PARAMETRIZING INDIAN KARNATA-DRAVIDA TEMPLE USING GEOMETRY

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Abstract. The Karnata-Dravida temple tradition flourished and evolved for 700 years. The evolution of the typology was demonstrated through the structure. However, as the Shastras or ancient texts proclaim, the underlying principles of geometry remain unchanged. Geometry and the unchanging principles of construction made the architects experiment with form, material and ornamentation. Geometry does not only mean shapes or two dimensional diagrams but it is a rule to amalgamate all the elements to form a dynamic form of a temple.

The paper validates the use of geometry through an evolving sequence of Karnata-Dravida temples with the help of an analytical model created using the grasshopper software. The components of the model are based on the geometric rule (the basis for parametrizing) and parameters of the algorithm – plan forms, organizational compositions, vimana or superstructure composition – which result in a geometry. Even though building science is an old tradition, the use of computational procedures reveals the predictable nature of temples in the Dravidian clan and enables the analysis of existing temples, development of new possibilities or evolution of interpreted forms. Hence, enriching the existing understandings of previous scholarships in the field of temple architecture with an entirely new system of interpretation.

In the age of technology where analytics plays a crucial role in almost all sectors, ancient temple architecture in India unfortunately falls behind when it comes to computational methods of restoration or reconstruction. This research questions the applicability of computational technology as a facilitator in preserving or reconstructing existing temples while maintaining its creative liberty.

Keywords: Karnāṭa-Drāḍi Temple, Geometry, Parametric Design
1. Introduction

Flourishing rulers of India considered temple construction as a way to exhibit their power and supremacy to the common people as well as their counterparts. The requisite to build temples better than the other rulers led to an evolutionary flow. In political discourse, the grandeur of an era, rule or dynasty was showcased not through the dwellings but through the magnificence of their religious monuments. Developments followed the same ruler or fundamental principles as their predecessors and were thus termed as evolution. The continuity was backed by the fundamental norms that were listed down in manuscripts that were strictly followed. Squares and triangles were the basic units of the principles governing the temple model. The temple form does not seem to have suffered any limitations by following the grid. The question that Volwahsen (1969, p. 3) puts forward, “is it possible that this profusion was only able to develop because it was based upon a grid?”. The principles and measurement systems that the temples cohesively used for construction were listed in manuscripts even before this typology started. Without the knowledge of parametric processes, temple construction used complex geometries and evolved with time. Today, we are trying various permutations to interpret the transformation seen in the centuries of temple development may it be visual, social, political, geographical or more.

Indian temples were mainly classified in three styles namely Nagara (north Indian), Dravida (south Indian) and Vesara (hybrid). This research limits itself to only one style, i.e. Dravida, especially in Karnataka, one of the reasons being the availability of well-documented information and drawings. This study will analyse the use of geometry in the design development of Dravidian temples in Karnataka through a timeline. The term morphological evolution can be divided into smaller fragments or components. There are two levels to the understanding of the component composition, the first being a fundamental unit that becomes the primitive article of design. The second level is the use of this fundamental unit and types of geometries to create a complex composition. In totality, the design is a two-way process where on one hand, it has evolved from the most basic elements put together, while on the other the fundamental unit itself has evolved with time with the above mentioned influences (Hardy, 1995). By doing so, the arrangement can be mathematically explained and a formula can be created which serves as a template for all chronological structures. Analytically approaching the study of temple development needs an external instrument. Computer technology shows promising prospects for efficiently analysing as well as periodically documenting the temples.
2. Methodology

This research is taken forward in a qualitative approach with the following components: literature based study initially, case study analysis, generation of parametric model followed by experimentation through computation. The methodology is summarised systematically in Table 1.

### TABLE 1. The three-stage methodology of the research.

<table>
<thead>
<tr>
<th>Stage I: Data collection</th>
<th>Stage II: Parametric model</th>
<th>Stage III: Investigation</th>
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<td>I. Literature Study</td>
<td>I. Decomposing the Temple</td>
<td>I. Testing</td>
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<td>i. Geometric-principles of Temple construction</td>
<td>i. Spatial arrangement</td>
<td>Two case studies from different dynasties will be compared with the parametric model.</td>
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<td>ii. Documented temples by other scholarly works.</td>
<td>ii. Element composition</td>
<td>II. Analysis</td>
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<td>II. Case Studies</td>
<td>II. Generating a Parametric model</td>
<td>Comparative Study: Comparing case studies to find differences and deviations.</td>
</tr>
<tr>
<td>A sequential database of temple development with respect to the morphology</td>
<td>i. Parametric 3D model will be developed with the Geometry as an underlying rule using Grasshopper software.</td>
<td>Correlation analysis: To find the link to the evolutionary temple form.</td>
</tr>
<tr>
<td>• Selection of cases specific to the requirements.</td>
<td>ii. One proto model</td>
<td>III. Application</td>
</tr>
<tr>
<td>• Fundamentally complete</td>
<td>definition of Karnata- Dravida Temple, Sangameshwara Temple, Pattadakal</td>
<td>Representation, reconstruction of temples and development of new temples.</td>
</tr>
<tr>
<td>• Simple deducible organisation</td>
<td>Adequate documentation</td>
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3. Case Studies

The Karnata-Dravida tradition began and matured entirely during the reign of the Early Chalukyas (Hardy, 1995). A few temples from all three phases are studied in order to justify the evolution and completion of typology, though only two have been detailed here since one was built during development phase (Upper Sivalaya Temple, Figure 2) and the other during the matured phase (Sangameshwara Temple, Figure 3). The later temple forms the proto definition for the type and is used to develop the script. However, typology remained unaltered during the Rastrakuta rule but a strong influence of the Nagara temple is observed in temples constructed by the Later Chalukyas and Hoysalas (timeline shown in Figure 1).
Note: Only Shiva temples are chosen throughout the tradition in order to maintain the uniformity in sculptural ornamentation.

3.1. UPPER SIVALAYA, BADAMI

**Plan Forms:** Square plan with shallow projections of aedicules
- Sandhara (with an ambulatory) temple

**Organization Composition:** Consists of the garbhagriha or sanctum with an ambulatory path and an attached mandapa (pillared hall, seen for the first time) and porch

**Vimana Composition:** Dvi-tala (two floors) topped with alpa-vimana (monolithic temple)
- Kuta(K)-Sala(K)-Kuta Projection System, seen on first tala Adisthana (plinth) is primitive
3.2. SANGAMESHWARA TEMPLE, PATTADAKAL

**Plan Forms:** Distinct projections
- Sandhara temple
- Antarala or vestibule with 4 pillars

**Organization Composition:** Consists of the garbhagriha, a developed antarala and mandapa consisting of 4 rows of pillars

**Vimana Composition:** K-S-S-K Projection System is seen on aditala (ground floor) and K-S-K on the second tala
- Adisthana consists of developed parts

**TABLE 2. Inferences from Case Studies.**

<table>
<thead>
<tr>
<th>Facets of the temple</th>
<th>Attribute</th>
<th>Parameter of the attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Temple in two dimension</td>
<td>Garbhagriha as the focal point</td>
<td>Vastumandala, Nirandhara or Sandhara, Projection system in plan</td>
</tr>
<tr>
<td>2. Temple in three dimension</td>
<td>Height and components of Vimana</td>
<td>Talas, Shikhara, Adisthana</td>
</tr>
<tr>
<td>3. Arrangement of spaces</td>
<td>Composition of temples with respect to the functional spaces</td>
<td>Vimana, antarala, mandapa, entrance porch and nandi mandapa</td>
</tr>
</tbody>
</table>

**4. Analytical Parametric Model**

The model is developed in 3D using the inferences from the cases (Table 2). For easier understanding it is briefly explained under three headers, i.e. plan form of the garbhagriha, organizational composition of the temple and the Vimana (superstructure), with its associated geometrical rule.
4.1. PLAN FORM

Application of Vastumandala: A suitable grid is selected from the thirty-two mandalas available of 4, 9, 16, 25…1024 squares or padas (Figure 4).

Ad-quadratum: The method to determine the walls and its thickness around the garbha griha where the length of wall is \( M \) and length of exterior wall is \( \sqrt{2M} \) (Figure 5).

Projections on Aditala: Different possible arrangement of aediculer arrangements with three types of aedicules Sala, Kuta and Pajara (Figure 6).
4.2. ORGANISATIONAL COMPOSITION

![Figure 7](image_url) Proportioning the Mandapa

The size of antarala, mandapa, Nandi mandapa etc, are all proportional to the cella length (M) (Figures 7 and 8).

![Figure 8](image_url) From left; Sizing the mandapa; columnar arrangement inside the mandapa; axially arranged entrance porch and Nandi mandapa.

4.3. VIMANA COMPOSITION

The typology was fundamentally complete by the construction of Sangameshwara temple therefore it forms the proto model definition to be parametrized. The adisthana (Figure 9) and talas (Figure 10) are developed in concurrence to the prescriptions suggested by Hardy (2009: p. 43).

![Figure 9](image_url) Parametrically developed parts of the adisthana of Sangameshwara temple, Pattadakal (Hardy, 2001).
4.4. PARAMETRIC REALIZATION OF SANGAMESHWARA TEMPLE

The various components of Sangameshwara temple are parametrized and the results are shown in Figure 11. In a similar manner all the temples with equal or lesser complexity can be represented through this model.

Figure 11. Stages of temple development shown through the parametric model.

5. Application of the Model

See Figures 12 and 13.
Figure 12. Comparative analysis of Sangameshwara Temple, Pattadakal

Figure 13. Reconstruction of temple parts.
6. Discussion

Geometry’s major role and contribution according to various literary works, such as the Samaranganasutrādha, was in establishing a relationship between width of the innermost shire and elevation of the temple. A mathematical relation was inferred from the existing designs between the width of the garbhagriha, the total height of the vimana and the individual heights of various independent components composed together to form the vimana. Though, not concretely justifying its role in the evolution, the inferred relation would act as a boon in the restoration and reconstruction of Karnata-Drāvīda temples. Hence, application of geometry and its computation can open a plethora of opportunities in not only studying the existing but also in creating a new paradigm. The interesting factor that can be derived from the above statement is that the study of the elevation shouldn’t be confined to its elevation characteristics, but should be studied in conjunction with the plan, of which it is a translation. Therefore, the question or the possibility that needs to be explored is the effectiveness of the parametric model in the restoration of existing designs. This research definitely raises a few pertinent questions considering the rich culture and heritage that India exhibits and they are:

1. Are we doing justice to the current scenario of reconstruction of temples?
2. Can computational technology act as a facilitator in preserving or reconstructing existing temples and still maintain creative liberty?

7. Conclusion

The parametric model shows sufficient results to understand the role and relevance of geometry in temple evolution. The chronology of the evolution of architectural components and sculptural decorations or aedicules can also be tested from the model. The deviation from the manuscripts seems to come across as very subtle, with not much disturbance to fundamental geometry. Weighing each of these inferences individually and later amalgamating their contextual translations clearly shows geometry’s significance in typology evolution.

7.1. SHORTCOMINGS AND FUTURE SCOPE OF RESEARCH

Considering the severe levels of complexity seen in the design of ancient Dravidian temples constructed during the later stages of tenth century, the parametric model raises concerns about its application in the analysis and applicability on ornamentation being the torch bearer of this complexity. This research can be further developed with enhanced attention to detail, at
both macroscopic as well as microscopic level. Successful establishment of a script which could also help in generation of the aedicules, would not only be path-breaking but also revolutionary, as it would change the way Indian temple architecture is currently preserved and documented.

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References


