptual awareness of network and modular thought. It asks questions that monitor and measure the opinions and viewpoints of 40 architecture students in local colleges and 10 architect designers, and they are extracted from descriptive suspicions and knowledge gaps that the research tries to correct with regard to the applications of modular networks, with the aim of Adjusting and checking the steps of the phased sequence, directing its course according to the theoretical and practical needs and shortcomings, and determining the appropriate degrees for the research depth. The questionnaire is concerned with monitoring the nature of the relationship between the terms network and module and revealing the conceptual confusion between module design networks and all other networks, and what are the suspicions associated with it such as boredom, repetition, superficiality and impeding creativity, and the extent to which architecture students and designers need curricula and guiding methods, with an indication of their capabilities and technical role.

Questionnaire indicators in support of the research orientation:

The sample of the questionnaire acknowledged the positive impact and organizational efficiency of the modular network in the functional distribution within the horizontal planes, the signature of the construction systems and the control of the visual axes. And she expressed the need for a guiding mechanism for designing the modular network, provided that it has a clear and applicable methodology and does not negatively affect the designer's thought and freedom.

Contrasting survey indicators that the research orientation is trying to address:

The sample of the questionnaire believed that the aesthetic effects of the modular design were weak, its visual impression negative, and its outward rigidity.She confused the nature of the network and the module in that they are one concept or two different concepts. And I mixed between the design network and the structural axes, and I thought they were similar. I also thought that the grid units are always square in their divisions.

Experimental application and hypothetical design model:

The research presents a hypothetical example of a hotel building containing 80 rooms, banquet halls, service and entertainment annexes, to implement the proposed research steps for design using modular networks, adjusting the sequence of its stages and actually linking them to the design process.Then the research tests it again by re-designing the same building and experimenting with it inside another site, carried out by a sample of architecture students and professional practitioners to measure their skills in modular application. The stages of this proposed mechanism consist of:

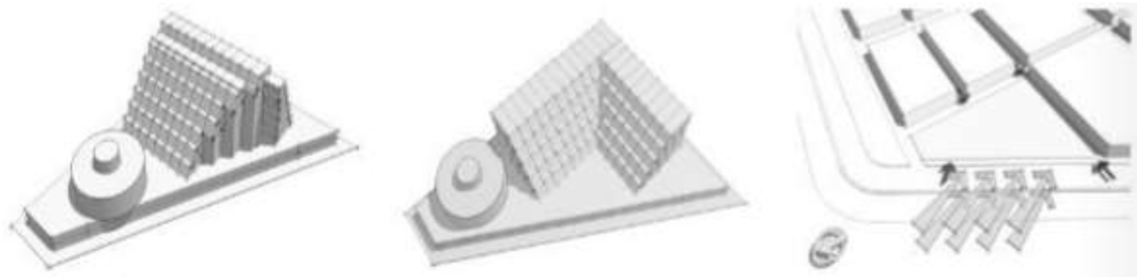
The first stage: Determining the inputs and alternatives of the design solutions:

First: the conditions of the construction site: the geometry of the site, building laws and requirements, and construction materials methods are studied.

Second: The design problematic: The decisions of the functional program are identified from determinants, technical standards and engineering needs.

Third: Determining the general formative alternative:

Select the most logical and efficient design option, functionally and in line with the architectural concept, through critical comparison and review, awell as a review of the strengths and weaknesses of each alternative.



The second stage: preparing the network system:

First, the network connection between the construction site and the design problem: The network covers the entire area designated for construction within the site, studies the engineering and geometric boundaries, activates wind directions, and explores the entrances compatible with the sides of the surrounding streets.

Building requirements: The percentage of buildings and setbacks are applied, taking into account the maximum height.

The functional program: It defines the container boundaries of the elements and blocks within the functional scopes according to the technical parameters and standards.

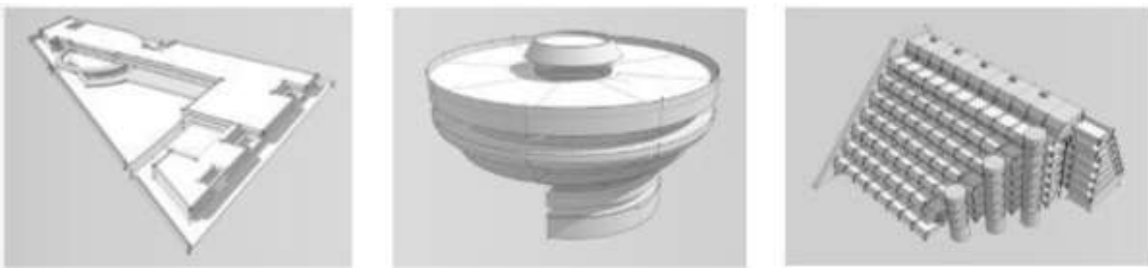
third level:

Preparing the modular unit: The primary modular unit and the principles of its structural structure are built from geometric components and virtual scales.

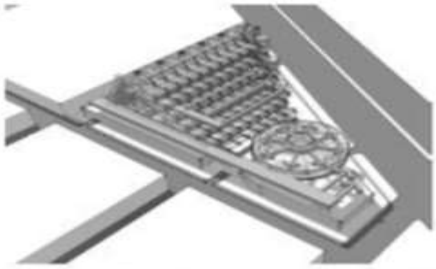
Second: Compilation of Modular Boundaries: It defines the laws of cumulative addition and generative multiplication that govern and organize the merger of primary modular units, their spatial diffusion, and their geometric ratios regulating their generation and compositional overlay, and then linking them later to the network system axes in the form of formative groups.

Fourth stage: Activating the module network in the actual design stage:

First, the signing of the architectural elements and their sub-formulation: the modal and non-modular units are signed in separate groups after solving their aggregative relationships within the ranges of the equipped modular network and before their final assembly.



Secondly, engineering connection to network systems: The architectural network is linked to other complementary engineering networks, such as structural and electromechanical, and their overlapping points are shown, taking into account their technical limitations and technical requirements.



The final design of the modular network product:

Questionnaire indicators in support of the research orientation: The designers supported the difficulty of design applications in the modular network, and that it needs a methodological guiding mechanism that coincides with the steps of architectural design supported by illustrative methods and training practice.

They also unanimously agreed on sensing the benefit in preparing the network systems, preparing the module, providing design alternatives, and its ability to come up with innovative ideas and solutions in a short time.

Research summary:

Theoretical structures of the concepts of the modular network:

Endoscopic Structure of Retinal Systems:

The network has duality: it is either point / coordinate, represented by network intersections, or domain / zonal, and it is represented by repetitive spaces within flat networks and volumetric spaces.

And it has design bodies: either linear or central circular.

As for its design benefits and technical advantages: it directs the paths of functional solutions, provides plastic alternatives for formations, controls geometric coordinates and projections, organizes the intersections and axes of construction systems, as well as supports aesthetics.

The endoscopic structure of the modular systems:

The module has a dual nature: it is either physical / solid or spatial / volumetric, and it has design bodies: either discrete date or compound, and it has a quantitative character (i.e. numerical): represented by being a standard unit knowing the value mathematically and controlling for aesthetic and plastic proportions.

Theoretical Structure of the Modulus Design Network:

Modular grid: It is a compact design tool based on the integration and interaction between the geometric grid system interconnected by geometry and propagation axes, and between the standard modules with their flat and spatial repetitions.

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