P3 Project Report

Using Classical Indian Knowledge Systems to Teach Principles of Design to CBSE Class XII Students

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Introduction

The CBSE NEP 2020 [22] incorporates design as an introductory course for classes 6-8, and a full 650 hour subject for classes 9-12. This project deals with designing workbooks and supporting material for teaching the topic 'Design based on Indian Knowledge Systems' specifically to CBSE class 12 students following the guidelines set by the DT (Design Thinking) curriculum, the aims and objectives of which are already in place. Class 12 was chosen for the project because, firstly, the subtopics are sufficiently complex and there is enough potential to design interesting, engaging and interactive activities and learning material for students. Secondly, this project would aim to approach the problem of teaching design with a fresh perspective to achieve new and novel ways of teaching its different aspects; ways that could be implemented in the future to either replace or complement the existing curriculum. It can be safely assumed that class 12 students would have a proficiency with computers to the level that they can easily engage with online interactive learning material.

Although class XII curriculum includes various subtopics including Social Design and Design for Public Spaces, Design for Indian Knowledge Systems was chosen because of various reasons. Firstly, the topic has enough scope to be made into a full subject, with Indian design history being rich and brimming with content and untapped potential; especially considering the education in India, especially in design, has been greatly inspired by the West [29] [20]. Secondly, students in India generally disassociate themselves with traditional Indian sources of knowledge because of several problems with how that knowledge is being served to them. Such content isn't generally presented well, is uninteractive, boring or sometimes simply outdated and unrelatable, thus not intriguing enough interest. One of the challenges of this project would be to pique this interest among students.

While the project aims to tackle the problem keeping in mind the incredibly diverse student backgrounds and school locations in India, it would assume access to basic technology like mobile phones or computers with internet connections. Considering the recent push to online services that has taken place, partially due to Covid-19, the prospect of still distributing static workbooks and learning material to students seems limiting. Many sectors like banking, personal identification (Aadhar) and medicare (like vaccinations) have made a push to online space, with education following closely. This project seeks to leverage the realm of possibilities such a push would open.

Interactive workbooks are one way of leveraging this opportunity. Although they can be, both, screen and paper based, screen based options can harness the technologies of the web to create enlightening and fun experiences, considering they are practical to implement, and effective. One can also imagine hybrids, where workbooks could also incorporate physical artefacts, interactive devices, spaces and conceptual experiences. Such

workbooks could also boost collaborative learning and make evaluation fairer [17]. Design is subjective, requires experience for judgement, and is a completely new domain for most Indian schools and teachers. Evaluating it is unlike most other subjects, and one has to think outside the realm of MCQs and input boxes, something which limits most interactive workbooks available today. Innovatively designed online workbooks could leverage the power of digital intelligence [9] and online expert communities to provide all students a fair head start. Lastly, such workbooks could provide personalised learning to students, adjusting to their needs and learning styles, unlike traditional hard-printed books.

Aims and Objectives

The project aims to design and test workbooks, students' resources and teachers' resources for teaching 'Design based on Classical Indian Knowledge Systems' specifically to CBSE class 12 students following the guidelines set by the DT (Design Thinking) curriculum (part of NEP 2020).

It is important to be clear of what the project's focus would and wouldn't be. The project aims to:

1. Discuss the notions of representation of content (graphical images, motifs, building plans) and extract theories of design that can also be relevant today
2. Discuss the use and applications of said theories in modern times
3. Discuss the thought process- the speculative thought- that underwent the design of those principles originally.

The project doesn't aim to:

1. Dwell deep into the metaphysical meanings of forms, symbols and so on.
2. Discussing the religious and spiritual origins and philosophies behind the techniques and practices. (no stories, unless they are useful to understanding the technique itself, and its applications)

Scope

The workbooks and student /teacher material would be designed keeping in mind implementation that could be within the next 5-10 years, and preferably today, considering the technology schools have access to.

Target users are CBSE class XII Design students and teachers.

Methodology

The project begins with a heavy focus on research and analysis followed by prototype designs. Evaluation would be participatory with support from class XII teachers and students, with evaluation of the conceptual prototypes

and course content at every stage. The whole process of designing and developing the course would thus, be iterative.

The literature review for the project consists of researching the following major domains:

1. Learn different design fundamentals covered in the curriculum regarding Indian Knowledge Systems
2. Explore instructional design techniques and ways of teaching said fundamentals
3. Explore innovative ways of teaching, including looking at different types of workbooks

Project Outcomes

1. Lesson Plan for teachers
2. Workbooks for students containing tasks and activities
3. Exposure Content: A reference book for students and teachers
4. Online interactive content for students in the form of websites
5. Offline interactive content for students in the form of 3D printed models
6. A consolidated online portal for accessing all course material, both for teachers and students
7. Assessment matrix for workbook evaluation

Stage	**Deliverables**
Stage 1	Research to understand principles of Indian Knowledge Systems, techniques to teach design and types of workbooks.
Stage 2	Conceptualisation and Ideation of techniques to teach aspects of design extracted from classical systems of knowledge. Prototyping and participatory testing of ideas to single out the most effective techniques.
Pre-Final	Development and compilation of said techniques to arrive at the products mentioned in expected outcomes.
Final	Evaluation of the products.

Figure 1: Project Timeline

Project Timeline

A detailed timeline of the steps to be followed for the project are:

1. Broad selection of subtopics
2. Primary research (contacting experts) and secondary research (research material and books)
3. Filtering and arrangement of subtopics in an order for the course
4. Filling up the subtopics with content and sketches
5. Design of exercises for the subtopics
6. Design and development of interactive content
7. Initial Participatory evaluation of content and exercises (students and experts)
8. Revision based on evaluation (iterative process)
9. Development of course material and exercises formally to get the final product (workbooks + assessment matrix for evaluation)
10. Evaluation of the final product

Topic Introduction: What are Indian Knowledge Systems?

Indian Knowledge Systems use the ancient and indigenous knowledge of India to arrive at principles and techniques that are timeless, unique, and based on centuries of work. While the meticulously detailed temples with their mathematical grids are awe inspiring, the simple and innovative design solutions and techniques encountered in the rural and urban 'wilds' of India are genuinely surprising and inspiring. There isn't a shortage of indigenous solutions that surpass expensive designs while being sustainable, cheap and accessible. NEP 2020 highlights the importance of preserving and promoting India's cultural wealth, as it is important for the nation's identity as well as for its economy. Indigenous Indian design has developed akin to evolution, arising at times from necessity and limited resources, birthing the best of ideas. Indian Knowledge Systems can be incorporated both as course content and as a way to teach the course itself, with its old values and methods.

Since the topic of Indian Knowledge Systems is immensely vast, spanning over a large amount of content and time, it is important to keep a singular focus. For that, it is important to first realise all the subtopics which could potentially be a part of the course, or at least know their method of classification. Some ways to potentially classify Indian Knowledge Systems can be:

1. Historical (knowledge gathered from scriptures and ancient documentation) or contemporary (looking at modern grassroot innovations). Contemporary innovations could be those done by people in extreme environments, either in rural or urban circumstances.

Figure 2: Classifications of Indian Knowledge Systems

2. According to era: ancient (before Mughals), medieval (Islamic) and modern (Post British)
3. Based on discipline, like Architecture, arts, etc.
4. Based on modern locations. India is huge, and focus could be set on Indian Knowledge Systems from specific states and communities.
5. Based on existing classification within design education, like colour, composition, etc.
6. Ancient scriptures (shastras) could be classified and one could be focussed upon. Another source of ancient knowledge would be curricula of ancient universities like Nalanda, Taksha Shila, Vikramshila and Vallabhi.

Exercises like scouting for local techniques, materials and products could make learners aware of the innovations in design around them. Additionally, Indian theories, spatial strategies and examples of visual artefacts taken pre-Bauhaus could challenge or complement modern theories of composition and geometry. This knowledge could be documented and applied to modern problems and needs.

Subject positioning in the Curriculum

As the subject of Learning Design from Classical Indian Knowledge Systems would not be taught in isolation, but as a part of the whole design curriculum, it is important to be aware of what is being taught in other classes and subjects. That would enable design of such a course that complements and constructs on the knowledge already gained by the students.

The Design Thinking (DT) Curriculum introduces design from CBSE Class 6 to 12. For classes 6, 7 and 8, the course duration would be 18 hours, while for classes 9 10, 11 and 12 it would be 160 hours. Basic aims of the curriculum in each class are listed below:

1. Class 6/7/8 (18 hours): Focus on discovery and exposure. Kickstarting the curriculum with an exposure to design skills, design sensitivity and the design thinking process.
2. Class 9 (160 hours): Focus on concerns, skills and sensitivity. The students would learn design skills, build empathy and apply the design thinking process to simple problems.
3. Class 10 (160 hours): Focus on creativity and problem solving. Includes further learning of design

skills, discovery through creative explorations, prototyping and application of design thinking process to contextual problems.

4. Class 11 (160 hours): Focus on design options and solving problems together. Students are introduced to different fields/branches of design, and are made to solve wicked problems working collaboratively.
5. Class 12 (160 hours): Focus on application and execution. Class 12 is concerned with application of design problem solving to different environments followed by a semester long design thinking process capstone project.

Class XII consists of the following subjects (refer to Figure 3):

1. Fundamentals of personal design (20 hours)
2. Fundamentals of social design (20 hours)
3. Fundamentals of environmental design (20 hours)
4. **Design based on Indian Knowledge Systems (18 hours)**
5. Final Design Thinking Project (82 hours)

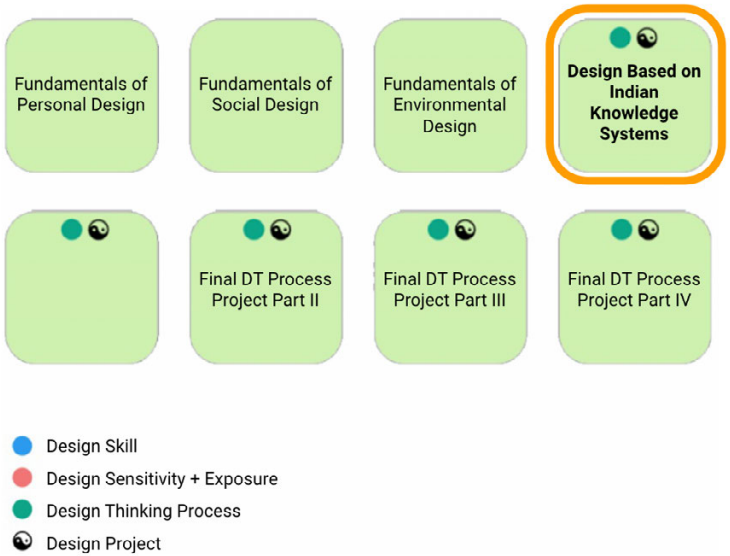


Figure 3: Subjects in Class XII

Choosing the right literature and the challenges up front

The biggest challenge is determining the exact list of topics that can come under the umbrella of Indian Knowledge Systems, along with their classification. It is already established that identifying contemporary and indigenous design solutions is a difficult endeavour due to the fact that it mostly happens in rural regions of India. If one considers ancient Indian arts, design has no clear definition, and one has to manually scourge through the scriptures and establish connections, and then map them to modern design to identify relevant principles that can be learned and taught. Secondly, most Indian knowledge was oral and passed down as word of mouth [15] [19] [14], or it was written in old scriptures, making them difficult to preserve and decipher. The knowledge required to read classical texts far exceeds the mere knowledge of a language like Sanskrit [31].

Ancient India also consisted of various periods of history, each having its own influence on arts and literature, and it is important to recognise this diversity to be able to extract principles of design relevant today. Choosing the right literature with an optimal focus on art theories and principles, rather than the underlying stories is of utmost importance.

Literature Review: Broad and Initial

The broad literature covers three domains: understanding the instructional design principles, researching innovative techniques of teaching design, and research into Indian Knowledge Systems.

Instructional Design techniques

Traditional education has focussed on what's called instructionalism, where students are required to learn facts and their success is measured by their ability to remember those facts [2]. It was soon realised, however, that education needs to focus on a deeper conceptual understanding, and needs to build on prior knowledge (constructionism) by creating reflective learning environments. Learning always takes place against a backdrop of existing knowledge. The best ways to teach involve the person, the tools and other people in the environment (the peers), along with the activities in which that knowledge can be applied. Apart from constructivism, 'connectionism' is a term often used to describe the power of connections in human learning, in the way it helps in importing similitude [12]. When computers are added to the mix, it is important to note that they aren't just being used as supplements to instructionalism.

Piaget's Theory of Cognitive Development highlights three epochs of cognitive development in the life of a young adult. The age group being targeted here would fall under the third stage, or the 'formal' stage, in which thought is driven and disciplined by principles of logic, deduction, induction and by the principle of developing theories that can be empirically tested [24] [1].

Apart from exposure material, instructional design techniques can also be applied to create more engaging and effective learning activities. Exercises in which learners are asked to attach strong emotions to events end up being more engaging, and thus, more effective in the long term. One way of doing this could be creating fictitious scenarios and situating learning activities in them. [10]

A challenge while designing activities for learners is to be able to cater to the different learning capabilities of all the learners. Here, we can distinguish "difficult" from "challenging", as in there could be easy but challenging problems that require effort rather than ability to solve, thus requiring time and hard work from all the learners. During assessments, these problems could be just as challenging but with a higher difficulty level. Another important aspect of designing effective exercises is correctly augmenting satisfaction levels of learners once they've accomplished the task, providing a positive sense of accomplishment. [28]

Innovative ways of teaching design

Interactive workbooks, as opposed to traditional pen and paper exercises, can leverage the power of interconnected interactive media to provide education in new and more effective ways. Transforming student workbooks into electronic interactive workbooks will broaden the limits and make learning more fruitful by satisfying individual needs and being more enjoyable [13]. Interactive workbooks invoke hearing, seeing, reading and experiencing, thus ensuring more active participation, while also making evaluation easier and effective for a large number of students. Various examples of interactive workbooks are discussed here.

The simplest types of interactive workbooks are perhaps those that use the PDF format, and provide options for text and radio inputs, while all the content is static. The exercises in such a workbook would be restricted to MCQs, fill in the blanks, true/false and matching type questions [16]. Different pages could be hyperlinked to different responses to provide real time feedback. Although easy to make and distribute, PDF workbooks are limited in terms of content presentation and peer networking. On the other hand, web-based workbooks, although much more difficult and time consuming to make, can open a myriad of ways of content presentation and evaluation [18].

Indian Knowledge Systems

NEP 2020 highlights that Indian knowledge would include knowledge from both ancient and modern India [23]. The relevant elements will be incorporated in a scientific manner, and knowledge would include tribal knowledge and indigenous [39] and traditional ways of learning. The issue arises, however, when one tries to attempt to define design strictly in the Indian sense. Indian women make floral patterns and traditionally it is called design, just like the intricate border of a sari or a piece of jewellery. However, an innovative chair made by a carpenter, which the modern world calls design, isn't considered design in India [6].

Crafts and materials are the soul of Indian design. In India, craft is not a thing of the past, but of the present and future, as it brings the artist in touch with the actual materials. Apart from that, Indian design education teaches design as an approach- a creative process. It can be related to the traditional system of Ayurveda, which aims at strengthening the body to overcome diseases rather than offering a local cure. Rather than offering medicine, it prescribes plans for rest and dietary plans.

Most Indian design schools are located in urban centres, leaving the vast majority of culturally rich areas untouched. Also, a huge wealth of local knowledge, like local materials, forms and techniques, remains undocumented because of the oral nature of Indian society where written records were seldom kept. A proper documentation of these ancient and existing knowledge forms can bring forward knowledge that can be applied to the modern design education in a myriad of ways.

Modern Indian Knowledge Systems

The sheer size and diversity of India warrant scores of creative, cultural and heritage industries and individuals possessing vast undocumented knowledge. Tapping into this knowledge can reveal innovations both at the grassroot level and the larger level. These may or may not be derived from majorly orally passed traditional Indian knowledge, and a proper study can reveal many ideas and principles that could potentially make their way into modern design education.

Knowledge provided by local rural or semi-rural schools can be used for certain topics to teach arts and design, and with modern networking technologies, they can be linked with modern schools of design to provide them a picture of a larger socio-economic reality. Networking could also be leveraged to connect products arising from traditional practices with the markets located in big cities, to connect the local products to a global platform.

It's also important to focus on grassroot innovators and artisans in India, a majority of whom continue to reside in comparatively smaller cities and towns. Most of these are practitioners without formal training, relying on their skills, innovations, and orally acquired knowledge. Two such premises aimed at highlighting the grassroot innovators are the VCTEL-NPTEL (a digital resources library) and the Honey Bee network (a virtually collaborative network of people and communities generating ideas and products) [26]. VCTEL aids inter institute transfer of learning resources by providing a shared library, which the smaller institutes can benefit from. Honey Bee started as a project around a decade ago, and aimed at scouting for new innovations done by farmers, artisans etc. at grassroots level, seeking to preserve the fast eroding traditional knowledge. It consists of around 10,000 innovations documented by an NGO called SRISTI, done in journeys called Shodha Yatras. Other ways of scouting for these innovations are keeping an eye out for stories published in regional magazines or newspapers, and tapping into the reasonably strong networks of

local artisans to discover a large number of innovators [7]. Another mention is that of 'Rural Bazar', an internet based solution that helps in sales and marketing for rural artisans. Networks like these help de-localise innovations, making them widely known and subject to experimentation by artisans in other areas as well as scientists. There is also a focus on keeping these networks fair for all, especially the artisans, by providing them with protection for each innovation, either by funds or patents.

Coming across modern knowledge systems of India at the grassroot level, where much utility is achieved from minimal cost and sustainable materials opens up unique opportunities to teach problem solving skills to design students. Instead of the 'lab-to-land' approach of modern science, we see the importance of 'land-to-lab-to-land' approach [11].

Ancient Indian Knowledge Systems
Indian art has a long sustained history of many years spanning over different periods, classified as ancient, medieval (Islamic) and modern (British and post-British) [3]. These periods brought with themselves vastly different design principles and guidelines, clearly visible in the remaining scriptures, architectural structures and artefacts. The modern system is chiefly inspired by the British-era policies, which were designed to systematically sabotage the rich educational heritage while marginalizing the indigenous educational practices. Apart from that, rapid industrialization and corresponding advances in technology began to affect the holistic approach to creativity that used to be the norm in India. Tapping into the vast depths of ancient Indian Knowledge systems would help restore the uniqueness of our design history and the Indian aesthetic language, replete with the depth of philosophical thought and the strong accent on the interconnectedness of all things, the holistic approach to creation of a unique design identity.

Ancient India didn't discriminate between applied art and fine art, hence there isn't a separate treatise on design. We, however, can look at examples of remaining architectural structures, scriptures and artefacts, such as temples and historic cities [32], and extract for ourselves traditional and unique design principles which can be applied to the problems in the current scenario.

Focussed Topics

The project extracts theories and principles from ancient Indian Knowledge Systems to teach principles of design, which can be applied in the modern world. Main principles of ancient Indian design include:

1. Grids, Ratios and Scale: This section would focus on the basic underlying grids and ratios that govern Indian arts and architecture, like the mandalas, 5:4 ratio, and so on.
2. Patterns/Fractals and Symbols: This section focuses on motifs, their meanings and the layers of abstraction, discussing examples like Swastik and Rangoli.

3. Anthropometry and body mappings: This section aims to understand the basic human body and its movements for a potential application in modern ergonomics.

4. Emotions, basic principles and design guidelines merging from study of the ancient: This part aims at understanding and explaining abstraction and transitory emotions using the deeper principles of Indian art, by diving into the speculative thought process that was behind creation of these principles.

The uses of these principles in ancient architecture (eg. temple architecture), product design and other sastras are discussed, along with their applications in modern fields like storytelling, game design (strategies), graphic design and modern architecture. The discussion starts with the basic principles of Indian arts and crafts, and how they translate to what we see around us.

Literature review for focussed topics: Square and the Circle of the Indian Arts

Kapila Vatsyayan in this book explores traditional Indian arts and attempts to extract information that is very relevant to this project, and a detailed discussion of the thoughts and ideas presented in it is paramount. Square and Circle are very important motifs of Ancient India, and also refer to space and cyclic time respectively. The word 'Art' had a different meaning in Ancient India than it does today, with its umbrella being a lot larger, its disciplines being different colours of the same spectrum [40]. Since

Figure 4: Traditional Sources of Knowledge of Indian Art

there was no discrimination between arts and craft, the knowledge we gather from Indian Arts can be applied to a variety of modern design fields like graphic design, architecture, game design, stage design, principles like abstraction and so on.

The book discusses knowledge and principles gathered from the four Shastras: Natya sastra (performing arts), Vastu sastra (architecture), Silpa sastra (crafts and sculpture) and, briefly, Sangita sastra (music). It attempts to find core principles and conceptual basis that guide the fairly detailed content of the four shastras, and tries to form connections between them. Since ancient India doesn't differentiate between arts and crafts, these art forms are closely intermingled, with techniques and rules from one passing over to the other. Presented here is a summary of the content, which would be helpful to understand ancient Indian Knowledge Systems better. Some of the concepts described here may seem to purely emerge out of metaphysical philosophies and keeping an open mind is necessary to be able to extract content of modern relevance.

While this project doesn't aim to focus on metaphysical origins, it is certainly important to discuss them here and be aware of them as a content designer. The vision is not to dwell on the entirety of the metaphysical background but to examine those aspects of speculative thought which determine artistic vision and expression [40]. Traditional Indian literature is often termed as otherworldly, mystical and world denying, due to its supposed fictional dependence. This examination attempts to bring forward the fact that what has so far been considered a mere metaphor is indeed an indicator of the awareness of the relationship between the microcosm of Man (purusa) to the macrocosm of existence as a whole (Purusa) [40].

Connection of the sastras to the concept of Yajna
The discussion begins with the Purusa, the Supreme Being, the Primordial Man, a human body figure whose different body parts became different parts of the universe, like earth, fire, water and so on. The centre of the body, the navel became the centre of the universe, and an important part of Indian arts and architecture as well. Different places in space are mapped to different locations of the body, and it is important to take them metaphorically rather than literally. These comparisons just provide a grammar, with the metaphors just importing similitude for explaining the cosmic phenomenon. Indian literature places great emphasis on realising and controlling human senses.

While discussing different metaphors in the Upanishad, like the chariot and the wheel, the sun and its rays and the body and its senses, it is realised that all these metaphors are based on the same basic principles: the concepts of internalisation and externalisation (the macrocosm entering the microcosm), the concepts of space and time, relationships of parts to a whole, concept of formless and the multiple forms, and so on. The shape of a spiral is discussed to explain the significance of the centre (the bindu) in Indian arts, corresponding again to the navel. The bindu is a state of rest, with the region around it being in a constant state of flux, or movement, leading us to the important principle of motion around the stillness of the unchanging centre; a concept clearly perceptible in many Indian compositions like sculptures (see Figure 57). Similarly, life abstracted into design can give a variety of meanings to simple symbols like circles, triangles, lines and dots. Simple layering of abstraction brings multiple layers of depth.

The yajna, a Hindu ritual done around a fire, is discussed in detail, to extract methodologies that may provide us with the basis for the artistic principles in the Indian tradition. The first is the depersonalization of an individual, where an individual is but a unit in a collective effort. The site of the Yajna is a finite symbol of the macrocosm (the cosmic space), and the 360 degree revolutions done around it are related to the concept of cyclic time. The central pillar, or the stambha, unites heaven and the earth, signifying a symbolic relationship between earth and sky. During the yajna, a figure of man is cre-

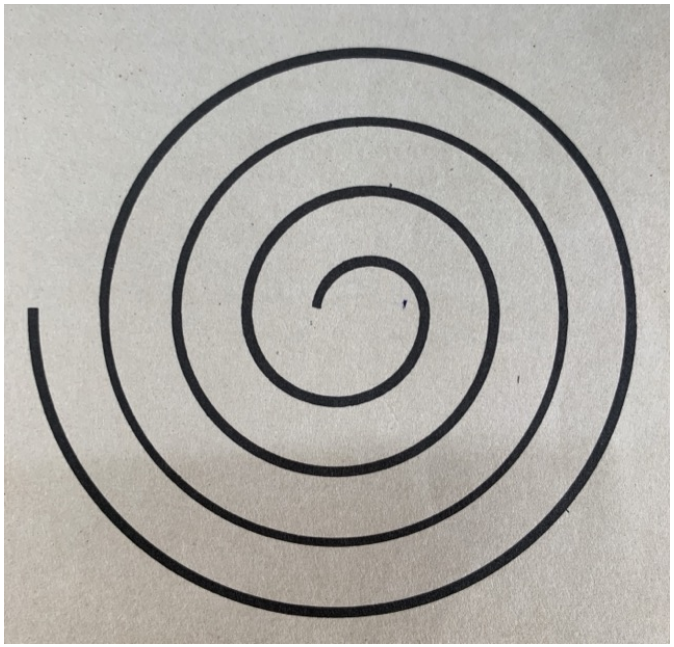


Figure 5: The spiral shape with an unchanging centre

ated through different implements, so as to make out his different body parts, and the structure is built using a combination of 3 basic geometric forms- the square, circle and triangle. The whole motive of the ritual is to create a microcosm on the earth suggestive of the macrocosm, using motifs and symbols to represent larger elements like earth and fire. These motifs went on to guide Indian arts for centuries. The plan of the Yajna is the conceptual basis of all sacred Indian architecture.

Natyasastra (performing arts)

Performing arts might not strictly be a part of modern design education, but in ancient Indian arts it uses the same concepts as the other arts and architecture, thus being of interest to us. Most importantly, since all art and craft forms of Ancient India have such strong connections and interdependence, excluding any one would make the aesthetic theories and traditions seem complex and meaningless. The Indian artist is described as both the experiencer and a detached seer, who sees, hears, feels, but above all, reflects. He seeks to invoke the formless using the form he creates. The work is symbolic and connected to a larger truth, seeking to invoke a similar psychic experience in the spectator. The content is an impersonalised emotion and not actuality, and this is how the artist achieves abstract design. This impersonalisation of the subjective, along with different examples from the past, can be an excellent tool to explain the difficult topic of abstraction to the students.

Theater, like the yajna, is another symbolic representation of the cosmos. Its two seemingly opposite worlds- the sastracara and lokacara- can be viewed as complimentary but different segments of the same circle, giving rise visually to the shapes of square (lines of two opposites coming together) and circle (showing the continuum of time). This provides an elaborate grammar of form. The architectural plan of the theater, inspired from the yajna, has a center and a vertical. It follows rectangle, square and triangle shapes. Each of these can be divided into small, medium or large, giving rise to 9 possibilities. The directions are laid out along the symbolic colours, where white is the colour of the East, blue is West, yellow is South and red is North. The space is then divided into units, where each unit is a square of area 8X8 (see Figure 6). An understanding of this ground plan helps us understand the structural form of the dramas, or the natya.

Meticulous measurements were used for the design of stages to establish emotive and psychic correspondence. The central pillar, called the jarjara, marked the centre of the stage. An image of 5 concentric circles is used to represent major and minor episodes of a drama. They are conceived sequentially, and are mapped to the five avasthas (mental states referring to how one advances through the plot). The five avasthas give rise to the nucleus of the plot which is indicative of a continuous expansion from the centre of the plot to the circumference and back again (see Figure 56). The imagery of a grow-

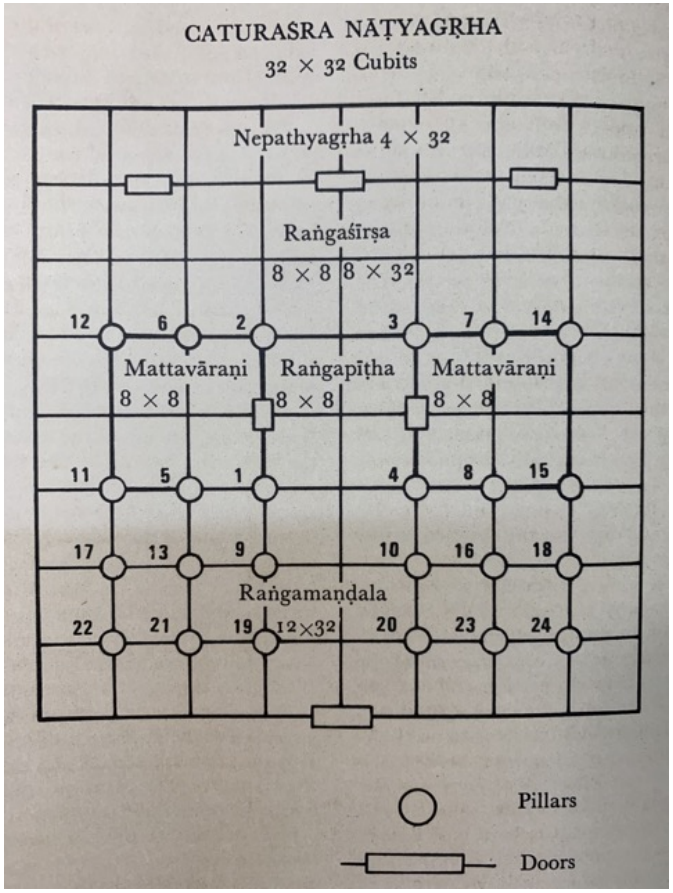


Figure 6: Plan of a Natyagraha

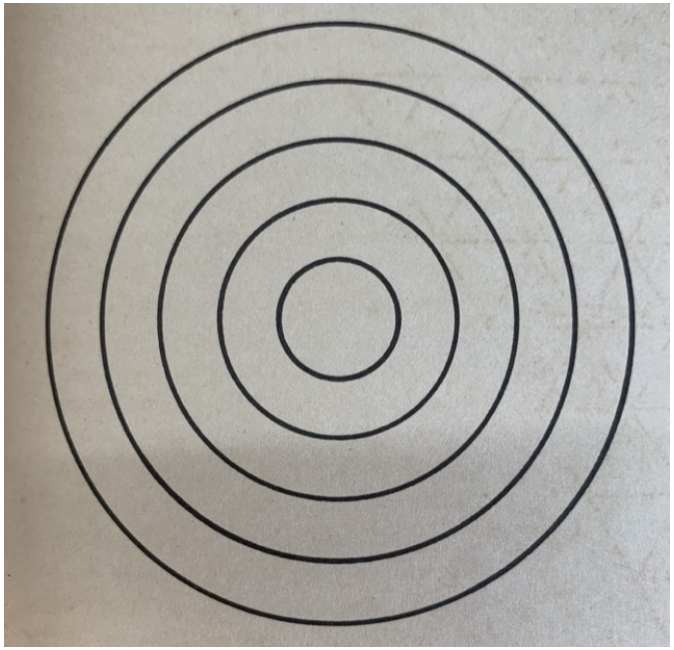


Figure 7: Concentric circles representing a drama

ing seed is used, which develops and expands. The imagery might not be the easiest to understand, but it shows a relation of the inner with the outer, and cyclic movement, like that in the Yajna. Changes in locale did not take place in the drama through division of the script into scenes and acts, but through movement from one demarcated area to another.

The classification and breaking up of the man-body into its several constituents, as done by the Natyasastra, can be compared to the several descriptions of man and his multiple organs as found in the Upanisads, thus indicating a strong conceptual connection. Each element, like in the Yajna, has a unique value, but acquires significance only when placed in a special relationship with some other part. Natyasastra divides the human body on the basis of organs and their ability to function as tools of expression of emotive psychic states [40]. It then explores the possibility of the physical body to manifest and evoke psychic states (emotions in the viewer).

The Primordial Man from the Natyasastra can be an important tool in learning anthropometry. Here, the man body, or the purusa, is placed in space, and there's an attempt at establishing relationships between the sky and the earth using this man body. It's an erect man with extended arms. Primary and secondary movements commence from this basic posture, called the sama. All dynamic actions return to this still state, the psychical centre, and it is described as a moment of perfect control and discipline. The concept of the sama is pivotal in Indian arts. The figure is imagined as a spoked wheel, or a chakra, and the centre of the figure corresponds to the navel. The vertical median, the spinal cord, demonstrates the diameter of the circle. Various positions evolve from the sama, like standing (sthana), sitting (asana) and the reclining positions (syana). The centre, the vertical corresponding to the joints, pelvis, knees and ankles are seen as the cage of the body, and this cage guides the movement patterns within the circumscribed space of the circle. The body is basically depersonalised to the

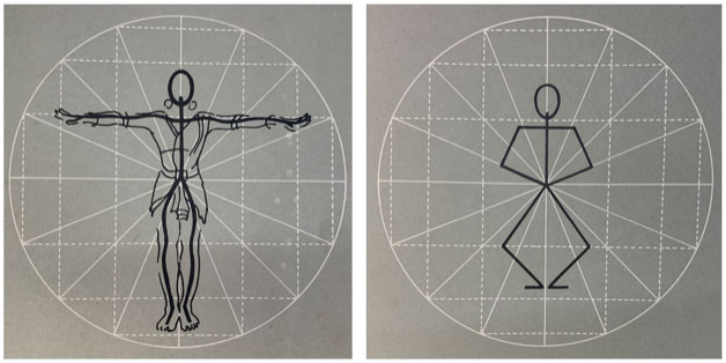


Figure 8: The figure of the standing man, along with its abstraction

point of geometrical shapes (see Figure 8). This imagery can be a wonderful tool for explaining body movements and dimensions, even for modern anthropometry and anatomy.

Natyasastra teaches us the art of storytelling using abstraction, and literature is bustling with examples of such stories that use multiple layers of imagery and abstraction. An example of a similar Sanskrit play called Abhijnana Sakuntala demonstrates how almost everything can be depicted using actions (abstraction) instead of props (realism), an example being a masked dancer representing a deer just by his movements and expressions. Different figures using the anthropometric Primordial man are discussed. Movements and actions of these figures abstractly show enactment of various situations, like being annoyed by a bee. Abstraction of scenes can also be depicted by zonal divisions and stylised walking on stage, giving art a lyrical beauty not possible with realism. Similar examples from traditional Indian stories can be wonderful to teach abstraction and symbolism, topics that aren't that easily understood, especially by a novice audience.

Vastupurusa (architecture)
Like the Natyasastra, the consistent language of art translated from the imagery of Upanisads is also executed in the design of buildings and structures, again following the fundamentals of the Yajna. Other arts like performing arts were following an identical system of establishing correspondences and correlations with the figure of Man as reference, as is also followed in architecture, called the Vastupurusa.

The basic principles of ancient Indian art were abstraction and concretization (giving a form to the formless), organic interconnectedness of all living things (acknowledging the ecosystem) and reducing life into impersonalised states of being. Indian architecture concretised these abstract thoughts and principles.

The temple architecture was mapped to a human body, where the door is the mouth of the purusa (body), platform terminating the trunk of the superstructure the shoulders, the projection or bhadra the arms and the lowermost moulding the feet. The purusa is the horizontal ground plan as well as the vertical plan, with the head as the sky, navel as the garbhagriha (temple centre) and

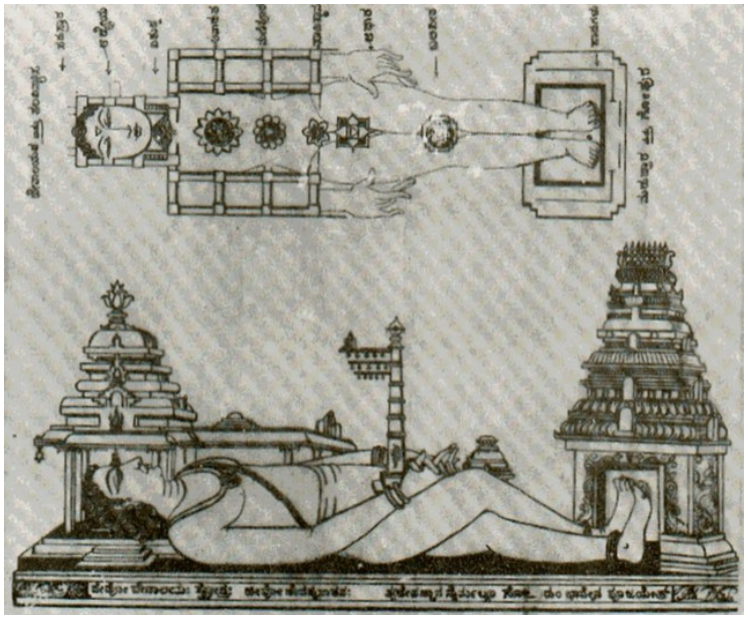


Figure 9: Mapping of Man's body to Temple Architecture

the lowermost moulding, once again, the feet (see Figure 69). Although not to be taken literally, this imagery is important because it gives a frame of reference and a measure of construction. The symbolism helps relate the aspects of the structural organism (man-body) to the macrocosm (the universe). In terms of abstraction, the motifs of square, circle and triangles, and the axis are fundamental. Aspects central to the design and functions of the temple are- firstly it is a proportionately reduced image of the cosmos, secondly the material world is perceived as a figure of man.

During construction of the temple, firstly the soil is tested for sound, smell, taste consistency and colour. Seeds are planted and their germination is watched for several nights. Then, on the clean flat earth, the diagram of the Vastu purusa mandala is drawn. It is, just like the theater, a square divided into multiples. Physical orientation of the temple depends on the motion of the planets, and the four sides of the temple correspond to the four cardinal directions. Units of measurement are all multiples of a primary unit, equal to the breadth of one finger. Another useful measurement is that of the artani (the tip of the middle finger to the elbow).

The significance of the square and the circle in Indian arts is discussed. Where Western civilization has considered time to be freely flowing unidirectionally, akin to a river, time in the Indian context is cyclic, recurring just like the seasons. Both square and circle also govern architectural plans, with some less popular shapes being that of rectangle and ellipse. Like in theater, the square stage represents the space, and the movement in this space, which has a time relationship, happens in the dynamic rhythm of a circle, in temple architecture everything spatially rises from a square, which symbolises order.

In the general square plan of a temple, a centre (navel of the man) is established, and different proportions of each area, the triangles, the diagonals and the intersections of lines, are worked out (see Figure 10). The garbha griha is the centre of this man body, and is surrounded by a

circumambulatory path called pradakshinapatha. It is then surrounded by thick walls on which rests the high superstructure, corresponding to the thighs. The buttress and other projections of this wall are the perimeter of the temple, metaphorically the feet. The imagery here is the man body almost sitting on earth, contained in a square. In the elevation, the same analogy can be used, where the vimana (the structure above the garbhagriha) rises from the centre upwards, each layer also broken into a system of squares corresponding to other limbs of Man. From the centre of the central square (garbhagriha) rises the central axis upwards, reaching the highest point. It corresponds to the head of the purusa. The garbhagriha is always the central navel, regardless of the direction- horizontal or vertical, in which the temple is seen. There are two simultaneous images- one of a sitting man beginning with the navel which is the garbhagriha, and the other of the horizontal man where the outermost portions become the feet and lead to the navel.

Numerous sculptures on the walls are arranged in accordance with the different strata of life; plant, bird, animal, human and celestial. From this multiplicity of form there is a movement to the formless, concrete to abstract. As one enters the temple, there is an awareness of the gradually diminishing forms and entering a near empty space (transition from forms outside to the formless inside). As one ascends higher in the temple, the number of images diminishes to none. In physical terms, the transition is that of light outside to dark and still in-

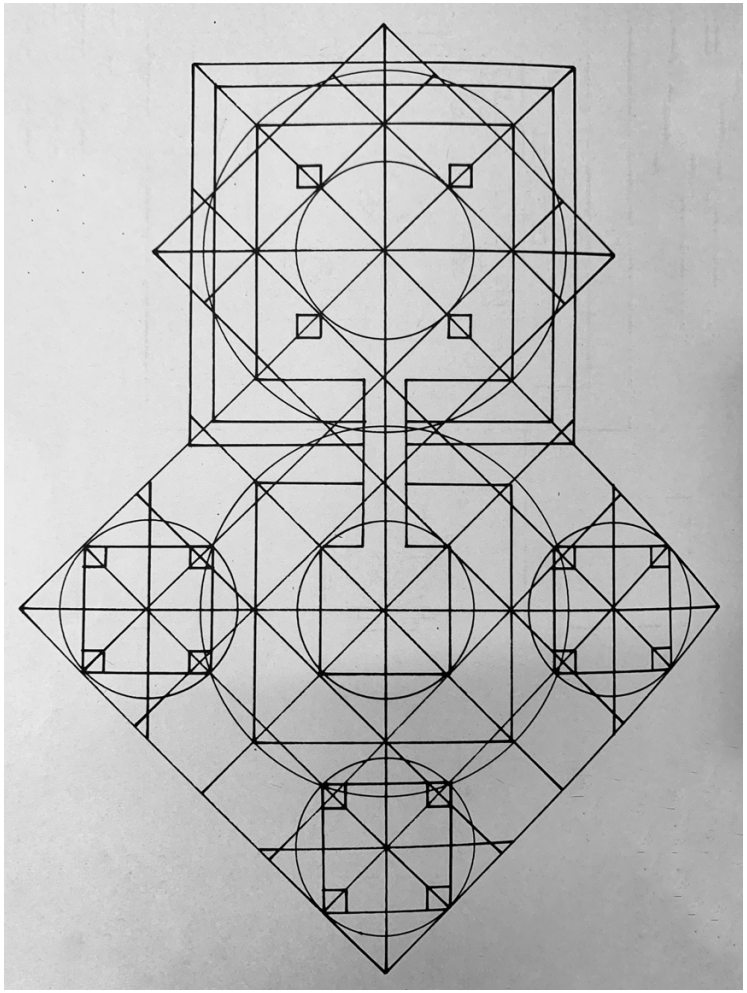


Figure 10: Grids of a Temple Plan

side. In psychical terms, transition is from outer darkness to inner light. This imagery is helpful in explaining emotional transitions using transitory forms and spaces.

Specific examples can help concretise this understanding. One such example is that of a stupa in Nagarjunakonda, which has a circular central column with 8 radial walls meeting at a peripheral circular wall. This symbolises a cartwheel (echoes of the Upanisadic images of the wheel we discussed above). This is a clear representation of transference of speculative thought into architectural design. An examination of temple plans shows that the principle of multiplying a spatial unit horizontally and vertically was uniformly followed. Thus, the superstructure may be different but the approach is similar. The visual language had a uniformity in terms of fundamental principles across temples, and diversity in many formal elements, giving rise to regional architectural styles. The fundamentals are the concept of the figure of man and the adoption of certain geometrical motifs.

The motifs on the temples are symbols. They are intrinsically symbolic, although seemingly only decorative and aesthetically pleasing. They, while being decorative and tools of storytelling (mythology), also contain the same principles of concentric circles and the bird-animal-man and nature relationship mentioned above. An analysis of these motifs reveals multiple layers. First is the literal, what is visible to us, like a wheel and its spokes (see Figure 11). Second is the meaning of each element, what

Figure 11: Motif of a spoked wheel

the abstraction says. Third is the deeper interconnected meaning of the whole motif, while being a part of the larger temple as a whole. These premises can be explored using examples in modern systems like Communication Design and Logo Design, while also being wonderful tools for teaching layers of abstraction in modern design and arts.

Silpasastra (sculpture)
Like vastupurusamandala is the guiding motif or architecture, the human body itself is the vehicle of expression in sculpture. The silpasastra reduces the body of man into horizontal and vertical lines, beginning with the

image of the standing man. The motifs that thus evolved were the square and the circle. The man with his arms outstretched recalls the Vedic description of height and width being same, thus fitting in a square. The different parts and limbs were equated with different lines and intersections on one plane and the different elements of the universe on the other (planes referring to layers of abstraction). The centre is the navel and the vertical axis is the brahmasutra, uniting earth and sky.

A system of vertical and horizontal lines helps understand the anatomy better (see Figure 12). The physical body has been reduced to an impersonalised design, which provides possibilities for various permutations and combinations, while being useful for teaching anthropometry, body movements and ergonomics in the modern age. The human body is divided into primary units and their groups based on the major and minor movements, and the relationship with surrounding space is explored using different positions of the body. Fundamental motifs here, like earlier, are the square, the circle with its spokes and the spiral as an unending line of eternity (often shown by a snake biting its own tail). It is established that the images, or the sculptures, are just representations of the Absolute, the Primordial, which is without likeness and can't be determined by form.

The human body is viewed as two halves, divided by an imaginary absolute vertical median, which represents the earth sky principle, and all movement is visualised with respect to it. The other four axes are drawn from different

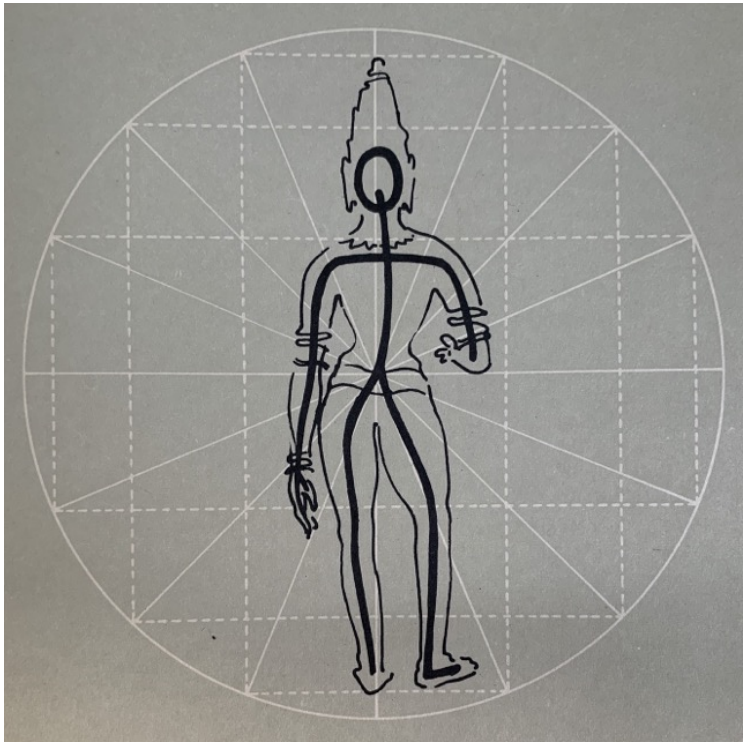


Figure 12: Anatomy of the body using circle and lines

parts of the body. Different lines/axes passing through different parts are discussed. The measurements of all these axes are taken with the length of the face or the stretched hand as the unit. It is further subdivided, like the smallest is the breadth of the finger. Using this imagery and the different axes, the body positions can be determined. When the weight of the body is distributed equally on either side of the median, a sense of calm and poise is evoked. When the weight is unequally distributed, a sense of disturbance or imbalance is evoked. The sense of how the weight is distributed gives rise to different emotions the sculpture expresses. Thus, the sculptor doesn't need to rely on surface treatment or muscular tension to depict states of mood.

Most Indian sculptures can be seen within the space of a circle circumscribed within a square. The circle is sectioned off by 4, 6, 8 or 12 diameters, with the most important being the vertical median. Second is the principal horizontal diameter, passing through the navel. The detailed framework for the radii passing through the circle, passing through various body parts is discussed. Another way of dividing is by making chords from the ends of diameters, to get a rhombus (see Figure 13). Here, the diameters and radii become the spokes, and the centre is the hub of the spoked wheel. It is basically a circle divided by a system of lines corresponding to the dominant points of articulation of the human body.

The division of the circle into horizontal and vertical is referred to as space division, while the oblique division

Figure 13: Anatomy of the body using chords

is the time division. This is because the framework of vertical and horizontal is static and refers to the structure armature of all positions. The oblique diameters and chords determine movement through time. The interaction of these space and time units provides a distinctive and specific rhythm. This imagery is a useful tool for distinguishing between positions and movement. Reducing this imagery further into simple shapes and lines gives us a tool for exploring human positions and movements. The different positions of one leg can be seen as a radius moving within a circle, and each different position corresponds to an oblique diameter or chord. Thus, the relative positions of closing in of energies and expansion of energies (via different poses) are all explored through a centre, principal diameters, oblique diameters and chords within a circle.

An example of a Mahalakshmi figure from Elura Cave XIV is discussed (see Figure 94). Here, the goddess is sitting on a lotus throne, flanked by 4 deva. The symbolism is the connection of the bottom water world, the central earth mandala and the top celestial world. Sprinkling of water symbolises fertility. The text reduces this image into grids. The composition is set in a circle, with the devi's navel as the centre. The principle and the horizontal verticals can be deciphered as passing through elements of interest. The composition is that of a 16 spoked wheel with the navel as the hub. Another layer of oblique chords gives us triangles in the circle, which corresponds to the movement of the devas. A balancing

Figure 14: Mahalakshmi Figure along with its abstraction

of dynamism and static stillness is done, and a sense of rhythm and tension is produced through this balancing of forces. This is a great example to demonstrate basic design principles like composition, balance, grids and symbolism.

The external layers of Silpasastra sculptures are the particular myth, the iconographical form and the holding of implements, and they all reinforce the inner core, that is the circle and its system of lines. An example of a Nataraja figure shows the symbolism used, where uplifted legs and crossing arms provide intersecting lines, suggesting dynamism (see Figure 99). The damru suggests cyclic continuous time, being made of two triangles meeting at the apex, suggesting past and the future, and the striker can reach either past or future from the moment of the present, the centre (see Figure 60).

Sangitasastra (music)
Although music is not of much relevance to modern design, it certainly was a continuum of the same philosophies followed by other art forms in ancient India. Here again, the figure of man is the guiding principle, where each swara refers to each different body part. Music is represented as circles, and the centre, the diameter and the circumference are of vital importance. The tala can be visualised by a circle with spokes, and the different segments of the circle are the sections of the tala.

Figure 15: Nataraja Figure showing dynamism

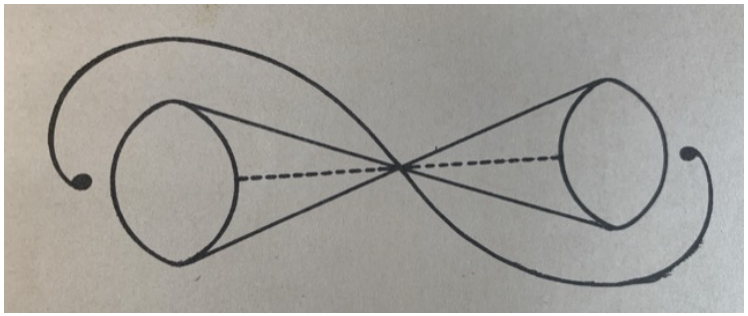


Figure 16: Damru representing cyclic time

Literature review for focussed topics: Works of Prof. Dimple Bahl

Work done by experts such as Prof. Dimple Bahl highlights the importance of visual design principles and elements of ancient India, like the grid system. Unlike the static grids used in Western designs, Indian grids are more fluid, responsible for everything from the layout of temples to sari designs [8]. Indian culture is rich in examples of creative and flexible uses of the grid, be it in the yajna rituals, or the navgraha grid depicting the nine planets [5]. Unfortunately, with the march of technology and mass production, the role of grid as a tool for enhancement of design took centre stage, leaving its depth and meaning behind. Traditional India shows that grids need not be strict and rectangular like the present, especially when one looks at examples of grids in the past, like Chakravyuha, which were modular and fluid, and served their purpose. At present, grids seem more of rigid structures which the designs serve, rather than grids serving the design. Apart from losing its flexibility, Western design also largely ignores the symbolic aspect of the grid. The grids used in the current scenario are useful and practical, but they seem to lack a unique language that makes them stand apart, to create truly indigenous design [25]. With the wealth of knowledge from Indian scriptures, change in technology, and a mix of old and new techniques, it is possible to make the grid a freely flowing design tool that omits rigidity and serves to enhance design.

Different types of grids and their components are discussed, such as the point, the axial line and the intersection (see Figure 17). Sub forms of grids like coordinate based, intersection based, module based and line based are visually shown (see Figure 75). It is emphasised once again that the purpose is not to dwell on the religious background, but to examine those aspects of speculative thoughts which determine the core artistic principles [5].

The Indian version of the golden ratio, the 5:4 ratio, is discussed. It was first seen in ancient Indian cities, and underlines the importance of the grid in Indian history. This ratio was first witnessed in the town planning in Harappan cities in 3000 BC, and finding evidence in the city of Dholavira. It also emerged a thousand years later in religious texts, used for precise instructions to create altars for Vedic ceremonies.

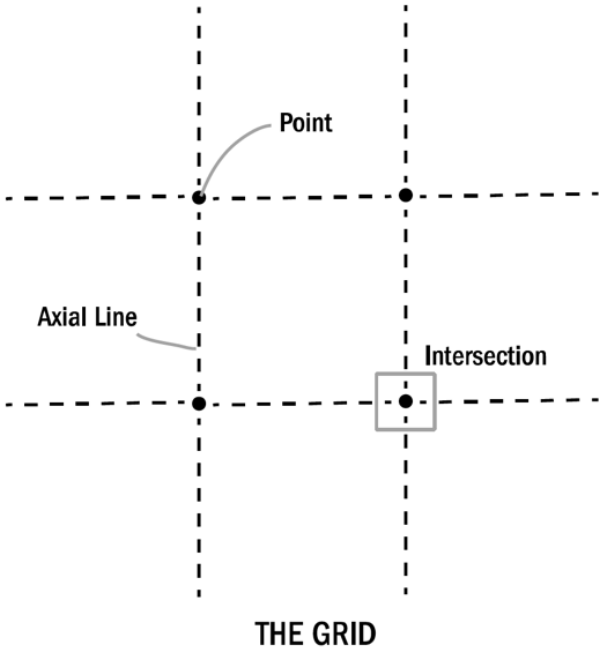


Figure 17: Components of a grid

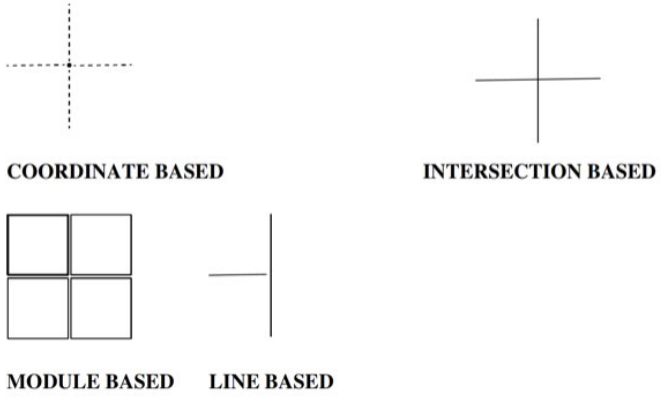


Figure 18: Types of grids

Literature review for focussed topics: The Works of Prof. Kirti Trivedi

Literature written and published by Prof. Kirti Trivedi, a pioneer in the field of research related to Indian Thoughts and Traditions, is of great relevance to this project. Prof. Kirti's work ranges from Exploring Ways of Asian Design, graphic designs of ancient manuscripts, the ancient Indian Design Process and a detailed investigation into ancient form detailing techniques like parametrics and fractals.

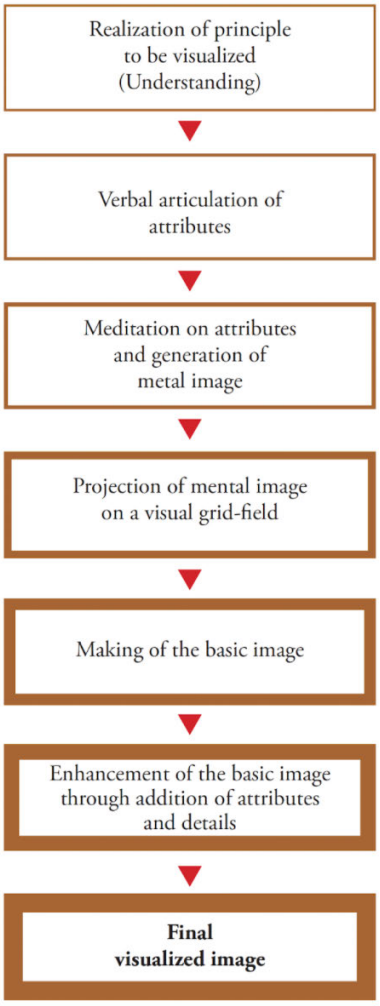
The Indian Design Process

In the Western design tradition, the object evolved from an exploration of the physical: the materials, the forming processes and their possibilities, and the utilitarian physical function. In contrast, in the Eastern Asian tra-

dition the object emerged as a result of Giving Form to Ideas [34] [38]. The Asian Design deals with giving form to formless, express the essence, creating hierarchy of space and measure to establish importance of different components using techniques like grids and mapping, creating the form by a fixed procedural system, and finally allowing variety in expression even while having a rigid procedure using techniques like parametrisation. The traditional Indian Design Process seeks to give Form to the abstract Formless ideas. Prof. Kirti discusses the step-by-step procedure of the process as is shown in Figure 19. An abstract idea is given a meaning, and that meaning is assigned to basic shapes and symbols. These shapes then act as metaphors, holding multiple layers of meaning, and become the building blocks for creation of the form [36]. The abstract concepts can be realised in various forms, and are used as building blocks to express various notions and ideas, such as unity, nature of time, origin of the Cosmos and so on. The quality of visualisation is judged by the effectiveness of the meaning expression, as in, if the initial abstract concept is clearly being represented.

The Talamana System

Prof. Kirti discusses the importance of the ancient Talamana system, a system of grids and proportions that used to dictate visual compositions, particularly iconography. This system gives rise to many useful grids, such as the one shown in Figure 77, which can be used to explain basic concepts like component hierarchy and pre-



2
The visualization process according to Vastusutra Upanishad

Figure 19: Traditional Design Process

sentation. The different locations on the grid system determine the hierarchy of information. When used as a grid for composing scenes, different beings have different importance irrespective of their physical size, just dependant on the position in the grid.

The Talamana system is a hierarchical measurement system. A similar system in the contemporary scenario would help design effective communication, in which information elements have to be placed in a given space according to hierarchical meaning or effective communication according to their size and position [35] [37]. Prof. Kirti maps these steps as-

1. Realising a strong communication message first. The abstract concepts should be clear in the mind of the artist.
2. Removing details that don't contribute to the meaning. Every remaining detail should be there to communicate some meaning.
3. Generating forms using set procedures and recursive methods (which when executed with even tiny changes result in totally different and visually rich results), by:
   (a) Giving a basic form to the essence, the idea, by removing ambiguity and isolating meaning
   (b) Executing the complexity of the full growth following processes that replicate the procedures in nature, like parametrics and fractals.

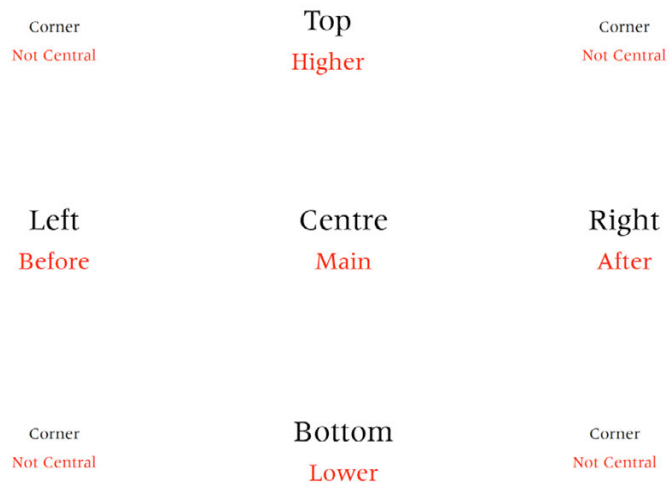


Figure 20: Grid Hierarchies arising from Talamana System

   (c) This constant variation of the same principles without exact repetition gives non repetitive art. Set frameworks for form generation exist to create visualisations with similar essence, and the parametric variation creates the individual uniqueness.

The traditional Asian designs were manifested beautifully using set principles and only traditional tools. Modern tools can leverage those principles even further [30].

Study of Manuscripts
"Roopartha: Form and Meaning in Indian Visual Culture" takes a look at manuscript designs, such as the Jain

Figure 21: A Jain Manuscript

manuscripts. Jain Kalpasutra/manuscripts, as shown in Figure 21 can teach principles like horizontal graphic design and lettering. The borders establish the context of work, and different letterforms with varying boldness and font weights represent information hierarchy. Technical works had specially designed formats to best bring out the information.

The Devanagari script manuscripts included multiple level texts like main text, commentary, footnotes, references. New grids emerged to have space separators and attention directing devices. Apart from manuscripts, Islamic influence on literature also led to stunning book designs, with elaborate embellishments and border decorations.

Parametrics and Fractals

Once the basic form is in place, it has to be detailed to bring out the uniqueness in design. Form results from following mathematical procedures, where the surface is filled with a density of details. Complexity is achieved through recursive (repetitive) procedures. Shapes can contain smaller replicas of themselves as a method of detailing. Prof. Kirti discusses various such procedures like parametrisation, fractals and shape transitions.

Fractals are patterns that are invariant when scaled, self similar, recursive and are used for space filling [33] [27]. The discussion begins with looking at the fractal patterns in nature, where mountains are not smooth cones and barks are not cylinders. Nature expresses many irregular and fragmented patterns with different levels of complexity as one zooms in. These techniques make their way into ancient architecture especially in Hindu temples, where complexity can be seen as increasing, both in plans and elevations, along with the motifs (Figure 22).

Detailing can also happen using shape transitions. In Hindu temples, circles are derived through successive faceting of a square. There are different ways of achieving circles, such as rotating squares (Figure 23). Both shapes represent different abstract concepts, and the temple in turn represents the cosmos as a whole. These concepts can be a great visual tool to teach form and shape transitions.

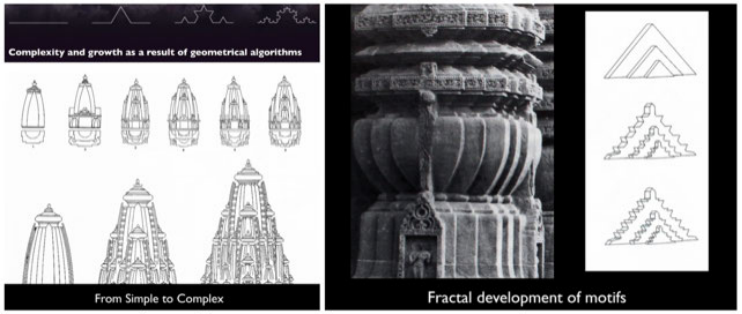


Figure 22: Fractals in Hindu Temples

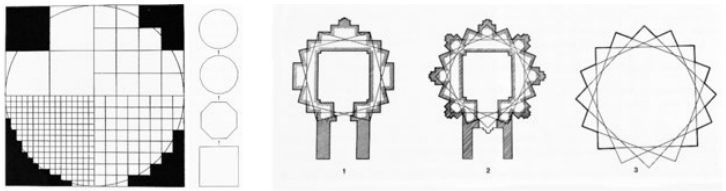


Figure 23: Transition of squares to circles

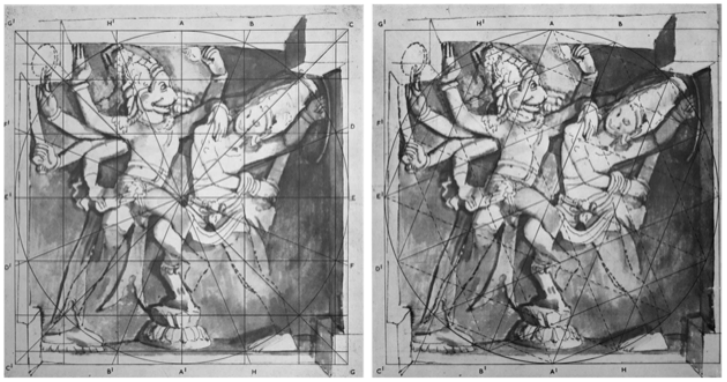


Figure 24: Alice Boner's Analysis of Narsimha Avatar

Fractal procedures which were employed in early architecture can be a great tool for detailing contemporary forms as well. Paramerics also ensures constant newness, the desire to always make something new. This is achieved by frameworks and procedures with parametric variation. These recursive processes when followed result in creation of rich forms that wouldn't be possible intuitively.

Literature review for focussed topics: The Works of Alice Boner

Alice Boner was a Swiss-trained sculptor and artist who lived in Varanasi, India in the twentieth century. The diary she kept for documenting her observations offers fascinating insights into her discoveries about the geometrical underpinnings of Indian art [21].

One such analysis was that of an 8th century panel in Elura Caves, called Narsimha Avatar. The image, as shown in Figure 24, conveys energy and tension of the moment, as Vishnu, transformed into the form of a man-lion called Narasimha, prepares a death-dealing blow to the asura Hiranyakasipu. Alice Boner's suggestion is that although the panels are square or rectangular, the primary geometrical feature is a single circle, inscribed in the square or having two opposing sides as tangents in a rectangular case. This primary circle is divided by diameters, here 8, and generally 6, 8, or 12, into equal sectors, the vertical and horizontal diameters being the fundamental. The intersections of the diameters with the circle form the basis of a rectangular grid, as seen in the left side of Figure 24. Note that the grid spacing varies vertically and horizontally. This forms what she calls the space division of image. It is static in nature and serves to locate the important elements of the composition. It can be seen how the vertical neatly divides the space for the two opposing forces. The two central grid interspaces are taken with the bodies of Narasimha and the asura, while the horizontal interspaces divide the bodies into the heads, torsos, and thigh regions.

More interestingly, the right side of Figure 24 shows what are called time divisions, using oblique grids. They are obtained by selecting two or three families of parallel chords, also based on the cutting points of the diameters and the circle. The time divisions determine the direction of movement [21].

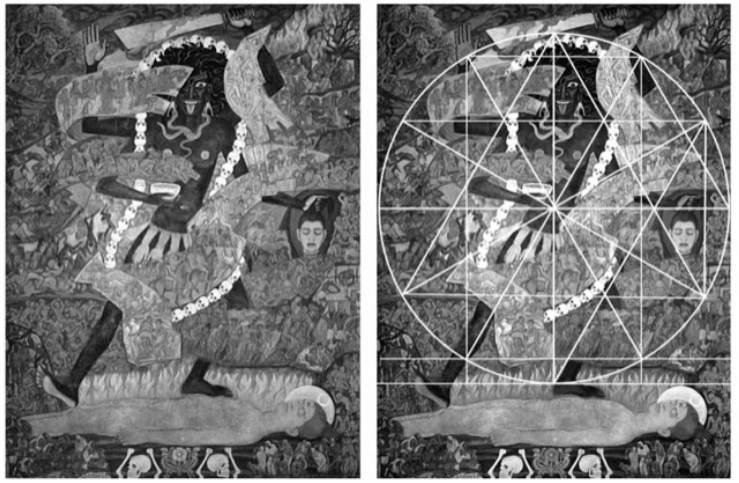


Figure 25: Alice Boner's Analysis of Sumhara Kali

Boner analyses 21 panels in this manner. Another example of a grid superimposition on a 2D composition can be seen in the Sumhara Kali figure, as shown in Figure 25. Looking at the right side image, the grid shows a circle centred exactly on the navel of Kali. There are six diameters and the space and time divisions (superimposed here) are straightforward.

Figure 26 shows a scene from the Mahabharata, with Arjuna standing on his chariot and Krishna driving it. The panel is elongated into a rectangular shape. Geometrically there are three equal circles, centred one radius apart, the centres being directly between the eyes of Vishnu, on his navel, and on a multi-headed serpent. The circles cover heaven, the earth, and the underworld.

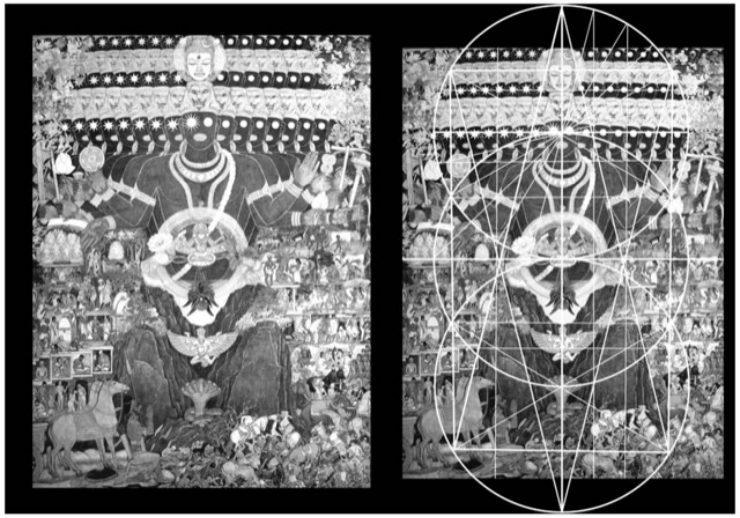


Figure 26: Alice Boner's Analysis of Vishvarupa

The division is by 12 diameters. The space division is used to indicate repetition and hence order and form, while the time division shown by the oblique lines emphasizes its vastness.

A List of Subtopics for Exposure Material

For the exposure material of the course, the following topics would be covered.

1. Basics of traditional knowledge systems
   (a) Symbolism and the importance of storytelling in design
   (b) Basics of abstraction as seen in traditional knowledge systems: Although abstraction above a certain level might seem too vague and unrequired to an uninitiated outsider, it (a) helps giving a concrete direction to the design process which would otherwise be lost considering the diverse cultural and geographical backgrounds of artists all around India, and (b) it gives every design a "story", making the design itself more valuable, interesting and timeless.
   (c) Basic elements of design: Basic shapes and elements of nature as guiding principles.
2. Anthropometry and the Human Body
   (a) Measurements and grids
   (b) Movements and ergonomics
   (c) Abstraction
      i. Mappings to elements of nature
3. Form and Architecture
   (a) Abstraction
      i. Exploring transitory emotions using form and space transitions
      ii. Body mappings
   (b) Symbols, motifs and basic shapes as the guiding principles
   (c) Grids and Ratios
      i. Significance and use, both in terms of utility and abstraction
      ii. Examples and analysis

(d) Patterns and Fractals

4. 2D Compositions
   (a) Theories for 2D compositions
      i. Focal points
      ii. Balance
   (b) Abstraction and meanings

I believe that, based on the extensive literature review from multiple sources, this list of topics would provide an exhaustive overview of the Classical Indian Knowledge Systems to Class XII students and would enable them to extract design principles relevant today, without being too overwhelming for the limited duration the course would run for. Any subtopic chosen or left from this list is done purely on my understanding of its capability to provide enough relevant information.

Structuring the Subtopics

For structuring the subtopics, a template replicating the Indian Design Process itself will be followed, inspired by the 'Form to Formless' design process laid down by Prof. Kirti Trivedi, as has been discussed above. The process deals with concretisation of abstract ideas and principles to arrive at forms- giving Form to the Formless. I believe that equating the lesson plan with the design process itself would enable coverage of a wide range of subtopics, allowing presentation of case studies and analysis from every stage and discipline of classical design. These case studies can be from different geographical regions and religious faiths, providing a thorough understanding to the students. The structure consists of three basic parts- the Idea, the Form and the Enhancement, and is as follows:

1. The Idea- Kickstarting the Design Process with having an initial abstract idea. It would consist of:
   (a) Understanding the design process.
   (b) Understanding symbolism and importance of storytelling.
   (c) Understanding the meaning of abstract, and how it compares to realistic representations.
2. The Form- Deals with giving a basic initial form to the idea. It consists of the following procedures:
   (a) Concretisation of the abstract:
      i. Deriving design principles from the abstract idea
      ii. Body mappings and mappings to other elements of nature to represent the abstract
   (b) Giving a Form to the Abstract:
      i. Understanding basic shapes and ratios that arise from the mappings
      ii. Grids
         A. Understanding hierarchy of elements in a composition using grid placement
         B. Dynamic and flexible grids to suit design requirements

C. Examples of grids in architecture, books and sculptures

iii. Compositions, mainly in 2D artworks

A. Visual Balance

B. Focal Points

C. Example Analysis

iv. Understanding the Human Body, looking at basic human measurements and movements in an Indian context using traditional grids like the Chakra Dagram.

3. Enhancement- Deals with detailing the basic form to get a complex product. It consists of:

(a) Fractals:

i. Exploring recursive procedures in 2D and 3D to achieve simple and complex fractals

ii. Form transitions from one basic shape to another (like circle to square) to get complex forms

iii. Form transitions from simple to complex by increasing parametric variations

iv. Fractals in nature

4. Reflection- Taking a step back and reflecting if the final product can achieve the desired goal of representing the abstract successfully.

Structure of the Subject

The course is an 18 hour subject which is part of the design stream for class XII, in which 12 hours would be taught at school and 6 hours would be taken at home. The 12 hours at school would be divided into 6 sessions of 2 hours each. The subject would be taught to class XII CBSE students with an average class size of around 30 students. The learning objectives of the subject would be:

1. Identifying and exploring the meanings of abstraction, symbolism and storytelling using principles from ancient Indian arts and design.

2. Familiarising with and following the traditional Indian Design Process to give meaning to the abstract, converting formless ideas into form.

3. Learning abstraction using mapping of various design elements to the human body and elements found in nature.

4. Understanding the human body using anthropometric measurements, ratios and movements from ancient arts to create universal designs.

5. Learning the importance and application of different types of grids in design and architecture.

6. Learning theories of visual communication like balance, hierarchy, focus and transition using examples from ancient Indian arts.

7. Exploring recursive procedures like fractals to detail forms in design using examples from traditional Indian arts and nature.

Design of Lesson Plan

Once the subtopics are structured, the lesson plan is made according to the timing specifications and requirements, and can be seen in Table 1. The lesson plan is designed for 6 days having 2 hour slots each. For easier allotment of topics, each slot is further divided into 3 lectures of 40 minutes each. It also includes the tasks that students can do in class and at home for a better understanding of the subtopics. A PDF version of the detailed lesson plan can be found via the link: https://bit.ly/3lignbl.

PDF copies of the workbooks that would complement the lesson plan can be found on Google Drive via the link: https://bit.ly/3LmRi9y.

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 1 // 2 hrs.	Slot 1 // 40 mins.	**Introduction**	What are Indian Knowledge Systems?	1. Discussion on what the students understand by IKS 2. **Introduction** to IKS and its classifications (ancient and modern) 3. Introduction to the **Design Process in ancient India** (converting formless to form) using an overview from existing examples like temples	
Day 1 // 2 hrs.	Slot 2 // 40 mins.	**Having an abstract idea**	Abstraction and storytelling	1. Kickstarting the Indian Design process with **having an initial abstract idea** 2. Form v/s formless : Introduction to what is **abstract v/s what is real** using traditional and existing examples 3. Communicating the abstract using **Symbolism and storytelling** using examples from Indian arts and theatre: How abstract ideas were communicated with the help of intriguing stories 4. Doing the class exercise (15-20 mins)	**CLASS EXERCISE 1**: Abstract v/s real: In groups, **segregate a collection of images and artefacts into abstract and realist**. Give reason for the segregation and explore what makes an artefact abstract, and **what ideas the abstract artefacts are trying to represent are** (the story they're telling). As a contingency plan, the teacher can show **screen based images as slides** if printouts and artefacts aren't available.

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 1 // 2 hrs.	Slot 3 // 40 mins.	**Concretising the abstract**	Metaphors	1. Understand **metaphors to communicate stories** as a way of abstraction using examples from Indian theatre (eg. representing deer and hunter) 2. Brainstorming and discussion on where the students might have encountered similar metaphors to represent something in daily life (can be theatre, movies, stories, etc) 3. Explore representation of abstract ideas in stories using **metaphors like shapes** (spiral with unchanging centre, circle showing cyclic time, etc), colours, position in space and direction.	1. **HOME EXERCISE 2A**: Consider these **formless ideas and communicate them using simple abstract shapes** such that the core message remains communicable (make 3 versions for each): Connection of heaven and the earth, An explosion, The circle of life, The centre of the universe, Outside. 2. **HOME EXERCISE 2B**: Write a simple **story in five lines** using the following word cloud: Sunrise, perseverance, colours, fear, determination, elaborate. Using simple abstract shapes, communicate the story in five frames. 3. **HOME EXERCISE 2C**: Choose any two themes out of the given words and **make a collage** of no less than 10 entries each. Can use photos, sketches, magazine cutouts or other visual entries for the collage. The word cloud is: Determination, connection, centre, unchanging. *(1 hr)*

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 2 // 2 hrs.	Slot 4 // 40 mins.	**Concretising the abstract**	Mapping to human body and nature	1. **Introduction to mappings** as a way to metaphorise the abstract using examples like human body mappings and mappings to elements of nature. 2. Explore how ideas are **mapped to different elements of nature** using examples from Islamic architecture and churches.	**HOME EXERCISE 3**: Take any one element out of the five elements of nature; earth, water, fire, wind and space. Click three pictures showing the mapping of this element. Can take articles in and around your house, paintings, patterns and so on. For each of the three pictures, write in one or two lines how you think the mapping has been done. Students are encouraged to bring the articles to the class. *(30 mins)*

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 2 // 2 hrs.	Slot 5 // 40 mins.	**Concretising the abstract**	Mapping to human body and nature	1. Discussion of home exercise- show the articles and pictures collected by the students and discuss the mappings 2. Explore how **components of human body are mapped to different elements of design** to represent different abstract concepts using examples from Hindu temple architecture. 3. Class exercise (15 mins) 4. Explore different ways of extracting a visual design grammar from the abstract and concretising it to be translated into design principles: Explore **basic shapes, ratios and hierarchies** that arise from the mappings	 **CLASS EXERCISE 4**: Consider the **human body silhouette in the figure and label it with the given words** in such a way that the labelled body part best compliments the word: Movement, thought, life, motion, work, rest.

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 2 // 2 hrs.	Slot 6 // 40 mins.	**Giving form to the abstract**	Spatial positions of elements and their hierarchies	1. Explore different ways of executing the next phase in the design process- giving form to the abstract. Understand **how the design principles can be applied visually** using different shapes and concepts like positions and hierarchies. 2. Explore ways of **using shapes that arise from the design principles visually**, using examples like architecture and graphic design. 3. Explore different **ways of demonstrating element hierarchies** like spatial placement, size, colour, etc. using examples from ancient architecture, books and plays. If possible, physical manuscripts may be procured and distributed to the students.	**HOME EXERCISE 5**: Take 9 different leaves of different sizes, shapes and colours, preferably from different plants. Arrange the leaves in a hierarchical order based on their visual attributes like size, colour, etc. in a manner as shown below.  Now, paste the leaves on the Talamana grid (refer to Figure 77) given on the next page according to their hierarchy. For example, he most visually striking leaf would occupy the central and the most important position. *(1 hr)*

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 3 // 2 hrs.	Slot 7 // 40 mins.	**Giving form to the abstract**	Grids and 2D Compositions	1. Discussion of some of the entries of previous day's home exercise. 2. How to translate hierarchy and position visually using the grid system- an **introduction to grids**. What are grids and why are they required? 3. **Basic rectangular grids** to divide space for simple element positioning 4. Basic **types of grid systems and components of a grid**. 5. Class Exercise with Talamana Grid (15 min)	**CLASS EXERCISE**: The teacher brings a large printout of the Talamana Grid, and brings some artefacts which are ordered according to importance. The class then brainstorms to decide which object should be placed where on the grid.

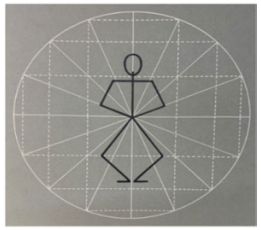
Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 3 // 2 hrs.	Slot 8 // 40 mins.	**Giving form to the abstract**	Grids and 2D Compositions	1. Visually translating design principles like element hierarchies using **Complex grids** (with unequal space divisions and other features), using examples of natyagrahas and ancient cities like Harappa. (modify a grid to suit your story) 2. **Analysing a temple plan in detail** to understand Grids arising from multiple design principles at once, like element hierarchies, body mappings, directions and other meanings of the story being told.	**HOME EXERCISE 6**: Take any **temple/mosque/church floor plan** and take the print out: 1. Identify and draw the major and minor **grids**. 2. Identify major **mappings** if applicable and label them. 3. Label the **cardinal directions**. 4. Label the different **parts of the plan** (for example, in a temple, label the grabhagriha, etc). *(1 hr)*

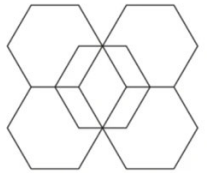
Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 3 // 2 hrs.	Slot 9 // 40 mins.	**Giving form to the abstract**	Grids and 2D Compositions	1. **Grids in 2D visual composition** using examples of ancient books, manuscripts and sculptures. 2. Understand different **theories of visual composition like balance and focus** using different examples of ancient artworks and sculptures. 3. **Detailed analysis of any one traditional artwork**, like the Mahalakshmi Figure, to show principles of graphic design, storytelling and abstraction.	**HOME EXERCISE 7**: Take any **Elura Cave Figure**, print it out, and do the following: 1. What is the **story** behind the figure? 2. How have the **elements of the story been abstracted**/shown in the figure? 3. Mark the major **grids** on the figure. 4. Mark **points of focus** on the figure. *(1 hr)*

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 4 // 2 hrs.	Slot 10 // 40 mins.	**Giving form to the abstract**	Site Visit	1. **Site visit to a nearby ancient architectural site** (preferably a temple, mosque or a similar structure) preferably with a historical significance, and wonder/explore/understand the story behind it. The building should also preferably have a clear grid layout, surface detailing and other features of Indian design.	1. **Analyse the building** and its significance. 2. **Come up with creative stories** of the building's origin, with relativistic realism, supported with pictures and sketches. 3. Try to **assign meanings to various elements** of the building by comparing them to the elements of the story; how they might have been abstracted and represented. 4. If the building actually has a story behind it, that along with the abstractions can be compared to what the students did. 5. **Identify the grids used in the building**, and sketch them. Label the various locations of the building in the sketch. 6. Try to **identify the mappings of architectural elements** (could be to body parts or elements of nature). 7. Identify and **sketch any interesting details** in or on the building.

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 4 // 2 hrs.	Slot 11 // 40 mins.	**Giving form to the abstract**	Site Visit	Continuation of site visit	If site visit isn't possible, a **case study of a famous temple/mosque/church or any other relevant historical building** should be done by the students (could be done in groups) and presented in class. The students should note: 1. **Significance** of the building and the **story** behind it (if there is none, come up with one creative story) 2. How the **story elements have been abstracted** into physical forms 3. **Grids** used, along with sketches 4. **Mappings** of elements to human body or nature, whatever applicable
Day 4 // 2 hrs.	Slot 12 // 40 mins.	**Giving form to the abstract**	Site Visit	Continuation of site visit	

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 5 // 2 hrs.	Slot 13 // 40 mins.	**Giving form to the abstract**	Grids and 2D Compositions	1. **Analysis and discussion of the site visit**/case study- what was the grid system? 2. Conclude grids by exploring **Grids in all dimensions** using examples of architectural plans, sections and elevations of different ancient buildings. (slightly different grids for similar storytelling)	

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 5 // 2 hrs.	Slot 14 // 40 mins.	**Giving form to the abstract**	Human anatomy and movements	1. Application of **grids to understand human body proportions**, anatomy and movements, using the circular chakra diagram. 2. **Abstraction of human body** into simple shapes. 3. Understanding **how different body positions translate into different emotions** and meaning, using examples of sculptures. Can use the interactive mannequin to demonstrate various poses, and discuss with the class the different emotions portrayed by those poses.	**HOME EXERCISE 9**: Click pictures of yourself or someone else from the front, while doing ten different poses, and print them out. Use the **circular Chakra diagram shown in the figure and draw it over each picture** such that: 1. The navel corresponds to the centre 2. The figure is balanced on both sides of the vertical median  Next, **give a title** that best describes each pose. *(1 hr)*

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 5 // 2 hrs.	Slot 15 // 40 mins.	**Detailing the basic form**	Fractals and form transitions	1. Discuss some entries from previous day's exercise- how the grid helps understand human poses better. 2. Explore the next step in the design process- **detailing of the basic form; why it is needed**, and how it helps produce intriguing and unique designs. 3. Class exercise to warm the students up to the idea of detailing (10 mins) 4. **Explore ways of detailing using examples** from architecture and books- fractals, facade sculptures, etc.	**CLASS EXERCISE 10**: Consider the following simple shape. Try to give it complexity by filling the blank areas with simple shapes. Make 3 different products using this process. 
Day 6 // 2 hrs.	Slot 16 // 40 mins.	**Detailing the basic form**	Fractals and form transitions	1. **What are fractals**? Introduction and looking at basic examples from nature. 2. Introduction to **fractals in architecture**: following recursive procedures in 2D and 3D to achieve complex shapes, using visual examples.	**HOME EXERCISE 11**: Click 5 pictures showing examples of fractals in nature and in your home. Try to identify the basic repeating pattern. *(30 mins)*

Day	Slot	Topic	Subtopic	Introduction + Learning Objectives	Main Tasks
Day 6 // 2 hrs.	Slot 17 // 40 mins.	**Detailing the basic form**	Fractals and form transitions	1. Class exercise to introduce recursive processes to students (15 mins) 2. Form detailing using fractals in architectural plans made by form transitions: Understand shape transitions to get complex forms. (scope for interactive exercise) 3. Modifying parametric variations to get different types of transitions, both in 2D and 3D, and arrive at unique products. 4. Ornamentation of forms	**CLASS EXERCISE 12**: Take any one of the shapes given below. **Join the midpoints of each edge to get a smaller version of the same shape**. Continue the process until you can't go any further.  **HOME EXERCISE (exploratory)**: In class, we joined the midpoints, at half the length of the edge from the vertex. What happens if we try to join the points a third of the distance away from the vertex? Can also try other variations using other ratios like 1/4, 1/8, etc.
Day 6 // 2 hrs.	Slot 18 // 40 mins.	**Reflection**	Application and overview of the design process	1. **Reflection on the whole design process** of converting the formless to form using different examples (like ancient architecture), and how effective the product is is at conveying the intended meaning to the viewer. 2. **Discussions** and query resolution	

Table 1: Lesson Plan

Evaluation Matrix for evaluating student workbooks

The workbooks for the students can be found at this link: https://bit.ly/3LmRi9y. Since the subject of design is unlike a conventional subject like Science or Maths where there are fixed answers, evaluation can be a bit challenging. There can be a wide range of student responses without any one correct answer, and the evaluator might judge the results based heavily on subjective interpretation. The vast scale of CBSE schools pan India makes the problem even more complex. To prevent this and to make the evaluation fair for all students, it is of utmost importance to highlight detailed assessment rubrics for each exercise. The Design Thinking Curriculum proposes a grade based assessment, in which fulfilment of individual rubrics would result in the corresponding grade (see Figure 27). The grades are designed in such a way as to encourage all the students to perform better (see Figure 28).

For the purpose of this course, each exercise has been accompanied with clearly laid down rubrics, as can be seen in Table 2. The evaluators are expected to award the grades based on the criteria given in the corresponding rubrics. A PDF version of the evaluation matrix can also be found at https://bit.ly/3FSYTfb.

Beginning FF- EF - EE 0 - 1- 2	Developing DE - DD 3 - 4	Promising CD - CC 5 - 6	Proficient BC - BB 7 - 8	Excellent AB - AA 9 - 10
Criteria 1	Criteria 1	Criteria 1	Criteria 1	Criteria 1
Criteria 2	Criteria 2	Criteria 2	Criteria 2	Criteria 2
	Criteria 3	Criteria 3	Criteria 3	Criteria 3
			Criteria 4	Criteria 4
				Criteria 5

Figure 27: Evaluation Rubrics

Grade Awarded	Grade	Points
Outstanding	O!	10
Above Excellent	A1	10
Excellent	A2	9
Above Proficient	B1	8
Proficient	B2	7
Above Promising	C1	6
Promising	C2	5
Above Developing	D1	4
Developing	D2	3
Above Beginning	E1	2
Beginning	E2	1

Figure 28: Grade assignment for evaluation

Achievement Levels / Exercises	1-2 (Beginning)	3-4 (Developing)	5-6 (Promising)	7-8 (Proficient)	9-10 (Excellent)
1- Abstract and Real	Less than half of the images are labelled correctly. Need to assign correct or at least relatable meanings to abstract images.	More than half the images are labelled correctly. The visual descriptions need improvement, and effort needs to be made to understand the essence of the abstraction.	Most images are labelled correctly. All abstract images have been assigned visual decriptions. Need to move on to understanding the essence of the abstraction	Most images are labelled correctly. All abstract images have been assigned relatable meanings. Effort has been made to describe the essence of most images rather than simple descriptions.	All 8 images are labelled correctly. All abstract images have been assigned creative and relatable meanings, which explain the essence of the image, rather than just describing them.
2A- Communicating the Abstract	Less than 2 ideas are clearly coming forward. Can start abstracting some elements.	At least 2 ideas are clearly coming forward. Only realistic elements are used. Can start abstracting some elements.	At least 3 ideas are clearly coming forward. Mostly realistic elements have been used, but there is some effort of abstraction.	All the ideas are clearly coming forward. Realistic elements have been used to convey some ideas, but clear effort has been made for abstracting most elements.	Abstract shapes have been used to convey all the 5 ideas, which are clearly coming forward in a creative manner. Colour, if used, justifies its necessity.
2B- Communicating the Abstract	Less than 2 frames are clearly coming forward. Can start abstracting some elements.	At least 2 frames are clearly coming forward. Only realistic elements are used. Can start abstracting some elements.	At least 3 frames are clearly coming forward. Mostly realistic elements have been used, but there is some effort of abstraction.	All the frames are clearly coming forward. Realistic elements have been used to convey some frames, but clear effort has been made for abstracting most elements.	Abstract shapes have been used to convey all the 5 frames, which are clearly coming forward in a creative manner. Colour, if used, justifies its necessity.

Achievement Levels / Exercises	1-2 (Beginning)	3-4 (Developing)	5-6 (Promising)	7-8 (Proficient)	9-10 (Excellent)
2C- Communicating the Abstract	None of the entries complement the chosen theme.	At least 1 entry complements the chosen theme.	At least 2 different sources of material have been used, and at least 4 entries complement the chosen theme.	Different sources of material have been used, and at least 8 entries complement the chosen theme.	Different sources of material have been used, and all the entries complement the chosen theme.
3- Mapping	None of the 3 pictures correctly show the mapping of the mentioned element. The articles taken could be more diverse. The description could be clearer.	Not more than 1 picture is able to show the mapping clearly. The description could be clearer.	Not more than 2 pictures correctly show the mapping of the mentioned element. The articles taken could be more diverse. The description could be clearer.	All the 3 pictures correctly show the mapping of the mentioned element. The articles taken could be more diverse. The description is clear and informative.	All the 3 pictures correctly show the mapping of the mentioned element. The articles taken are creative and diverse. The description is clear and informative.
4- Body Mapping	None of the words are labelled to body parts that complement the word/action they suggest.	At least 1 word is labelled to the body part that complements the word/action it suggest.	At least 3 words are labelled to body parts that complement the word/action it suggests.	At least 5 words are labelled to body parts that complement the word/action they suggest.	All 6 words are labelled to body parts that complement the word/action they suggest.

Achievement Levels / Exercises	1-2 (Beginning)	3-4 (Developing)	5-6 (Promising)	7-8 (Proficient)	9-10 (Excellent)
5- Hierarchies	The visual attributes of none of the leaves complement the positioning on the Talamana grid. Could take a more diverse selection of leaves.	The visual attributes of at least 1 leaf complements its position on the Talamana grid. Leaves could be taken from different plants with more diverse visual attributes.	The visual attributes of at least 3 leaves complement their position on the Talamana grid. Leaves could be taken from different plants with more diverse visual attributes.	The visual attributes of all the leaves complement their position on the Talamana grid. Leaves could be taken from different plants with more diverse visual attributes.	The visual attributes of all the leaves complement their position on the Talamana grid. Leaves are taken from different plants with diverse visual attributes.
6- Grids	The grids are not marked. There is no effort to identify mappings and different parts of the building.	Grids and mappings are not marked, could show some effort in identification. Different parts of the plan and the cardinal directions are mentioned.	Effort has been made to identify the correct grid pattern. Mappings are not correct, but effort has been made to identify them. Directions are mentioned. Different parts of the plan are labeled.	Grids are not correct but effort has been made to identify the correct pattern. Mappings are correctly identified. Directions are mentioned. Different parts of the plan are correctly labeled.	All the grids are correctly identified. Mappings are correctly identified. Directions are mentioned. Different parts of the plan are correctly labeled.

Achievement Levels / Exercises	1-2 (Beginning)	3-4 (Developing)	5-6 (Promising)	7-8 (Proficient)	9-10 (Excellent)
7- Composi-tions	The grids and focal points are not marked/are incorrectly marked. Effort could be made to come up with a story that goes with the visual composition.	More effort has to be made to identify major grids of the figure and the points of focus. The story behind the figure doesn't really go with the visual composition. Explanation for abstraction of elements doesn't complement the story and the visual composition.	Effort has been made to identify major grids of the figure and the points of focus. The story behind the figure could be more creative and currently falls apart at some places. Explanation for abstraction of elements could complement the story better.	Major grids of the figure and the points of focus are correctly identified and labelled. The story behind the figure could be more creative and currently falls apart at some places. Explanation for abstraction of elements could complement the story better.	Major grids of the figure and the points of focus are correctly identified and labelled. The story behind the figure is creative and complements the visual elements. Explanation for abstraction of elements complements the story and the visual composition.
9- Human Body	The pictures of the poses are incomplete/do not fulfill the question's requirements. The labelling is not done/incorrectly done.	The pictures of the poses do not fulfill the question's requirements. The poses have been labelled with words that do not complement the pose.	The poses are dynamic and different from each other. At least half the poses have been labelled with words that complement the pose.	All 8 poses are dynamic and different from each other. The poses have been labelled with words that complement the pose. Words describing the pose could be more creative.	All 8 poses are dynamic and different from each other. The poses have been labelled with words that complement the pose. The choice of words is creative.

Achievement Levels / Exercises	1-2 (Beginning)	3-4 (Developing)	5-6 (Promising)	7-8 (Proficient)	9-10 (Excellent)
10- Detailing	The 4 products do not look unique. Very less effort has been put into proper detailing of any of the products.	At least 1 of the products has been detailed with effort. Could start detailing other products with similar effort to make them look unique.	At least 2 of the products have been detailed with effort. Could start detailing other products with similar effort to make them look unique.	At least 3 of the products have been detailed with effort. More effort could be made to make the patterns more intricate and detailed.	The detailing has been done intricately on all 4 products. All 4 products look different from each other.
11- Fractals	None of the 5 pictures show products that exhibit a fractal pattern.	At least 1 picture shows a product that exhibits a fractal pattern, which has been identified and sketched. Sketches could be clearer.	At least 3 pictures show unique products that exhibit a fractal pattern. The patterns could be identified and sketched more clearly.	All 5 pictures show unique products that exhibit a fractal pattern. The patterns could be identified and sketched more clearly.	All 5 pictures show unique products that exhibit a fractal pattern. The pattern has been identified and sketched clearly.
12- Parametrics	None of the shapes have been drawn upon/have been drawn upon as specified by the question.	At least 1 shape has been drawn upon as stated by the question.	At least 2 shapes have been drawn upon as stated by the question.	All 3 shapes have been drawn upon as stated by the question. The fractal pattern has been drawn but smaller patterns could further be drawn.	All 3 shapes have been drawn upon as stated by the question. The fractal pattern has been drawn until smaller patterns couldn't be drawn further.

Table 2: Evaluation Matrix

Design of Exposure Material for Teachers and Students

Since the knowledge contained in the subtopics the lesson plan embarks to convey is decentralised and not easily available, it is of utmost importance to first create a learning resource, in the form of a reference book, which explains each subtopic in detail, as per course requirements. This reference book could be used as an exposure material guide for both students and teachers. It could also be used by the teacher to make the presentation slides to actually show to the students in class.

The contents for the exposure book can be found in the Appendix. The subtopic structuring is done exactly according to the lesson plan and the learning objectives. As can be seen in Figure 29, the book contains explanatory images and sketches, along with images showing examples from the real world, to help students grasp contents easily. All the interactive content including drive files and websites can be readily accessed via QR Codes provided within the book.

Figure 30 shows the design of the cover for the exposure content book. An ornamental display font called "New Delhi" has been used for the title, with the highlight being a red spiral, a shape that holds major significance in classical Indian arts. A PDF copy can be found on Google Drive via the link: https://bit.ly/3IfJ0G2.

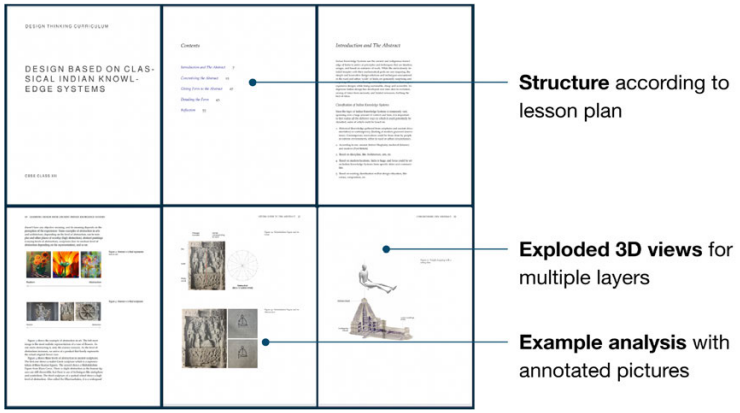


Figure 29: Exposure Content: Book

Addition of Interactive Content

Some of the subtopics covered in the lesson plan have scope for interaction. These interactive environments are web based, and can be accessed on mobile or laptop. They would help give a clearer understanding of the subtopic to the students, along with opening possibilities for giving the students tasks and exercises based on these tools.

Homepage for the course

The homepage can be accessed via the link: https://jribh.github.io/IKS/ (currently best viewed on Chrome for desktop/laptop). This website contains all the course material for the course, as can be seen in the following list:

1. Interactive resources redirecting to the 'Temple Fractals' and 'Human Poses and the Grid' websites.

Figure 30: Exposure content: Cover

2. Exposure content
3. Workbooks and Evaluation Matrix
4. Lesson Plan
5. Assets for 3D Printing

The design of the website has been kept minimal and modern, with the focus being on the contents. Different elements have been presented in a tile format, as can be seen in Figure 31.

Digital Human Mannequin
To teach Human Anatomy and Movements, a digital and interactive web-based human figure- abstracted into basic parts- can be used by the students to understand body positions, and what positions correspond to which emotions (see sketch in Figure 32). It is based on the Chakra grid (see Figure 12). This mannequin consists of movable parts with proportions and movement constraints reflecting those of the actual human body. An interactive web based prototype of this tool can be accessed via this link: https://jribh.github.io/Stickfigure/ (currently best viewed only on Chrome for desktop/laptop).

First Iteration: As can be seen in Figure 33, the tool contains various interactions to help the students explore various body poses. The bottom panel consists of a collection of images which consist of compositions and dance poses. The student can select an image, position it correctly over the grid using move and zoom tools, and

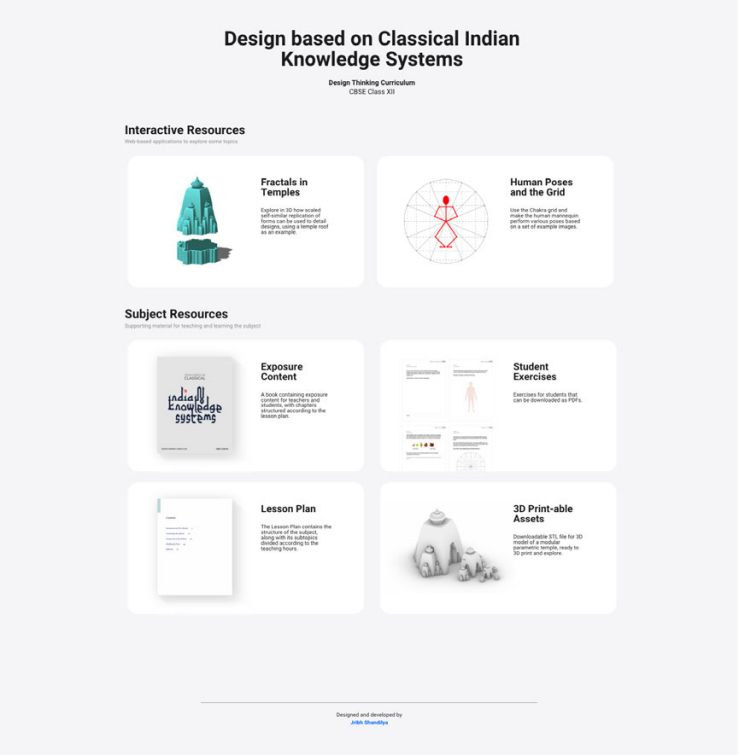


Figure 31: Homepage for the Course

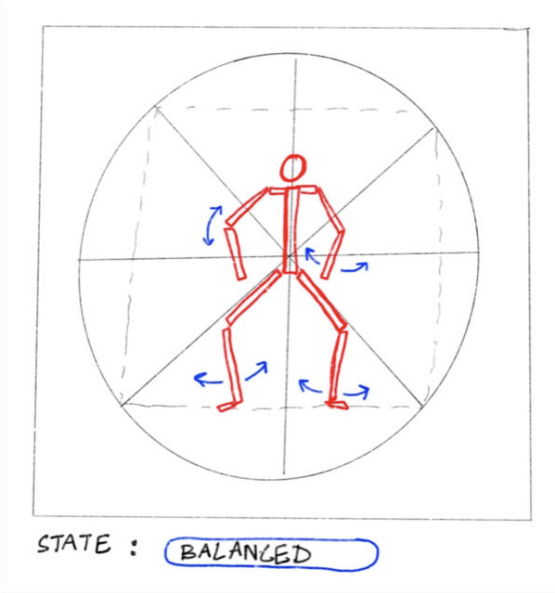


Figure 32: Sketch of the Interactive Mannequin

can reposition the central interactive mannequin to make it perform those poses.

Second Iteration: After the first iteration of the website was tested with class XII students, it was realised that some students found it difficult to understand what to do exactly. To combat this problem, options for hints were added, as can be seen in Figure 34. When a student hovers on one of the hint buttons, instructions appear on the screen to guide him/her.

Fractals in Temples

Indian temples are a great case study to understand parametrisation and fractals. A web-based tool for the same has been designed to be part of the course, and can be accessed via: https://jribh.github.io/TempleFractal/ (can be accessed via laptop, desktop, tablet or phone).

First Iteration: The tool, as can be seen in Figure 35, consists of a 3D model of a temple, shown as an exploded view containing the roof and the base. There is an interactive slider at the bottom, which provides 4 different levels of parametrisation (see Figure 36). As one moves up the levels, the detailing in the temple increases. One can see that the roof follows addition of self-similar scaled variants of itself, and with each level, the size of the self similar module decreases, till it gets very small. This tool thus helps teach the concepts of fractals to the students. Similarly, in the plan, one can see how the initial shape is that of a square, and as one moves up the levels, the facetting of the square increases

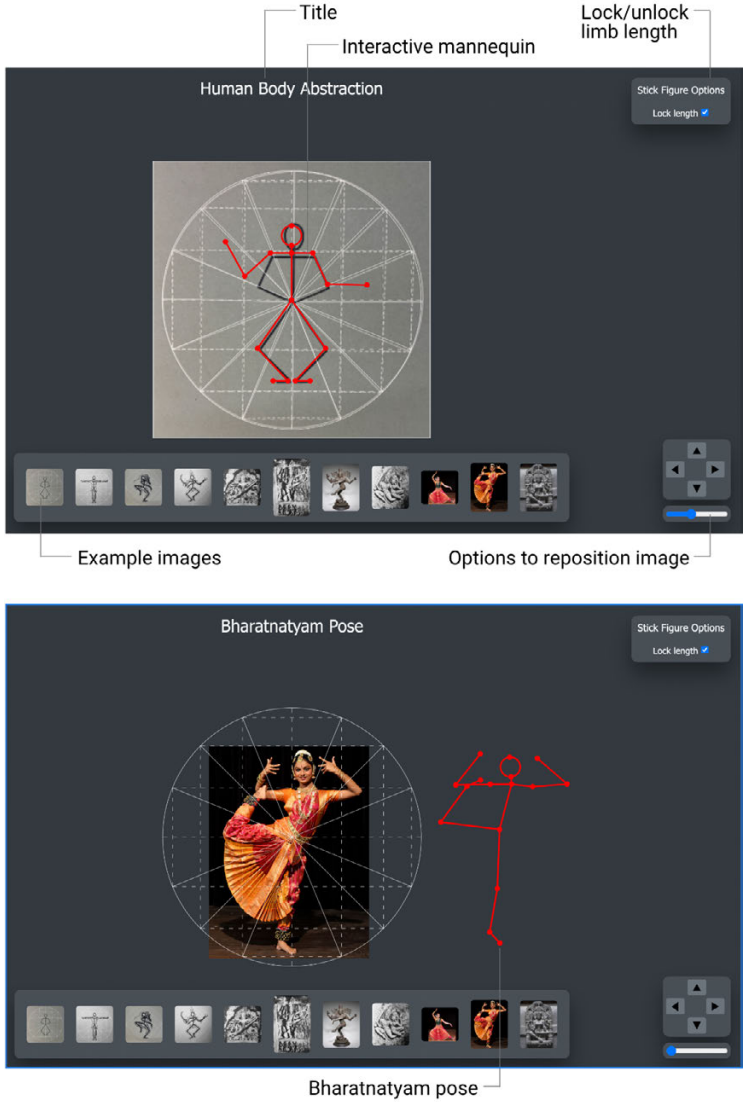


Figure 33: Website for Interactive Mannequin: First Iteration

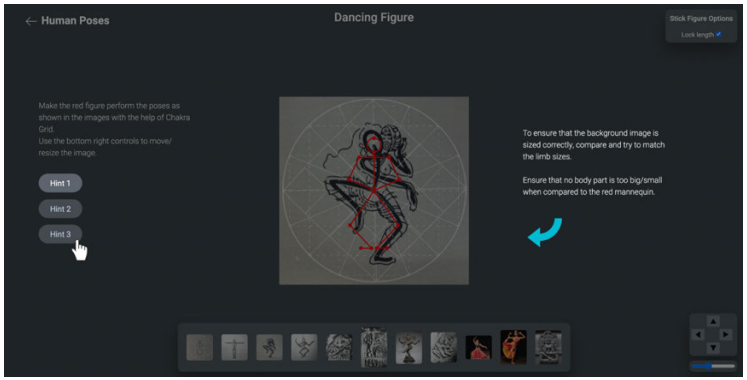


Figure 34: Website for Interactive Mannequin: Second Iteration

more and more. This helps understand shape and form transitions; how a square shape can be transitioned to a circular shape.

Since these tools would be accessed by students across the nation with very different means of access, it is important to make these available on as many devices as possible, by making them responsive. Figure 37 shows the 'Fractals in Temple' tool as being accessed using a mobile phone, with intuitive touch-based interactions to easily navigate through the 3D space.

Second Iteration: The User Interface of application is made more usable and aesthetic, which would appeal to the students while being informative. As can be seen in Figure 38, a description of the parametrisation process has been added to the left. To make the written description least intrusive and keep the focus on the central 3D

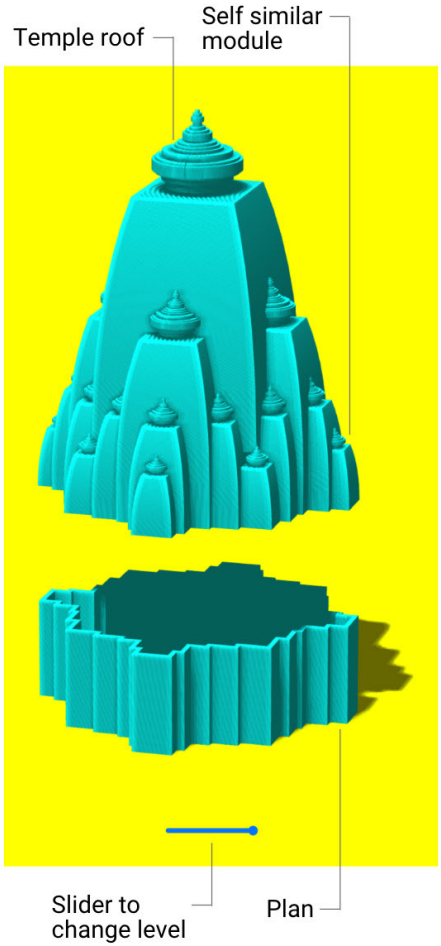


Figure 35: Tool to visualise fractals in temples

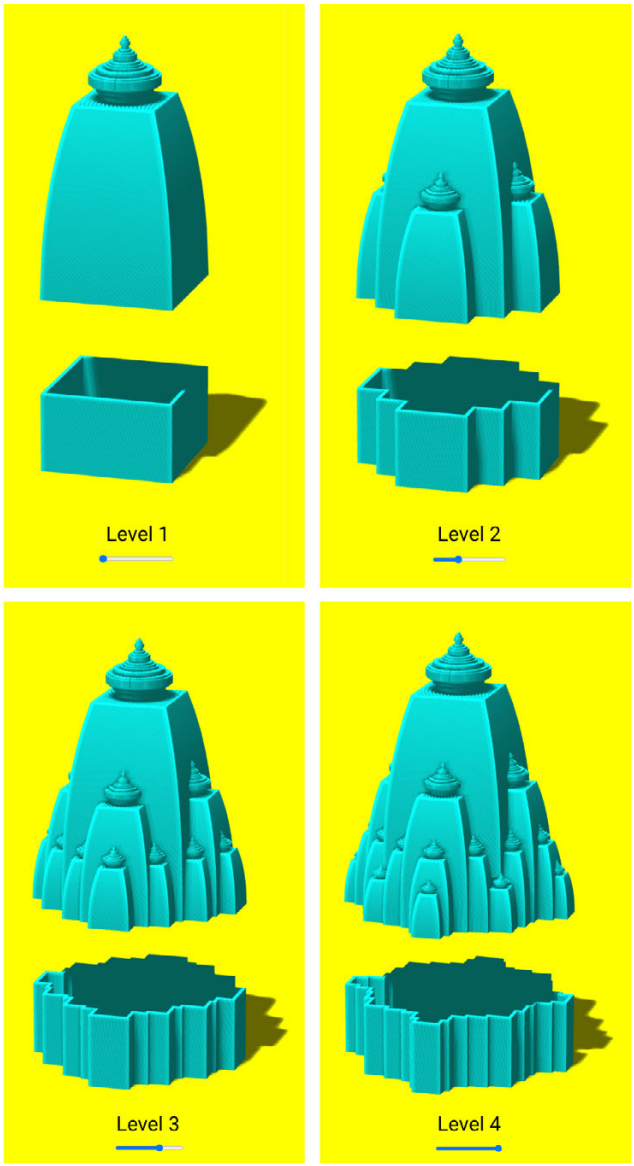


Figure 36: Different levels of parametric variations in Temples

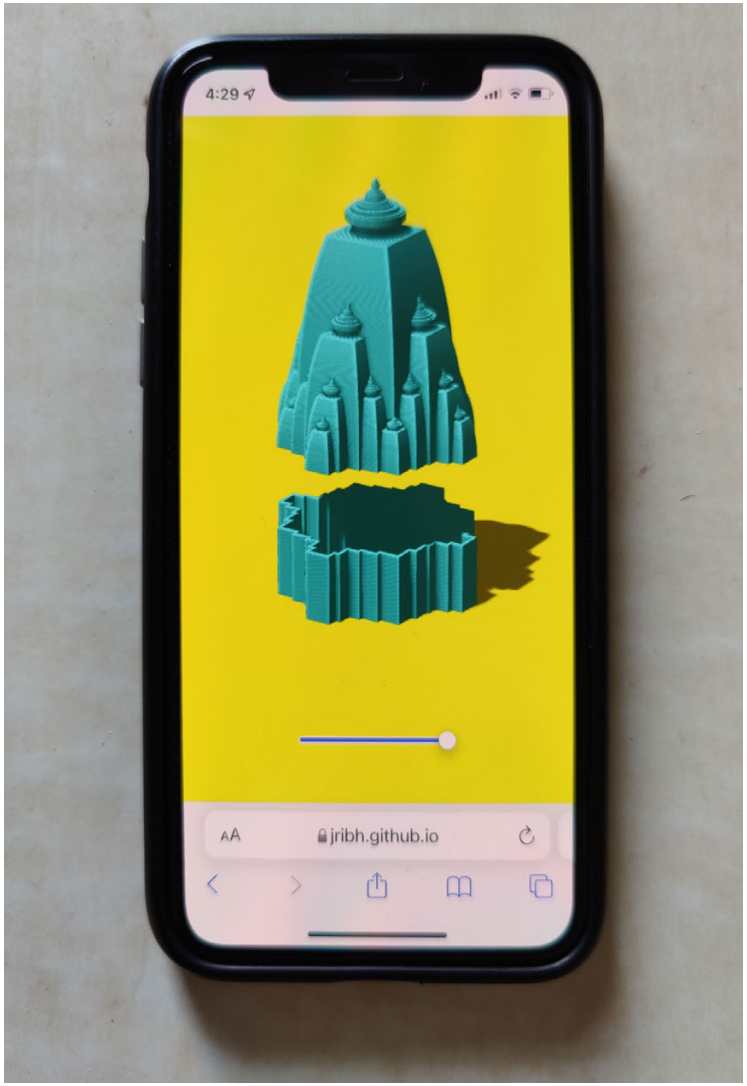


Figure 37: 'Fractals in Temple' accessed on a mobile phone

model, the description is only clearly visible when one hovers over it with the mouse pointer. The bottom slider has also been re-designed to be more informative and aesthetic. On top right, an icon of a 3D gimbal has been added as an affordance to clearly tell the students that the 3D space is navigable.

3D printed interactive model to understand fractals
The Atal Innovation Mission (AIM) set up by the Government of India in 2016 has been an effort to foster entrepreneurship and innovation in schools. A major initiative under the program is the establishment of Atal Tinkering Labs, a state-of-the-art space established in a school with a goal to foster curiosity and innovation in young minds [4]. These labs would be provided for classes 6-12 in schools across the country, and would feature technologies like 3D printing, rapid prototyping tools, robotics, miniaturized electronics, do-it-yourself kits and many more.

Even in the age of major advancements in digital interactive technologies, the potential of a physical artefact to teach basic concepts cannot be overlooked. To leverage the power of Atal labs, this project also introduces a 3D printed interactive model to teach parametrics and fractals to students using a temple as an example, similar to the one discussed in the interactive website above (see images in Figure 39). As can be seen in Figure 40, the model contains 4 different levels of fractals. The biggest roof form is scaled down and attached to the main form on all the four sides. This process is repeated 4 times,

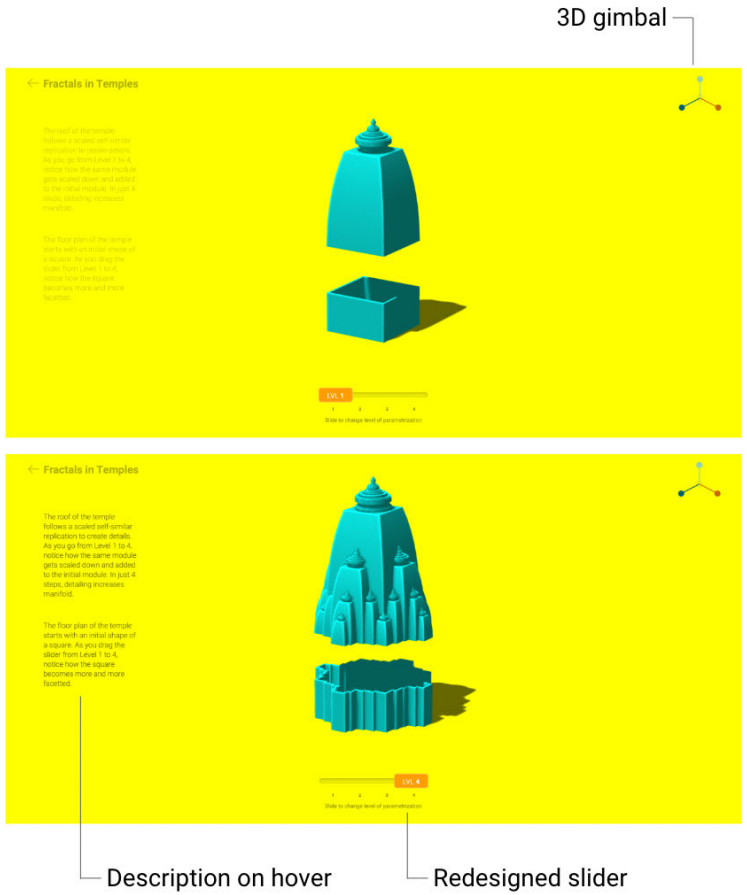


Figure 38: 'Fractals in Temples': Second Iteration

until the last form becomes very small.

The 3D print ready digital STL file for the model will be provided to the school, where the students can use the Atal Labs and get print done. Once printed, the model is ready to be tinkered with. The STL file can be found on this link: https://bit.ly/3yKfbFy.

Second Iteration: The 3D print was taken to a CBSE school where class XII students were asked to explore it (see Figure 41). The observation led to improving the design of the joints between different parts such that they are easy to attach and remove, while not being too loose. For this purpose, sliding joints were made, as can be seen in Figure 42. Now, the parts can simply be slid into the bigger parts, without falling down.

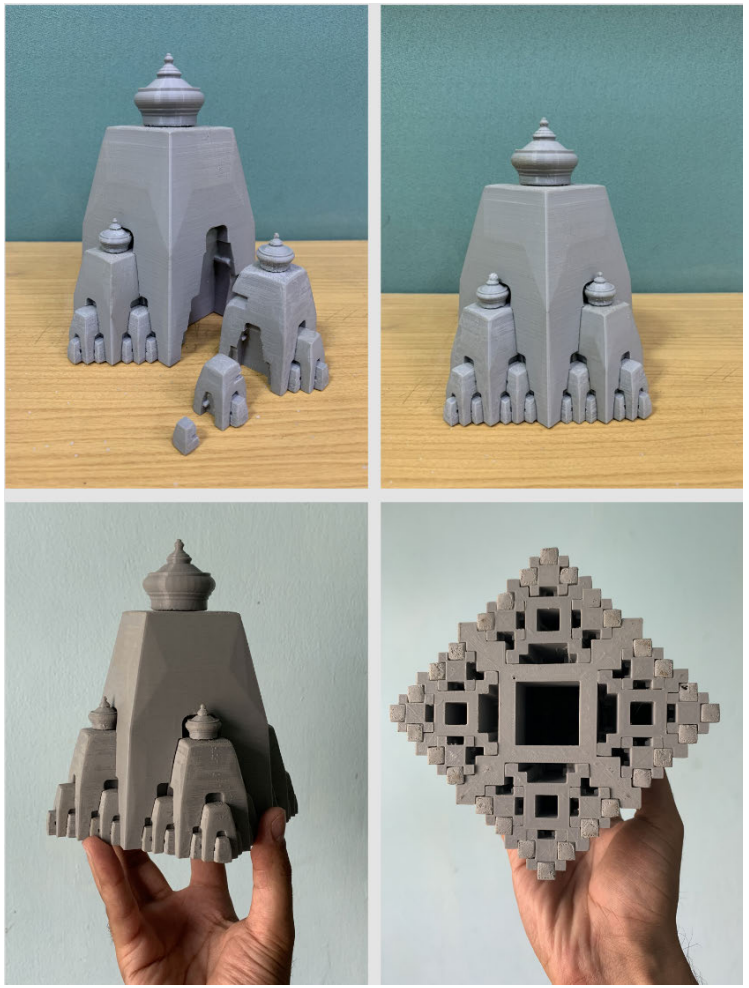


Figure 39: 3D Printed Model of temple to teach parametrics and fractals

Reviews from experts

Various experts in the field of Indian Knowledge Systems were contacted for feedback, especially on the course structure and the exposure content, as are listed below:

1. The panel of Design Thinking Curriculum, consisting of Prof. Amit Ray, Prof. Prajakta Kulkarni, Prof. Rupa Agarwal and Prof. Rupa Chakravarty.
2. Prof. Prasad Bokil, IDC, IIT Bombay: His work includes study and research on visual communication and semiotics.
3. Prof. Dimple Bahl, Associate Professor of Design at the National Institute of Fashion Technology, Delhi:

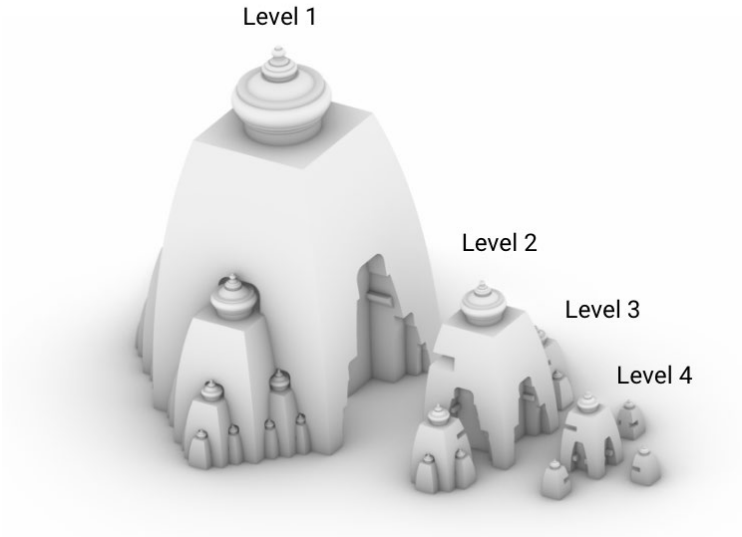


Figure 40: Levels of parametrisation

Figure 41: Class XII students exploring the 3D printed model

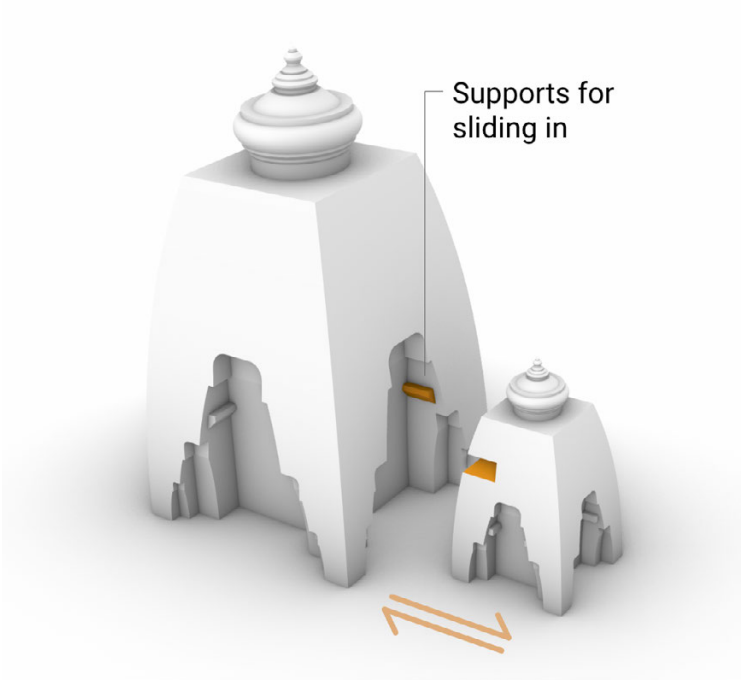


Figure 42: Designing joints in iteration 2

Her work includes research and exhibitions that seek to take inspiration from ancient grid systems of Indian arts and architecture, and how they can be applied contemporarily.

4. A panel of experts working on an interactive program to teach the role of grids in Indian history. The presentation was incredibly helpful in exposing me to many types of grids that are used in a variety of fields such as architecture, rangolis, textile and manuscripts.

The reviews have been largely positive. Some of the key insights gathered are noted below:

1. Ancient knowledge could be classical or traditional; this project focuses on Classical, and that should be clearly mentioned
2. Classical knowledge doesn't separate arts from design, thus a line needs to be drawn manually based on relevance of the subtopics in the contemporary scenario
3. Although a set design process can be inferred from the texts, artists had full freedom to experiment. Thus, nothing should be presented as being concrete/black white.
4. Exposure content should be used as an umbrella to show examples and case studies- how something could be done.

5. Exercises could have more constraints to build more connection to Classical knowledge. Also, it is important to test these exercises on the go.
6. New reference material like Alice Boner and Ganpati Sthapati.

Evaluation of Exposure Content

I contacted a school teacher who teaches English to class XII in a reputed CBSE school. Based on the course structure, exposure content and the exercises, I got the following crucial insights:

1. Concepts of abstraction are not too vague for class XII students, and can be discussed with them.
2. Need extensive visuals and realistic images as examples as much as possible, as students tend to skip over text and understand the most from visuals.
3. When talking about visual metaphors, it should be visually shown where they have been used.
4. In home exercise 2B, literal and easy words like sunrise, hunter and meadow could be removed. Giving more difficult words like perseverance, exhilarating and baffled to class XII students would make the exercise more challenging.
5. Abstraction exercise (Workbook 3) seems a bit kiddish, and could be made more challenging.
6. Group discussions and brainstorming sessions should be added to the lesson plan, as it enables face to face discussion and piques student interest.
7. An exercise could be added for the Talamana grid, where the teacher could get a large print out of the grid.

Evaluation of Workbooks

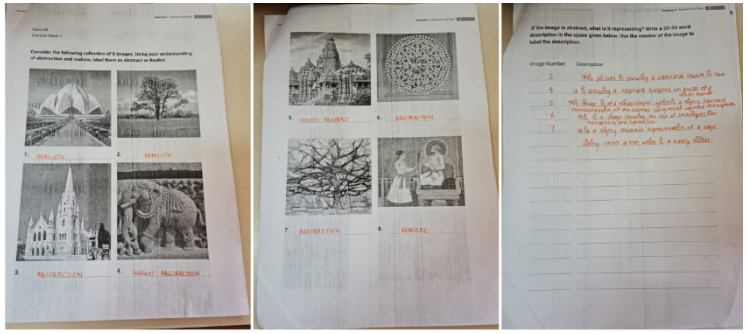
Some of the exercises and the exposure content were sent to class XII students for participatory evaluation. Here are some of the insights I got from this evaluation:

1. The language of the exposure content is a bit tough at some places, and takes multiple reads to figure out, especially the topics on abstraction and metaphorisation. The provided pictures are helpful for understanding such difficult topics. After getting this insight, I added more descriptive pictures in the exposure content.
2. Some exercises could be better worded to get the intended result from the students. For example, when writing a 'description' for Exercise 1 (see Figure 43), students plainly described what they saw, instead of speculating and taking more risks.
3. The results clearly show that students know what abstraction means. However, as can be seen in the works of two different students in Figure 44, different mediums can lead to different results, making

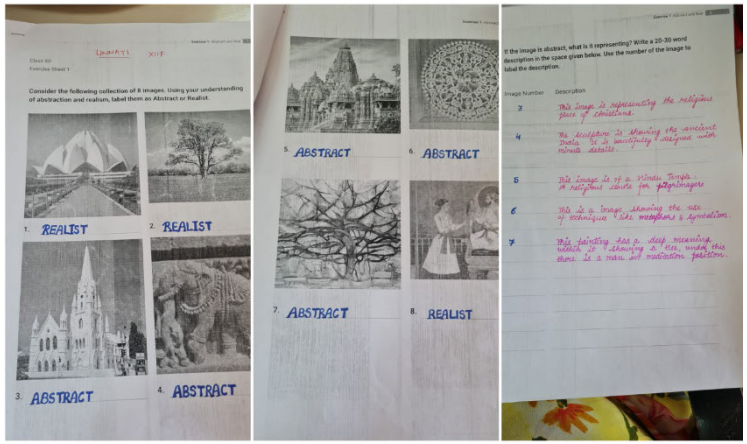
evaluation harder. To keep the playing field fair and focus the evaluation just on the rubrics provided in the evaluation matrix, I locked the medium, such that only pencils or certain colours could be used for such exercises.

4. Different students can have different approaches when executing the same problem. As can be seen in Figure 45, one student used simple abstract shapes while the other took a more realistic approach. Such situations would reflect in the grading which would be done according to rubrics. However, I have made the language as clear as possible to minimise such a possibility.

5. Exercise 5, where the students had to paste 5 leaves according to hierarchy, had to be reworded because students completely misunderstood the assignment, pasting leaves which matched the shape of the letter instead, as can be seen in Figure 46. In the next iteration, the steps and guidelines were made simpler and clearer.

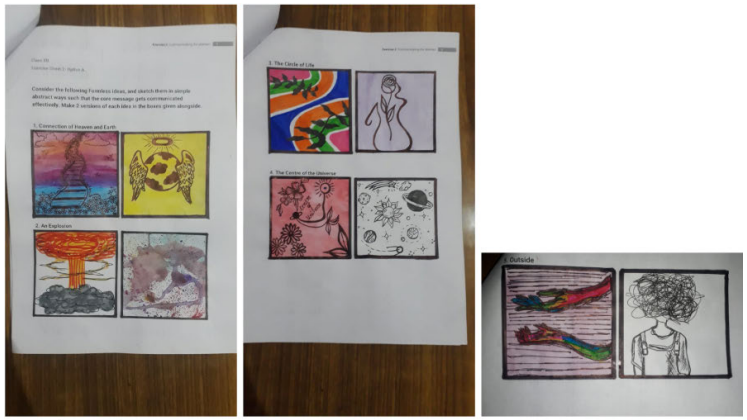


Student 1

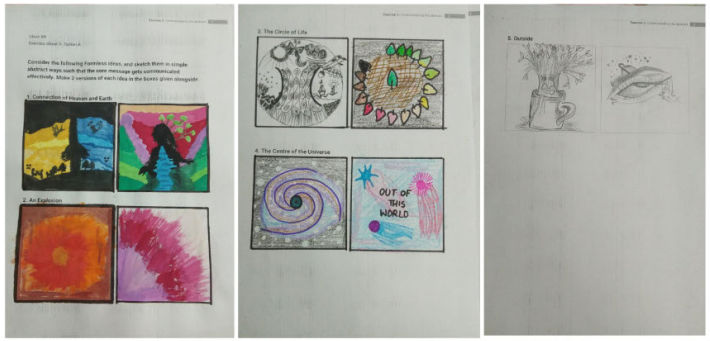


Student 2

Figure 43: Exercise 1 done by the students

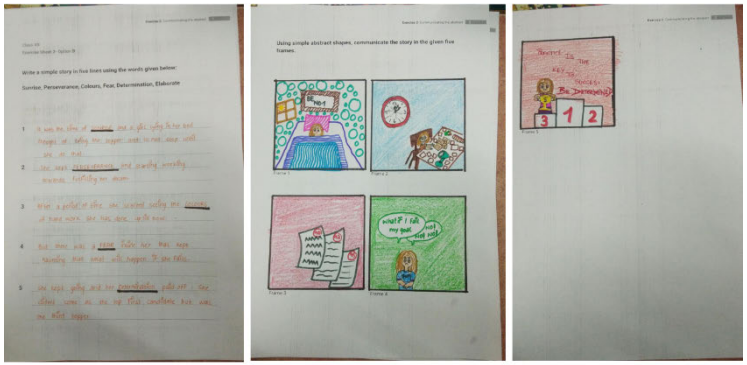


Student 1

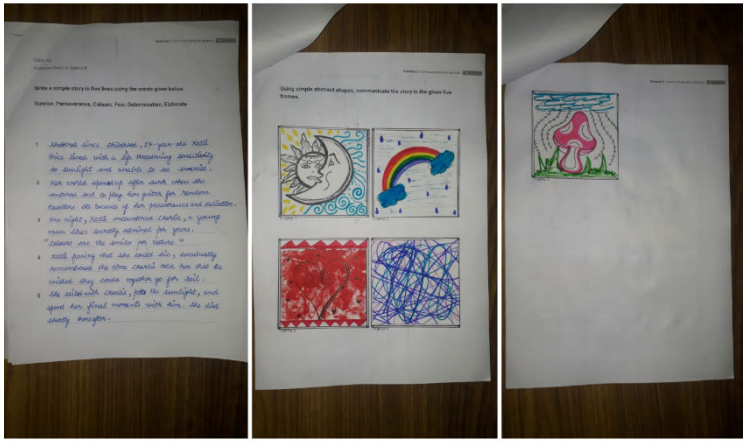


Student 2

Figure 44: Exercise 2A done by the students



Student 1



Student 2

Figure 45: Exercise 2B done by the students

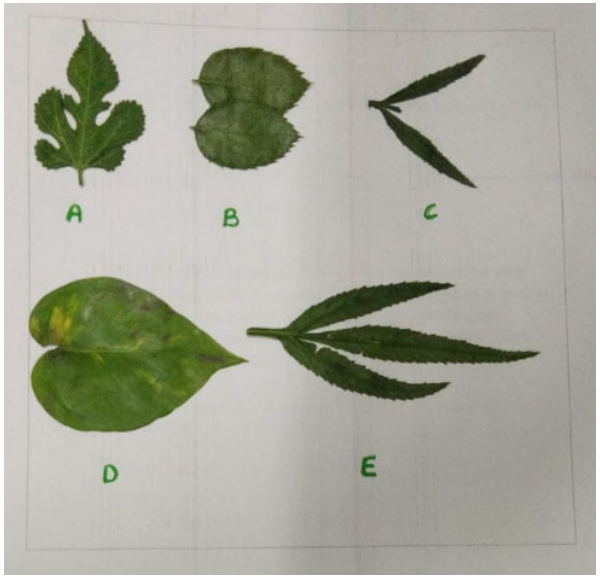


Figure 46: Exercise 5 done by students

Discussion

The project provides resources for teaching the subject "Design Based on Classical Indian Knowledge Systems" to CBSE Class XII students based on the outline provided by the Design Thinking Curriculum of CBSE National Education Policy (NEP) 2020. The resources include the lesson plan for the subject, a book for exposure content, workbooks, evaluation matrix for the workbooks and interactive content in the form of digital websites and a physical 3D printed model. Throughout the project, participatory evaluation of the above material has been done starting from an early stage, both with teachers and students. This iterative design approach resulted in several revisions of the above resources, based on evaluation results. The resources, especially the interactive ones, have been designed keeping in mind the implementation possibilities in CBSE schools in India, either today or in the future. For example, the 3D printed model leverages the fact that the Government of India has proposed incorporation of tinkering labs, called Atal Labs, in all schools within the next couple of years.

The future scope for this project would comprise of the following:

1. Further testing of the workbooks in a full scale setting with more number of students would give better and normalised results, resulting in better design insights. Considering the whole class of students would enable consideration of students of all capabilities, allowing for better and more accessible workbooks.
2. Since the subject is new for most Indian schools, it is important to consider the capabilities and motivation of the teachers. Thus, large scale testing of the resources, especially the lesson plan and exposure content with as many teachers as possible would give better insights. Also, since neither the subject nor the teachers supposed to be teaching it exist yet, it is important to recognise the recruitment process for the teachers. For example, teachers with a strong background in Humanities and Arts would be able to better relate to the content provided, understand it and convey it to the students.
3. Since the exposure book contains a lot of content, a summarised guide could be provided to the teachers highlighting the most important parts. The exposure content itself could be digitised and made interactive, rather than being in a printed book format.
4. Some more interactive content could be added to teach the subtopics. For example, different layers of abstraction in 2D compositions (see Figure 63) could be digitally shown in the form of an interactive program, where the students could tinker with the different layers and see the results in real time.

Personal Reflections

I have always believed that my strength lies in researching and designing for more contemporary topics having majorly a technological base. To challenge this assumption I decided to venture into the vast resources of knowledge contained within the ancient knowledge systems, a domain almost completely unfamiliar to me. Due to lack of knowledge, I have always been majorly dismissive about ancient Indian sources of knowledge, especially on the basis that they were heavily reliant on stories and myths. Through this project I aim to broaden my previously rigid viewpoints.

REFERENCES

[1] 1978. *How a Child Thinks*. Plume.

[2] 2014. *The Cambridge Handbook of the Learning Sciences* (2 ed.). Cambridge University Press. DOI: http://dx.doi.org/10.1017/CBO9781139519526

[3] Sashiranjan Akela. 2021. Promotion of Indian Knowledge System – A blend of ancient learning system with contemporary practices in the new age of information. (2021). https://www.mynep.in/

[4] Niti Ayog. 2022. Atal Innovation Mission (AIM). (2022). https://static.pib.gov.in/WriteReadData/specificdocs/documents/2022/feb/doc202222519701.pdf

[5] Dimple Bahl. Untangling the Gridlock.

[6] Singanapalli Balaram. Design Pedagogy in India: A Perspective.

[7] Honey Bee. 1996. HoneyBee: Scouting and Documentation. (1996). http://honeybee.org/scout.php

[8] Nitya Chablani. 2016. What do graphic design and ancient Indian art have in common? (2016). https://www.vogue.in/content/what-do-graphic-design-and-ancient-indian-art-have-in-common

[9] Philip Chambers. 2020. Artificial Intelligence for Learning Design: Potential Uses. (2020). https://blogs.oregonstate.edu/inspire/2020/07/27/artificial-intelligence-for-learning-design-potential-uses/

[10] GSD. 2019. Innovative Ways of Teaching Design. (2019). https://www.gurukulschoolofdesign.com/blog/innovative-ways-of-teaching-design

[11] Anil Gupta. 1996. The Honey Bee Network: Voices from Grassroots Innovators. (1996). https://www.culturalsurvival.org/publications/cultural-survival-quarterly/honey-bee-network-voices-grassroots-innovators

[12] Yasmin B. Kafai and Mitchel Resnick (Eds.). 1996. *Constructionism in Practice: Designing, Thinking, and Learning in a Digital World*. Lawrence Erlbaum Associates, Mahwah, NJ. http://www.amazon.fr/exec/obidos/ASIN/0805819851/citeulike04-21

[13] Ozlem ULU KALIN. Creating Interactive Student Workbook for Primary Education Social Studies Class and Researching Its Efficiency.

[14] Avadhesh Kumar Singh Kapil Kapoor. Indian Knowledge Systems.

[15] Dr. Pragya Khanna. 2020. Traditional Indian knowledge systems: A National Treasure. (2020). http://www.earlytimes.in/newsdet.aspx?q=292925

[16] Jonathan R. D. Kuhn. An Interactive Workbook For Internet and Classroom Students.

[17] Ineta Luka. Design Thinking in Pedagogy.

[18] Rully Charitas Indra Prahmana Marfilinda Atma Sari Subekti. Developing Interactive Electronic Student Worksheets through Discovery Learning and Critical Thinking Skills during Pandemic Era.

[19] Charu M Maurya. 2021. Ancient Indian ergonomics wisdom and its contemporary significance.

[20] Harsh Mehta. Influence of Bauhaus on Design Education in India.

[21] Robert Moody. 2017. *Alice Boner and the Geometry of Temple Cave Art of India*. 219–231. DOI: http://dx.doi.org/10.1007/978-3-319-57259-8_13

[22] Ministry of Human Resource Development. 2020. National Education Policy 2020. (2020). https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

[23] Ministry of Human Resource Development. 2021. Stimulating Indian Knowledge System, Arts and Culture.

[24] Seymour Papert. 1993. *The Children's Machine: Rethinking School in the Age of the Computer*. Basic Books, Inc., USA.

[25] Bhumika Popli. 2016. We have been ignoring our design heritage while trying to ape the West. (2016). https://www.sundayguardianlive.com/art/4038-we-have-been-ignoring-our-design-heritage-while-trying-ape-west

[26] Edward James Ravi Poovaiah, Ajanta Sen. A blueprint for design education and practice: using emerging technologies and traditional knowledge systems to widen design's constituency in India.

[27] Iasef Md Rian, Jinho Park, Hyunguk Ahn, and Dongkuk Chang. 2007. Fractal geometry as the synthesis of Hindu cosmology in Kandariya Mahadev temple, Khajuraho. *Building and Environment* 42 (2007), 4093–4107.

[28] Jonathan Sim. 2021. How to design unforgettable class activities that help students learn better. (2021). https://www.timeshighereducation.com/campus/how-design-unforgettable-class-activities-help-students-learn-better

[29] Rajiv Singh. 2020. Stimulating Indian Knowledge Systems, Arts and Culture.

[30] Kohei Sugiura. 2008. *Graphic Design Methodology and Philosophy*. Kohei Sugiura.

[31] Lawrence Surendra. 2021. The Knowledge Systems Debate in India. (2021). http://www.dialogue.ias.ac.in/article/21853/21853-the-knowledge-systems-debate-in-india

[32] Nalini Thakur. 2002. The Architectural Knowledge Systems Approach. (2002). https://architexturez.net/doc/az-cf-21179

[33] Kirti Trivedi. 1996a. *Fractal Architecture of Hindu Temples and Parametric Form Generation in Contemporary Architecture*. Kirti Trivedi.

[34] Kirti Trivedi. 1996b. From Formless to Form – A methodology to make manifest the unmanifest according to Hindu Iconography.

[35] Kirti Trivedi. 2003. The Talamana System of India: A Measure for the Cosmic Order and the Cosmic Rhythm.

[36] Kirti Trivedi. 2010a. *Maanen nirmite bimbe swayam abhati daivatam*. Kirti Trivedi.

[37] Kirti Trivedi. 2010b. *Roopartha Form and Meaning in Indian Visual Culture*. Kirti Trivedi.

[38] Kirti Trivedi. 2010c. *The Way of Asian Design: A Direction for Tomorrow*. Kirti Trivedi.

[39] Jerome-Alexander van Wyk. Indigenous Knowledge Systems: implications for natural science and technology teaching and learning.

[40] K Vatsyayan. 1983. *The Square and the Circle of the Indian Arts*. Roli Books International.

Appendices

This appendix contains the exposure content, structured according to the chapters as given below.

Introduction and The Abstract

Indian Knowledge Systems use the ancient and indigenous knowledge of India to arrive at principles and techniques that are timeless, unique, and based on centuries of work. While the meticulously detailed temples with their mathematical grids are awe inspiring, the simple and innovative design solutions and techniques encountered in the rural and urban 'wilds' of India are genuinely surprising and inspiring. There isn't a shortage of indigenous solutions that surpass expensive designs while being sustainable, cheap and accessible. Indigenous Indian design has developed over time akin to evolution, arising at times from necessity and limited resources, birthing the best of ideas.

Classification of Indian Knowledge Systems

Since the topic of Indian Knowledge Systems is immensely vast, spanning over a large amount of content and time, it is important to first realise all the different ways in which it could potentially be classified, some of which could be based on:

1. Historical (knowledge gathered from scriptures and ancient documentation) or contemporary (looking at modern grassroot innovations). Contemporary innovations could be those done by people in extreme environments, either in rural or urban circumstances.

Figure 47: Classifications of Indian Knowledge Systems

2. According to era: classical (before Mughals), medieval (Islamic) and modern (Post British)
3. Based on discipline, like Architecture, arts, etc.
4. Based on modern locations. India is huge, and focus could be set on Indian Knowledge Systems from specific states and communities.
5. Based on existing classification within design education, like colour, composition, etc.
6. Ancient scriptures (shastras) could be classified and one could be focussed upon. Another source of classical knowledge would be curricula of ancient universities like Nalanda, Taksha Shila, Vikramshila and Vallabhi.

Design Process in Ancient India

In Western design tradition, stress on utility and function has led to the design process being an evolution of the final product from an exploration of the physical- materials and the forming processes. In contrast, the Eastern tradition, mainly emerging in India and China, gave rise to a design process where the object emerged as a result of giving Form to Ideas. Indian design process aims to give Form to the Formless. The Formless is an abstract principle/phenomenon, for which an Image is created to express the qualities and attributes of that phenomenon.

The Design Process begins with the realisation of an abstract idea. An integral understanding of the phenomenon to be visualised is essential. Some examples of abstract ideas that have been explored in the Indian scenario are 'Cosmic Order', 'Cyclicity', 'Time', 'Wisdom' and so on. The designer/artist is expected to fully understand the ins and outs of the principle and its attributes, as a Formless mental image.

The second step is metaphorising the abstract. This involves giving meaning to the Formless mental ideas using universally understood examples, like those from the real world. This is done using different techniques like mapping. The abstract is then concretised by extracting a universal design grammar from the metaphors. The design grammar can be a visual one if the final product is visual in nature, in which case the design grammar would consist of directly usable attributes like shapes, ratios and hierarchies.

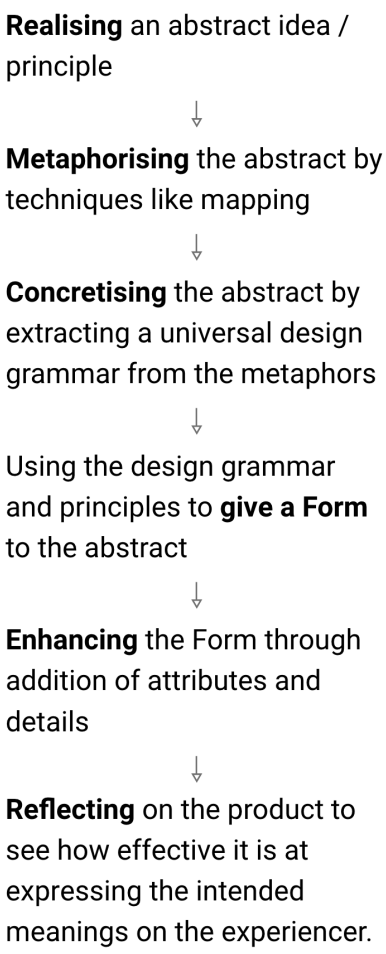


Figure 48: Design Process for giving Form to Formless

The design grammar is then used to give the abstract a basic Form. This step involves exploring different ways of directly representing concepts such as hierarchies using techniques like grids. Once the basic form is in place, it is then enhanced through addition of attributes and details. These enhancements are done using techniques like parametrization and ornamentation.

Finally, a reflection of the final product is done to see how effective it is at expressing the intended meanings to the experiencer.

The Indian Design Process has been followed in the creation of many ancient design artefacts and buildings, such as Temples.

Abstraction and Storytelling

Having an Abstract idea

'Cosmic Order', 'Cosmic Process', 'Cyclicity', 'Continuity', 'Time', 'Abundance', 'Wisdom', 'Grace'- are some of the common themes which have been visualised. In some cultures, the concepts of Cosmic Order have been realised as a relationship between the microcosm of man (purusa) to the macrocosm of the universe (Purusa). This microcosm is created here on Earth and is suggestive of the larger macrocosm (see Figure 49). Almost all religious places of worship, like temples, mosques and churches, aim to be such microcosms.

An abstract idea arises from a set of strong principles and beliefs, which need not be religious. Its principles

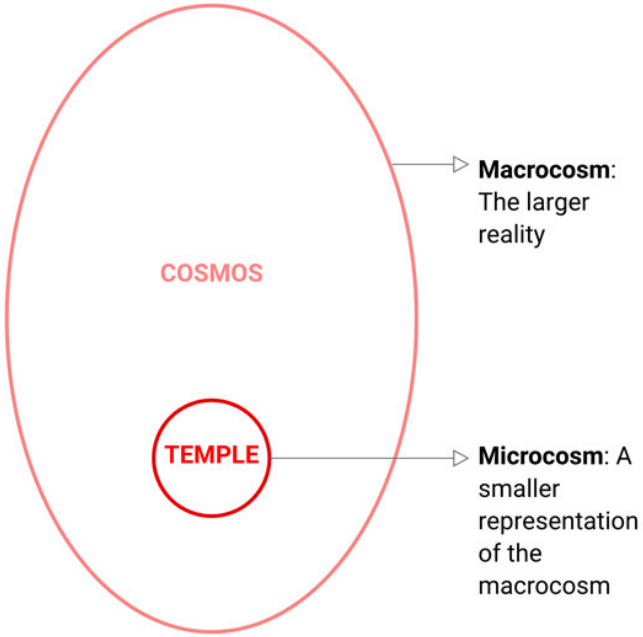


Figure 49: Microcosm and Macrocosm

are well understood by the artist/designer, and it exists in his mind as a Formless mental image. Although abstraction above a certain level might seem too vague and unrequired to an uninitiated outsider, it (a) helps giving a concrete direction to the design process which would otherwise be lost considering the diverse cultural and geographical backgrounds of artists all around India, and (b) it gives every design a “story”, making the design itself more valuable, interesting and timeless.

Abstract v/s Real

The real world around us has what’s called Form- it is a direct representation of what it is. A direct representation of the world around us is called a realism. Some examples of realism can be seen in visual arts, such as Greek sculptures and realist paintings. Realism attempts to represent the subject matter truthfully without any artistic embellishments and implausible elements.

Abstraction, on the other hand, is a representation of ideas, the formless, the abstract, in such a way that it doesn’t directly depict any person, place or thing. The artist impersonalises the subjective, and the content then becomes that abstract emotion, rather than a representation of actuality. Abstraction takes liberties of not having to conform to any particular shape or colour. Total abstraction bears no trace to any recognisable reference. Abstraction allows the imagination to run wild and gives one a chance to escape from reality. It doesn’t have any objective meaning, and its meaning depends on the perception of the experiencer. Some examples of abstraction in arts and architecture, depending on the level of abstraction, can be temples and other places of worship (high abstraction), abstract paintings (varying levels of abstraction), sculptures (low to medium level of abstraction depending on the representation), and so on.

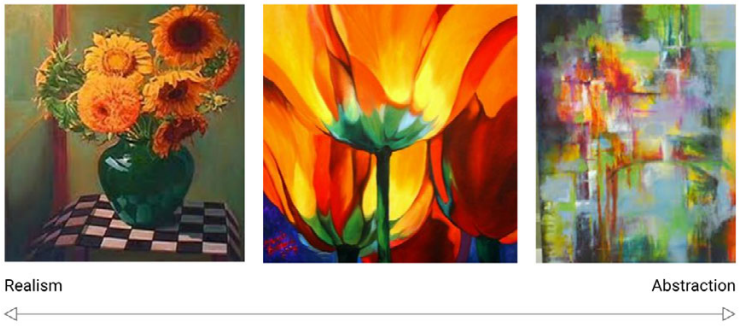


Figure 50: Abstract v/s Real representation in art

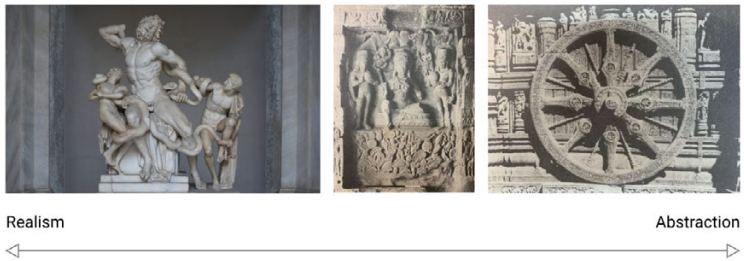


Figure 51: Abstract v/s Real sculptures

Figure 50 shows the example of abstraction in art. The left most image is the most realistic representation of a vase of flowers. As one starts abstracting it, only the essence remains. As the level of abstraction increases, we arrive at a product that barely represents the actual

Figure 52: Abstract v/s Real architecture

original flower vase.

Figure 51 shows three levels of abstraction in ancient sculptures. The first one shows a realist Greek sculpture which is a representation of three human figures. The second shows a Mahalakshmi Figure from Elura Caves. There is slight abstraction as the human figures are still discernible, but there is use of techniques like metaphors and symbolism. The third sculpture of a spoked wheel shows a high level of abstraction. Also called the Dharmachakra, it is a widespead symbol found in many Buddhist and Hindu arts, and holds multiple meanings.

Figure 52 shows abstraction using examples from architecture. The left most building is a famous fisheries office in Hyderabad, India, and is represented using the form of a fish. The middle one is the Beijing Airport by Zaha Hadid architects. The roof of the airport is folded in such a way as to resemble the wings of a bird. It holds the essence and communicates it visually, but doesn't literally depict a bird. The third image is that of a Hindu temple, which is a highly abstract representation of the cosmos on earth using multi-layered metaphors.

Symbolism and Storytelling

When the artist has an abstract idea, it is important to effectively communicate it to the audience, so that they can fully understand the product/art in its depth. In Ancient India, this communication was done with the help of storytelling and symbolism. An intriguing story is of paramount importance because it captures and captivates the audience, making them take even more interest in the design.

In ancient India, a countless number of stories emerged across the vast geographical landscape. Although different from each other in their own way, many of these stories shared common themes and characters which people could relate to. It also helped provide the artists a common design grammar, even though they were separated by thousands of kilometers.

One such story that led to the creation of almost all temples throughout India was that of the origin of the Cosmos, which began with the Primordial Man, the purusa, the Supreme Being, whose body parts became different parts and elements of the Universe, like Earth, Fire, Water and so on. The centre of the Universe formed from the navel of the Purusa. This story was slightly moulded to suit different cultures throughout the sub-continent, but the basic premise remained the same. That is the reason we see a common binding theme across all temples,

although their detailing and form might differ. This story of the Cosmic origin did not just influence temples and other architecture, it also greatly influenced other classical arts like Dance and Sculpture. A story acts like a binding theme, both for the artist and the experiencer, making the whole experience richer and deeper. It gives every element some meaning, some role to play in the grand scheme of things, and connects it to other elements effectively.

Concretising the Abstract

Abstract ideas are given meaning with the help of intriguing stories. However, in arts, the ideas present in these stories need to be communicated to a large audience in such a way that they are consistent over space and time such that:

1. Communication doesn't mean different things for different cultures, since the audience belongs to a large geographical landscape with a plethora of backgrounds.
2. Communication is timeless. The meaning it holds doesn't change over time, and the symbolism is understood in the same way.

One such way of effectively communicating abstract ideas to concretise them over space and time is using metaphors. Simply put, a metaphor is an object used in the place of another such as to suggest an analogy between them. In

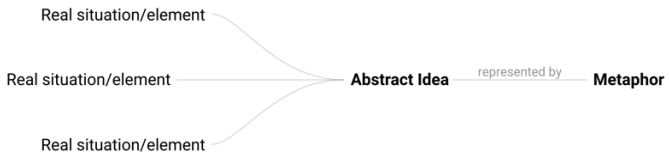


Figure 53: Metaphorisation

arts and design, metaphors are simple and abstract representations used to communicate multiple ideas.

Metaphors

A story can have multiple characters and locations, along with various actions and emotions. A realistic depiction of all these attributes would, depending on the complexity of the story, clutter the information presented and confuse the viewer. Also, it wouldn't be consistent over space and time, as discussed, as such representations might lose their meaning. Giving elements or a bunch of elements from the story a meaning that can be represented by another abstract element would solve the problem of inconsistency, provided the meaning communicated by the abstract element is understood equally by all viewers and fellow artists. This process of representation is called metaphorisation.

Indian arts and architecture are filled with examples of metaphorisation, be it in visual arts, temple architecture, or classical plays. The Upanisads discuss different metaphors like the chariot and the wheel, the sun and its rays, the body and its senses. All these are based on

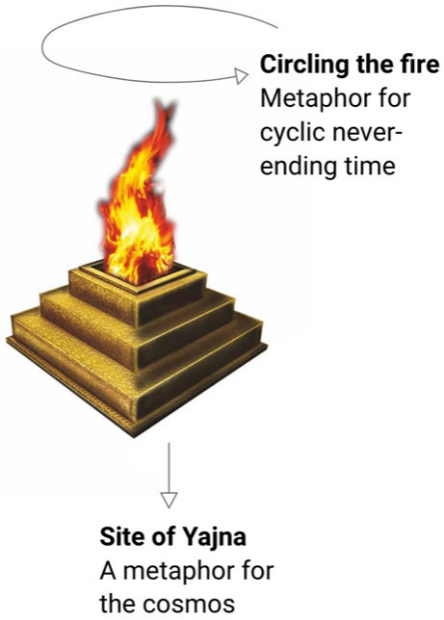


Figure 54: Metaphorisation in the Yajna

the same basic principles- the concepts of internalization and externalization, and the concepts of time and space, relationship of parts to a whole, one to many, concept of formless and the multiple forms, and so on. Understanding metaphorisation is also useful if one wishes to understand the meanings of classical arts and architecture, as all shapes and symbols like circles, triangles, lines and dots have multiple layers of meaning.

Many ancient Indian arts derive their metaphors from the concept of the ritual of Yajna, which has been referred to in some of the oldest Indian texts. Yajna is a sacred ritual done around a fire. It in itself is a metaphor- being a finite symbol of infinite cosmic space i.e., the universe. The motive of the Yajna is to create a microcosm on the earth suggestive of the macrocosm, that is the whole universe, using motifs and symbols to represent the larger elements like earth and fire (see Figure 54). Various actions done during the ritual also hold their own metaphorical meanings. For example, the act of circling the site for doing 360 degree revolutions refers to the concept of cyclical time. Cyclical time is a concept referred to in many cultures, which refers to the cycles apparent in the real world, like day-night, seasons and so on. Almost all traditional Indian arts take their basic symbols and ideologies from the concept of yajna- which included symbolic representation of Primordial man (Purusa), and other symbols like fire, water and earth. There is importance given to the shapes of square, semi circle and circle, and the centre (the axis mundi, or the pillar, that connects heaven to earth), which arise from the abstract Formless concepts of the ritual.

Metaphorisation in Indian Theatre

Indian theatre, the Natya, used metaphors to communicate different elements and scenes of the plays. The actual space of the theater in itself is a metaphor to represent the cosmos, a representation of all three worlds, with a central pillar symbolising a connection between the Earth and the Sky. The stage for the play, an erection of a microcosmos, is an area divided into units, with different marked colours symbolising different directions,

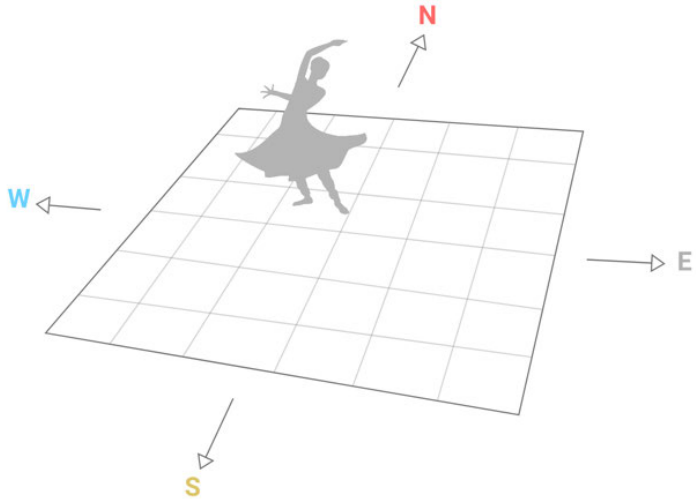


Figure 55: Natya stage as a metaphor to represent the Cosmos

with white being the color of the East, blue being West, Yellow being South and Red being North (see Figure 55).

To metaphorise the structure of the drama itself, an imagery of five concentric circles, as shown in figure 56 is used. These circles represent the major and minor episodes of a drama. The five stages of development of action- the beginning, the effort, the continuation of effort, the possibility of attainment and the attainment of the fruit- are conceived sequentially as circles of different sizes. The development of the plot of the play is also metaphorically compared to a seed which expands and develops.

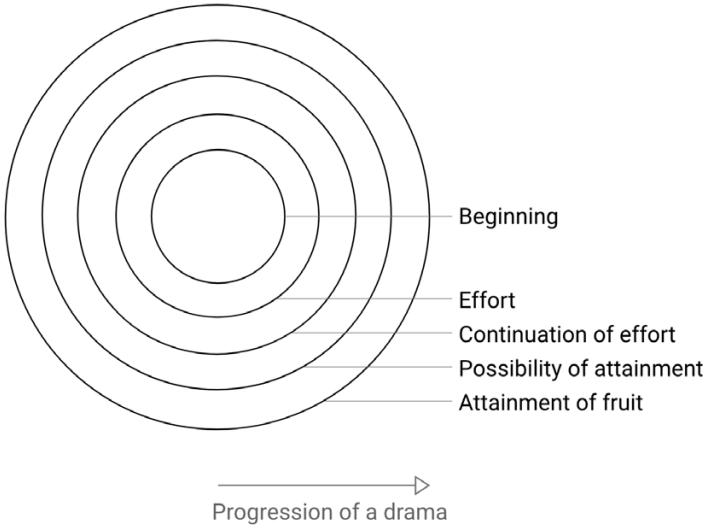


Figure 56: Concentric circles representing the structure of a drama

An analysis of a popular Sanskrit play 'Abhijnana Sakuntala' shows how different elements like simple and complex movements, thoughts and things have been represented using techniques like 'angikabhinaya' (depicting something using actions instead of props). The facial expressions, actions and speed of movements would depict the underlying emotions and tempo. Representation of deer, for example, was not done by actual deer, but by a dancer wearing a deer mask, constantly peering and frisking in fright. Along with acting, the physical position on the stage corresponded to the structure of the drama itself. Changes in locale did not take place in the drama through division of the script into scenes and acts, but through movement from one demarcated area to another. Abstraction of these scenes were depicted using metaphors like zonal divisions and stylised walking on stage. The lyrical beauty of such scenes could not be possible with realism.

Metaphors in Visual Arts

Visually, ideas and concepts can be metaphorised using different shapes, colours, spatial positions and directions. The purpose of these metaphors isn't literal comparison, but importing similitude. They are physical vehicles for communicating the ideas- similes for explaining the phenomenon/abstract ideas of the stories.

The Bindu (a spiral shape) as shown in figure 57 is an important visual metaphor, which has conceptually guided Indian Arts for centuries. The centre of the Bindu signifies a state of rest, the unmanifest. This in turn creates

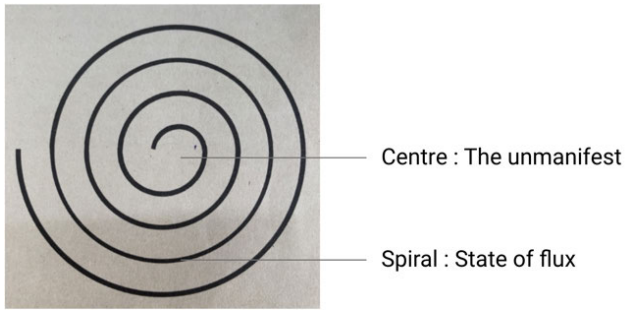


Figure 57: The Bindu

the many, the manifest, which are in a constant state of flux within the area of the circle. This state of flux is depicted by the spiral arms emanating from the stationary centre. This metaphor of the Bindu has also been used to represent cyclical never-ending time.

The shapes of the square and circle also became some of the most important and widely used visual metaphors in Indian arts, ranging from visual arts to architecture. They emerge from the analysis and comparison of opposite psychic states, or more simply put, exploration of complimentary pairs. Visually they give rise to the geometrical figures of circle and square, each of which symbolises the coming together of two opposites and an unbroken continuum (see Figure 58). Although these pairs are polar opposites, their relationship isn't one of tension, but of fading and evolving into one another. The square form symbolises order in a world of opposites, with two sets of parallel lines. The circle suggests the continuum of cyclic time. These metaphors provide an

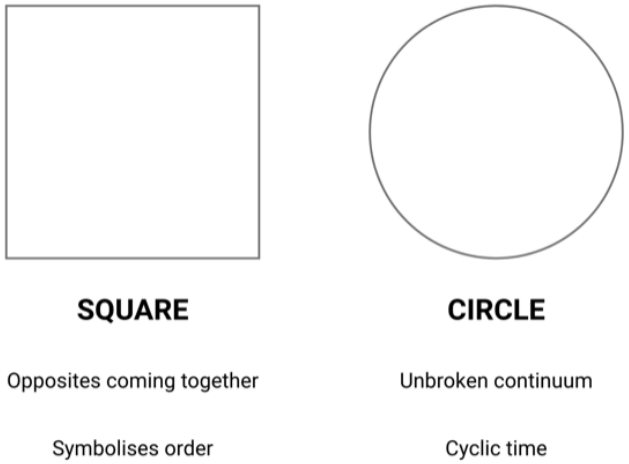


Figure 58: Metaphors of Square and Circle

elaborate grammar of form. In Indian theater, the square plan represents the stage, while movement in space, which is related to time, happens in the dynamic rhythm of a circle, as can be seen in figure 59.

The imagery of a circle with its diameters, resembling a cartwheel as shown in figure 61, is used in various depictions. It signifies collecting energies from a central point, the bindu, and the shape of the chakra that is derived from it is used in various formats like depiction of different human poses.

The image of the Damru as shown in figure 60, a musical instrument, has been used in various art forms as a metaphor for cyclic continuous time. Being made of two

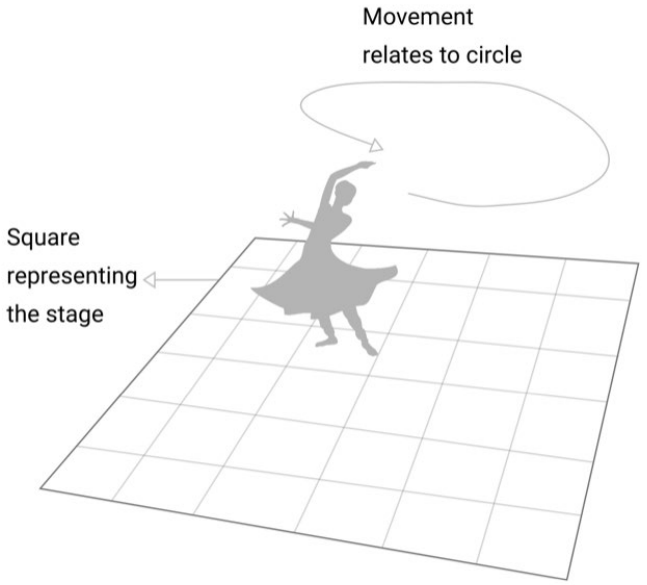


Figure 59: Square and Circle in Indian Theater

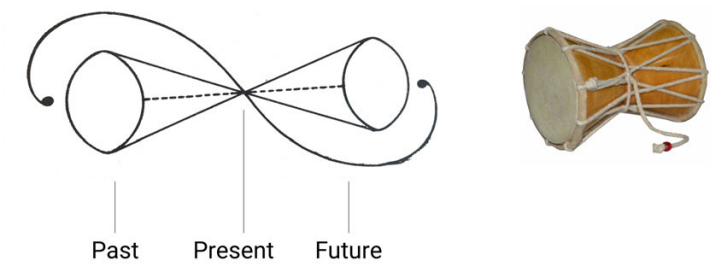


Figure 60: The Damru suggesting cyclic time

triangles meeting at the apex, suggesting past and the future, the striker can reach either past or future from the moment of the present, the centre.

An important abstract concept in Indian arts is the depiction of the unison of the earth and sky, since most art forms seek to depict a relationship between the microcosm and the macrocosm. This depiction is shown by different metaphors. In architecture, it is shown by a vertical pillar, the Stambha, in the centre, an example of which can be seen in figure 62. In sculpture, a central vertical median is the chosen depiction.

A proper understanding of metaphors can help uncover several layers of abstraction from an artefact, as shown in figure 63. The first layer could be literal- what is actually visible to us, be it a chariot wheel, a pillar, or so on. The second layer is the first layer of meaning hidden by the metaphor- what the metaphor is trying to symbolise.

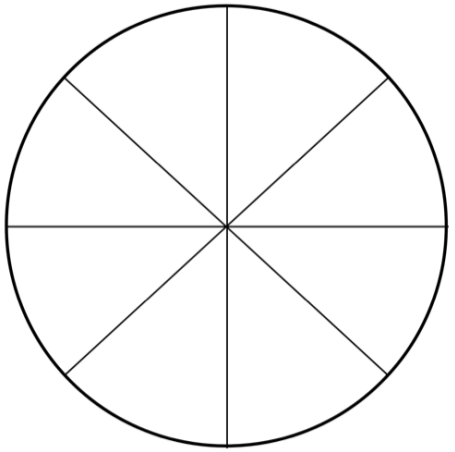


Figure 61: The Cartwheel

Figure 62: Ashoka Stambha

Some examples can be cyclic time, opposites coming together and earth-sky unison. The third layer can be the deeper interconnected meaning of the whole artefact itself, while being a part of the larger context. For example, a cartwheel motif on the base of a temple could be a metaphor for an element of a story that the whole temple is trying to convey.

Mappings

A widely practised way to metaphorise abstract concepts is to map them to different well-known elements. These elements could be parts of the human body, elements of nature, and so on. Mapping allows creation of a design grammar that can be used by artists throughout space

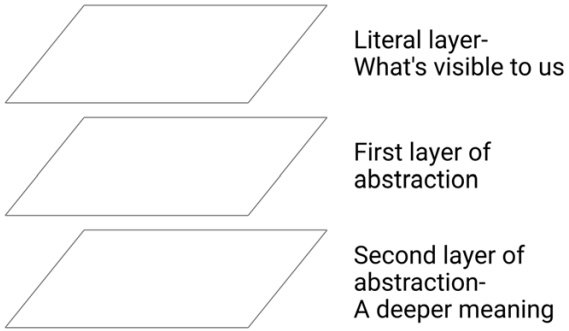


Figure 63: Layers of Abstraction

and time, and makes it easier for the viewer to understand and relate to the product.

Mapping to Elements of Nature

Elements of nature like Fire and Water are universally understood, hence it is easy to assign complex abstract concepts to them for better representation. Since all these elements are vital to supporting life, and have well-defined characteristics, the mapping is done in such a way that the said characteristic compliments the abstract idea. Different elements of nature- Earth, Water, Fire, Wind and Space- hold special significance in Indian arts and architecture, and have been mapped and represented in different ways.

Different elements of nature can be assigned to represent different abstract ideas based on their physical characteristics, thus being metaphors for those ideas. Earth, or the ground, is referred to calm, rigidity and sta-

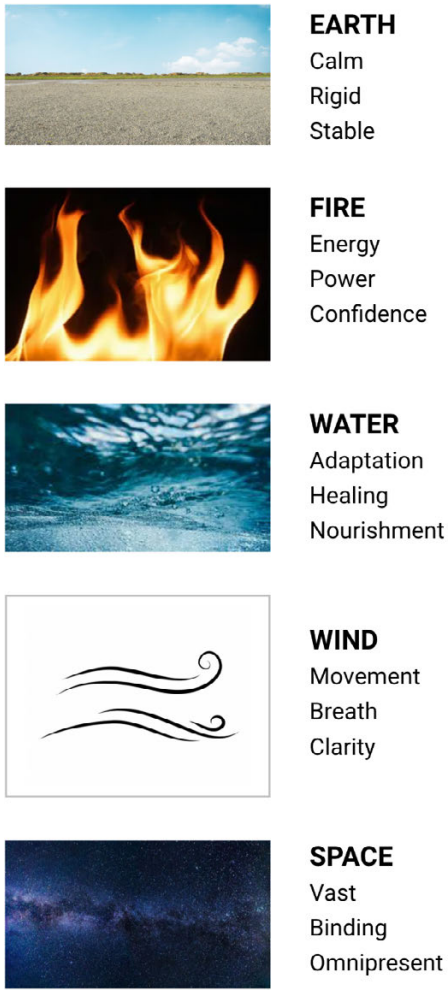


Figure 64: Five Elements of Nature

Figure 65: Stars in Islam as a metaphor to represent abstract concepts

bility, with the power to hold something. Water represents adaptation, healing and nourishment, as it leads life to food. Fire signifies energy, power and confidence, and has the ability to transform one form of matter to another. Air, or Wind, signifies movement, breath, clear communication and self expression. Space acts as the omnipresent binding element where all other elements originate and return to. Space can also refer to the sky, with its inspiring vastness (see Figure 64).

The Yajna, as discussed above, itself refers to many elements based on their characteristics. The two most important elements of the ritual, water and fire, are significant, with a third element, the Earth, being the base itself for holding the ritual. Water is equated to food, since when water comes, there is plentiful food in this world. Fire is seen as the creative force full of energy which determines movement in the universe. It awakens matter and can be transformed into diverse forms of nature, since it doesn't have any particular shape.

Arts and architecture across cultures refer to these elements of nature, taking conceptual inspiration as well as displaying them directly. Islam forbids direct repre-

sentation of animate beings and objects, thus, Islamic architecture is embellished with intricate patterns and shapes that act as the visual symbols to represent the abstract concepts. The artists focuses on the delicate shapes and geometries found in nature, and imitates these shapes to create beautiful patterns. For instance, the motifs and patterns of stars, as shown in figure 65 are found on almost all Islamic arts and architecture. Stars are a metaphor for light of the heaven, which guides the thoughts and actions of the follower, along with providing directions at night. In a similar way, the symbol of Moon also emerged, as a metaphor for providing light, guidance and directions.

Indian literature, which places great emphasis on realising and controlling human senses, has mapped these five elements of nature to the five senses of sound, touch, sight, taste and smell. This mapping has been used in several art and architecture forms. Smell has been associated with earth, taste with water, shapes and form (as conceived by sight) with fire, touch with air, and sound with space.

Mapping to the Human Body

In some cultures, different parts of the human body have been mapped to different elements of the universe, like Earth, Fire, Water and so on, with special significance given to the navel, which is considered the centre of the universe. There is a deep interconnectedness between the elements of nature, parts of the human body used as metaphors and their characteristics used to represent abstract concepts, and it is most apparent in temple architecture. All these mappings aren't just standalone metaphors, they indeed have connections and acquire significance only when placed in the special relationship with some other part.

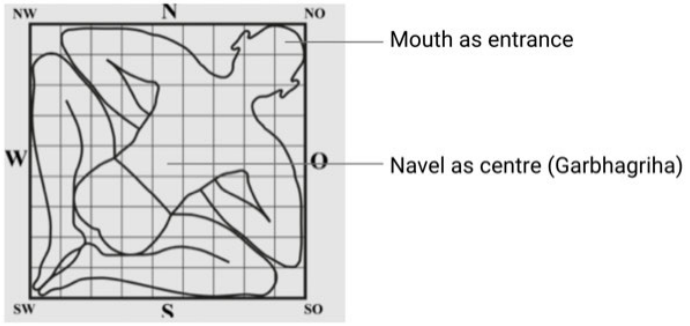


Figure 66: Mapping of human body a Square Temple Plan

The architecture of Hindu temples follows an imagery of Man called the Vastupurusa. If one analyses the plan of the temple, as in, the top-down view, The door of the temple is the mouth of the Man, signifying the entrance. The platform terminating the trunk of the superstructure becomes the shoulders. The projections on both sides become the arms. The lowermost mouldings at the periphery of the temple become the feet. In a general square plan of the temple, the centre, or the Garbhagriha, which is the most important part of the temple, corresponds to the centre of the human body- the navel. The Garbhagriha is surrounded by thick walls on which

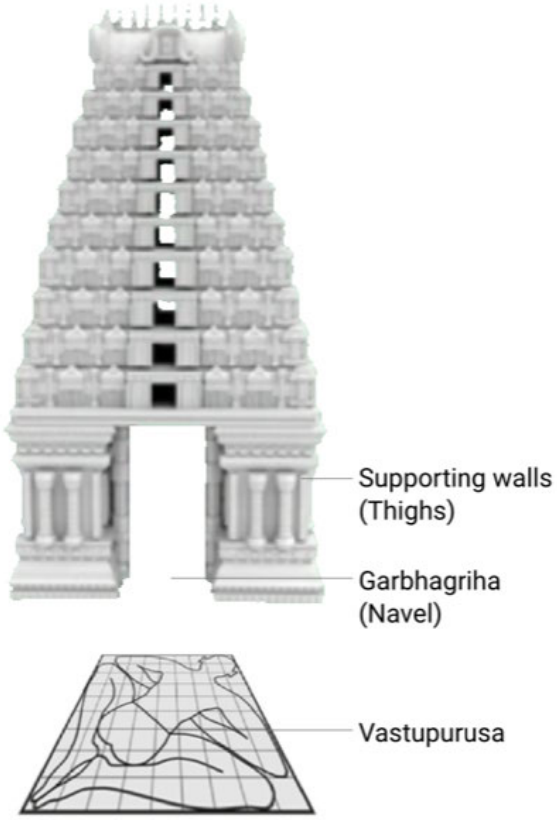


Figure 67: Mapping in a Square Temple Plan

rests the high superstructure. These walls correspond to the thighs of the Man body, as a metaphor for providing support (see Figure 67). When viewed in a simplified fashion for a basic square plan, one realises that the image here is the Man body almost sitting on earth, contained in a square, as shown in figure 66.

This mapping is not just prevalent in the plan, but also in the elevation, which is the view of the temple from the side. In a side view, the head becomes the sky, the navel the Garbhagriha and the lowermost mouldings the feet. From the central square where the Garbhagriha is rises the central axis upwards, reaching the highest point of the temple. This corresponds to the head of the Man body, with the rest of the temple corresponding to the body. The Garbhagriha is always the central navel, regardless of the direction- horizontal or vertical, in which the temple is seen. There are two simultaneous images- one of a sitting man beginning with the navel which is the Garbhagriha (see Figure 68), which corresponds to the elevation, and the other of the horizontal man where the outermost portions become the feet and lead to the navel in the centre (see Figure 69), which corresponds to the plan.

The mapping is not to be taken literally but is important, as it gives a frame of reference and measure of construction. For instance, the smaller units of measurement are equal to the breadth of one finger. The symbolism is relating the aspects of the structural organism, which is the body of a human, to the macrocosm, or the whole

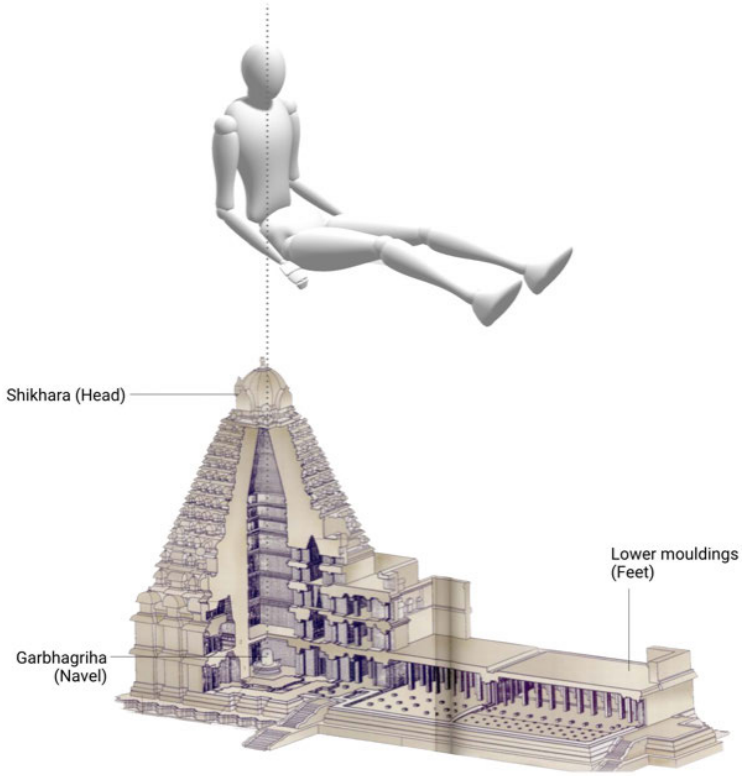


Figure 68: Temple mapping with a sitting Man

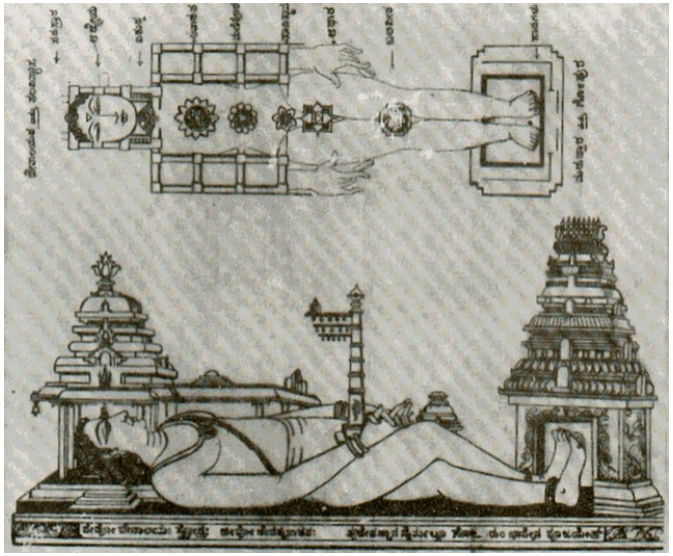


Figure 69: Mapping of human body in Temple architecture

universe.

Visual Design Grammar arising from the Mappings
Mapping and metaphorising elements of design helps understand relationships between them. These relationships can be quantified and converted into design principles, and can be used directly. Some of these relationships can be hierarchies of elements, ratios of sizes, element shapes, etc. Hierarchy refers to importance given to design elements. An element higher up in the hierarchy needs to be highlighted more, either visually or my other methods, depending on the medium. These interrelationships between elements needs to be properly understood before visually displaying them.

Giving Form to the Abstract

Once the design grammar constituting the metaphors and mappings arising from the initial abstract idea is in place, the artist/designer needs to start giving the idea a visual form. The metaphors assigned to each element dictate the importance/hierarchies between them, along with other relationships. There can be several ways to visually show these relationships.

Visually Representing Element Relationships
Relationships between elements can be their hierarchies, proportions, spatial positions, and so on.

In temple architecture, elements are given a hierarchical importance based on their mappings. Garbhagriha, mapped to the navel, is the most important part of the temple, thus its spatial position is in the centre. Other aspects, like positions and sizes also depend on element hierarchies arising from the mappings. Considering the bounding shape, the square as a fundamental shape has given rise to a square plan for multiple temples over centuries. When one considers other arts like sculpture, an analysis of the compositional structure of most 2D sculptures, mostly on temple walls, show that effort is made to highlight the navel of the human figures, mostly by placing it in the centre of the composition, or in one of the focal points.

Element hierarchies can also be visually depicted using ways other than spatial placement. When one looks at ancient manuscripts (Figure 70), it is noticeable how different techniques have been used to represent different families of text. White spaces have been used as attention directing devices to highlight certain chunks of text that seemingly hold more importance. There is use of varying letterforms and font weights, ranging from thin to bold to emphasise certain text. Of importance from a graphic design perspective are the many treatments for borders and border decorations to establish areas of importance. Thus, hierarchy isn't just represented by attributes of the element itself, but also by attributes of the space surrounding it.

Golden ratio is an important principle to consider when analysing visual arts and architecture, and its presence has been prevalent throughout the designs of temples and mosques. Golden ratio is best approximated by dividing any two consecutive numbers in the Fibonacci se-

Figure 70: Ancient Manuscripts

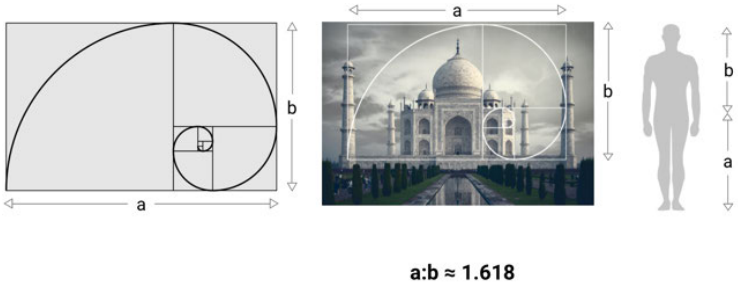


Figure 71: Golden Ratio in Taj Mahal

quence (a sequence where a number is equal to the sum of the previous two numbers), and is considered to be one of the most beautiful numbers in the universe, with a value lying close to 1.618. It is almost equal to the ratio of the length between the top of the head to the navel, and the navel to the feet. Golden ratio is used throughout Hindu and Islamic arts, ranging from governing proportions of plans of religious buildings to the beautiful geometric patterns and sculptures. Figure 71 shows the front view of the Taj Mahal, and how the ratio of its width to its height follows the golden ratio.

Apart from 1.618, another important ratio in ancient India has been 5:4. This ratio dictates the length to be a quarter longer than the breadth. First witnessed in the town planning in the Harappan cities in the third millennium BC, and finding concrete expression in the excavations in the Gujarat city of Dholavira (see Figure 72), the golden proportion re-emerges almost a thousand years later in the ancient texts, where the ratio of 5:4 is used to

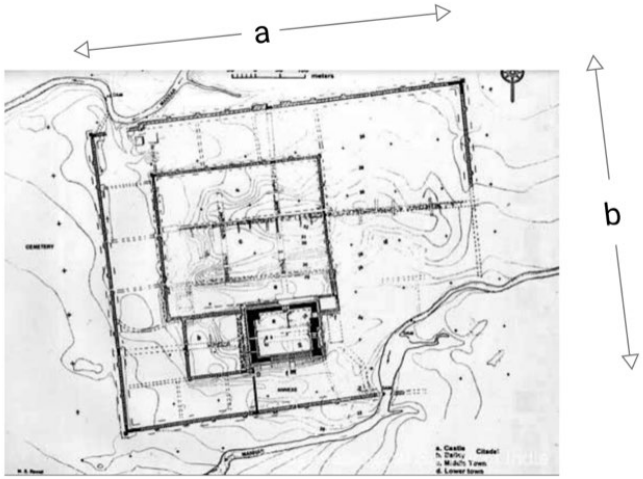


Figure 72: Golden Ratio in the Plan of Dholavira, Harappa

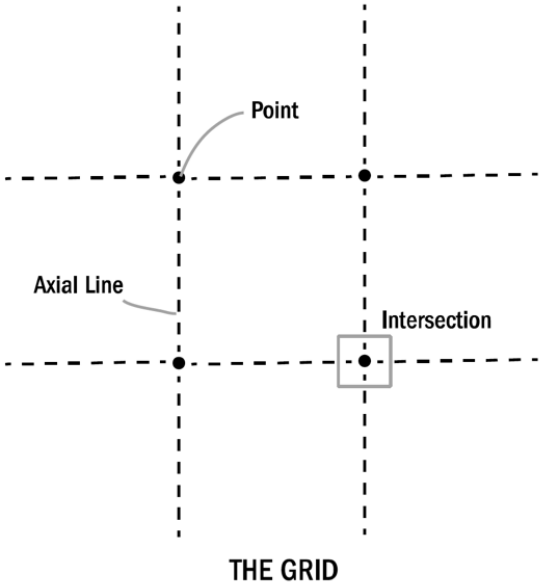


Figure 73: Elements of a Grid

create fire-altars for vedic ceremonies.

Grids and Compositions

Once the hierarchy and basic positioning of the design elements are in place, they need to be composed and organised. The grid system is a design method that helps visually compose these elements based on their attributes like hierarchical order, and helps lay them out.

Element A	Element B	Element C
Element D	Element E	Element F
Element G	Element H	Element I

Figure 74: A simple rectangular grid with design elements

Types and Elements of a Grid System
A grid consists of three elements- the Point, the Axial line, and the Mode of intersection (Figure 73). The shape and density of axial lines and the number of intersection points determine the complexity of the grid.

Classification of grids could be done based on their structural systems, as coordinate based, intersection based, module based, or line based, as shown in figure 75. Usually, these grid systems are found in pairs to form Point based and Field based systems, as shown in figure 76. Point based systems use a combination of Coordinate and intersection based sub-forms, while Field based systems use Module and Line based sub-forms.

In its most basic form, a grid system can be thought of as an array of squares that act as placeholders for laying out various design elements. Although a simple grid as shown in figure 74 may dictate similar sizes for all elements, hierarchy could still be dependent on the element position. Centrally placed elements would be considered more important.

Figure 77, based on the ancient Talamana system, shows a simple but well designed grid that is used as a hierarchical measurement system, and it ensures correct presentation of important components. It helps communicate large amounts of information according to its hierarchy and order.

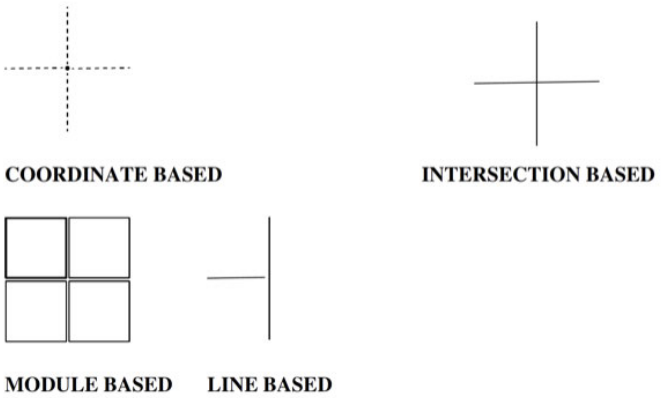


Figure 75: Types of Grid Systems

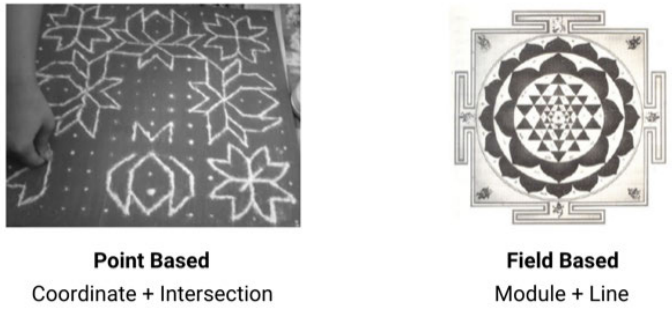


Figure 76: Pairs of Grid Systems

Figure 77: The Talamana System

Complex Grids

Unlike the static grids used in Western designs, Indian grids are more fluid, responsible for everything from the layout of temples to manuscripts to sari designs. Indian culture is rich in examples of creative and flexible uses of the grid, be it in the Yajna rituals, or the Navgraha grid depicting the nine planets (Figure 78). Grids in Indian arts are not just a tool for enhancement of design, they themselves hold depth and meaning derived from the abstract ideas and stories. Traditional India shows that grids need not be strict and rectangular like the present, especially when one looks at examples of grids in the past, like Chakravyuha (Figure 79), which were modular and fluid, and served their purpose.

Figure 78: Navgraha grid and its meaning

Figure 79: Chakravyuha grid and its use in Mahabharata

Applications of Grids

Different types of grids were used in design and construction of all kinds of designs, ranging from arts to architecture. For better understanding, we can have a brief look at the grids used in the following:

1. Yantra
2. Floor Graphics
3. Textile
4. Architecture
5. Sculpture

Yantra Grids

Yantras are geometrical diagrams consisting of shapes such as the triangle, circle and square in numerous combinations and permutations that have symbolic significance in meditation and ritual worship. Although mostly associated with metaphysical and astrological connections, Yantras use elaborate grid systems to create different kinds of complex geometries. Yantras can be of different types, some of the most important being Ganesha, Durga, Sun and Moon durga, as can be seen in Figure 82. The basic elements of the Yantra are the Bindu (The central dot with maximum importance) and the shapes like circle, triangle, square and the lines.

Grids in Floor Graphics

Floor graphics are patterns found in various architectural structures like temples, mosques and churches.

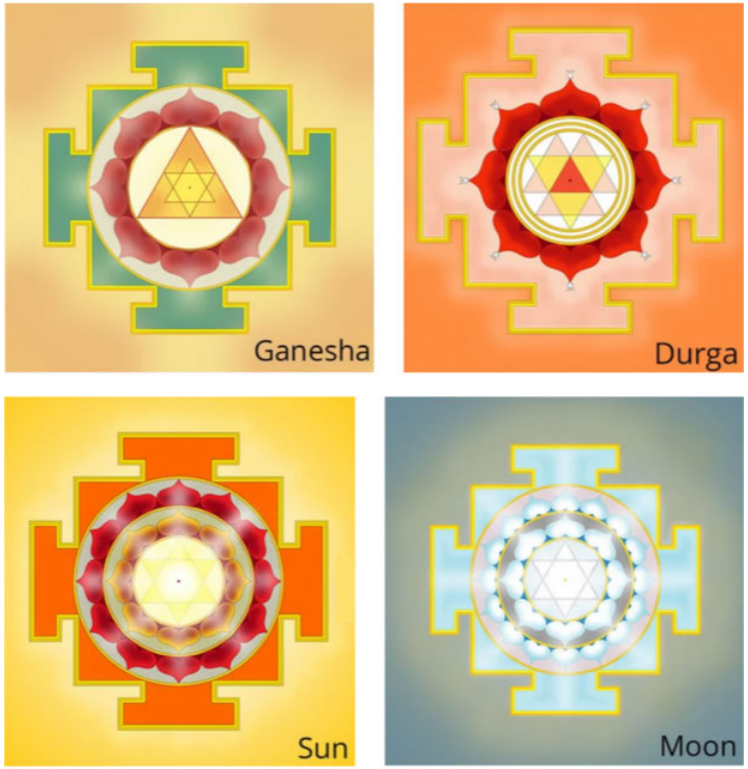


Figure 80: Types of Yantras

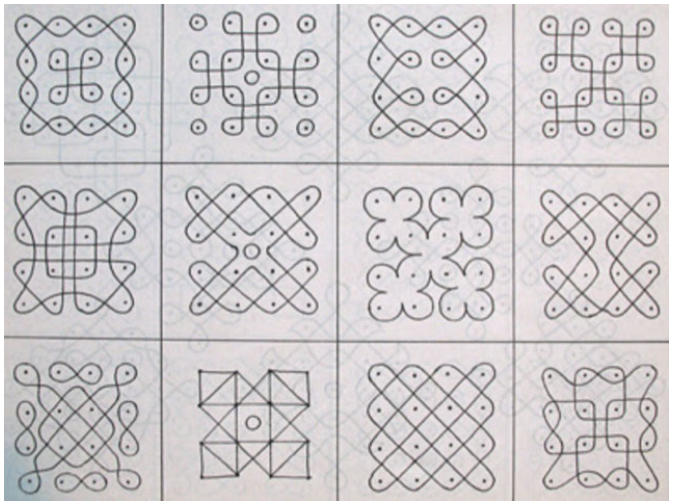


Figure 81: Rangoli Grids

Floor graphics like rangolis are made by the process of drawing on or around a system of dots using straight or curved lines, as can be seen in Figure 81. Rangolis themselves also have many symbols that act as metaphors for representing different meanings. Figure **??** shows a rangoli design with feet and flowers. The feet act as a metaphor for the path for the deity to enter the house. The flowers represent the fertility of the land.

Grids in Textile

Prints on clothing showcase highly elaborate patterns that emerge from following a set of fixed rules. Figure 83 shows one such example of a print known as Ajrak print, which uses shapes like hexagons, rectangles and circles to create motifs. The remaining spaces are filled with

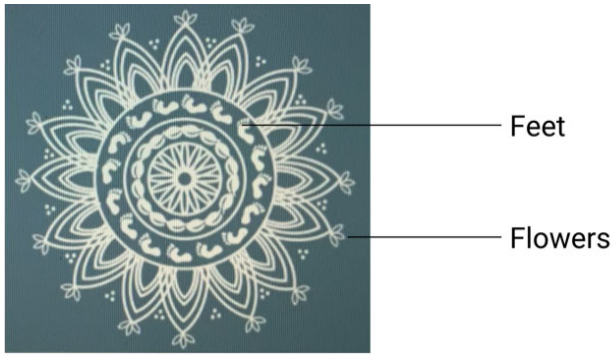


Figure 82: Rangoli

flowers and leaves, as a way of representing natural elements.

Grids in Architecture
Mohenjo-daro and Harappa, major cities of the Indus Valley Civilization, were built with blocks divided by a rectangular grid of straight streets, running north–south and east–west, as shown in figure 84. Each block was subdivided by small lanes.

When one looks at the plan for a traditional Indian theater, the different types of grids can be seen, as shown in figure 85. The shape of the theater can be rectangular, square or triangular, and these could be further subdivided into large, medium or small spaces, giving rise to multiple configurations. The size and basic shapes of these grid modules were dependent on the abstract idea the design was trying to convey, using its different elements.

Figure 83: Ajrak print on Textile

Figure 84: Rectangular Grids of Mohenjodaro

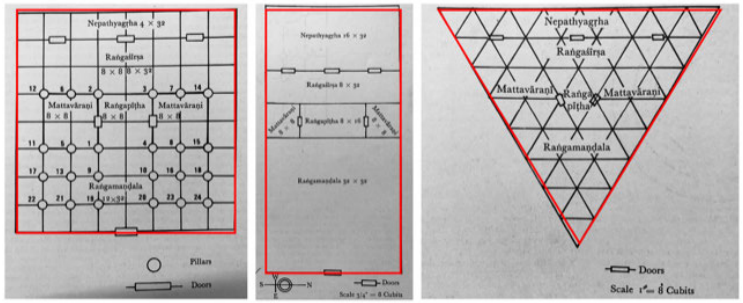


Figure 85: Different grids in theater plans

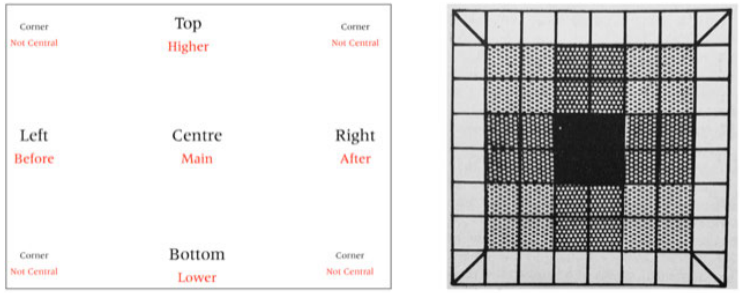


Figure 86: Talamana Grid as shown against a simple square temple plan

An examination of temple plans shows that the principle of multiplying a spatial unit horizontally and vertically was uniformly followed, with the unit being mostly square shaped (see figure 86). When seen against the Talamana grid, it is apparent how the element hierarchy works in the grid according to positions. Central position is the most important, which is given to the Garbhagriha. When one looks at more complex temple architecture, the ground plan can be broken up into geometrical motifs of the square and the circle, as shown in figure 87. The resulting geometry provides an elaborate grid system which conforms to the metaphors and mappings discussed above.

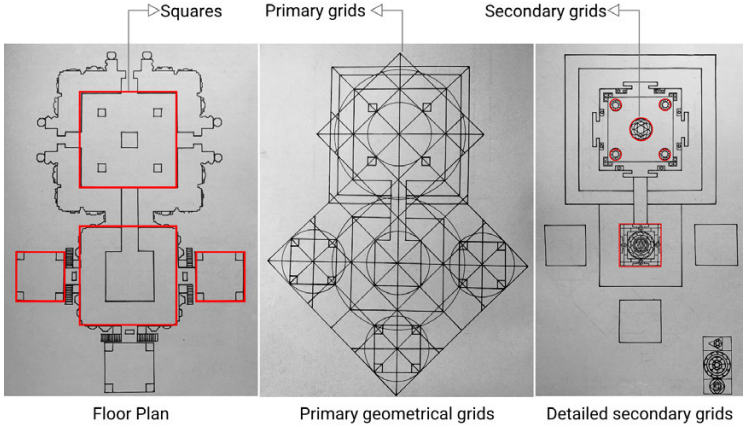


Figure 87: Primary and secondary grids in a temple plan

Temples usually follow a square grid which is subdivided into different number of squares. For example, figure 88 shows the grid of Kandariya Mahadev Temple, Khajuraho. figure 88 (a) shows the picture of the actual temple, figure 88 (b) shows its floor plan, and figure 88 (c)

shows its grid. Counting the number of squares shows that the temple was built following a 16 square grid. Similarly, different temples have grids with different number of squares based on their size.

Islamic architecture, as seen in the previous chapter, extensively uses the star shape. The stars can be of different types, resulting from the various types of grids they arise from. The stars arise from dividing a circle into different number of segments. As can be seen in figure 89, there can be 4 point, 6 point, 8 point or 10 point stars based on the number of divisions of the circular grid. These stars are then tessellated to create large patterns by copying them over and over next to each other, which can be seen on places like roof patterns, floor patterns and jalis (figure 90). These grids clearly show the significance of the circular shape in Islamic geometry, a symbol of unity and diversity in nature.

In Buddhist architecture, inspiration is drawn from the five elements of nature, called the Chakras (see figure 91-a). They are Space, Air, Fire, Water and Earth, with each holding its own meaning. These elements are represented by different geometrical shapes, which also become the guiding grids for the design of Buddhist Stupas, as can be seen in figure 91 (b) and (c). These shapes can have varying sizes across different stupa designs, but the basic structure and order remains constant.

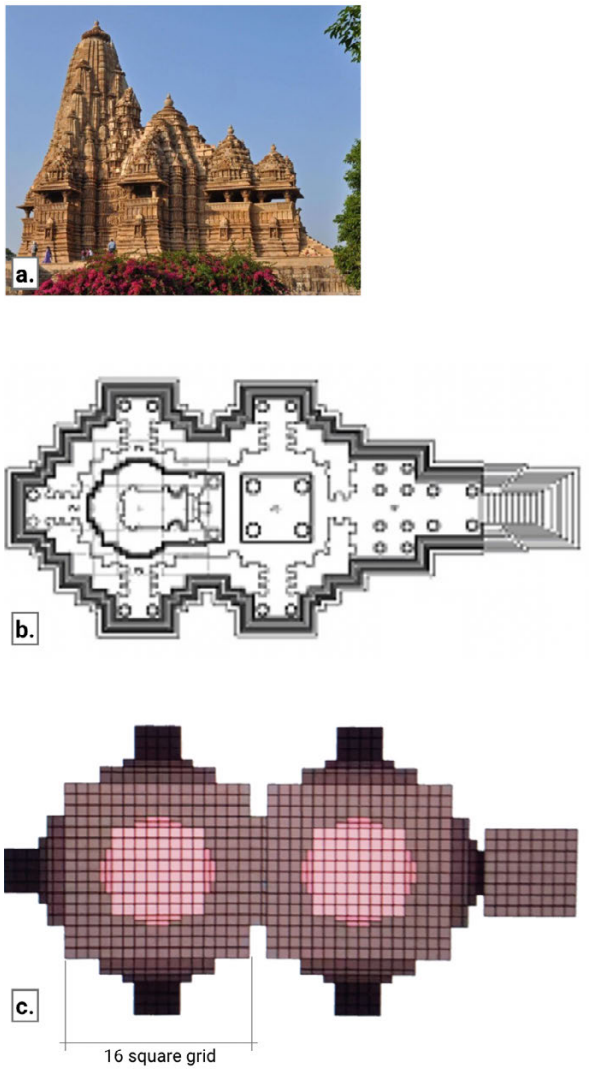


Figure 88: Grids of Kandariya Mahadev Temple, Khajuraho

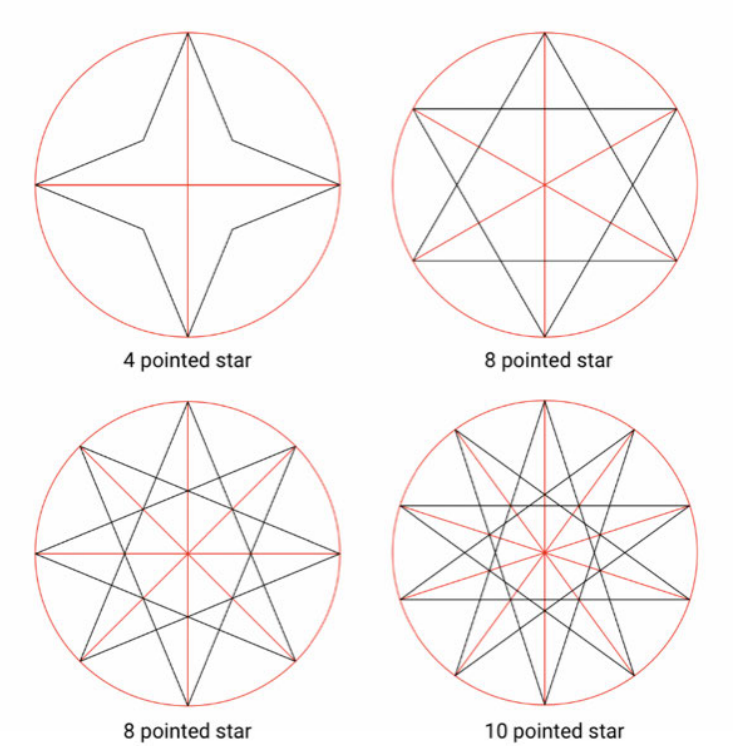
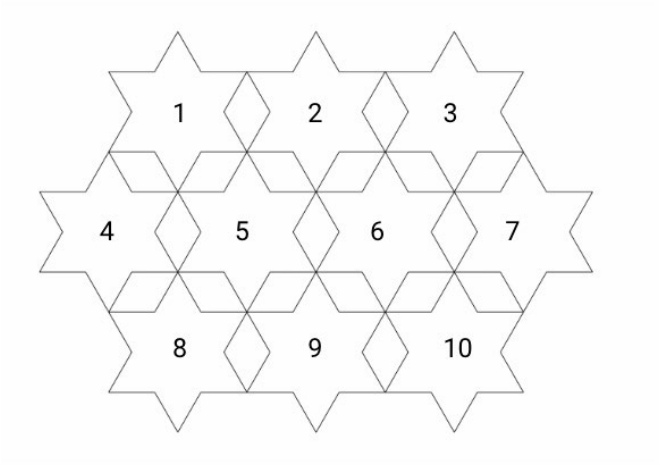


Figure 89: Different point stars in Islamic architecture



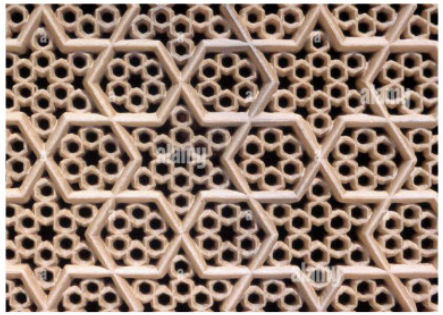


Figure 90: Tessellation of stars to create Jali patterns

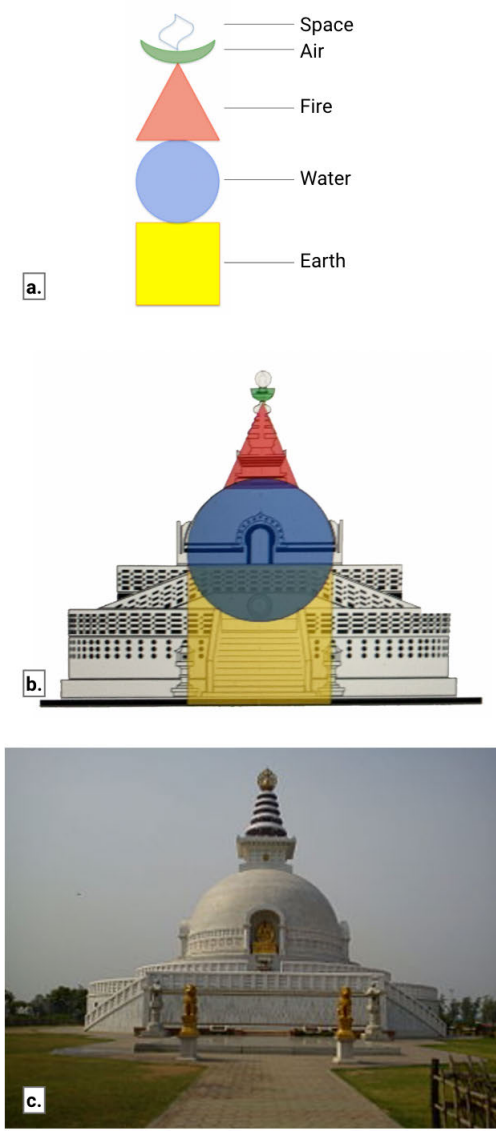


Figure 91: 5 Chakras of a Buddhist Stupa

Grids in Sculptures and 2D Compositions

Ancient books, manuscripts, sculptures, motifs on building walls- all follow the grid system to display different elements of design. Figure 92 shows an example of a Jain manuscript, and how the layout is composed. The paper is divided into five horizontal units. The text is arranged in two columns, which appear rectangular in shape due to the width of the paper. The paper proportion is roughly 4:1 as corresponding to the width and height respectively. The text block also responds to this ratio. The borders define the columns within the page layout, highlighted by red lines with black borders. The third and the fourth manuscripts show examples where a full height image takes up a column, occupying the top and bottom margins.

The Mahalakshmi Figure from Elura Cave XIV is an excellent example of how motifs on temple walls followed the grid system to bring forward theories of visual composition like balance and focus, while remaining true to the metaphors, storytelling and the abstract idea. The image shows the goddess sitting on a lotus throne, flanked by four deva. The symbolism is the connection of the bottom water world, the central earth element and the top celestial world, or the sky. A geometrical analysis of the composition reveals that it is set in a circle, with the devi's navel as the centre. The principle and the horizontal verticals(the diameters) can be deciphered as passing through elements of interest, or the focal points (see Figure 93). The composition gives us a grid that resem-

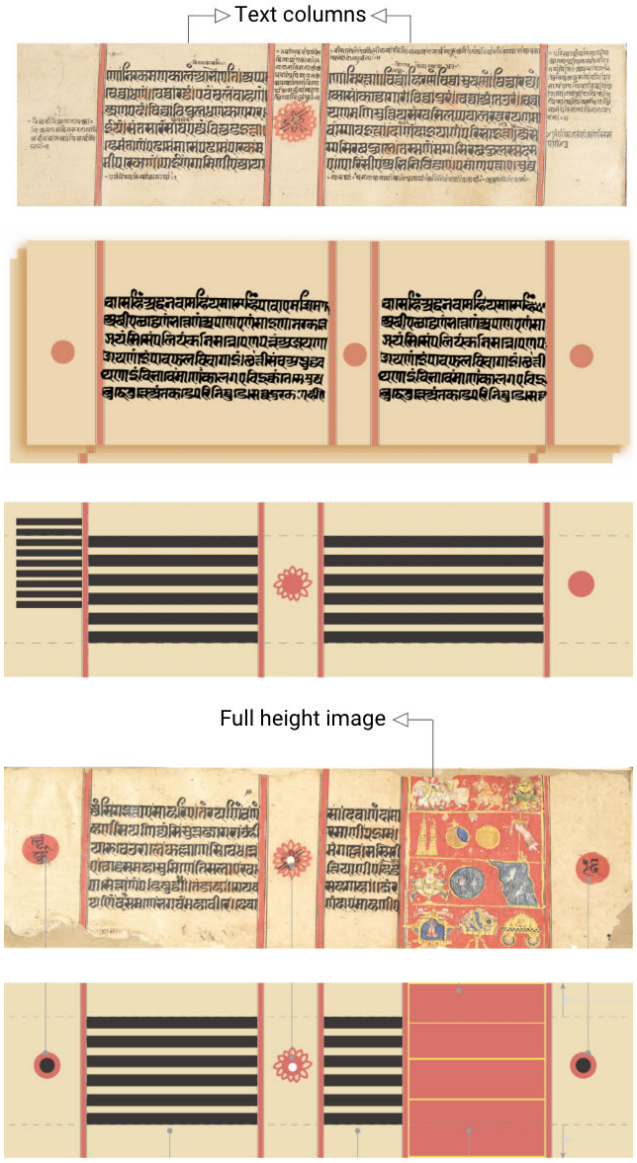


Figure 92: Layout of Jain Manuscripts

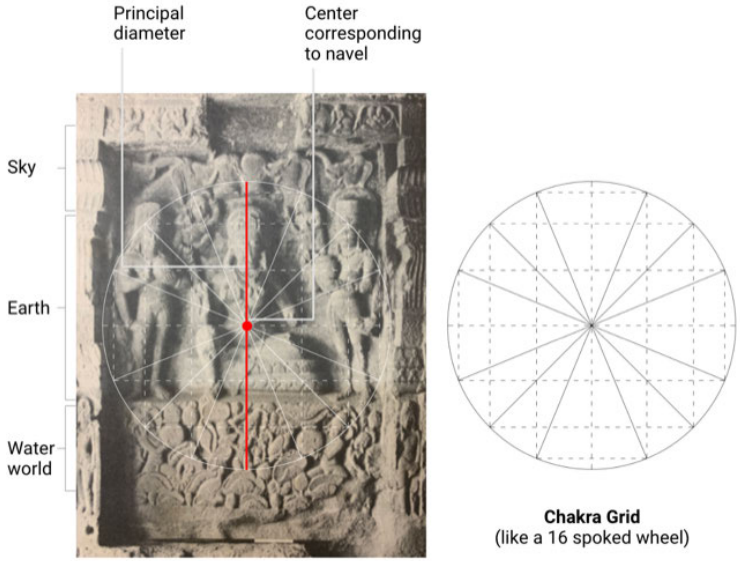


Figure 93: Mahalakshmi Figure and its Grids

Figure 94: Mahalakshmi Figure and its Abstraction

bles a 16 spoked wheel with the navel as the hub, or the centre of the circle. Another layer of oblique chords give us triangles in the circle, which correspond to the movement of the devas. Using the circular grid system to set the composition up makes it look visually balanced, with an equal distribution of elements and action across the canvas. Figure 94 shows the figure of the Devi as a system of abstracted curves, which makes it easier to understand the different poses against different types of background grids.

Grids in Multiple Dimensions
When considering temple architecture, grids don't just dictate the floor plan, but also dictate composition of elements in the vertical space, or the elevation (side view). As can be seen in figure 95 which shows the Kardmeshwar Temple as an example, basic rectangular grids can lead to highly geometric and ordered structures.

Human Anatomy and Movements
Since design is in most cases meant to be used by humans, a basic understanding of the human body proportions, movements and constraints is essential to create truly usable designs. This study of human body measurements is called anthropometry. Although the term is new, classical India employed various grids and techniques that made it easier to understand human anatomy.

Classical arts refer to the Sama, a basic posture in which the man body is shown erect with arms extended. Primary and secondary movements, and various other posi-

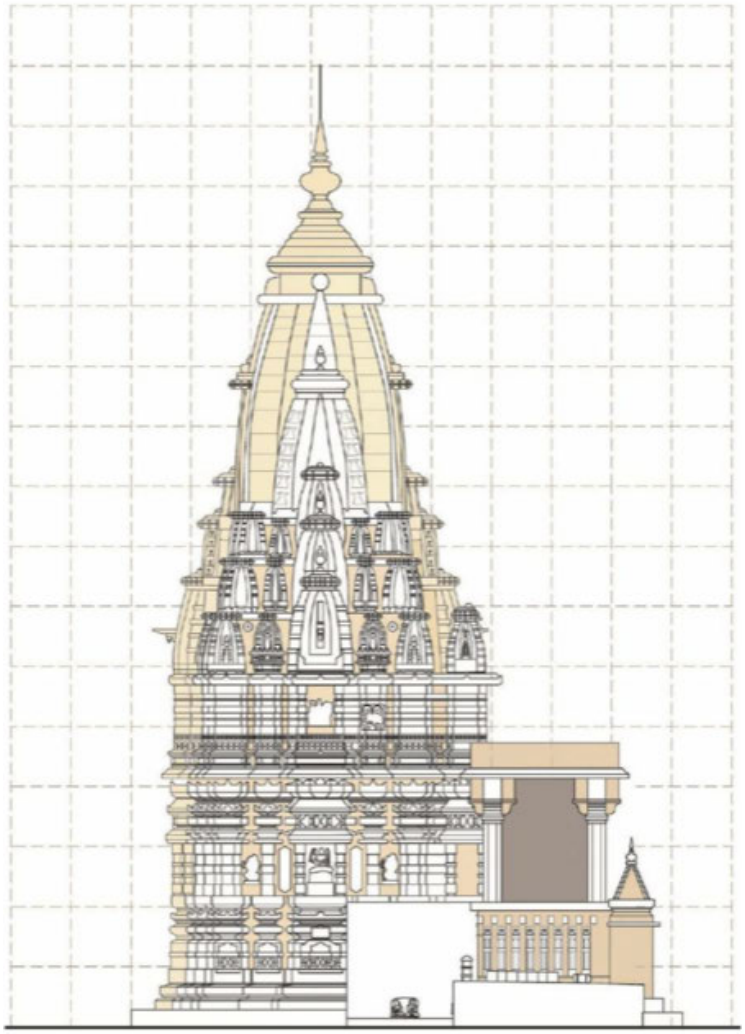


Figure 95: Grids in Elevation of Kardmeshwar Temple

tions like sitting, standing and reclining commence from this position of stillness. The imagery of a chakra is used (see Figure 96), the centre of which corresponds to the navel, similar to the one that was used in the Mahalakshmi Figure. The vertical median, which acts as a metaphor for connecting the sky and the earth, becomes the spinal cord. This circular grid, with its centre and diameters, acts as the cage of the body guiding the movement patterns within the circumscribed space of the circle.

The bounding circle of the Chakra grid is usually placed in a square, and sometimes a rectangle, as can be seen in many Indian sculptures. The circle is sectioned off by 4, 6, 8 or 12 diameters depending on the complexity of the scene. The most important diameter is the vertical one, and the second most important is the horizontal one, both passing through the navel.

Another way of dividing the circle in the Chakra grid, apart from diameters, is by making cords from the ends of those diameters (see Figure 97). Here, the division of the circle into the horizontal and vertical, as per the diameters, refers to the space division. The oblique chords refer to the time division. This is because the framework of vertical and horizontal is static and refers to the structural armature of all positions, whereas the oblique chords correspond to the movements of the body parts through time.

The human body can be further abstracted into a system of shapes and lines, an example of which can be seen in

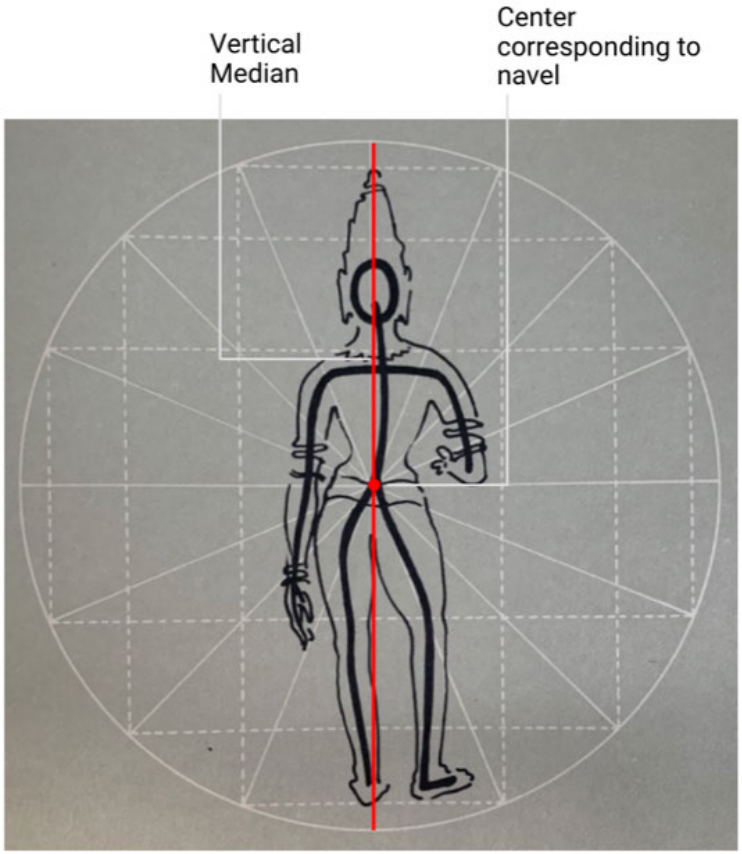


Figure 96: Chakra Grid for the Human Body

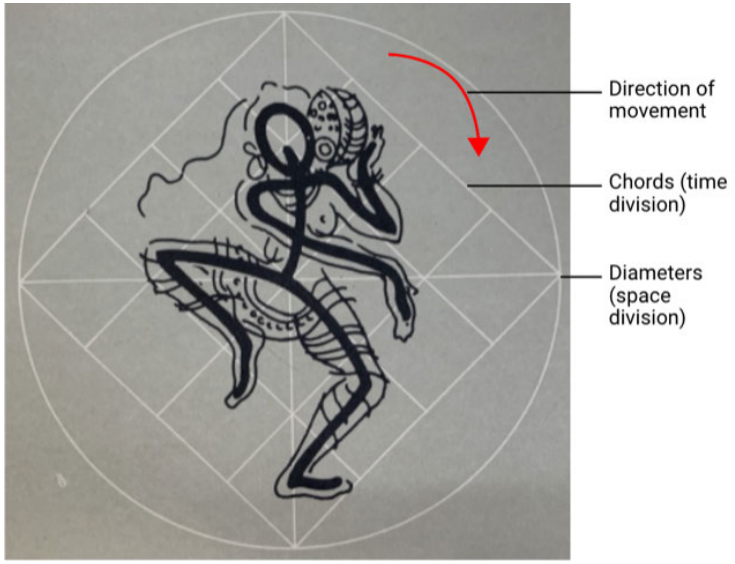


Figure 97: Chords in the Chakra Grid

Figure 98. Such abstraction helps in easily creating different poses while keeping all the proportions and movement constraints natural and not having to focus on the details.

Although the Chakra grid helps quickly and accurately construct different poses and movements of the human body, it also helps easily assign different emotions to those poses. For example, the vertical diameter (median) helps assign a balance to the pose. When the weight of the body is distributed equally on either side of the median, a sense of calm and poise is evoked. When the weight is unequally distributed, a sense of disturbance or imbalance is evoked. The sense of how the weight is distributed gives rise to different emotions the sculpture expresses. Thus, the sculptor doesn't need to rely on surface treatment or muscular tension to depict states of mood. The pose itself can get the job done. The positions of various body parts with respect to the centre, principal diameters, oblique diameters and chords within the circle determine the emotion conveyed. For example, Figure 99 shows Nataraja with uplifted legs and crossing arms which lead to intersecting lines. This gives the image a sense of dynamism.

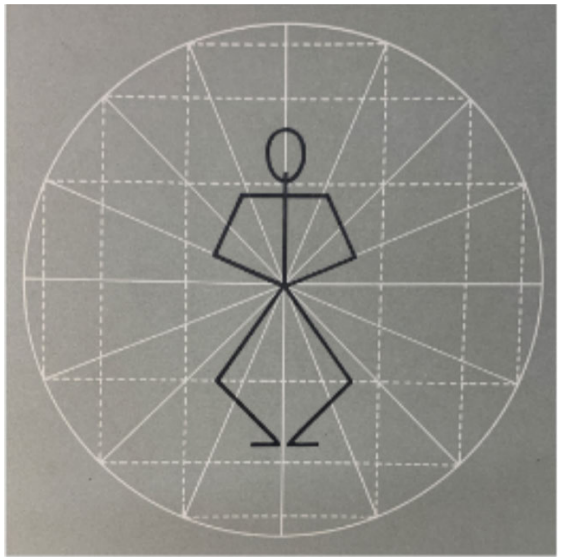


Figure 98: Abstraction of Human Figure into Basic Shapes

Detailing the Form

Once the abstract ideas are given a basic form, the artist moves on to the last step of the classical design process- enhancing the form by detailing it and adding attributes. Procedures followed for detailing allow full scope for a variety of creative expressions to emerge even when the

Figure 99: Nataraja Figure with a sense of Dynamism

Figure 100: Indian Temples with Unique Designs

earlier steps in the design process might appear rigid. This leads to a creation of a variety of unique and intriguing designs that don't look the same, even when they share the essence. A look at Indian temple architecture (some examples shown in Figure 100) clearly shows that all temples have a unique design and details, even though the basic abstract concepts, mappings and high level metaphors are constant. This is a crucial step owing to the need of constant newness of the contemporary world, where there is a constant demand for something new and appealing.

Ways of Detailing Form

There are various procedures and techniques for detailing forms depending on the type of form, inspired from artefacts ranging from architecture to manuscripts. These techniques involved ornamentation, procedures like parametrization, shape and form transitions to get complexity, and so on.

A look back at Figure 70 shows various embellishments used to decorate the text in Jain manuscripts. There are Gold borders that serve to highlight chunks of text. On some pages, these borders are filled with intricate designs of flowers that increase the aesthetic appeal, along with having a symbolic significance. Figure 101 shows how Jain manuscripts called the Kalpasutra use a variety of colours, intricate border ornamentation and hand made patterns to create visually appealing designs. Similar ornamentation can also be seen in the heavily decorated Mughal era writings as shown in Figure 102. A variety of handmade patterns inspired from elements of nature like plants and animals have been used to decorate the text, as can be seen on the margins. The text itself has been given different colours, along with a gold background.

A look at examples from classical Indian architecture sheds light on many ornamentation techniques. Mughal architecture like mosques and mausoleums contain embellishments with a heavy inspiration from elements of nature and geometry, as can be seen in Figure 103 which shows different details on the Taj Mahal. Figure 103 (a)

Figure 101: Ornamentation in Jain Kalpasutra

Figure 102: Ornamentation in Mughal Writings

shows a hexagonal Jali design, with small Jalis made of different shapes on top. Figure 103 (b) shows surface embossments inspired from plants and flowers. Figure 103 (c) shows religious text written around the opening, where the text itself is the ornamentation. All details are meaningful, and have a purpose of communicating some abstract idea. No detail is meant to be standalone, just for the purpose of filling up space.

Similarly, Hindu architecture also contains decorative motifs on temple facades, some examples of which can be seen in Figure 104. These motifs physically as well as conceptually are part of the structure as a whole, and complement the story being told.

Fractals and Parametrization

A way of detailing form that has been heavily employed in classical Indian arts, and is apparent from structures

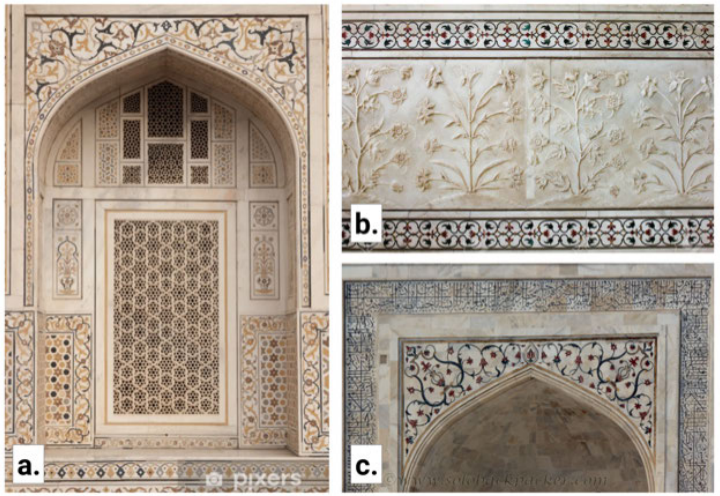


Figure 103: Detailing in Taj Mahal

like Hindu temples, is by using fractals. Fractals, in simple terms, are self-similar patterns that are invariant to scaling. This means that they look the same no matter how much one zooms in. They are made by following simple iterative steps over time, which results in extremely rich, unique and non-repetitive forms which could not have been visualised by intuitive means. Nature is full of examples of repetitive patterns that can be classified as fractals, from which Indian arts and architecture are heavily inspired.

Natural objects around us are filled with fractal patterns at multiple levels, ranging from flowers, trees and plants to even coastlines and mountains. Figure 105 (a) shows the branching pattern of a tree. The branching pattern

Figure 104: Motifs on Hindu Temples

as a whole is self similar- it repeats until the branches become smaller and smaller, and would look the same when one zooms in. Similar branching can also be seen in lightning strikes and earthquakes. The branching in itself is a recursive process which results in unique non-repetitive shapes. Figure 105 (b) shows fractals in a flower. Here, the pattern gets increasingly smaller as it repeats towards the center. Since even a small change at this scale can create different patterns, each flower ends up being unique. These changes, or variations, are referred to as parametric variations, and the whole process of making fractals is called parametrization. Fractals need not be always symmetrical, as can be seen in a shoreline in Figure 105 (c). A shoreline, especially a rocky one, exhibits fractal behaviour as it is formed due to natural processes of erosion over a long period of time. It gets more detailed as one zooms in, and this behaviour needs to be kept in mind when one is measuring the length of the coast.

Indian arts, especially architecture, heavily employ fractals to generate detailed and unique forms with constant variations without exact repetition, much like nature. Hindu temples employ self replication as a method of fractal generation, in which shapes contain smaller replicas of themselves at various scales, as can be seen in Figure 106. Here, the recursive process becomes addition of these self similar shapes until the shapes keep getting smaller and smaller, to achieve a complex end result.

Simple shapes in themselves can be modified or filled

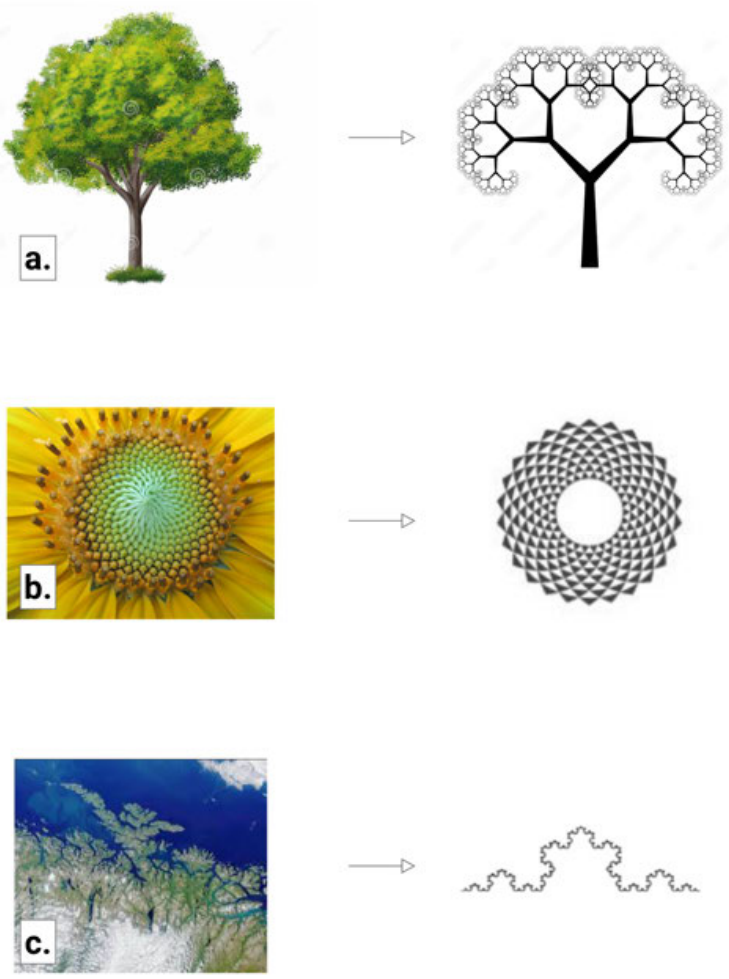


Figure 105: Fractals in Nature

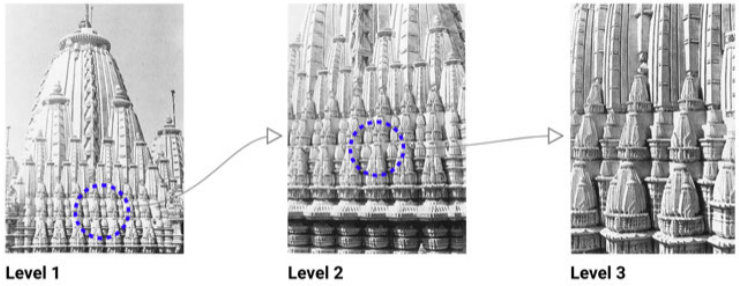


Figure 106: Self replication for Fractal generation in Temples

up using simple recursive processes to achieve complexity of growth, as can be seen in Figure 108. This growth can happen on the edges, similar to coastlines, or it can happen within the shape to increase detail density. In all kinds of fractal creation, there is a rule which defines what recursive procedure to follow. For example, Figure 107 shows two different fractal patterns made using a scaled self-similar replication of a circular shape. In both the cases, smaller versions of the same circle are added over and over. However, there is a difference in the rule followed to create the fractal, leading to results which are visually vastly different. Similar recursive processes are applied to architectural forms, like temples to create more and more complex variations, as can be seen in Figure 109. The first image shows the detailing done on temple elevations. On the left is the simple form the architect starts with, on which the big details are added. Then, following recursive process, smaller versions of these shapes are added again and again to achieve a complex and detailed elevation, as seen

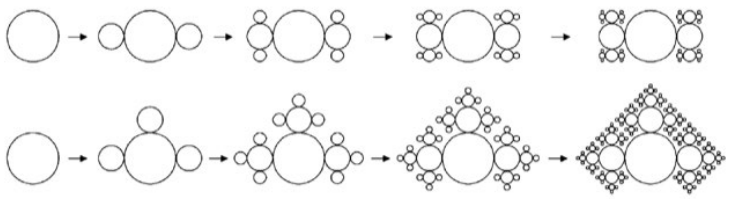


Figure 107: Generating fractals from circle using two different rules

in the right image. A similar technique can be applied to the temple plan, where details are added again and again to simple edges. The third image shows the fractal growth on temple motifs and pillars. Here, the details themselves have replication, providing the temple complexity at multiple levels.

Fractal growth can also be imagined in all three dimensions, as can be seen in Figure 110. Here, the process of self replication by adding smaller and smaller cubes to a bigger cube has been followed to achieve a complex end result.

Shape transitions are another way of adding complexity to form. Circle and square are two of the most important shapes in Indian arts, as they are metaphors for order and the continuum of respectively. Indian architecture, especially in temple plans, derives circle from square using various methods. This increases form complexity along with employing both the shapes for their abstract meaning. One approach can be deriving the circle from successive facetting of a square, as can be seen in Fig-

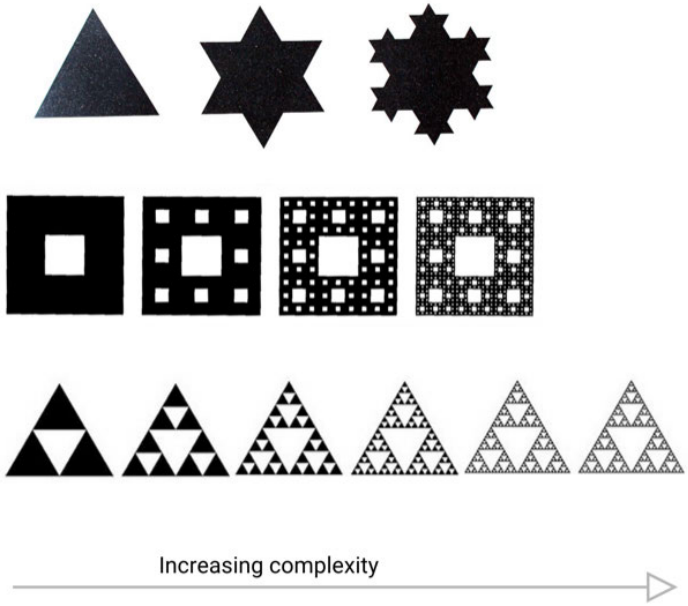


Figure 108: Increasing complexity in simple shapes

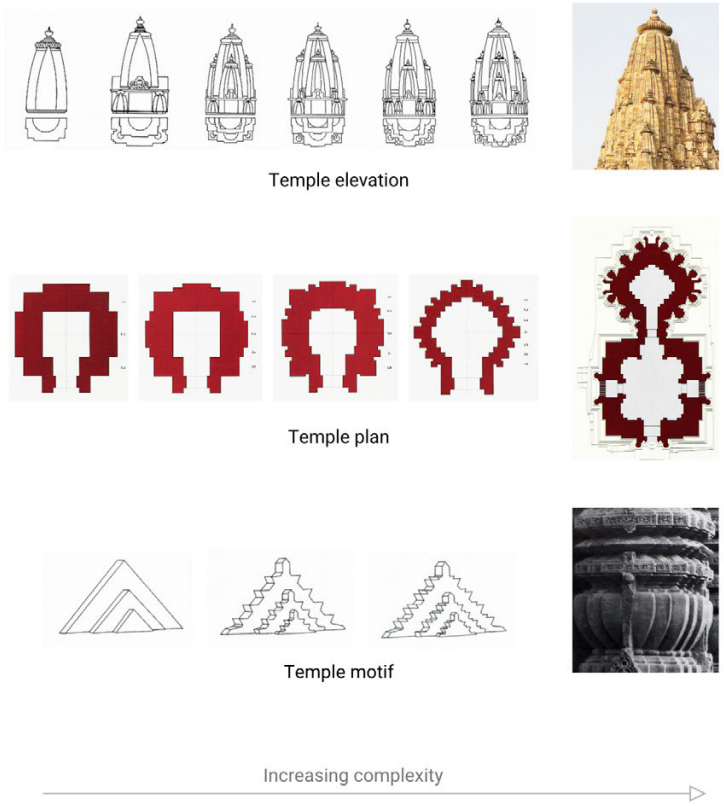


Figure 109: Increasing complexity in Temple architecture

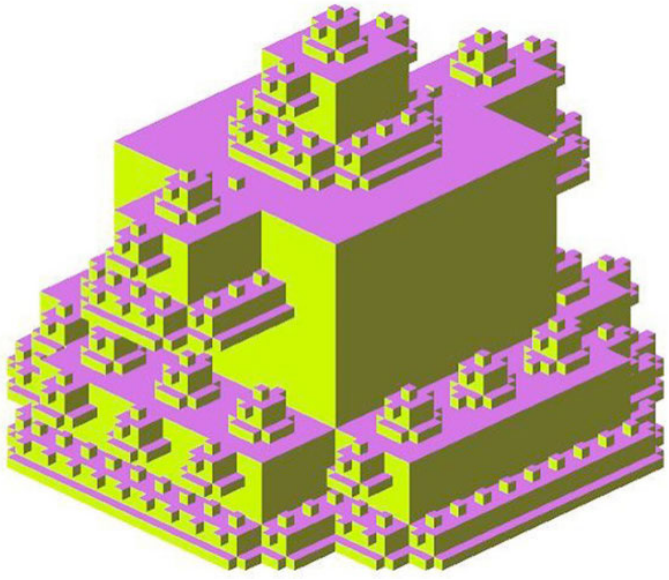


Figure 110: Fractal in 3D

ure 111 (a). The size of the square would determine the complexity of the resulting shape. Another approach can be keeping on increasing the number of edges taking the initial shape as a square, as can be seen in Figure 111 (b). The third approach can be rotating a square to get a circular outline, as can be seen in Figure 111 (c). Modifying the parametric variations, such as changing the size of the initial square, its angle of rotation or the number of times it replicates, can result in vastly different end results.

Figure 112 shows the facetting technique more clearly. As one increases the number of small squares, the whole outer shape starts looking more and more like a circle, even though it is still made of squares. The number of small squares in this case becomes the parametric variation for this process of converting a square into a circle. This variation leads to many different results just by tweaking the number of squares.

Fractals help in making complex forms, but they also help in ornamentation of these forms with complex patterns, the best example of which is Mughal architecture. Figure 113 (a) and (b) show fractal patterns added as ornamentation for ceiling and floor respectively.

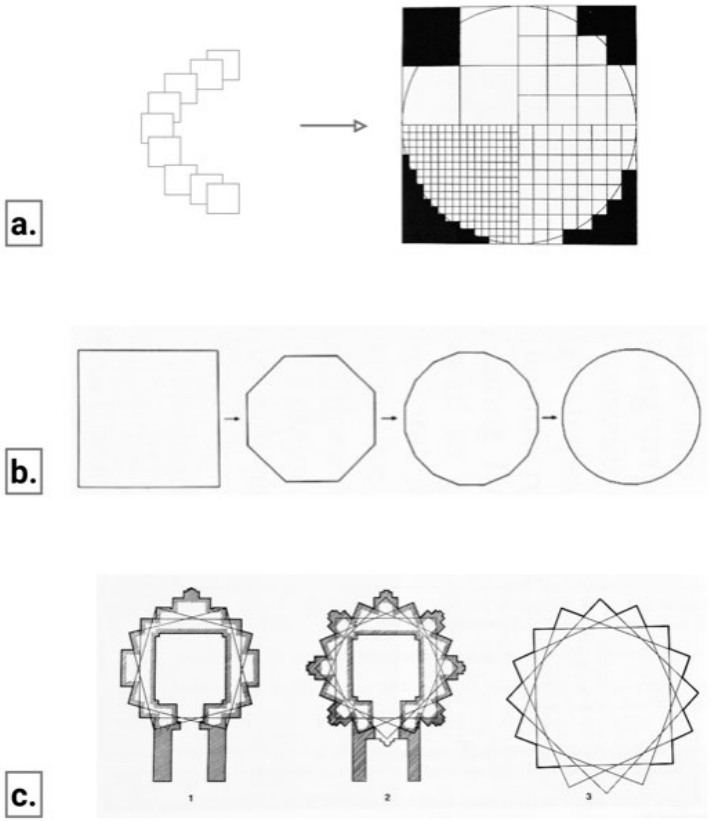


Figure 111: Various approaches to achieve Circularity

Reflection

The quality of the final product is measured by how effective it is at conveying the initial abstract idea to the viewer, or the experiencer.

An example of a temple can be used to demonstrate how

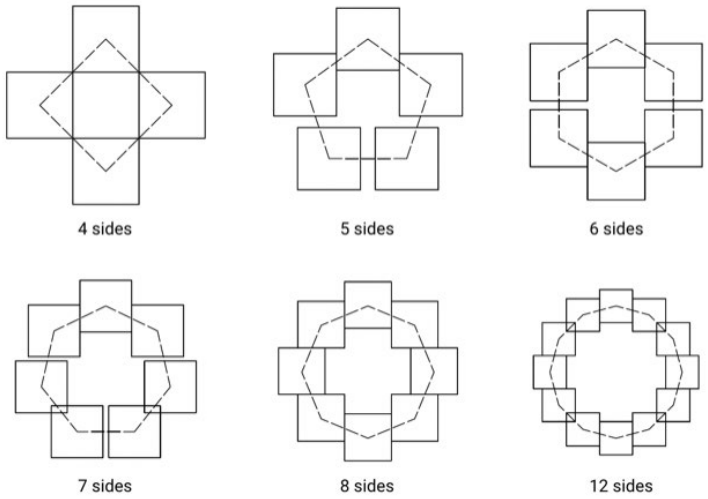


Figure 112: Facetting a square to make a circle

different steps of the design process are implemented to reach the final form that we see. As can be seen in Figure 114, the process starts with realising an abstract idea, that is creating on earth a microcosm that represents the macrocosm (the whole universe). This idea is communicated using stories. This abstract idea is then metaphorised using different elements to make communication easier. Basic shapes like square and circle are given meanings based on their form and characteristics. Many elements are mapped to different parts of the human body, like the head, feet and the navel. Next, the relationships between these elements and their heirarchies are realised for giving the structure a basic form. These hierarchies are put into place using frameworks

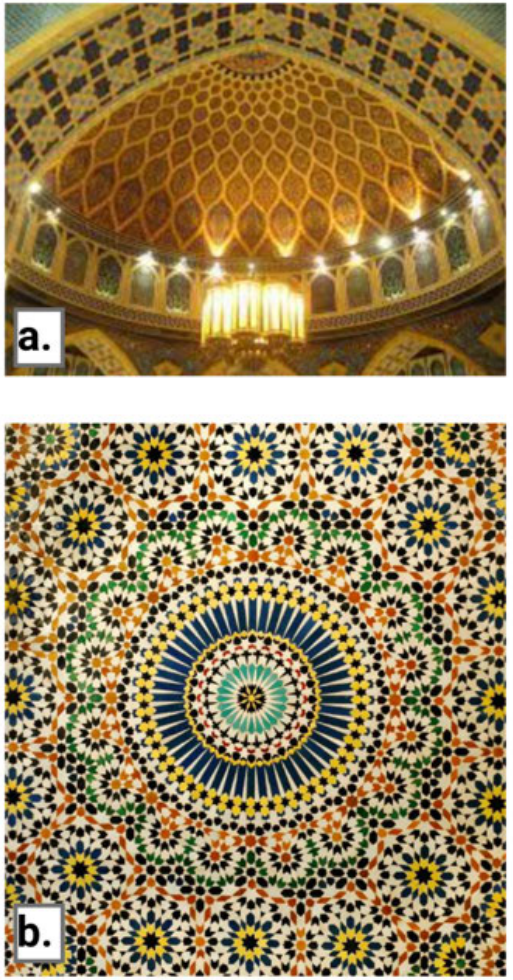


Figure 113: Fractals in Mughal patterns

like grids and the Talamana System. These frameworks help create consistent and ordered designs. Finally, the basic form of the temple is detailed using techniques like parametrization, in which simple recursive processes are followed to achieve complex end results.

It should be noted that the temple is only an example, and the process can be extended in a similar way for other products as well. The Classical design process should not be seen as a rigid framework, but as a flexible guiding framework that adapts to the needs of the product, enabling it to convey the Formless ideas the artist has. There is no evidence that it had been followed by all artists across the subcontinent in ancient times, and much like the many other design processes being followed in contemporary times, it was but one of many ways of converting the Formless to Form.

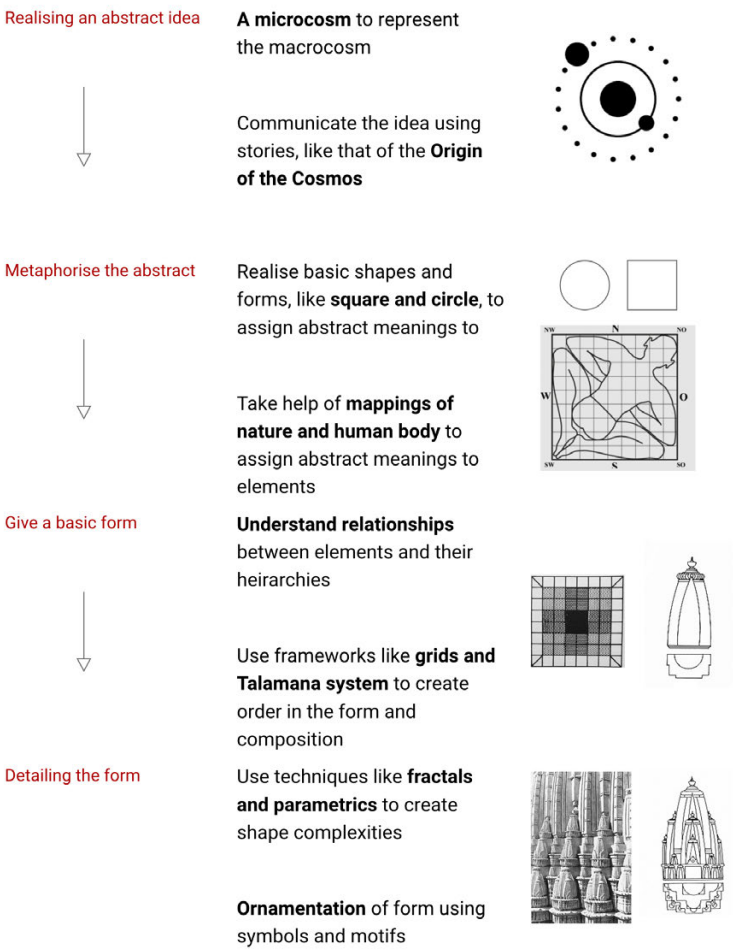


Figure 114: Various stages of creating a Temple