

Possible Applicability of Nikos Salingaros' 'Parameters' for Architectural Analysis

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Abstract - Philosopher, physicist, and Computer Scientist, **Nikos Salingaros**, in his book 'A Theory of Architecture', has outlined and explained various study aspects of **design theory** for architectural form, evaluative of a building's structural order and other formal characteristics. These aspects can be applied to architecture of any style and period for assessment of structural harmony and aesthetic appeal. This paper picks out these aspects and classifies them as 'Parameters' for convenient use to analyze buildings. To assess a typical Hindu **temple architecture's** compliance with **fractal geometry** and hence aesthetic appeal with psychological comfort, these parameters may be used for analysis of a temple structure. The illustrations used to visualize these parameters are from the Laxman Temple, Khajuraho, India

Keywords: Design theory; fractal geometry; temple architecture; Nikos Salingaros

1. INTRODUCTION

Largely lost in the aesthetization of utilitarian ideas is the primacy of architecture as a vessel of life, accommodating the needs of human beings to connect with one another and with nature in a complex pattern. Philosophers and psychologists point out that our experience of the built environment depends upon interacting with deeper aspects of life than conscious experience alone (Salingaros, 2006, 2008). Taking this thread of thought further, this paper elaborates and applies those aspects of formal analysis of building structures which are most directly applicable to analysis of temple form and symbolism. Though, there are other parameters mentioned which may be helpful in the analysis of other architectural typology. Aesthetic appeal also depends, in part, on the perception and experience of the temple complex by humans. This aspect has been

entertained well by Prof. Salingaros, as for the more philosophical aspects of Hinduism, these have been only touched upon where necessary for understanding.

The eminent mathematician, urban planner and thinker Nikos Salingaros' 'A Theory of Architecture' is a comprehensively written book which touches every important aspect of theory of architecture. These ideas have been lined up in a logical sequence to make understanding and application easy. Most of these ideas become clearer towards the end of the book when the reader has summarized all the chapters in his mind. This paper therefore encounters the obvious difficulty of discussing each concept fully in its own right.

The book is a compilation of short passages explaining each idea concisely. The elaboration of these ideas and concepts may be found in the respective papers previously published by the author. Parameters are described and explained in the book, with the backdrop of 'Pattern Language' and to a certain extent 'Form Language' producing 'Adaptive Language' or 'Adaptive Design'.

The 'rules', very precisely and thoughtfully formulated by Prof. Salingaros, even though not mentioned here, have not been ignored, and have helped in the formulation of the list of 'parameters'. This article has excluded the discussion on the equations derived for temperature, harmony, life and complexity of a building.

1. 'Parameters' outlined

The list of 'parameters' that have been outlined are: Structural Order, Scale, Natural Scaling Hierarchy, Ornament, Hierarchical Cooperation, Concept of Metaphor, Organization and Pattern Language.

1.1.Structural order

Structural order depends upon human perception, hence it cannot be judged strictly from abstract formal criteria. This flexibility exists only to a certain extent, but beyond which the collective understanding becomes important. This is a concept familiar to physicists, where the observer becomes part of, and influences the behavior of, a quantum system. An underlying theme of this enquiry is that architecture exists in the universe of human beings (the concept of 'Aham Brahmosmi' is explained later), and cannot be isolated into an abstract realm of its own. The basic criterion may be stated as: 'if we respond to it in any way, then it is a component of structural order' (Salingaros, 2006, 2008). Since 'architecture exists in the universe of human beings', it is a single whole organism, consisting of nature, human beings and universe; these being interpenetrating within, and consisting of each other. The underlying geometrical order must necessarily have a common thread.

Putting this theory into general rules to be followed for creating and assessing architecture, Prof. Salingaros generates three laws for achieving structural order.

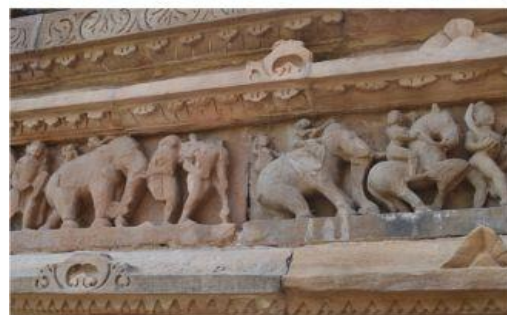
'Balanced visual tension' among 'contrasting elements' shows the importance of eliminating monotony, along with the evolution of a pattern which is dynamic in nature because of the visual tension that balances each other lending dynamism to it. The eye movement - to and fro - between the complimentary shapes/ themes/ patterns, enhances the dynamic appeal and helps in the arousal of the brain to its optimal activity.

Applying this law to temple architecture, in Pictures-1 & 2 it is seen, that this technique has been used to tie the whole structure together like a ribbon. It ties the rhythmic *kuta stambhas* with the main structure integrating the 4 major units in the temple with its interesting facade. The mini contrasting elements woven together to form a ribbon, creates a rhythmic pattern in itself maintaining visual balance with the rest of the structure. Picture-3 & 4 shows the band in the *jagati* depicting the royal scene, with the series of events relating the story. This ribbon, balances itself visually through contrast, by using sitting and

standing figures, royal figures and peasants, humans and animals, farming scene and court scene, varying sizes of figures and celestial maidens and earthly beauties. These elements are contrasting in subject, size as well as treatment. The essential point of, why there is a need to tie the structure, together will become clear as the other parameters are discussed along the article.



Pictures 1: The various bands in the *Jagati* of the Laxman Temple showing visual balance through contrasting elements



Pictures 2: Bands in the Laxman Temple depicting events (stories)

Reduction of entropy takes place when a relationship is formed between the elements at a

distance. This relationship may be physical - similar shapes, patterns, colors, themes etc. or psychological - mythological stories, basing classically conditioned values etc. In the temple context the impact of the latter is enhanced due to the psychological state man prepares himself for. Nonetheless, the contribution of the physical relationship between elements of the different scales is immense. Picture 5 & 6, along with Figure 1 focuses on the repetition of the *shikhara* curve integrating the whole structure.



Picture 3: The whole structure seems to be integrated through the *shikhara* curve pointing towards the common axis

As Lauwerier (1991) mentions that a fractal structure shows non trivial geometrical substructure at every level of magnification, it can thus be seen from the above example (Picture 5 and Figure 1) that these fractals have defined a scaling hierarchy that is complex at every level of magnification (Salingaros N. A., 2006, 2008). This example highlights self-similarity as it is easy on the brain to perceive and relate with. Self similarity, in this context, also highlights the concept of 'whole in part and part in whole'.

Grasping a complex whole empowers us with knowledge about our environment, whereas confronting something that is too disconnected to grasp easily leads to frustration and anxiety (Salingaros, 2006, 2008). The brain creates connecting lines that appear to tie the geometry of the two units together. This establishes a physical relevance for a strictly visual phenomenon. It appears that the brain sees the proper physical connections for a coherent structure. (Salingaros, 2006, 2008). These connecting lines aids the visual experience through the knowledge of culture, religion and mythology, as these connections may not be visible without classical conditioning in the

sub-consciousness. Figure 2, graphically elaborates the rhythmic jump of this pattern through various magnifications. This becomes necessary, because it is difficult and stressful to relate to physically distant objects, and a tying thread is important to comfortably take the mind from one level or scale to another. These intermediate scales act as a series of steps, connecting the starting point and the end point. As comfortable as these steps are, a long leap is uncomfortable and undesirable, creating an uneasy mind state. It should be noted here, that the scaled units which are the result of this algorithm, are only one part of the intricate symbolism involved in creating the elaborately intricate facade and *shikhara* details. The other being the details adorning these elements which use another algorithm for proliferation, as a result, covering the façade with minute details supplementing the same concept.

The physical manifestation of these laws, for creating coherent structures is, but the ignition of these related ideas, giving rise to the chain of thoughts that follow, finally aiding the understanding process. The structure is merely the beginning point for the infinitely long process that is to begin. Therefore, the algorithm is set by the structure, following which the human mind proliferates the core ideas. The entropy of a design is perceived by our innate ability to visualize connection. Making adjustments to a complex structure so as to lower its entropy confirms precisely to the process that gives rise to natural forms (Salingaros, 2006, 2008). This emotional response to a building which is the deeper connection between structural order and nature (Salingaros, 2006, 2008) profoundly helps in understanding the process.

Hence the small scale is connected to the large scale through a linked hierarchy of intermediate scales with a scaling ratio approximately $e=2.7$. The different scales have to be close enough in size so that they can visually relate to each other, and the linking is accomplished through structural similarities, such as repeating forms and patterns (Salingaros, 2006, 2008).

[Structures], regardless of shape or use, is perceived as beautiful when an emotional link is established with it, and that is possible only when it has a high degree of structural order. The note

worthy point here being that perception of structural order as a positive emotional state is independent of opinion, fashion, style (Salingaros, 2006, 2008). Emotional link becomes magnified as the temple structure directs our gaze towards unity with the supreme.

We relate to the detail in a design or structure immediately, because connecting to the small scale is an emotional experience. On the other hand, perceiving the overall form often requires some thought which is a more intellectual process (Salingaros, 2006, 2008). Giving this concept, Salingaros makes it clear that there exists steps and a certain order in the perception process depending upon the hierarchy and scale.

Natural forms have an ordered internal complexity that mimics interacting physical processes and this is reflected in the world's great historical buildings and vernacular architectures (Salingaros, 2006, 2008). The presence of essential mathematical harmonies is perceived instinctively and is emotionally fulfilling. This is the foundation of much of religious architecture (Salingaros, 2006, 2008). There is a much deeper connection that follows not from the appearance but from the underlying mathematical structure. If the way components are combined corresponds to that of natural forms, then a man made structure will be perceived as natural even when its appearance is clearly artificial (Salingaros, 2006, 2008). This aim of attaining a coherent structure with natural hierarchy is a built in human need which results in structures that may not look like natural forms but give similar satisfaction because of the naturally evolution process involved.

1.2.Scale

Starting with Vitruvius, writers underline the necessity for architectural forms to have features on a scale to which human beings can relate (Licklider, 1966). As mentioned earlier, Licklider (1966) states that at any given distance, a person will connect to design components that correspond to the entire human structural scale: the whole body; an arm's length; a foot; a hand; a finger's width, etc. This impression is visual and relative, and depends on the changing distance between the viewer and the structure. (Salingaros, 2006, 2008). Bovill's theory of distance and eye angles, for

establishing box sizes is a helpful mention here. He elaborates the difficulty of analyzing architecture, with respect to scale, as it is a continuous process in space and time. The quality of space changes temporally, also continuously changing the scale to which one can relate. This makes architectural experience interesting and personalized.

Hindu temple architecture is the best example to study the scaling hierarchy, as it exhibits details at all scales. Therefore as one approaches the temple, the visible frame and the level of detail, modifies itself constantly generating new experiences. This may be compared to the journey of life, where as one moves forward, the pattern of complexity modifies itself, without compromising the level of complexity at each stage. Picture 7 focuses on this aspect of architectural analysis and shows the major highlights in the tour of temple experience. It shows the changing view, and therefore the changing experience, modifying the mental processes gradually, lending dynamism to each stage of experience, maintaining the neural activity of the brain at an optimal level for satisfaction.



Picture 4: The above series of pictures shows the changing views as one approaches the temple structure

Viewing limits or range (view frame), defined by the angle formed at the human eye, facilitates this process by dynamically modifying the view at each step. Bovill prescribes a chart for relating the aspects of viewing distance, angle subtended at eye, visible range and details experienced. The finest detail is observable only within the centre 2 degrees, but significant detail can be observed through 10, 15 and 20 degrees (Helms, 1980). Picture 7 shows the changing views as one approaches the Laxman Temple from the main gate. It becomes clear that the dark interior space of the temple is the focus along which the symmetry of the temple structure is enhanced. After one has climbed

the plinth, the eye angle range modifies the view to contain the details of the façade to a certain extent, and limit the range. This helps in adopting a new focus. Gradually our attention is drawn further towards the sculptural details of the façade which portrays varied aspects of mundane and royal life, finally taking us towards the finial of the *shikhara*, reminding the visitor of the ultimate goal.

1.3.Natural Scaling Hierarchy

If the scales are spaced the same way as in natural structures (i.e., obey the natural scaling ratio), and if they also correlate with each other via connections and similarities, we perceive the structure as a coherent whole (Salingaros, 2006, 2008). A design with a natural scaling hierarchy influences the viewer because it facilitates the process of human cognition. First, the mind groups similar units of approximately the same size into one scale. Then, it looks for similarities or links between all the different scales. Since the mind has evolved in response to patterns found in nature and the natural scaling hierarchy, a certain set of rules for recognizing hierarchical cooperation is "hard-wired" within our perceptive mechanism (Fischer & Firschein, 1987). This phenomenon may be attributed to the concept of 'collective memory', which helps us recognize patterns and algorithms with a certain background. This 'hard-wiring' also correlates with the formation of a complex fractal-like brain. The brain structure is said to be fractal and hence is able to comprehend such structures and meanings easily. The final result of any phenomenon is hardly understood, nor is it very relevant. More important is the understanding of the underlying process or phenomenon which makes the result, a logical outcome. This rationalized result or the final product finds a place in the 'aesthetically appealing section of the brain' thus gaining acceptability artistically and geometrically. Systems theory relates the organizational mechanisms underlying design to analogous processes taking place in biology, physics and computer science and is in a better position to explain this effect.



Picture 5: Above pictures depict inspiration from nature

Salingaros points out that the concept of structural order can be reached from three entirely different viewpoints: we can use science to discover how structures are put together coherently; we can use art and architecture to do the same thing; and we discover that our own mind works in precisely the same way. This reveals a universality for all the concepts discussed in this book- a level of validity that cannot possibly be dismissed as accidental (Salingaros, 2006, 2008).

Euclidian geometry remains the basis for any physical manifestation of the concepts embodied in architecture, but the mind-brain continues to evaluate it through the lenses of the underlying process in its organization. This process of organization and arrangement is fractal in nature and therefore renders it acceptable to the intellect. A Fractal structure shows non-trivial geometrical substructure at every level of magnification (Lauwerier, 1991). By repeating the algorithm for replication of the *shikhara* to form the *unniprattis*, a continuous process is evolved, which results in transmitting the idea of endless proliferation, in-sync with fractal iteration. By repetition of this algorithm a fractal structure is formed, and the structure gains the required level of complexity needed to satisfy the human intellect. Drawing on the analogy of hierarchically- organized anatomic modules in the brain, Salingaros assumes that the systems of organization that also characterize the mind are at least partially fractal in nature. That is, each contains a hierarchically- arranged system characterized by an algorithmic continuity between the successive functional levels of activity. Our

mind appears to deal with hierarchies of thoughts rather than with single thoughts as isolated units (Salingaros, 2006, 2008).

People have a basic need to extend their consciousness to their environment, something that occurs effortlessly when surrounded by nature (Salingaros, 2006, 2008). "Baat baat mein baat hai, baat baat mein baat hai; jo kele ke paat mein, paat paat mein paat." This Hindi saying means that ideas and conversation are interlinked hierarchically, connected by the means of a tying thread continuing towards infinity. It is compared to the composition of the banana leaf, which opens leaf after leaf infinitely. It explains the relationship and continuity of thoughts to infinity hierarchically.

1.4.Ornament

The broader implication is that architecture adapted to human beings requires ornament for a sense of well being. Salingaros also acknowledges other factors that influence the appreciation of architecture, including past experience, cultural formation and environment, and upbringing.

In classic experiments on human eye motion while scanning a picture (Hubel, 1988; Noton & Stark, 1971; Yarbus, 1967), the eye is observed to focus most of the time in the regions of a picture that have the most detail, differentiations, contrast, and curvature. Therefore it is concluded that the visual system is built to select those items of concentrated information that can provide the most complete response in the shortest possible time (Salingaros, 2006, 2008).



Picture 6: Ornament focuses the attention and seeks concentration

In a temple, consider a case where there is no ornamentation on the façade, the formal structure contributes to the rhythm of the form/concept to a certain extent. This keeps the human brain functioning and busy till a certain level, that is, till a certain distance has been reached close to the structure. But beyond this, due to the proximity to the building, and the viewing angle to the human eye, very little or sometimes no complexity is experienced. This lack of excitement, may dampen the experience of the temple now due to a sudden drop in the complexity, and force a monotonous and boring experience. This will even disturb the spiritual experience interrupting the path, withholding the climax, that is, enlightenment. To overcome this problem, the temple walls are adorned with intricate carvings, again, having complexity at various scales, following a certain hierarchy. This maintains the rhythm of the intellectual experience, seamlessly continuing our journey on the path of spiritual achievement.

The beauty of the patterns used as ornamentation, lies in its continuity, in our mind, long after the physical manifestation has ceased to proliferate. This is enjoyed most by people who are classically conditioned to imagine the mythological stories and their related concepts, integrating it with the temple experience, to create a holistic experience.

The *saptaratha* temples especially have magnificent sculptures on each *ratha* or storey (Gupta, Vijaykumar 2010). Aesthetically and functionally, these elements made the temples get rid of, not only the monotonous heavy and closed look, but also the mysterious darkness surrounding the *garbhagriha* of the temple (Gupta, Vijaykumar 2010). Temple sculpture noticeably increases in extent and scope: carved figures are no longer confined to wall niches, and are often multiplied both horizontally and vertically so as to cover exterior wall surfaces entirely (Michell, Hindu Art and Architecture, 2000).

Symbolically, the outer walls are adorned with sculptures of mundane life of villagers and maidens. It depicts the outer concentric circle of life containing numerous daily life issues. As the temple is entered, the topics of sculpture and carvings change to more specifically spiritual ones. In the interior spaces of the temple, the sculptures

no more consist of the daily life of locals, but the walls are adorned with celestial maidens and other subsidiary gods of the pantheon. The more important of these are enshrined in subsidiary shrines and niches. This change in ambience, assists the change in mood, distinguishing ones thought process outside and inside the temple. The structure and sculptural ornamentation on the outer walls should not be undermined as the gods are the constituents of the body of the *Vastupurusha* (Kramrisch, 1976), which gives form to the temple structure. Also, the complexity in the outer façade sets the rhythm and opens the mind for the experience to come.

1.5.Hierarchical cooperation

An important point is that the greatest buildings do not eliminate randomness entirely and the optimal value for the architectural harmony is below its theoretical maximum. The fact that 'Architectural Harmony' value is ideally not at its theoretical maximum, as having the highest value would mean that the structure lacks variety in patterns and its usage algorithms. This may lead to monotony, resulting into boredom in the architectural experience. To avoid this feeling, and to retain the interest of the viewer, some degree of randomness is inserted, breaking the monotony. An underused/under-aroused mind may go off to sleep, and since this situation has to be avoided, the above method is ideal. Every great building has some degree of randomness, which can manifest itself on different scales (Salingaros, 2006, 2008). Structural order, the natural scaling hierarchy, and ornamentation, all contribute to the increase in complexity.

An alternative terminology more appropriate to complexity theory is to call the architectural 'life' the "degree of organized complexity"; and the architectural 'complexity' the "degree of disorganized complexity". (Salingaros, 2006, 2008). Any effort to quantify the degree of pattern in a structure or design leads one to consider its information content. There are two separate variables here: the actual information and its presentation (Salingaros, 1999b); and how well that information is organized (Klinger & Salingaros, 2000). Complex, ordered patterns have a large information content, which is tightly organized and

therefore coherent, i.e., it can be grasped and has meaning for a human being. Random information is incoherent, which, by failing to correlate, cannot be encoded (Klinger & Salingaros, 2000). Encoding is possible only for an organized pattern. For unorganized elements or incoherent shapes, interpretation becomes difficult, due to failure to correlate.

Repetition (using translational or other symmetry) of an empty module does not necessarily create patterns with any content; one needs contrast as well (Alexander, 2004). This correlation develops not only through pattern recognition but also the background knowledge regarding the theoretical concept being experienced. In the temple context, this knowledge, in the form of mythology and basic divinity statistics, is implanted in every individual's mind in a sub-consciousness terrain. The mythological stories and knowledge are interwoven to form a chain of concepts and ideas forming a well-co-related whole. Therefore, analysis, through these lenses, automatically lend the coherence needed in the structure. Hence, the lenses through which these structures are viewed are as important as the metaphysical concept guiding the temple ornamentation and its physical manifestation. This lends coherence to the elements that lack physical coherence through patterns.



Picture 7: Hierarchy is visible through the ascending sizes, social value and spirituality.

1.6.Concept of metaphor - Symbolism in Temple Architecture

A metaphor is the use of words that trigger a complex system of connections and associations, generating new ideas and meanings in the process. The effect of metaphor may be interpreted as the

transference of one hierarchical meaning system onto another, very different one (Salingaros, 2006, 2008). Saying this, it seems to be the best way to transfer human mind from one meaning system-shape grammar of temple architecture and formal parametric analyses, onto another very different one- philosophical concept and esoteric aspect of temple architecture. This travel from one psychological environment to another is the goal of temple architecture, fulfilled by 'Symbolism'.

Metaphors are an important part of the symbolic representations in temple complexes. It is only through the cognitive process of metaphors, that symbols and their meanings are perceived. These meanings through perception, give way to various streams of thought which are connected through fractal hierarchy, generating appropriate ideas and coherent meanings in the process.

The problem lies in the completion of the process itself, which gives a feeling of satisfaction, hence the illusion that one has understood what was said (Salingaros, 2006, 2008). This is why the process and method of symbolism is successful, as one can assume the meanings according to the feeling of satisfaction, related to one's own understanding. The 'illusion', that one has understood what is being communicated, plays the lead role here.

The built environment reflects structures in human thought, in that it is created by the human minds. Thought works by establishing connections between concepts, creating conceptual structures and ideas. We assume that fractal structures in nature influenced the development of neuronal mechanisms in evolution that could encode and decode these structures automatically. If true, it is reasonable to suppose that the mind, which uses these mental mechanisms, seeks to shape its environment according to the same rules for structural connectivity that inherently make up cognition. Internal patterns of neural nets that form our sensory and thinking processes are organized in a way that reflects similar patterns in organization in the external universe.

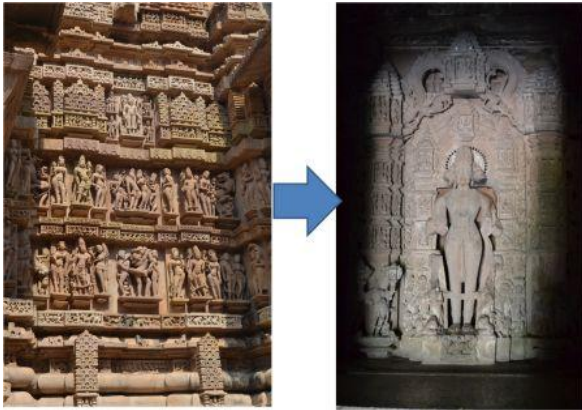
Salingaros 2006 2008

According to Salingaros, the built environment reflects structures in human thought, and so, it is created by human minds. This is especially relevant to Hindu thought, which believes that *Brahma* creates the whole world and universe. *Brahma* is a name for the creator, as well as a term used for one who imagines. This individual imagines the world and universe around him. This phenomenon is '*Brahma* creates *Brahmanda*'. In the Hindu philosophy each one is a *Brahma*, who creates a *Brahmanda* around himself, which is his universe. This concept very swiftly explains that, for an individual, the temple experience is a personal one. This experience need not match with anyone's, as most of the times it doesn't. Therefore, there exists a need for open ended symbolism, where the concept/ idea is open to interpretation. This way of expressing symbolism through metaphors, helps each individual to tread his own path and find his own goal, reaching which equals spiritual satisfaction. also, Hinduism holds that there are innumerable ways of liberation, it would never expect all its followers to be able to approach the divine in the same way, and therefore it provides different concepts, rituals and spiritual exercises for different modes of awareness (Capra, 2012).

The concept of metaphor can be especially applicable for the physical manifestation of the symbolic meaning to be transferred. On most occasions, the concepts to be transferred are metaphysical ones, which cannot be depicted easily through physical objects. This is where metaphorical depictions come in, through which, symbolic associations are made so as to relate to the concept of temple through physical manifestation. This physical manifestation is in the form of ornamentation on the temple walls which have multiple effects on the minds, from arousing the brain's activity to function at an optimum level, to, the communication of the spirit of the temple. Symbolic metaphors are strewn all over the temple ornamentation and embellishments. Metaphorical meanings also exist in the overall structure of the temple as also in the subsequent smaller scales.

It can be concluded that the 'concept of metaphor' has been well utilized in the communication of the spiritual concept. The geometry and theory of fractals support this process and vice-versa. Immense contribution of fractal geometry can be seen in all the areas of temple architecture, from

structural arrangement of components, the layout of plan and treatment of façade in plan and in elevation. The concept of fractal geometry and its influence has been included later in the article.



Picture 8: The path travelled from exterior (worldly subjects) to interior (towards the goal), where nothing else exists, but God

1.7. Organization - ordered complexity

Connectivity is the result of new geometrical insights into fractal structure, iterative processes, emergent properties, etc. Natural and biological structures arise from the complex interaction of many elements on different scales (both smaller and larger). Organisms, the unselfconscious creations of human beings, and our past's greatest architectural achievements are all fractal, complex, and internally connected to an incredible degree (Salingeros, 2006, 2008). The connection made within the structure internally is an attempt to connect with the human body at the nervous level. This connection is achieved through various processes going on simultaneously like, the similarity between the structural organization of the building and the mental processes, the capacity of the mind to process such hierarchical structures, and most importantly, the urge of human beings to transmit knowledge through such expression. Organization connects and coordinates processes; whereas imposition from above may eliminate them (Salingeros, 2006, 2008).

"The human mind has first to construct forms independently, before we can find them in things."

Einstein

Calvin (1987, 1990) states that, the world of the architect is created in an architect's mind according to physical systems that govern the biology of the brain. According to one theory of the thinking process, an idea arises out of the competition and selection among similar and dissimilar ideas occurring simultaneously in adjacent neural circuits of the brain.

'Ordering' in the patterns in temples is as important as the 'complexity' of patterns. This parameter has been elaborated to a certain extent in the discussion of the 'ornament'. Ornament is important as it reduces the brain's labor in understanding process of the pattern. On the contrary, if the same algorithm continues indefinitely the mind ceases to enjoy the process making it monotonous. Complexity, through new unrelated elements, is added to retain the interest level by changing either the algorithm or the parent pattern. This whole process results into a structure with ordered complexity which is comfortable as well as interesting for human minds.

The temple structure follows this concept accurately and displays an ordered complexity in its organization of the overall form of the structure as well as its façade decoration. The beauty lies in the fact that the algorithm followed by the structural hierarchy continues smoothly into the ordered pattern in ornamentation. This seamless blending of the two, dissolves their boundaries. Therefore the ornamentation on façade does not appear to be a separate element or add-on, aiding the subconscious on an uninterrupted path towards spiritual peak.



Picture 9: This shows the hierarchy in patterns and their coherence.

1.8.Architectural memes

The word "meme" denotes any idea, image, tune or advertising jingle that endures and propagates (Brodie, 1996; Dawkins, 1989; 1993; Dennett, 1995). Memes- ideas, tunes or images - are the equivalent of agents that "infect" memory (Salingaros, 2006, 2008). Commonly referred to as 'clichés', these are typical shapes, patterns or symbols, which are commonly accepted or understood to mean a certain thing. These may also be classically conditioned or just accepted, owing to its existence in the society for a long period. It acts as a stimulus and reminds us of another thing or aspect related to it, already in our memory.

An idea, together with its representation and the connection between itself and its representation, form a transmissible unit. This defines a "meme" (Dawkins, 1989; 1993; Dyens, 2001). An architectural meme is a visual component of a particular architectural style. It is a representation of form, geometry, surface, etc (Salingaros, 2006, 2008).

Salingaros highlights Francis Heylighen's identified list of these which are 'simplicity', 'novelty', 'utility', 'formality', 'authority', 'publicity' and 'conformity' in the context of architecture. 'Encapsulation' describes how memes link with other memes (Salingaros, 2006, 2008). Minimalist architecture crossed the complexity threshold going towards total abstraction. This brought it an unprecedented memetic advantage, but removed an essential quality that is associated with 'life' (Salingaros, 2006, 2008). It is mentioned that the idea of design as a Darwinian process that relies on selection has interesting ramifications for architecture as a whole. This explanation of how design emerges in the human mind reveals a split between design methods based on stereotyped images, and those based on adaptation to human needs (Salingaros, 2006, 2008).

An answer to why this is so comes from visual memes, which are self- sustaining conceptual entities that become fixed in human memory. Originally introduced in discussions of evolutionary biology, memes serve well to explain why

architectural fashions survive and propagate (Salingaros, 2006, 2008).

Temple architecture, too, uses memes, and sets the unconscious mind (mood) and prepares the mind-brain for the experience to come. On one hand, temple architecture is all about the subconscious experience, and on the other, the use of memes relates the 'known' or 'easily recognizable or relatable' aspect/ affect, to the esoteric aspects.

As soon as human beings began to establish a network of storage devices for their acquired knowledge, this network became a vehicle for other, useless entities. These are the "memes", introduced by Richard Dawkins (1989; 1993) as pieces of information that travel from human mind to human mind. Memes are propagated in the collective mind of the society (Salingaros, 2006, 2008). This has been explained to be engrained in the 'collective consciousness' of the society.

The concept of 'memes' contribute a great deal in the understanding of temple structure as these are embedded in one's mind. The algorithmic process of structural development may also be said to be acting as a meme, since this pattern is typical to temple structures. Some of the memetic shapes and forms attached to a temple are given below.



Picture 10: These are typical memes in the temple context, from the Laxman Temple, Khajuraho - 1- The keeper who drives evil away; 2- the emanating universe; 3- allied deities in niches, like miniature temples; 4- horseshoe-shape emitting light of enlightenment; 5- narrative, holding all parts together; 6- the celestial maiden in all aspects of daily life.

Other than these examples mentioned, the plan form can also be described in similar terms.

1.9. Form language

The form language is stored in collective memory and recorded in physical materials, and is older than writing. Each traditional form language is distinct, yet possesses a comparably high degree of organized complexity in terms of visual vocabulary and combinatoric possibilities (Salingaros, 2006, 2008). The form language, is explained to be strictly geometrical and is a repertoire of forms and surface elements that can be combined to build any building, and so it represents more than just a superficial style. The form language depends on an inherited vocabulary of all the components used in the assembly of building; rules for how they can be combined; and how different levels of scale can arise from the smaller components. It is a particular and practical conception of tectonic and surface geometry. Salingaros mentions that form language is a set of evolved geometries on many different scales (i.e., ornamental, building, urban) that people of a particular culture identify with, and are comfortable with.

An adaptive design method arises out of a complementary pair consisting of a pattern language and a form language (Salingaros, 2006, 2008). In a temple complex, pattern language, which is supposed to be a representation of interaction between human beings and their environment, is to a great extent dictated by the religious norms already set. Form language, on the other hand, contributes immensely to the understanding and cognition of temple architecture. Due to gradual evolution process and depiction of similar forms and meanings, it has a memetic advantage over other forms. The form language for a temple complex and structure can be said to be given by the ancient *shastras* of *Mayamata* and *Vastushastra*. These act as guidelines for the construction of temples, and when followed, result into the typical temple structure with important parts that form the 'form language'.

Environments should make human beings feel at ease; make them feel psychologically comfortable so that persons can carry out whatever functions they have to unselfconsciously, without being disturbed by the built environment in any way. This imposes a strong constraint on the design process, to adapt, to the many factors (both known and

unknown) that will influence the user on many levels including emotional (Salingaros, 2006, 2008). The temple structure is therefore said to be designed so as to facilitate the spiritual and emotional experience, along with the spatial experience, at changing levels. The temple experience is not a constant one. It changes continuously as one moves along the axis of the temple. The temple exterior sets the mood and promotes us on the spiritual path which reaches its climax in the interior of the temple. From the *ardhamandapa* or *mukhamandapa*, through *mandapa*, *mahamandapa*, *antarala* to the *garbhagriha*, the environmental experience influences and modifies our feeling to gradually transform it to become one with the almighty. It should be noted here, that the *garbhagriha* experience is only through visual impact as this space is not entered. Instead of expressing an adaptive tectonic culture, the form language becomes a set of visual symbols that operate under the guise of moral principles (and thus become emotionally loaded) (Salingaros, 2006, 2008). These symbols, aiding form language, have a profound effect on the thought process, algorithmically modifying it to create the holistic concept.

All human spoken languages are contained in a general "meta-language", which has a grammatical or syntactical structure common to all known languages (Maynard-Smith & Szathmary, 1999). Architecture acts as a human emotive common thread between cultures and its experience is not totally dependent on the knowledge of religion, whereas, its understanding is dependent on the background knowledge, that is classical conditioning. The success of the written language also depends on its presentation. Fractal geometry, as mentioned earlier, plays a helpful role in portraying the concept.

Differences arise in specificities, in the breadth of vocabulary for concepts important to that culture, and in their translation to a written language, but those do not affect the general richness of the language (Salingaros, 2006, 2008). This point is easy to explain from the mathematics of communication. In order to describe and communicate complex human activities and interactions, a spoken language itself has to have an extraordinary capacity for encoding complexity

(Salingaros, 2006, 2008). The complexity of human thought sets a rather high threshold for complexity that any language has to be able to express through combinatoric groupings (Salingaros, 2006, 2008).



Picture 11: These explain form language in the temple context, from the Laxman Temple, Khajuraho

Our desire and ability to connect to the physical world through a mental understanding of physical structure that extends our conceptual mental apparatus into the external world (Salingaros, 2006, 2008) aids in creating the connection between human mind and his environment. The construction process is natural, precisely because of our desire and ability to connect.

Salingaros very accurately says that human beings inhabit a hybrid world formed from the overlap or merging of the physical universe with the universe of information.

2. Discussion

2.1. How the mind works to respond

Salingaros says that the mind establishes a connection with the environment by processing information, an important process that drove the evolution of the brain. Therefore, in such environments, it continues the process of evolution of brain towards development. It is also possible to imagine a hierarchical system in which some clusters of levels may be connected according to one algorithm and others according to another algorithm. Salingaros has appropriately concluded that the human mind could then be using fractal encoding as a standard way of coding enormous chains of related thoughts into a single fractal

entity. A design pattern may well be a representation of an architect's natural expression of these chains of thought in a tangible form. Striking parallel properties exist in neuronal and thinking processes. (Salingaros, 2006, 2008). Environmental psychologists know that our surroundings influence not only the way we think, but also our intellectual development (Salingaros, 2006, 2008).

The complexity level needs to be optimum for the brain to function at highest productivity. This is also aided by the value of 'Harmony' being just below the theoretical maximum, as explained earlier.

The memory process is central to neural function and is an example of the basic mapping that links the brain and the mind. Information that comes from memory helps to support perception and meaning (Salingaros, 2006, 2008). Information that comes from memory are: mythological information, classical conditioning, legends etc., with complimentary information from visual impact through shapes, arrangement, rhythm, size, light and shade and light quality. All these put together give perception and meaning and can therefore be different for each person. (through associative memory). Neuronal pathways linking regions of the cerebral cortex correlate with the construction of long-term memories (Rolls & Treves, 1998). It is evident in a diagrammatic representation of connections within the brain, that there are layers of structures with projections from one to the other (Alexander & Globus, 1996). Divinities appear in a seemingly inexhaustible range of aspects and emanations, testifies more to the imaginative potentialities of literary iconographic sources than to the liturgical requirements of worship (Michell, Hindu Art and Architecture, 2000).

Associative memory is very important to Architectural design. It can be responsible for powerful emotional experiences when we identify with what we already know or which reminds us of something stored in our memory (Salingaros, 2006, 2008). When a mental connection is created with certain patterns or concepts, or among patterns and concepts, their meanings transform into intelligible ideas. This transmission of meanings to the human minds, remains the foremost goal of the temple complexes. The spiritual journey of uniting with the

Absolute, can be undertaken, only when the receptive mind is free to make connections, form relationships and associate patterns with concepts. These are of utmost importance to the temple experience.

When these concepts are applied to temple architecture, the aspect of what the structure is trying to say plays an important role in the understanding process. This, combined with the way human mind perceives, produces a holistic impact of the understanding gained from the structure. The temple structure, has certain messages to be transferred to the visitors for which a connection has to be established between the structure and the viewer. The elements are: the temple structure, inherent symbolism, the physical structure of the brain and the mental processes involved in understanding. This connection can easily be established when the underlying process is common.

2.2. Fractal Geometry in Laxman Temple Architecture

The Brain's multi layered structure has previously been suggested as providing a framework for associative memory (Marr, 1982). Salingaros suggests that a fractal-like neuronal system architecture provides a filter for selected memories to be stored in a stable layered configuration. Thus, associative memories that make one feel at ease would be manifested through this fractal mechanism (Salingaros, 2006, 2008). It is extremely important to remember the fact that the temple structures and their ornamentation follow the neuronal structure of the brain. This pattern in hierarchy has also been related to the processes involved in human thought. The existence of fractal patterns, as the common thread, shows the basis of natural configuration.

He also points out that the brain's neural patterns are responsible for recognizing structured complex systems that have a hierarchical organization in which the levels in the hierarchy are defined in a systematic, algorithmic way. Such recognition has in emotive value for the person (or higher animal) in question. In general, when a system recognizes a structured entity in the environment, it attributes "meaning" to it.

Brain mechanisms are said to be especially receptive to such signals, and would screen other signals that have a different algorithmic structure- i.e., any signal that shows no hierarchical linking among its components. This represents a "filter", allowing us to connect selectively and preferentially to fractal forms. It also explains instantaneous cognition as a kind of resonance between an external structure (i.e., the familiar forms and details of traditional architecture) and the internal structure of our cognitive system. Such a mechanism has already been suggested by Gibson (Claire F Michaels, 1981)(Gibson, 1979; Michaels & Carello, 1981) in his psychological model of "direct perception" (Salingaros, 2006, 2008).

Although life has not been rigorously defined as a concept, biological life consists of two components: metabolism, and replication (Dyson, 1999; Maynard-Smith & Szathmary, 1999). In examining how life arises, the physicist Freeman Dyson (1999) proposes that two distinct processes characterize all living forms: metabolism, and replication. This is significant as fractal geometry follows similar processes and results into natural forms not by shape but by replication and metabolic process involved in the creation of the final result.

This aspect is related to fractal geometry principles, wherein, it may be directly stated that a building which has a high fractal dimension is high on the aspect of 'life'. Evolution relies strongly on the organization of complexity. The metabolizing structure of all life forms exceeds a certain complexity threshold. Natural selection pushes organisms to become more complex (Salingaros, 2006, 2008). The level of complexity is again defined by the fractal dimension, which needs to be at an optimum level for humans to assimilate.

It has been noticed that, not only does the physical manifestation follow the principles of fractal geometry, but also the idea of construction, that is, the concept of the temple and its philosophy is akin to the concept of fractal geometry and fractal progression (Dutta & Adane, 2014). This, points towards the conception that even the formal theory of fractals had not been developed, like today, but at the time of temple construction, the concept existed in the minds of the priest and *sthatpaty* (Dutta & Adane, 2014). In the Laxman Temple, the Panchayatna plan, having four subsidiary shrines at

the four corners of the raised plinth, enhances the 'whole in part and part in whole' concept, arranged in a manner of proliferating prototypes. All the parameters discussed above can be well explained with this case study as this Laxman temple seems to be built according to these very principles.

At the end of the book, it can be concluded that fractal geometry, helps in attaining all these parameters successfully, giving it the required life and complexity a building needs, so that architecture connects with humans at an emotional and intellectual level.

3. Conclusion

Prof. Salingaros says, religion is an organizing system of knowledge (real and imagined) about the universe, which has proven essential for humankind to maintain itself. The vehicle for transmitting this knowledge is the temple structure. The temple structure is supposed to act at various levels for explaining the concept of spiritual journey, morale in daily life and concept of human beings and his environment, from the macro to the micro scale.

There is a value and meaning in the highest of human creations as opposed to their raw information content (Salingaros, 2006, 2008). The temple structure portrays meanings on the sub-conscious and conscious sides of our mind. The basic desire of humans, drives them to construct according to a similar algorithm, which makes them feel at ease with their environment naturally. Each pattern is presented as a process of resolving a recurring architectural problem: the relationship between a certain context, the forces that recur in this context, and a spatial configuration that permits these forces to resolve themselves (Alexander, 1979). It can therefore be concluded from this, that the application of these basic parameters can contribute immensely in the analyses of temple architecture on more than physical terms. The physical manifestation of the temple is merely a path towards understanding of the concept. The concept of proliferation and multiplication, with self-similarity, is equally explainable through fractals. Fractal geometry is hence proved to be satisfying the parametric requirements in the formal analysis of temples. An

affinity-relationship diagram can be drawn on the basis of the above discussion, which is as follows:

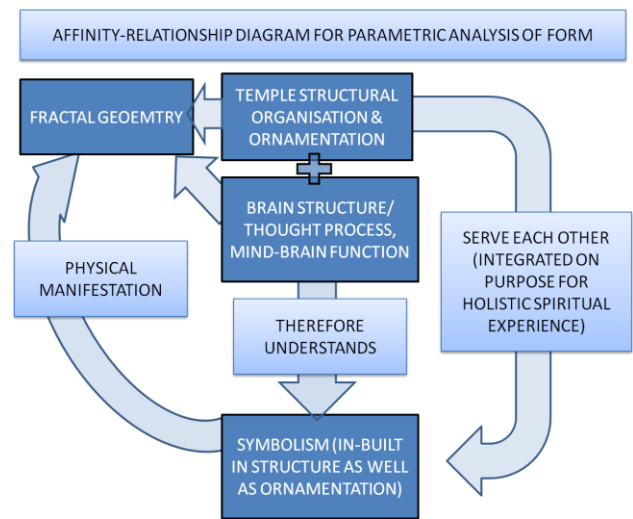


Figure 1: Affinity relationship established from the discussion

Thus the parameters mentioned in this paper are most appropriately applicable to temple architecture and this list of 'Parameters for analyses' can be modified slightly for analysis of other architectural typology.

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