Interaction Design Institute Ivrea
23rd June 2003

Harmony in Architecture

New technologies and ancient traditions

Shyama Sundar Duriseti

Thesis Committee

Stefano Mirti
Associate Professor
Interaction Design Institute Ivrea

Reed Kram
Visiting Professor
Interaction Design Institute Ivrea

Harmony in Architecture

New technologies and ancient traditions

Thesis dissertation

Submitted in partial fulfillment of the Masters level program
in interaction design at Interaction Design Institute Ivrea.

Shyama Sundar Duriseti

Harmony in Architecture

New technologies and ancient traditions

Shyama Sundar Duriseti

Abstract

Our daily experience in the physical world is riddled with conceptual boundaries and enclosures in order to define our life in relationship with space. As we enter the new century, conceptual and physical boundaries in architecture have been significantly blurred by the proliferation of interactive technologies. We will find ourselves interacting with buildings and building typologies through digital mediations more and more, but can such interactions improve experiences of living within established tradition? Architecture in India has been evolving while balancing the traditional with the modern. Like 'Feng Shui', 'Vastu Shastra', the ancient science of architecture in India, has been the basis for organizing space in urban design and architecture. It suggests minor arrangements in orientation and alignment that are believed to have profound effect on well being. What is the role of interaction design in such a scenario, where inhabitants desire new experiences of living crossing tradition and interactive technologies?

Based on the principles of *Vastu Shastra*, this project aims to enhance the experience of living in harmony with the forces of nature. A model based study helped to understand basic interactions between the human being and elements of space, led to a framework for a visual-spatial program. This is supported by using light, the representative of cosmic force as a revealing medium of interactions and changing spatial configurations. This study is then developed into experience concepts. 'SunScapes' is an interactive space set up in the atrium of a corporate building. In this vibrant space graphic patterns created by the inhabitants' interactions with the space get superimposed onto the Sun's natural patterns through a skylight, marking a momentary experience of harmonious living.

Acknowledgements

The work presented in this thesis is a result of conversations with the members of the Personal Technologies group and guest lecturers at the Interaction Design Institute Ivrea. I am extremely grateful for the support and encouragement of Stefano Mirti and equally grateful to Reed Kram for his inputs and support , I thank all the members and the advisors of the Personal Technologies group.

I am thankful to Casey Reas for his support and co-ordination during my two years at Ivrea that he extended to my project too. Special thanks to Yaniv Steiner for his fundamental help with prototyping and valuable inputs through the process of making.

The support given by people back home in India is invaluable. Thanks to my parents, Deepa Duriseti, Venkata Ramana Duriseti and Kaladhar Bapu.

The inputs given by a large array of people from the Interaction Design Institute Ivrea, community has also been instrumental. Thanks to Ranjit Makkhuni, Phil Tabor, Joachim Sauter, Deepak Pakhare, Rajesh Dahiya, Aparna Rao, Gaurav Chadda, Belmer Negrillo, Luther Thie, Marc Escabosa, Tal Drori, Antonello and Edoardo Brambilla.

Contents

1 Introduction

Space in architecture has always had an intangible dimension. The perception of space can be influenced by using light or sound or by using a dynamic sequence of rooms with different proportions. This project intends to bring the qualities of interaction design to identify the intangible dynamics of ever changing architectural space with the forces of nature. We will find ourselves interacting with buildings and building typologies through digital mediations more and more, but can such interactions improve our experiences in accordance to tradition?

1.1 Motivation

'Harmony in Architecture' is an exploration of possible intersections between architecture and interaction design, in order to check possible levels of application of interaction design in architecture. Interaction design is about designing interactions that are visible, felt and experienced. Where as architecture is about planning and designing space where different interactions take place, my goal is to plan seemingly invisible interactions between inhabitants, nature, space.

Architecture and psychology define the space around the body in terms of proxemics in an architectural space. Personal behaviors are influenced by the space of relationships around a person like oneself to his space, oneself to an another one in a space, oneself with the influencing invisible forces of nature. Different traditions have identified such relations, relations between inhabitants, their orientation and alignment with the forces of nature.

> 'I am not talking about piles of polygons, without any people in them, in glossy magazines. Instead I am talking about arrangements you seldom notice but which have profound effect in your life. I am wondering about ambient and haptic interfaces'
>
> - Malcom McCollough, *Flow needs fixity*. Doors of Perception 7

Vastu Shastra an ancient science of architecture in India identified relations between forces of nature and living in an architectural space. This is similar to *Feng Shui*, which is about objects, their placement and orientation in a space that influences its harmony for better living.

1.2 Defining the problem

Vastu Shastra is about designing a space in alignment with the forces of nature. This science helps to understand architectural space as a representative medium of interactions between natural forces and human actions. It helps in designing buildings and building typologies in a way to enable living in harmony with the forces of nature. It suggests minor arrangements in orientation and alignment in an architectural space that are believed to have profound effect on well-being by designing fixities that define the flow of natural forces. The field of corporate architecture in India provides designers with an opportunity to balance new technologies with the tradition of living according to the ancient science. What is the role of interaction design in such a scenario, where people desire new experiences of living with tradition along with interactive technologies? This project is placed in the Indian context where most of the inhabitants already live in spaces that follow *Vastu Shastra* tradition. It aims to improve existing experiences of living in harmony with the forces of nature. The intention is to base the study, investigation and design concepts on how people move and interact in an architectural space at both personal and social scale.

1.3 Scope of the project

The basic structure on which the scope of the project rests can be best explained by a triangle of 'Harmony in Architecture'

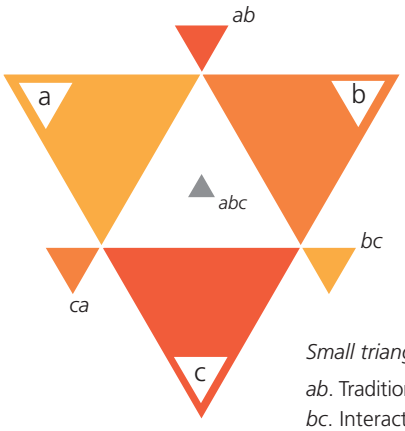


fig. 1 abc 'Harmony in Architecture' triangle

a. The context - Vastu Shastra and architecture in India
b. The background - Interaction design in architecture
c. The study - Inherent (existing) interactions in a basic architectural space.

Small triangles represent the intersecting work areas

ab. Traditional + Modern, balancing the dynamics of unseen forces and new technologies
bc. Interactive technologies with existing interactions in an architectural space
ca. Existing interactions in a space with hidden natural forces - a study. This study is described and documented in detail in the design and implementation section of this thesis report.

Vastu Shastra considers the influence of several natural forces of which *cosmic force** is the main one. Related to the role played in architecture by Sun, the scope of the project is quite large and changes across several spatial scales. Balancing the dynamics of natural forces in a space with mediated interactions is a fascinating field to explore.

* *Cosmic force :* Force pertaining to the universe, and to the one grand harmonious system of things, or to the solar system as a whole not just to the earth.

An interesting situation is prevailing in the contemporary Indian architecture. Ever since Le Corbusier introduced the concept of modernity to India by designing a new capital for the state of Punjab in North India, a series of new buildings and architecture emerged. His modular architecture has well complemented the use of geometry as suggested in *Vastu Shastra*. Since then there have been continuous efforts to balance the traditional with the values of modernity.

> It is surprising as the world moves rapidly towards the 21st century, propelled by the 'faster than mind' super computers, the art of building in India is pulling back to the ancient wisdom of *Vastu Shastra* texts. In an increasingly global world, where architectural style is ceasing to relate to regional characteristics, the work of some of the contemporary Indian architects is re-establishing a fundamental Indian quality. This is discussed in detail in the context and background section of this thesis.

Connections to the tradition is apparent in works of contemporary architects, like Charles Correa's museum for Jaipur called ' Jawahar Kala Kendra' and Raj Rewal's design to house 'Charles Ray Eames' exhibition in New Delhi. At the same time, projects like kinetic facade, responsive roof structures at the Kinetic Design Group, MIT and Christian Moeller's 'kinetic light sculpture' and 'virtual cage' are some of the main references that suggest effective ways to explore and apply technology .

A link between traditional Indian architecture and advanced explorations in interactive architecture in the west will lead to a possible new architectural phase in India that can balance the dynamics of natural forces with the dynamic nature of interactive technologies.

1.4 Areas of exploration

Based on *Vastu Shastra,* this project attempts to explore the prospect of interaction design in architecture enhancing experience of living in harmony with the forces of nature for the inhabitants of a corporate building space, a space which is fast getting disconnected from nature. Cosmic force is one of the main influence on which *VastuShastra* is based. *Cosmic influence*: heavenly bodies in the celestial space influence the activities on the surface of the earth, the Sun being the main source of energy is regarded as the major influencing factor. Sun, one of the most important heavenly bodies associated with divineness is considered as the purifier of soul and space. Besides defining the orientation of a room, building, temple and the city, the Sun also determines the arrangement of spaces and objects in a space based on the sequence of activities carried through a day.

> It becomes important to understand all possible interactions in an architectural space. Interactions between inhabitant-space, inhabitant-inhabitant and inhabitant-inhabitant-space. A model based study in order to understand the dynamics of interactions that occur in an intangible space, would lead to defining a visual-spatial program based on invisible interactions that can be revealed through appropriate means. The scope of the study can be extended to design ideas for the identified interactions that are appropriate to the theme

of living in harmony. It can even lead to exploring textures of a space by bringing tangibility to an enclosed architectural space that can act as a medium to reveal unseen and intangible interactions that occur in a space mediated by human intervention.

We could understand the people behavior in the context of an urban corporate environment in an Indian office space will be an important step, where people try to personalize their workspace and the way they orient themselves in order with the natural forces. They take great care to live according to the ancient science, by opting for minor adjustments in orientation and alignment at their personal spaces in home and if possible at their work place too. The idea is to work on a point of entry for interactive technologies and design ways to enable inhabitants live according to *Vastu Shastra*. It could be an atrium space used for transit in a corporate building is a potential space for creating momentary experiences. It provides a good basis to explore possibilities of balancing the vibrancy of existing movements and interactions in such space with dynamics of interactive technologies.

fig. 2

The *Shree Yantra,* a grid based on triangles signifies the balance of natural forces

&

Images from the model based study described in detail in the Design & Implementation section

2 Context & background

This section of the thesis discusses the status of architectural practice in India with examples illustrating the efforts to balance the traditional with the modern. By discussing potential opportunities for interactive technologies to intervene and bring in dynamic qualities to balance the traditional with modern, this section illustrates the reasons why this project is done. Key examples from the areas of interactive architecture are discussed along with the situation of architecture in India to provide a background and context for this thesis.

2.1 Context overview

The theoretical, practical and technological ground upon which 'Harmony in Architecture' is built refers to the following. The traditional science of architecture in India, a science that suggests living in harmony with the forces as well as provides a theoretical base. The situation in contemporary Indian architecture provides a good amount of examples of works where the tradition is balanced with modernity. Simultaneously, developments in technologies help to realize interactive architecture. This provides a supporting technological dimension to the project.

From the architectural tradition in India we learn about the value given to the ancient *Vastu Shastra*. We learn about the natural forces that influence the harmony in nature, which is believed to be in a balanced state when a new structure is planned according to the science. We get to know about the basic principles that are in practice. We will also get to know about the role it plays in contemporary architecture and design of spaces based on the inhabitant behaviors. From the state of contemporary architecture in India we learn about the efforts of balancing the traditional with the modern. We also learn about architects and their influential works in this direction that provides a good reference to future works that might involve interactivity.

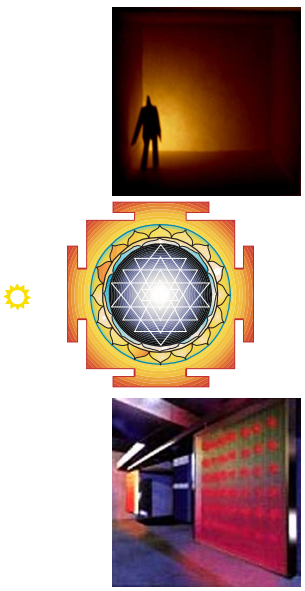


fig. 3

Representative images from the context

Model based studies in architecture,

Vastu Shastra, the tradition,

Interactive architecture projects from the West

From the work done in the intersections of architecture and interactive technologies in the West there are several examples of interactive explorations and possible applications in architecture. Even though not much of this research will find practical applications immediately, it provides a good foundation to base simple interactions that form entry points in to the yet to be tapped domain of interactive architecture in India. The idea is to connect representative examples in these areas to the concepts that will be discussed in the next part of the thesis. The background and context information is briefly discussed in the subsequent sections based on the references relevant to the project. A good source of inspiration on how the traditional is balanced with the modern is in the works of Charles Correa and Raj Rewal of India. *Parallax* of Steven Holl and Marcos Novak's *Transmitting Architecture* provided theoretical and architectural study references.

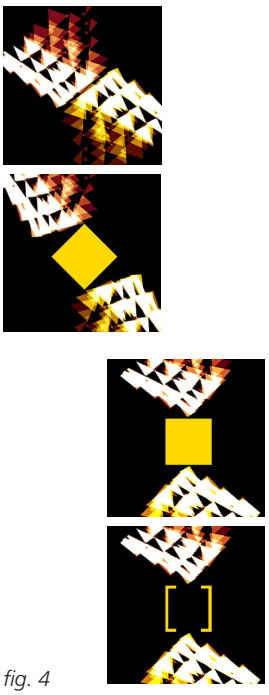


fig. 4

Series of images depicting a structure designed to ensure harmonious flow of energy

2.1.1 Vastu Shastra

The sudden emergence and the recourse to the tenets of ancient *Vastu Shastra* are both surprising and understandable. *Vastu* is the hidden harmony of nature and the environment around. We live in, and are surrounded by, various types of energy fields that operate freely in open space. When we place a structure here, the equilibrium is affected. *Vastu* helps in designing the structure to ensure that a harmonious flow of energy is present in the building and equilibrium is maintained. Some of these invisible energies have also been proved by the use of Pyramid model*. The awareness and the belief that 'Urja' or energy related in the cosmos was responsible for making of the 'Vishwa' or the universe to go, is the very basis of our metaphysics. The knowledge is documented and graphically presented.

The basis of *Vastu Shastra* seems to rest on the following

Cosmic influence: The heavily bodies in the celestial space influences the activity on the surface of the earth.

Solar energy: Energy levels and radiation from sunrays is not the same all over the surface of the earth.

Geo-magnetic fields: The magnetic field between the North and the South poles of the earth affects the bio-organisms. The magnetic field also creates sensitive spots on the earth's surface, which were used to advantage, especially in communication, whether marine or extraterrestrial navigation.

Geology of the crust: Materials for construction and other associated systems depends on extractable minerals common to a region and hence the ability to select appropriate materials.

Hydrology and Eco-systems: Habitable regions depend on perennial sources of water and the types of supportive vegetation.

Socio-cultural beliefs: Emergence of the human society from primitive to tribal to organized levels of a structured society. This indicates a shift to materialistic rather than a metaphorical view of life, resulting in need for body comfort.

fig. 5

Image showing natural forces in harmony

* *Pyramid model* relates to pyramid geometry that attracts all available energy particles from its surrounding. Dome geometry, stores the energy force field. All religious buildings are built with pyramid and dome. Temples, churches, mosques, and pagodas, have a pyramid shaped structure atop.

2.1.1.1 Vastupurusha Mandala

It will thus be seen that the ancient texts were based on a scientific understanding of the phenomenon and looked upon the man-made structure as a reaction to its environment. The Hindu concept of architecture had always been that of a model of the cosmos. This was further explained by the mandala graphics, the various *Vastupurusha Mandala* diagrams. Mansara* has described 32 mandala diagrams. These are similar to horoscopes, which locate the positions of various planets at a given time. The effect of celestial forces on the house and its occupants is possible to be studied. Much like the horoscope, the Vastupurusha Mandala depicts the positions of the origins of the effects on a human body. These diagrams are indeed, very complicated for the modern mind to understand and even more difficult if you are looking for proper interpretation.

fig. 6

Vastupurusha Mandala
- an ancient Indian diagram
to guide architecture

Vastu means surrounding, environment or nature (*Prakriti* in Sanskrit).
Purush means energy, power, vigor or soul (*Shakti* in Sanskrit).
Mandala means the astrological chart-which relates the layout to the orientation, right direction (both in space and in time), right proportion and right placement. These three collectively form what is called a *Vastupurusha Mandala* (form-being-diagram), used as a guide for which activities are best suited for each area of a building.

Following are some of the rules of *Vastu Shastra* that are commonly followed

The shape of the plot should be either rectangular or square.
The ratio of length to width should be less than two.
Doors facing south are not at all advisable.
While sleeping, head should be facing south or west direction.
The puja (prayer) room should be arranged in northeast.
The kitchen should be arranged in southeast or in northwest only.
All main doorways should be collinear for smooth flow of natural forces.

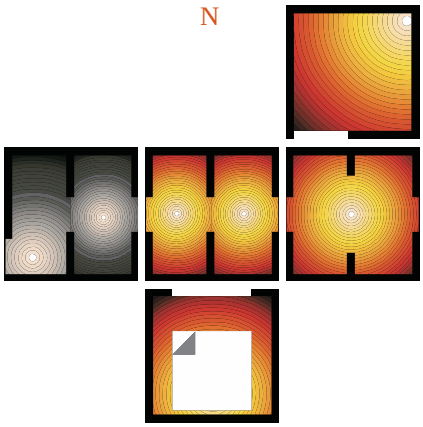


fig. 7

Sketch showing spaces
planned according to
Vastu Shastra rules

Vastu Shastra influences the direction and placement of objects in the context of buildings and buildings in the context of surroundings. One aspect of right direction involves attention to the Sun's relation to the progression of activity in the house through the day. For instance, generally the entrance is in the centre of the East wall of the house, the kitchen is in the South - East, the dining is in the South. So the sun's life-giving energy enters the house first thing in the morning, proceeds to the kitchen and gives life to the food preparations, and follows to the dining room for the noon meal, which is generally the larger meal of the day. The body's natural rhythms give us highest metabolism at this time as well, promoting best digestion and so on, through the house. The issue of placement has to do with everything, from the placement of the house on the plot, to placement of the rooms, to placement of the furniture, to placement of the trees outside, to placement of the plot in the town. All of these work together, and each element has to be designed with each other element in mind. The layering and relationships of all of the elements come together to create a building that is essentially an extension of inhabitants, as it was built to complement their unique relations to each other and to the world and cosmos around them. It is in essence a living organism, responding to the daily and seasonal cycles in the environment.

* *Manasara,* an ancient literature, a Vastu Shastra-architectural treatise

There are 32 versions of the *Mandala* that can be used in various circumstances with the simplest being a single square with no subdivisions; the largest has 1,024 subdivisions or padas; and the most sacred are the eight divisions giving 64 padas or the nine divisions giving 81 padas. From this we can witness how much of India's early architecture is based on this simple principle of the structuring of chaos by overlaying a pattern of order. A common feature of each *Vastupurusha Mandala* is that the centre, known as the Brahmastan, is representative of the silent center of all life. It is the connecting point of all the other parts of the building. The house breathes from there, the centre.

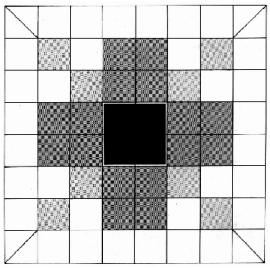


fig. 8

The most sacred *Mandala* diagram with 64 padas

The *Mandala* can be applied when interpreting the scale of a whole city down to understanding that of a house. Between these two, the public buildings and civil architecture of Hindu culture have also developed from the principles of the ancient orders. The general planning of the larger villages followed that of the so called magic square, representing the four corners of the universe. The long streets were laid out on an easterly axis, which ensured that morning and evening sun swept through them. The shorter streets running north and south provided a perfect circulation for air and cool breezes. The two principle streets that formed the arms of the cosmic cross were broad avenues, planted with large trees.

2.1.1.2 Indian Architecture

The use of geometry as an underlying principle in architecture and urban planning refers both to modernity as well as to tradition. The central character in introducing the concept of modernity to India was Le Corbusier when he was invited by India's first Prime Minister Nehru to design a new capital for the Punjab at Chandigarh. His approach to architecture had an instant impact on Indian architects. His design for the Parliament Building in Chandigarh, India in early 60's is rich with symbolism and ancient references. It is a modern structure with an ancient feeling of permanence in part related to the high degree of manual labor used in the project. He used the movement of the Sun in order to create more symbolism within the building to connect man and nature. In New Delhi a series of new buildings proudly presented themselves as strong concrete frames incorporating the rhythm of sun shields. His modular approach has well complemented by the use of geometry as suggested in Vastu Shastra.

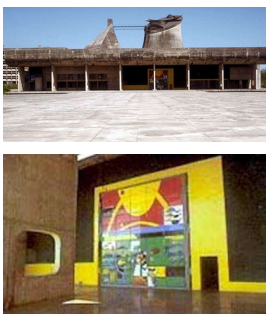


fig. 9

Parliament building designed by Le Corbusier, Chandigarh, India

fig. 10

Mandala diagram related to early Hindu architecture

Two of the famous contemporary Indian architects are Charles Correa and Raj Rewal they both demonstrate an awareness of the *Vastupurusha* principles of planning and the role of formal geometry in their architecture. In Raj Rewal's Delhi office is an Indian diagram mounted on the wall that relates to the early planning texts. While Rewal cannot explain the intricacies of the diagram, he is clearly influenced by its graphic quality particularly in relation to early Hindu architecture. Rewal even suggested that the relatively chaotic Indian urban scape could use a more formal structure to balance the bustling lifestyle. In an increasingly global world, where architectural style is ceasing to relate to regional characteristics, the work of Rewal and Correa is re-establishing a fundamental Indian quality.

Rewal's projects are not about planning the whole city but they do represent important cultural markers; one of his earliest buildings is a museum dedicated to India's first Prime Minister, Nehru. Designed in 1971 to house a Charles Eames exhibition, the plan is a classic Mandala shape wherein symmetrical squares and triangles interlock, in a partially buried building, now almost consumed by its landscape. Connecting to notions of traditional architecture and crafts while expressing Nehru's optimism to India's future, the building refers specifically to the relevance of tradition in Indian architecture. His recent projects in New Delhi include the National Institute of Immunology and the Central Institute of Educational Technology. Both illustrate a fascination with geometry in their overall form and in their detail right down to jali (perforated) screens.

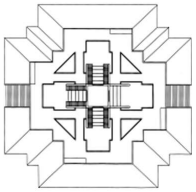


fig. 11

Raj Rewal's 1971 design for the Nehru Pavilion based on Mandala plan.

> Charles Correa is Bombay based and most of his projects relate to that city or other parts of India. In Delhi, Correa's most recent project is the British Council constructed just off Connaught Circus. Here Correa has reinterpreted some of the ancient planning principles in a very axial geometric form. The complex passes through a series of Charbagh (four square) gardens and even the street elevation takes on a strong graphic presence.

Correa's most obvious connections to the past are visible in his Mandala-based schemes for a new museum in Jaipur and a new state assembly for the government of Madhya Pradesh. The Jaipur project is based on a square subdivided into nine sub-squares, while the state assembly is a series of squares within a large circle. Correa has also carefully nurtured the design of the Crafts Museum in Delhi located near Rewal's Nehru pavilion, and both of these are located under the walls of the Purana Qila, one of Delhi's earliest cities.

fig. 12

Charles Correa's Kanchanjenga apartments based on Mandala grid.

Modern writers on Indian architecture are concerned that the mere copying of *Mandala* plans for the *Vastupurusha* principles will only lead to mimicry. Conversely, there is also a concern that the simple transference of ideas from other parts of the world is leading to the loss of a genuine Indian architecture. The work of Rewal and Correa does seem to have gone some distance in bridging these dilemmas by building from the past with the new materials of today.

fig. 13

Charles Correa's Jawahar Kala Kendra (Museum), Jaipur. Its entrance lounge ceiling painted with Indian symbology

2.1.2 Conflict resolution

In a way architectural design could be described as a conflict resolution. A conflict resolution between context and programs, form and function as much as between the traditional and the contemporary. Conflict between the traditional and the contemporary seems to be more acute in cultures that value historical significance. In such contexts the resolution of conflict is a tradeoff between the traditional and the contemporary where "signs" play a dominant role in the tradeoffs. How these "signs" are accommodated and transformed in a given design is hence significant in successful architectural communication.

> India is one such country where signs play a dominant role in the everyday life of people. In such a context the success of architectural design could

perhaps be measured with the degree of success in architectural communication. The success of architects like Charles Correa is hence predominantly seen as a contribution to this communication by going beyond the formal boundaries of the modern movement and evolving a personal approach that acknowledges tradition.

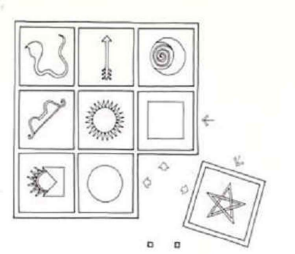


fig. 14

Use of semiotics by Charles Correa in museum of Jaipur

However, whether Correa's architecture necessarily communicates the very meaning he chooses to convey needs to be viewed critically. Assuming that the success of architectural communication is dependent on the legible correlation between signifiers and signified, a framework of semiotics is necessary to proceed on in the study. Semiotics is a science of signs that allows one to decipher the meanings of signs. Correa's recent work, the Jawahar Kala Kendra a museum at Jaipur is chosen as a case study as it is a very clear example of designs that exemplify an architect's conscious attempts to accommodate and interpret signs. Moreover, this model seems to have had an enormous influence on an evolving community of Indian designers. This sets a right contextual reference and architectural standard to this project.

2.1.3 Jawahar Kala Kendra - a case study

Jawahar Kala Kendra is a museum of arts and crafts located at Jaipur, India and built in 1986-91, launched by the government of India to communicate India's cultural and spiritual values and to display its rich craft heritage. The geometry of the layout plan is derived from traditional Hindu architecture based on self-similar squares (Mandalas) derived from ancient Hindu texts (Vedic Shastras) dating back to 1500-500 BC. These squares are the abstraction of cosmos in geometrical form where architecture is perceived as a bridge between cosmos and man - the model of "cosmic man" (Vastupurusha Mandala). The Hindu culture hence devised the cosmic man model for infinite applications in architecture whether it is at the level of urban design, public buildings or private dwellings.

The cosmic man model is a system of self-similar multiple squares starting from 1, 4, 9, 16…1024. The specific model used in the museum is made up of 9 squares representing nine planets (Navagraha Mandala). This idea of using multiple self-similar squares is justified by Correa as follows,

fig. 15

Jawahar Kala Kenrda's plan based on the 9 square mandala

> "The multiple squares make explicit a platonic ideal of built form which in turn reinforces and stabilizes society. Today such concepts are not in current use, and it would be foolish to think of invoking them unless we also subscribe to the underlying construct of the cosmos they are meant to represent. Still, in a century when science has postulated an ever expanding universe it may well be worth our while to consider modeling our central beliefs as the basis of structuring our environment"

The emphasis in the last statement suggests Correa's interest in the Mandala was insomuch as it can be used to "structure the environment." Hence the primary function of the 9 square Mandala is "structuring." However, the question remains why Correa chose to use only the nine square Mandala and not any other. An immediate response would be that the museum had to accommodate

nine space types laid out in the program of the museum. However, this was not the only reason. By using the nine square Mandala, Correa is also imitating the geometry of Jaipur city that was also based on the nine squares. This figure shows how the city plan of Jaipur started with the nine square Mandala. Square 3 was displaced by an existing hill and reappeared next to square 7 then squares 1 and 2 combined to house the palace. When one investigates further into the plan of Jaipur city, it seems that the Mandala was also seen as a structuring device. Another contemporary Indian architect *Balakrishna Vinod Doshi* notes

"Centuries of traditional vernacular wisdom are reinforced by high cultural ambition and a strong intellectual structure. The streets work in a hierarchy; broad avenues down to courtyards reached through gates and there is a harmonious relationship between built form and open space. The result is a city memorable for its clarity of form".

fig. 16

Manifestation of traditional vernacular architecture in the museum is visible when these two pictures are compared

In the museum, Correa's direct imitation of the Jaipur city is evident in the displacing of one of its square from the nine square construct to create a main entrance. Hence on a closer examination one could suggest that Correa used the nine square Mandala not only as a structuring device but also to consciously invoke the symbolism of traditional city. Insofar the museum uses it as a structuring principle, "structuring" becomes the primary function and insofar as the museum imitates the plan of Jaipur city - the symbolism of the "traditional city model" becomes its secondary function.

> This work of Charles Correa is important not just because it demonstrates the way ancient science is balanced with the modern in an architectural example that is applied. It is significant because of the way it creates an experience of living the ancient science in navigating and interacting through the spaces. It uses symbolism and extends it into a livable experience quite effectively by crafting spaces based on the elements of nature and their symbols. This stands as a source of inspiration for architectural practices that try to bring the traditional and the modern of Indian architecture together. It has influenced architecture created by the young and old alike. Architecture now is being practiced on grid system as a basis and arranging spaces, so as to optimally comply with the principles of the ancient science. This influence is evident in the practice of modern architecture, more so in the space of corporate architecture. Such structures housing information technology developments have been popping up over the Indian metropolis canvas.

2.1.4 Contextual space

The arrival of corporate culture in India has brought a rise in the standards of building construction techniques with the influence of the western technologies. Building for corporations is the space that has drawn the interest of architects, as it provides opportunity to explore and design architecture of image and identity as compared to other spaces that refer to technologies that are in practice locally and ask for architecture of regional influence. This leads to similar kind of architecture most of which is based on the traditional science.

fig. 17

The semiopen space and a cubilce space at Vanenburg Information Technology park, Hyderabad, a representative of the contemporary corporate architecture in India

Corporate architecture provided practitioners with an opportunity to work in the intersections between the tradition and modern. This forms a good basis to extend the situation beyond time and question the role of interaction design in such a scenario, where inhabitants desire new experiences of living with tradition along with interactive technologies.

> The Indian urban space has increasingly become a world in which humans have been decoupled from nature. In the upcoming work environments of corporate culture, people are spending more and more time in their cubicle space devoid of connections to the nature. More so in the Indian context where natural forces like Sun rays cleaning the desk/ workspace is considered auspicious. This is why we see most of our personal workspaces and cubicles populated with images of mountain scenes, furry animals and seashells.

fig. 18

The transition space with skylight at the India Habitat Centre, New Delhi, India

From a very personal static workspace to a dynamic and social atrium space, a corporate house provides opportunity to design for a range of spatial and personal to interpersonal scale. An atrium space is of a special interest to this project as it provides large spatial canvas to explore the phenomenon of Sun. Such a space provides a good context where the traditional courtyard is enveloped with the modern roof systems that address the changing ambient needs of a space with respect to the changing environment. This space is of interest because of its dynamic nature. Here a change is a momentary experience in transit. An atrium in an Indian corporate building is an ideal space to bring in new interactive technologies and set them up in this context of ancient traditions. This defines a space and the opportunity it provides in the context of ancient traditions in Indian architecture and emerging technologies. This defines the design theme for this project i.e., designing new experiences of living in harmony with the forces of nature through mediated interactions. Here living in harmony with the forces of nature refers to the ancient tradition ' Vastu Shastra' and mediated interactions are based on the interactive technologies.

2.2 Background

This section discusses a projects that broadly fall under the domain of interactive architecture. Most of the projects discussed here under different categories are research based. If some are conceptualized and executed at research laboratories the others are experimental installation works of individual architects. There are a few references to modern architecture and an architecture based studio study too.

2.2.1 Interactivity in Architecture - a survey

Most of the work done so far in the intersections of interactive technologies and architecture is research based and limited to research labs. On one side research at the KDG (Kinetic Design Group), MIT has produced and demonstrated various technological possibilities. This project is strongly based on a few specific projects done at KDG for technology. Also, this project takes

inspiration from designers who express themselves through installation works that are highly interactive and compelling. Following is a short survey of works in these intersections emphasizing projects related to interactive facades, ambient spaces and kinetic roofs. The works discussed under different sections range from architecture, architectural installations to research based interactive architecture.

2.2.1.1 Architecture in the electronic age

Tower of winds
Yokohama, Japan. Toyo Ito

Tower of Winds designed by Toyo Ito metaphorically represents the visual complexity of Tokyo as a constant and continually changing wind. The Tower, a 21 meter cylinder is covered in acrylic mirrors with over a thousand light bulbs inserted among twelve neon rings with aluminium panels and thirty reflectors at the base. The lights are programmed by a computer to reproduce various patterns from the surrounding environmental information. At sunset, they transform the transform the tower into a sparkling spectacle of dancing lights and fleeting transparencies.

fig. 19

Dancing lights and fleeting transparencies of the Tower of winds, Tokyo

Institut du Monde Arabe
Paris, France. Jean Nouvel

The Institut du Monde Arabe (IMA) is the smallest of the Grands Projects (Mitterrand's 15 billion franc program to provide a series of modern monuments to symbolize France's central role in art, politics, and world economy at the end of the twentieth century), housing a library, exhibits, and other functions devoted to the relationship of Arab culture with France.

Nouvel produces a wonderfully minimal composition of forms: a gently curving wall to the north facing the Seine comes to a sharp and deep cleft as it meets a rectilinear block which faces a large open plaza and the university buildings to the south. Most notable, as we would expect from Nouvel, is the surface treatment. Along the south facade the IMA reinterprets traditional Arab latticework screens in glass and steel: 30,000 light-sensitive diaphragms are designed to regulate the penetration of light into the building.

The unique use of high-tech photosensitive mechanical devices to control light levels and transparency-as well as the beauty of the solution-made this building famous and piqued interest in the use of 'smart' materials (which can respond to changing environments) in buildings. The problem: the system no longer works. Nonetheless, the south facade is quite beautiful. The striking south facade and the carefully orchestrated sequence between the entrance onto the plaza and the entrance of the building set up interesting scale relationships.

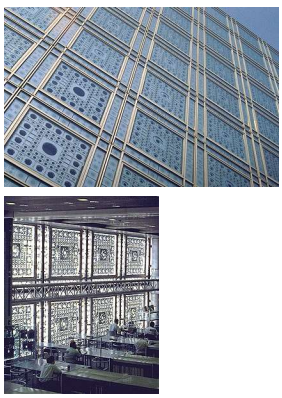


fig. 20

South facade and a interior of the Institut, reinterprets traditional Arab latticework screen in glass and steel.

2.2.1.2 Relational architecture

Relational architecture can be defined as the technological actualization of buildings and public spaces with alien memory. Here alien memory refers to something that does not belong, that is out of place, while technological actualization means the use of hyperlinks, aliasing, special effects and telepresence. Relational architecture transforms the master narratives of a specific building by adding and subtracting audiovisual elements to affect it and re-contextualize it. Relational buildings have audience-activated hyperlinks to predetermined

spatiotemporal settings that may include other buildings, other political or aesthetic contexts or other histories. Relational architecture is better understood when compared to virtual architecture. Virtual buildings are data constructs that strive for realism, asking the participant to "suspend disbelief" and "play along" with the environment; relational buildings, on the other hand, are real buildings pretending to be something other than themselves, masquerading as that which they might become, asking participants to "suspend faith" and probe, interact and experiment with the false construct.

fig. 21

Building revealing interiors when caressed digitally

Displaced emperors

Ars Electronica Festival, Linz, Austria 1997. Rafael Lozano-Hemmer

This installation used an "architact" interface to transform the Habsburg Castle in Linz, Austria. Wireless 3D sensors calculated where participants pointed to on the facade and a large animated projection of a hand was shown at that location. As people on the street "caressed" the building, they could reveal the interiors, which corresponded to Chapultepec Castle, the Habsburg residence in Mexico City. In addition, for ten schillings, people could press the "Montezuma button" and trigger a temporary post-colonial override consisting of a huge image of the Aztec headdress that is kept at the ethnological museum in Vienna.

fig. 22

Projected shadows revealing the texts of the IRC about the transformation of the concept 'fear'

Re:positioning fear

Film+Architektur Biennale, Graz, Austria 1997. Rafael Lozano-Hemmer

This is a large-scale installation on the Landeszeughaus military arsenal with a "teleabsence" interface of projected shadows of passersby. Using tracking systems, the shadows were automatically focused and generated sounds. A real-time IRC (internet relay chat) discussion about the transformation of the concept of "fear" was projected inside the shadows; the chat involved 30 artists and theorists from 17 countries.

2.2.1.3 Spatial Installations

Virtual Cage

ARTLAB - Prospect 2. Christian Moeller

"Virtual Cage" offers the three-dimensional space, created by media technology, which is to be experienced by one person at a time. In the middle of the installation, a hydraulic-balanced platform is placed. It tilts with the weight of the person standing on it.

fig. 23

Experiencing the unstable balance of the platform by moving around.

The unstable balance of the platform makes one aware that one's usual perception of space is based on the stable horizontality. While being conscious of one's physical change, the viewer moves around on the platform. Two special laser machines spread the tilt of this plane over the whole space as a transparent membrane, parallel to the platform. As a result, the installation generates a huge spatial change, which influences the very architecture.The image of a wire frame plane projected on the front screen displays the laser membrane prevailing over the whole space. On the screen, there is a swarm of particles, programmed to spontaneously gather in a group. The swarm is in an interactive relationship with the viewer as it is influenced by the tilt and the direction of the platform. The viewer and the audience perceive the position and the movement of this swarm by three-dimensional sound moving real time in the space, and gradually recognize the "virtual cage".

Kinetic Light Sculpture

ARTLAB - Prospect 2. Christian Moeller

The Kinetic Light Sculpture is a permanent installation attached to the facade of the Zeilgalerie in Frankfurt and was finished along with the whole ensemble in September 1992. Between the Kaufhof department store in the west and the post-office in the east, the impressive image of the facade becomes apparent. With the Kinetic Light Sculpture on the surface of the facade, this body gains an extra quality of 'vitality'. The light sculpture significantly changes the image of the folded daytime aluminium wall from its appearance at night. During the day, the perforated surface of the sheet metal, which is in front of the blue facade of the building, remains grey and reserved and only oscillates through the play of daylight. When dusk begins to fall, however, it transforms itself into blue-yellow floating figures which depending on their surroundings that are, on the current weather conditions change its colors like a chameleon.

fig. 24

The facade of Zeilgalerie in Frankfurt transforming into blue-yellow floating figures

Three groups of lights - a total number of 120 HQI spots - shine from the inside and outside on to the perforated sheet-metal surface in front of the building's wall. They flood through the surface upwards and downwards with variable yellow gradation. Temperature, wind, rain - as well as acting as a constant function of time are the parameters of the light sculpture that changes in real time. A computer terminal (Silicon Graphics Indigo Entry) and a weather station on top of the building directed the image of the facade. The prevailing temperature (relevant grade: 0-25 degrees Celsius) determines the amount of yellow on the blue wall. The yellow patches are moved in accordance with the direction of the wind from left to right or from right to left. The strength of the wind governs the speed in which they move over the surface. Rain substitutes the wind parameter and allows the flooded lines of yellow patches to fall in a vertical direction.

2.2.1.4 Ambient fixtures

The Ambient Fixtures are standalone ambient media displays that externalize the displays and distribute them throughout an open architectural space. Ambient fixtures allow ambient displays to be used by several people at once. The Water Lamp and the Pinwheels explore the ideas of physical movement caused by invisible information flow. Both are designed on the metaphor of natural physical phenomena. Ambient Fixtures make use of the entire physical environment as an interface. They move information off the screen into the physical environment, where it is manifested as subtle changes in form, movement, sound, color, smell, temperature, or light. Ambient displays are well suited as a means to keep users aware of people, weather, or states of large systems.

Water lamp

MIT Media Laboratory. Andrew Dahley, Craig Wisneski, Hiroshi Ishii

The Water Lamp is composed of a wooden base, 3 aluminum support tubes and an acrylic water pan. There are 3 small solenoids mounted above the water tray. These solenoids are controlled through a single circuit board. When actuated, the solenoids tap on the surface of the water in the tray, causing ripples in the waters surface. Various digital information sources can drive this circuit board to actuate these three solenoids. A light shines upward through a pan of water, and produces changing patterns of light and shadow projected onto a ceiling.

fig. 25

Water lamp shining upwards through a pan of water that produces changing patterns of light and shadow projected onto the ceiling.

The Ambient fixtures, both Water Lamp and Pinwheels are based upon a common control platform the iRX 2.0 PIC Micro-controller Board designed at the MIT Media Lab by Robert Poor. The iRX board accepts commands over a serial line from a computer to control each fixture. This allows distributing fixtures throughout research space. TCL-based software sends commands to the fixtures. Information can be relayed from the internet or other networked information source and be routed to the appropriate fixture.

Pinwheels
MIT Media Laboratory. Andrew Dahley, Craig Wisneski, Hiroshi Ishii

fig. 26

Pinwheels spinning by bit wind (bit wind is symbolic of the speed of digital information flow in a space)

The Pinwheels evolved from the idea of using airflow in the ambientROOM. Andrew Dahley and his team found that the flow of air itself was difficult to control and to convey information. As an alternative they envisioned that a visual/ physical representation of airflow based on the 'spinning pinwheels' could be legible and poetic. The Pinwheels spin in the 'bit wind' at different speeds based upon their input information source.

small DC motor. Four Pinwheels are connected to each iRX control board. Pulse width modulation controls the speed at which the motors spin.The upper area of the facade is crossed horizontally by the wide, rapidly changing line graphic (LED-Display 3m x 16m) that visualizes the degree of noise made by the passers by in real time. During the day, when there is no lighting visible, the line graphic turns into a source of the actual, local news.

Ambient fixtures like the Pinwheels and the Water Lamp have the potential to create subtle and yet informative reactive environments through the application of displays integrated within our architectural spaces.

2.2.1.5 Kinetic architecture

Kinetic Facade
Parallax Inc. Alan, Gray, Michael Fox

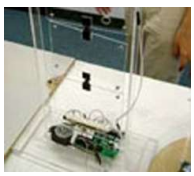


fig. 27

A prototype of the Kinetic Facade showing one of the six panels that stand the length of the building

Micheal Fox's work explores intelligently responsive kinetic and mobile architectural systems; with the motivations of creating spaces that can physically re-configure themselves to meet the changing needs. The kinetic façade was designed as an interactive façade for a gallery. The prototype model shows one of six panels that stand the length of the building. As people in the building walk along the façade it literally dances in a wavelike motion. Images can be silk-screened onto the glass to make animated temporary exhibits. Sensors can tell where the sunlight is and also where people are inside the building and make the patterns follow them, lead them or entertain them. The façade can also be useful for ventilation purposes and the entire set of panels can rotate 90 degrees around the center axis to completely open the space to the outside.

fig. 28

When someone approaches, embedded sensors trigger these walls to move towards the perimeter walls

Interactive Walls
Parsons School of Design, Beatrice Witzgall's students

This is a final project that responds to users as well as subtly influencing them. The installation rearranges itself and the surrounding space in response to human movements and traffic patterns. A set of two deceptively simple polycarbonate panels mounted into a garage-door track in the ceiling sit side by side, partially blocking passage between the lobby's elevator and the hallway beyond. When someone approaches, embedded sensors trigger the

panels to move towards the perimeter walls. These temporary walls remain parted during periods of high traffic, and return to the center of the lobby when there is none.

Each panel includes 128 LEDs linked to microphones. The LEDs light up within a grid to graph the volume inside; the X-axis represents time: the Y-axis marks the activity level. As obstacles these panels force users towards the sides allowing the passersby in this exhibition space to discover seating and exhibition space as they may otherwise have walked past.

2.2.1.6 Embedded kinetic structures

These are systems that exist within a larger architectural system or building, they respond to changing factors. Changes are bought about by both environmental and human factors and may include axial, torsion, flexural, instability and variation and sound.

Moderating Skylights
Kinetic Design Group, MIT. Michael Fox, Bryant P. Yeh

Moderating skylights shown in the figure demonstrate a networked system of individual skylights that function together to optimize thermal and day lighting conditions. Each unit contains eight individual panels that slide along four straight lines towards the center of the panel to create an open position. The system maintains structural stability throughout all stages of deployment of the individual units. One of corner joints of a singular unit contains an individual cable attached to a servomotor that deploys the unit as an individual whole through sliding that joint towards the center. Integrated computer control is done with a system of positional sensor devices attached to each panel. Each panel further consists of photovoltaic cell paneling under which lies a layer of shading film/ moisture barrier of variable self-adjusting opacity. This skin is affixed to a ribbed Plexiglas panel affixed to a structural aluminium frame. Optimum thermal and natural day lighting conditions can be achieved through the algorithmic balance between the individual deployment of the panel units and the individual opacity variances.

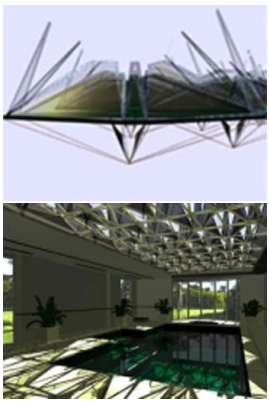


fig. 29

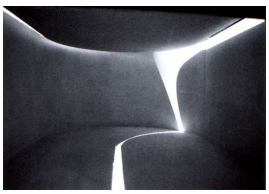
Moderating skylights demonstrating a networked system of individual skylights

Most of the projects discussed in this background section are limited in applicability. Some of them are incredibly executable projects that could not find their way out of research labs. The rest are successfully executed temporary installations. The ideas and final concepts discussed in the next section of this thesis are based on the technologies discussed in the projects explained here. The intention is to stand on the basis of demonstrated technologies and make an entry into the Indian context with a deployable idea. Moderating skylights can clearly be one of the projects to refer to for technological grounds. Interactive Walls provide as insight in to how to broaden the scope of the design project in the context of a public/ social space where interactive technologies can influence the inhabitant behavior to explore the space better by controlling circulation.

2.2.2 Light score

Light as matter is invisible. We cannot perceive light as it passes by unless it is trapped in dust, smoke, or water droplets. Nothing is contained 'in' the light beam. The range of astonishing phenomena of light and shadow contain mysterious ambiguities that glow elastically in a dreamlike uncertainty. The infinite possibilities of light have been evident from the beginning of architecture and will continue into the future.

Steven Holl's study based on the pressure of light to catch tectonic variations in an architectural space in his book 'Parallax' formed a reference. The cosmic connection is the common basis for referring to this study of light in space.



Properties of light provided the organizing concept for the Museum of the City designed by Steven Holl and Associates for Cassino, Italy. These pictures show a part of the study, which is an attempt to model light using physical models. In fact, light should be modeled full size as it falls off a wall at the square of its distance to the source. The galleries are organizing in interlocking light sections. Each exhibition area begins as neutral space individuated through its specific quality of light.Museo Cassino, Key to the score

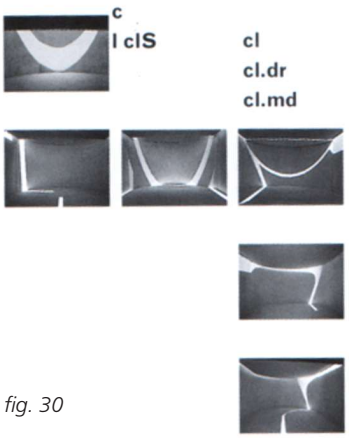


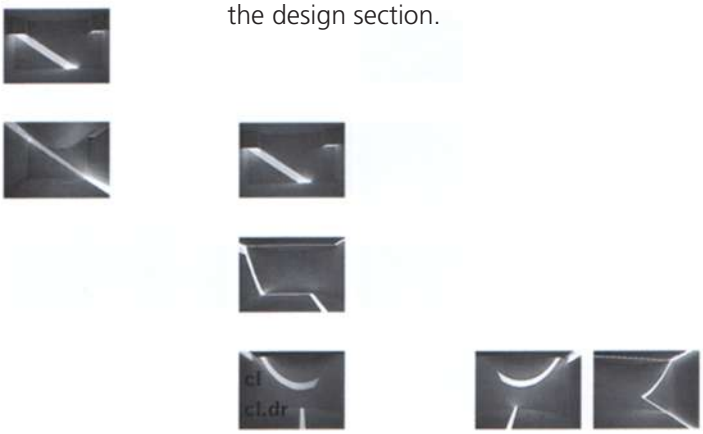
fig. 30

Light trapped on the surfaces in an architectural space.

Tectonic variations in an architectural space based on pressure of light

c	curve-shaped light
l	linear light
cl	curved and linear light
cl.dr	curved and linear light with dropped ceiling
cl.md	curved and linear light with round slit
clS	curved and linear light with superimposed slides

This kind of a programmatic approach in studying of light in space connects to this project's study based on the existing interactions in a space. We can imagine that when we move in a space, we are mediating the flow of natural forces. Considering light as a medium, the study of inherent interactions represent the result of the mediation caused by human interactions with unseen forces. This is discussed and supported with detailed images, a result of the study based on a program of progressive elements in a space. Elements like inhabitant, space, objects in a space give a structure to this study discussed in the design section.



3 Design & implementation

A discussion of the works progress almost linearly in three sections: from pure model based study of the unseen but common interactions in a basic space, to simple conceptual spaces with designed mediations*. This is followed by a contextual space connecting to the concepts and is illustrated with a thematic prototype.

A desire to create new experiences of living in harmony with the forces of nature through digital mediations has emerged from the process of studying existing interactions. The common thread is the prevailing interactions based on which spaces are designed and objects are oriented.

The idea is to create new experiences based on the prevailing interactions with buildings and building components in spaces such as circulation areas and transit spaces. Interactions with the space, spatial components and among inhabitants are mostly short lived. They are momentary but have qualities of spontaneity and frivolity. Such spaces doesn't necessarily catch one’s attention, while in a state of transit. The inhabitant’s movements and circulation are prone to get influenced by the design of the space.

> Initial discussions with my advisors led to a process. The beginning of this process was a simple study with light in space. This used light as an indicator, as a representative medium to show who has been in a space, his movements and nature of interactions in that space defined by an architectural structure. This refers to Steven Holl's 'Light Score", architects practice this kind of a process when working with light, but this study differs from others as it considers light as a revealing medium to show unnoticed interactions in a space. This is the beginning of a process that led to design concepts in the context of interaction in architecture.

* *Mediation* is the act of mediating, intervention

3.1 Inherent interactions - a study

The structure of this study is broadly based on Edward.T.Hall's classification of personal levels of interaction.

fig. 31

Modelling interactions in an intimate space, the beginning of a model based study to see our interactions with a basic architectural space

1. Intimate Space (Inhabitant - Space)
   a. Emotional interactions
      Interactions with a corner - signifies grief/ control/ emotional depressions
      With a window - indicates hope, lost in the past, communicating with nature
      With objects - brings memories, associations, love, relations
      Leaning onto a side wall - signifies state of balance in a space, control
      Standing in the centre - emphasizes focus, sense of achievement
      Standing towards to entrance - marks a sense of ownership, possession, secure
   b. Physical interactions
2. Personal space
3. Social space
4. Public space

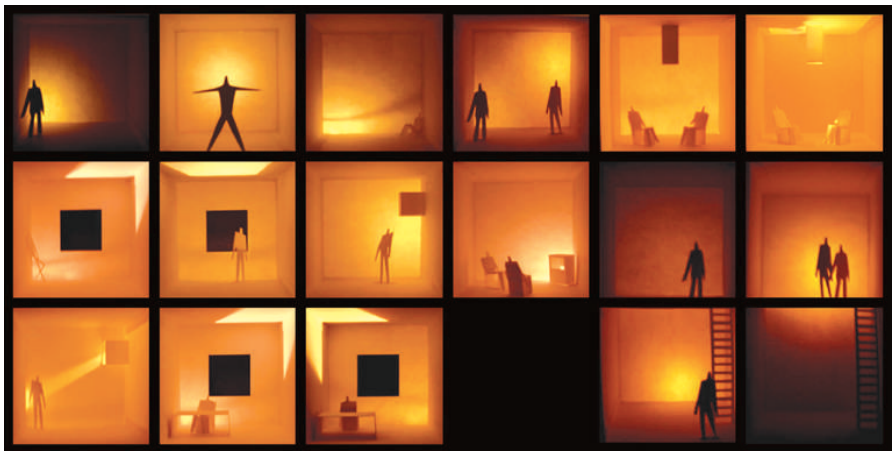


fig. 32

From emotional interactions to physical interactions in an intimate space, images showing results of the first phase of the model based study

A study into revealing existing interactions in a space began with physical models. Simple elements of a basic architectural space an open cube (this refers to the basic square form of Vastu Purusha Mandala) with light as a revealing medium of interactions in a space were considered. The intention is to capture all possible interactions that occur in between:

Inhabitant, space
&
Inhabitant, inhabitant, space

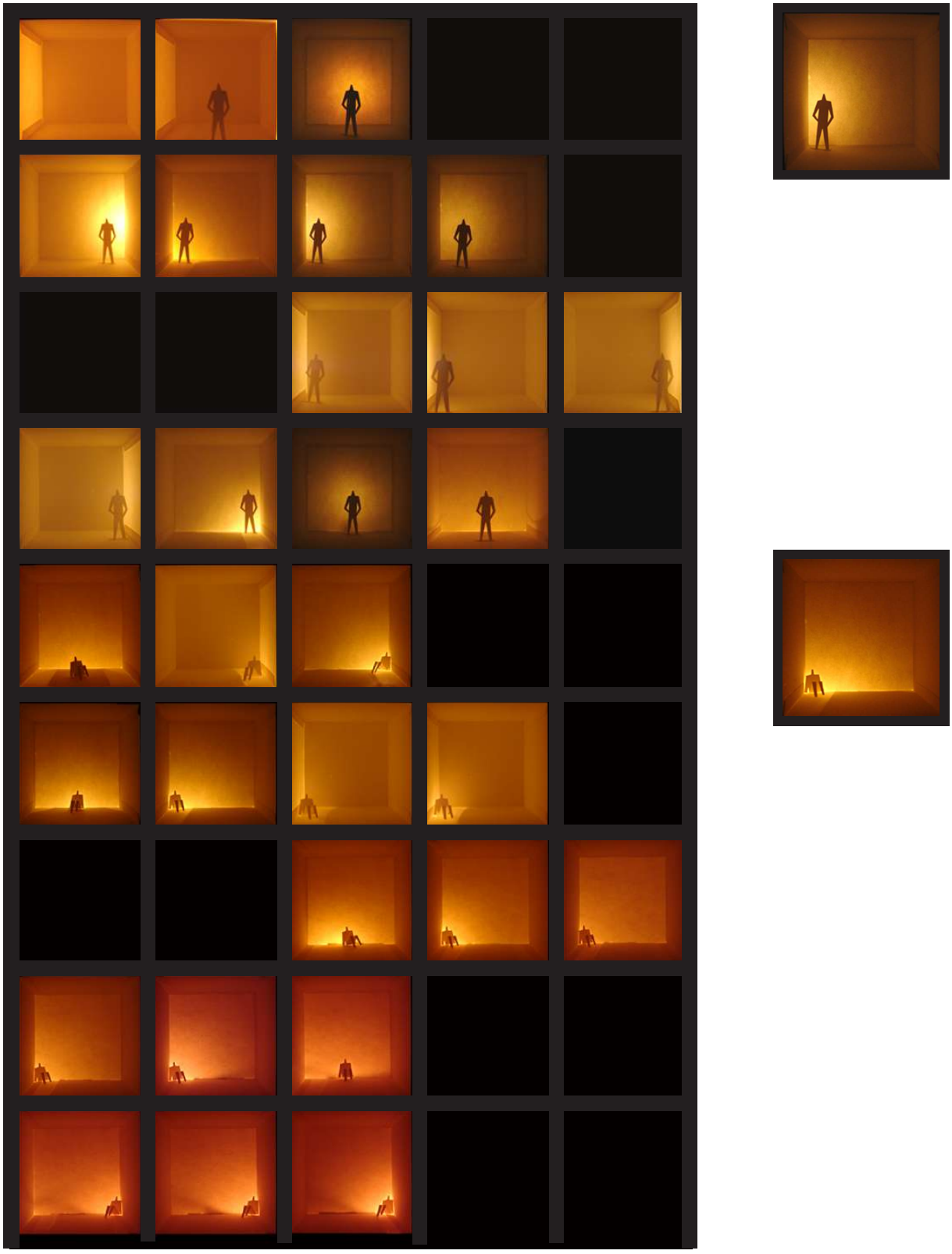


fig. 33

Interactions between *inhabitant* and *space* represented by light, revealing possible affordances of different segments of a space visually. The corners have a quality to retain information (in this case it is represented by light) for long than edges and sides.

fig. 34

Interactions between *inhabitant, inhabitant* and *space* represented by light, revealing possible affordances of different segments of a space visually over time. Showing this study as shaping into a visual-spatial program.

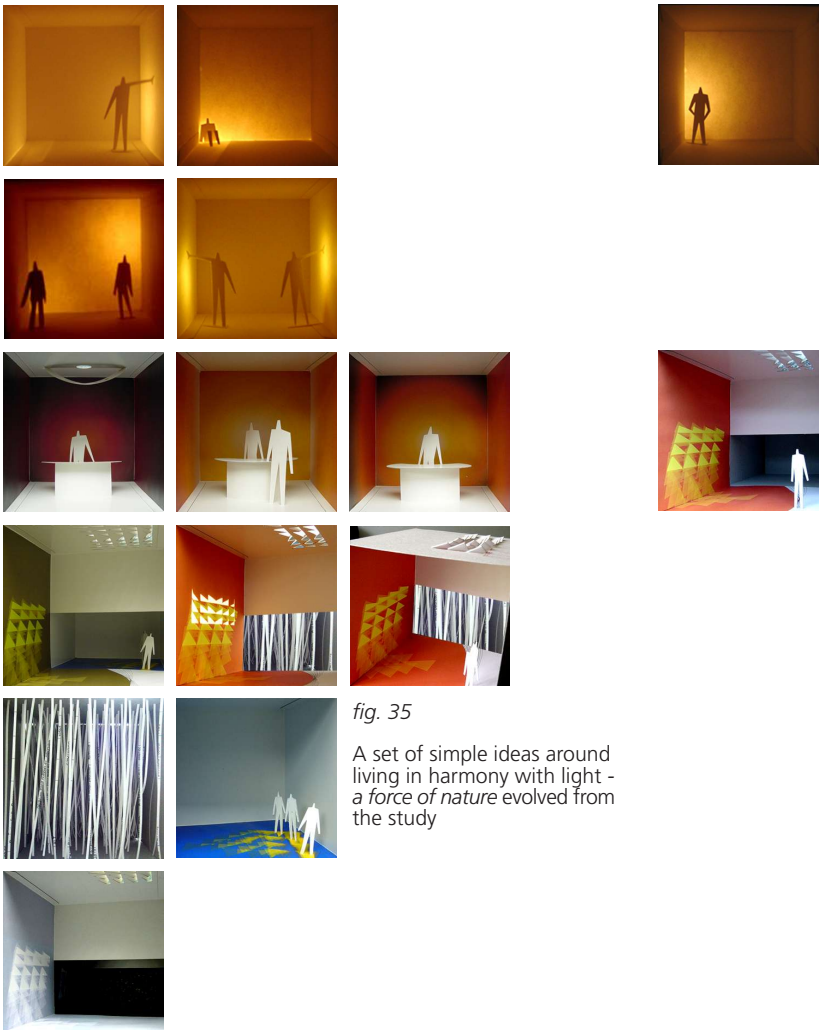


fig. 35

A set of simple ideas around living in harmony with light - *a force of nature* evolved from the study

This study seemed like a visual - spatial program with space as a constant, and light as a display medium of the interactive variations between inhabitants, objects in space and their positions. Progressive addition of variables would make the program more complex giving way to unpredictable results. Besides showing signs of a program in the making, this study helped in identifying basic interactions with a potential to evolve into design concepts, balancing modern technologies with the essence of ancient science in Indian context.

3.2 Concepts

A set of simple ideas evolved that seemed to be appropriately related to the context described in the previous section of this thesis. Most of the ideas attempt to bring out the qualities of nature in response to the interactions performed. The response to these actions is slow and spread across time, sometimes even delayed. With ancient traditions as the context, some of these concepts bring a feel of mythical qualities to the interactions. Three of the concepts that span across different spatial scales; from the static personal space to vibrant social space are discussed briefly with illustrative sketches and pictures.

3.2.1 Personal Sun

In Indian mythology, a sweep of Sun's ray is considered to be essential and purifying for a work space to commence the day. Personal Sun as a concept allows inhabitants to experience changing ambience in their cubicle. The ambient light varies according to the interactions they perform with their work desk. It is an interactive tabletop that senses human touch and lights up the room. Every morning as soon as one enters the workspace, a change in the brightness of the space is experienced when the desk is touched. This indicates the act of cleaning and also purifying the space with enhanced light. In some ways this influences the inhabitant behavior at the workspace and encourages etiquette at the table. The space gets brighter when a visitor sits on the other side of the desk but only by sitting right, resting his hands on it.

fig. 36

Space illuminating to the interactions of the inhabitants with furniture, the desktop

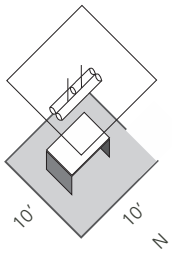


fig. 37

A cubicle space with the system

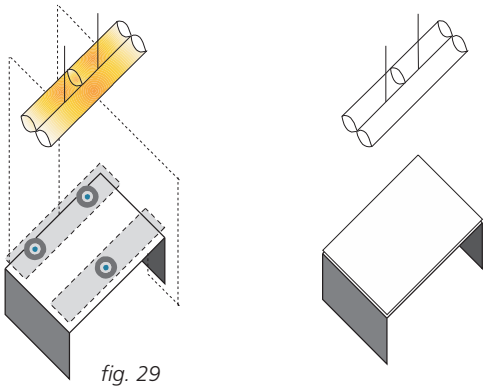


fig. 29

Touch sensors embedded on the surface of the table controlling light

A tabletop embedded with touch sensors on both sides of the table controls light in the space. The sensors enable the room to get bright by controlling lights of the corresponding sides of the table. They brighten slowly when touched and fade off when not in contact.

fig. 38

Finding a form for the table top that enables movement and action along the path of the Sun

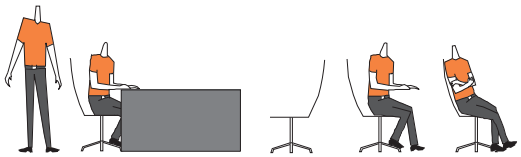


fig. 39

Illustrations showing basic gestures around which 'Personal Sun' works

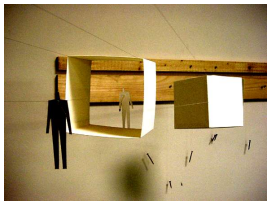
fig. 40

Illustrations showing working of the concept, 'Personal Sun' & the progress bar beneath each frame represents the light in each frame of the scenario

3.2.2 Float

Float is a direction for a thematic prototype, demonstrating the interactions captured through model-based study. It is an interactive installation put up in the corner of a room, a true scale replica of the model. Cubic models along with scaled human models are suspended from strings. Their arrangement is based on the forces acting diagonally and along opposite directions in a space according to the ancient science.

They are arranged in such a way that when scaled human models are moved through the hanging cubes or when the cubes are moved over human beings, the cubes will glow. Similarly, other floating cubes and human models when engaged in interaction will demonstrate those captured in the study.



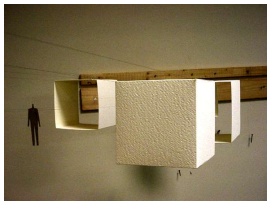


fig. 41

'Float' set up in a real space

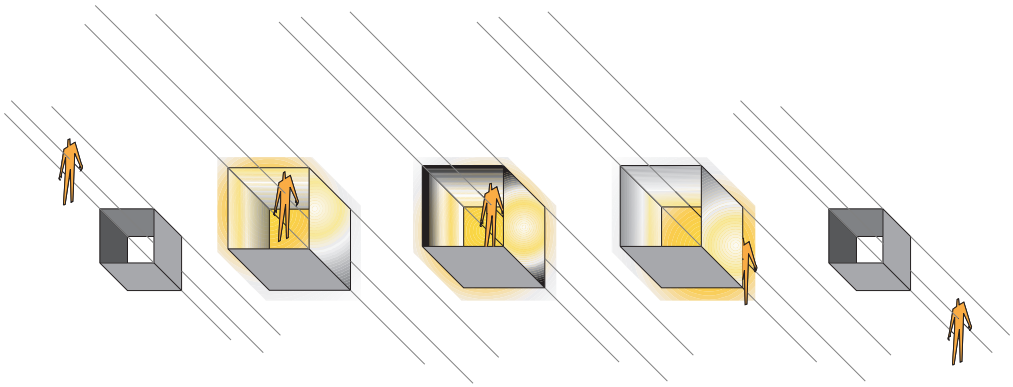
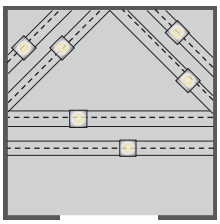
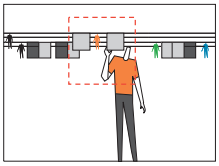


fig. 42

Illustrations demonstrating the working of 'Float'

Nylon strings fixed to the walls of a 300cm x 300cm x 300cm room, support the floating cubes of 16cm x 16cm x 16cm and scaled human models made of paper. When a human model is moved through one of the cubes, a magnetic switch embedded in them activates a group of LEDs placed inside the cube. The idea is to enable the cubes to light up gracefully and fade out slowly, as and when the human models are moved in and out respectively.





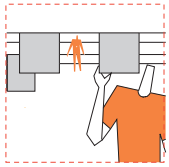


fig. 43

300cm X 300cm space for the 'Float'

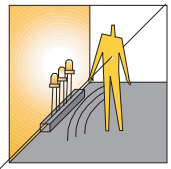


fig. 44

LED's light with magnetic sensing when a scaled human model is in the proximity

3.2.3 Sundial

This concept is based on the unconsciously aligning tendencies of the inhabitants while in transit. This considers aligning with the configured spaces, with the patterns on the floor, with dividing lines and with momentary shadows. This is set up in the atrium space of a corporate building with moderating skylights. This space encourages movement in synchrony with the Sun. A moment of coincidence with the position of the Sun enables skylight units to open up and create patterns on the surfaces within the space. The space is proportioned so that the Sun falls through the skylight on the natural green lawn creating varied patterns. This is brought to life by photosensitive plants in the green area of the atrium space.

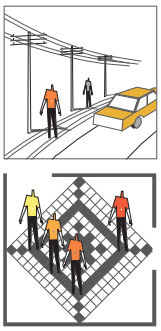
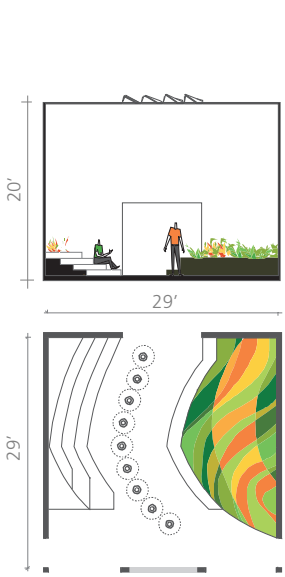


fig. 45

Aligning with the shadows of electric cables along the street and with the patterns on the floor



Section showing skylights and scale of the space

Floor plan showing layout of the embedded sensors and reactive plants

Roof plan with skylight arrangement

fig. 46

Drawings showing 'Sundial' in the atrium.

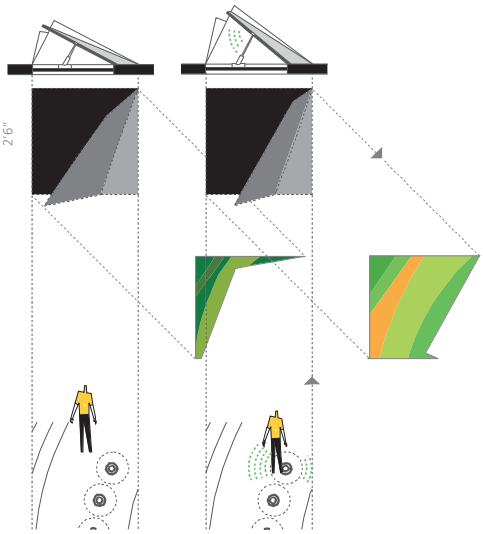


fig. 47

Details showing skylights responding to the interactions of the floor through pressure sensors and changing the color of photosensitive plants

Of the three ideas discussed, the concept 'Sundial' is carried forward to work in detail. This is placed in the real context of a vibrant social space (an atrium in a corporate building) chosen for its simplicity. This serves as a good point of entry for interactive technologies into a space with a traditional history. It is a simple but vibrant space to demonstrate the time-based qualities of aligning with natural forces through mediated interactions. This signifies balancing new technologies with ancient traditions in a most simple way in an architectural space. By keeping the demonstrative needs of this project in view, 'sundial' is a simple concept to execute and demonstrate at a prototypical scale. Thus, 'Sundial' becomes 'Sunscapes'

3.3 Sunscapes

'Sunscapes' is an extension of the 'Sundial' concept, based on the situations and activities that happen in the contextual atrium space of a corporate building. This is conceptualized for the atrium space of a corporate building located in India. This is a vibrant transition space for people to move through and access other areas of the building. Some times it acts as a trellis of pathways enabling inhabitants to move unconsciously aligned to certain predefined paths. Also this is a place for people to relax during tea breaks once in the morning and once in the afternoon. This space acts as a meeting place to socialise and meet visitors. People flock this space in the lunch break around mid afternoon. Then finally, special occasions and events bring people in groups.

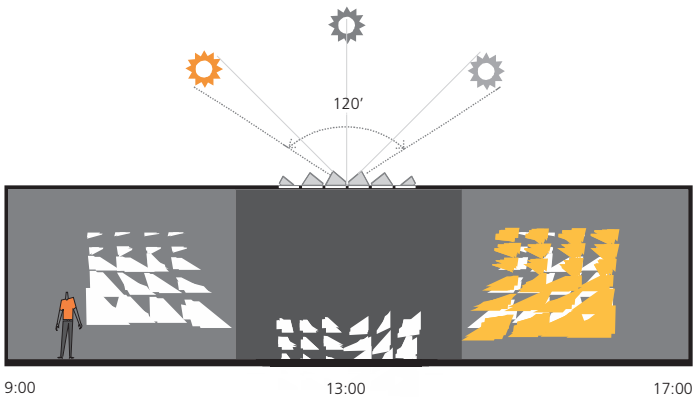


fig. 48

Progression of Sun's shadows in a space with skylights from 9:00 am to 5:00 pm, a 120 degree shift.

Sunscapes are superimposed digital projections with natural patterns of the Sun. They bring down the display time of interactions in order to keep up pace with the slow but steady 120 degree shift in position over a 9 hour cycle. This provides an almost instantaneous display of interactions as compared to the slow reactions of green life in 'Sundial'. In 'Sunscapes' projected graphic patterns triggered by the inhabitants' interactions with the space get superimposed onto the Sun's shadow patterns projected through the skylight marking a momentary experience of living in harmony with the forces of nature.

This is a double height space, proportioned well enough for the Sun's shadow from the skylights to follow the adjacent wall, the floor and the wall opposite to it. A digital projector is mounted on to the ceiling to project a digitally created trail of patterns that follow the natural patterns of Sun. Sensors embedded in the floor trigger digital projections when a person interacts with them, by aligning oneself with the position of the Sun.

3.3.1 Understanding the user

The experience of working within Indian architectural space gives a better understanding of users, who doesn't hesitate to modify building plans and seek minor adjustments, to live by *Vastu Shastra* principles. Arrangements like permanently closing doors facing wrong directions, aligning doors to make the passage through adjacent spaces direct and clean; and re-orienting the entrance of their residences if it is not facing North or East. Further, breaking compound walls in order to keep them perfectly parallel with a direction is an extreme instance. Adjustments like re-arranging interiors, re-orienting furniture to face either South or West, placing religious idols in the North East corner are strictly followed by people who live by *Vastu Shastra.* It is believed to have profound effect on their well being. Two user personas are discussed here based on the contextual inquiry conducted with seven employees of Vanenburg Information Technologis headquarters in Hyderabad, India. This enabled deeper understanding of the context they live and work in.

fig. 49

Vanenburg Information Technologies headquarters. Hyderabad, India

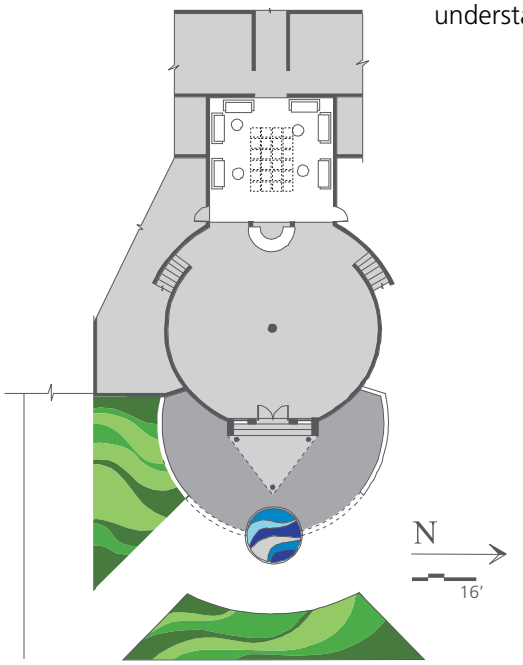


fig. 50

Plan of Vanenburg building showing entrance foyer, waiting lounge and the atrium.

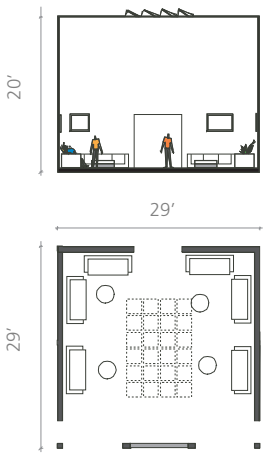


fig. 51

Details of the atrium space

Shankar Narayan is a program manager, working for Vanenburg, an information technology company in Hyderabad, India. Narayan is a well-educated, married man who has been working for seven years. He is from a traditional family and like many of his colleagues he has an inclination to both; traditional and the modern. This is reflected in his taste for music, he has a good ear for Hindustani classical and little of Jazz. He performs all traditional rituals and celebrates festivals at home, as per the tradition and enjoys socializing with his friends from work.

> He has recently moved to a newly furnished home, finally realizing his desire to live close to his work place. The conservative side in him wanted this new place to be perfect, leaving no room for disorientations and misalignments of spaces and objects with nature. He goes for minor adjustments as advised by a so-called *VastuShastra* expert. He reoriented the master bed so that he faces the South while sleeping and swapped the guest room in the

South East corner with the Kitchen. Now he has no more concerns about his new place, as every one of his social class with similar thinking have directly or indirectly approved his choice. He is equally concerned about his cubicle at work. He re-oriented his desk so that he faces north, facing east would have been ideal but that would mean showning his back to the visitors entering his cubicle.

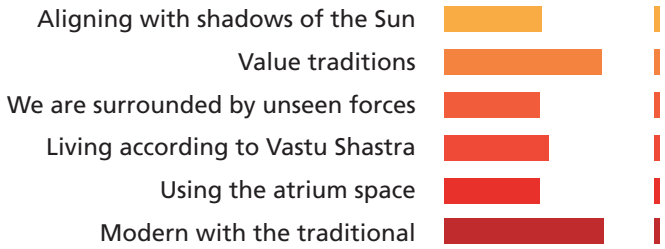


fig. 52

Diagram showing the results of the user study at Vanenburg

I value our traditions and believe in Vastu, but I think before blindly following them
- *Rajneesh, Documentation Engineer*

My rented flat is not according to Vastu, but may be my new own house will be
- *Madhuri, Instructional Designer*

New technologies should enable living as per traditions, but I have no idea for our atrium space
- *Manzoor Khan*

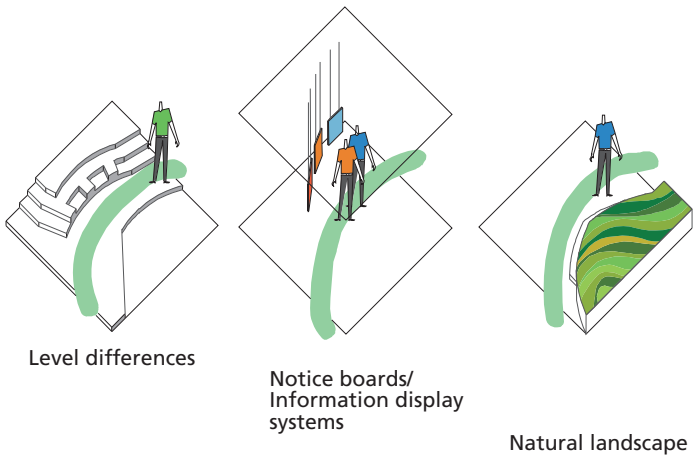
Anand Sharma has been working as a Senior Accountant with Vanenburg for four years. He is in his early 40's living with his wife and two children. He hails from a pure traditional family. From his ancestors he learned that there exists various unseen forces surrounding us.

He has tendencies to align himself with the orders of nature. While walking along a colonnade of trees, he walks under the shadow of the tree trunks. His footsteps unconsciously follow the shadows of electric wires on his way. He is very particular about living life in proper alignment with the forces of nature as learnt from the *Vastu Shastra*. His colleagues are not surprised when he takes a slightly longer curvilinear path to his work place while walking along the transition space instead of a directly going ahead. His work place is perfectly arranged according to the principles of *Vastu Shastra*, with his position and main objects correctly oriented.

These two personas represent a large user group working in the same company and similar companies in developing cities of India. These personas are quite specific to Hyderabad, a fast developing metropolitan in South India. With huge investments in building construction by information technology companies, there is a great focus on creating architecture that reflects the image of the company and the legacy of the place it is situated in. This provides an ideal opportunity for hypothetical projects to be conceived, demonstrated and possibly executed.

3.3.2 Explorations in spatial arrangement

This section illustrates various form factors and arrangements in a space that would influence inhabitants' movement within it. Keeping in mind that this space acts as an intuitive interface for 'Sunscapes', several types of spatial arrangements are illustrated and briefly explained.



Level differences besides defining circulation in a space provide information seating

Notice boards and display systems provide orientation and define circulation to a space

Natural landscapes define circulation and give a refreshing experience to the inhabitants

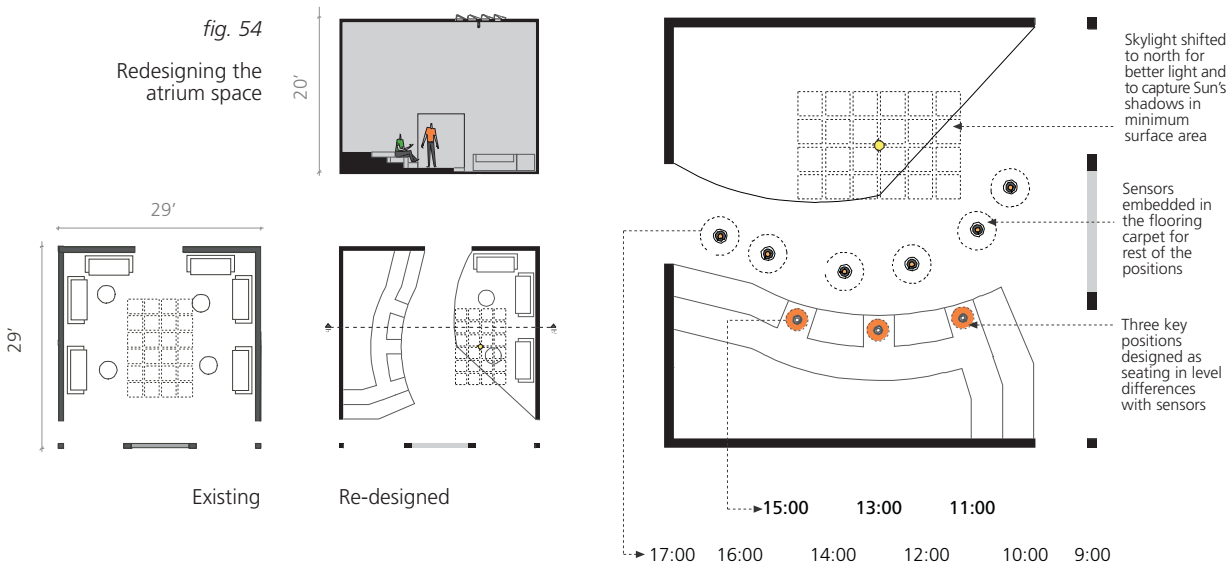
fig. 53

Illustrations showing ways of redesigning atrium layout to influence the inhabitant movement in harmony with the Sun

Since the shadow of the Sun always falls on the opposite side of it, a simple intuitive interface will be helpful to the inhabitants to find themselves in alignment in relation to the position of the Sun. For the sake of interface comfort, and to make the coincidences less so, three positions are marked. These positions take the form of sensitive furniture for people to spend more time in these spaces and understand if they are in line with Sun's position to see patterns created by them overlapping with that of the Sun. Two of them signify tea breaks, one at 11:00 am in the morning and the second one at 3:00 pm in the noon, and another position at lunchtime at 1:00 pm.

fig. 54

Redesigning the atrium space



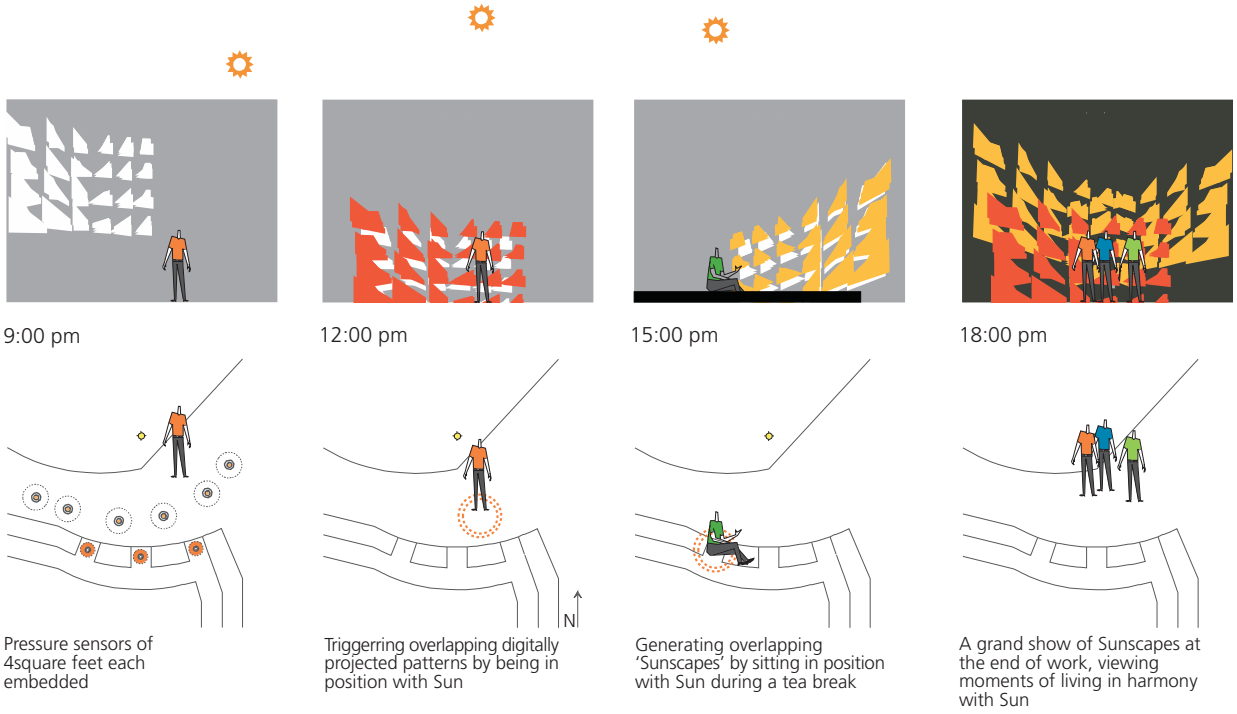


fig. 55

Illustrations showing 'Sunscapes' during a day

The rest of the positions are unmarked as they refer to positions in transit time, but these invisible positions in the path of the Sun are marked with sensors. These sensors are sensitive across a greater surface area of about a 4 square feet each. This allows for greater probability to see triggered graphic patterns in alignment with moving shadows of the Sun. During the evenings just after the working hours at 6:00 pm all the 'Sunscapes' that have been triggered by human interaction with the system get displayed on a grand scale in the space culminating into an abstract understanding of moments spent in harmony with nature.

The longer and denser the visual play at the end of the day, the more harmonious has the day has been with nature and so on. This phenomenon can be set up to work in such a space during sunny days. 'Sunscapes' runs on solar power to balance the experimental with the practical. Due to the fact that it is set up in the Indian context, chances are that this will be experienced almost through out the year, as it has a temperate climate.

Studying Sun's shadow patterns in an existing space across time

As a part of the implementation of the concept 'Sunscapes', a short study was conducted in Talponia, our apartment complex in Ivrea. The parking gallery of this semi circular apartment complex has skylights arranged linearly, providing a good reference. It was helpful to capture pictures of the shadows of the Sun to understand the progression of patterns created by the Sun through the day. This formed a good reference to create digital simulation of the situation for the prototype.

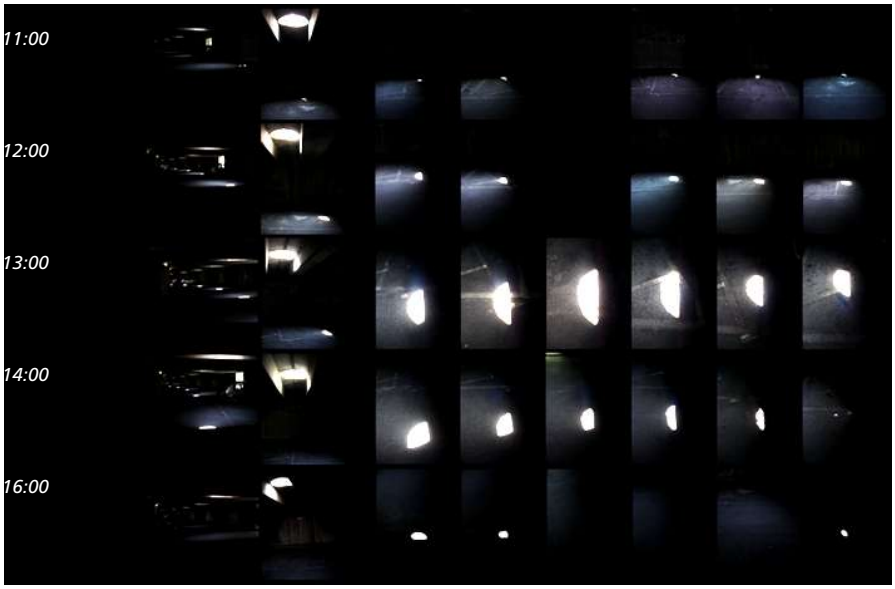


fig. 56

Progression of Sun's shadows during a day at Talponia, Ivrea

Overlapping Sun's shadows and digital projections

This is a short visual test conducted to see how exactly it works when a Sun's shadow digitally overlaps the graphic patterns that represent human interactions. Here are the pictures captured from a test conducted in a dark studio space by projecting images of the Sun's patterns from a projector and digital patterns from another. The result is satisfactory, as a digital overlap doesn't eliminate the Sun's patterns. This study helped to realize, that this phenomenon could be visually more effective if carefully created and programmed.

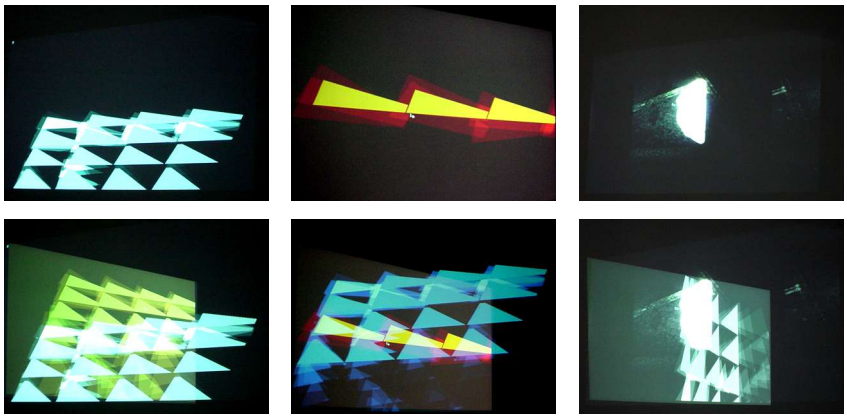


fig. 57

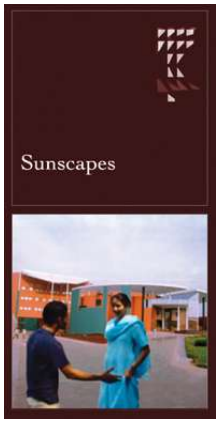
Natural + digital, overlapping Sun's shadows with digital projections

3.3.3 Use case scenario

A montage of a video scenario with animation demonstrates the phenomenon as it happens through a day in real space when 'Sunscapes' is in operation. This is set up in the atrium of a corporate building with positions marked as triangles on the floor to give orientation. This shows the basic interaction with the space, which is a predefined walk through it. A person can step intuitively to create overlapping digital patterns at the right moment by observing the position of the Sun's patterns in the space.

This scenario is setup at Vanenburg Information Technologies, Hyderabad, India.

Deepak comes out of his office, Vanenburg to receive his old friend Deepa.



Deepak:
Oh my God!
Look who is here.
When did you come back from Italy?

Deepa:
Good to see you Deepak, actually I'm visiting my parents

Deepak:
Come, come! let's talk over some tea. Would you like to have some?

Deepa:
Oh! sure

Deepak:
So you are visiting our new office for the first time. I must say , this office is unique. We have tried tostrike a radical balance here between new technologies and traditional architecture.

Our city is seeing a new wave of investments in information technology.

Deepak:
Look this is our atrium, the most vibrant space. It is actually a waiting lounge for visitors and designed to project right image of our company and its people.

Its 11:00 am now, let me show you something. At exactly this moment this space reacts to my alignment wit hthe Sun's position.

Deepa:
hmmm! that sounds intriguing.

At 6:00 in the evening all the triggered patterns are played together grandly, bringing atrium to life towards the end of a day's work.

fig. 58

Video montage of the use case scenario

3.3.4 Thematic prototype

A prototypical model was developed based on the 9 square grid of the *Vastupurusha Mandala* to demonstrate interactions of the concept 'Sunscapes'. This system comprises of a physical model and a computer screen to display the user interactions. The physical model acts as a simulated interface to the 'Sunscapes' environment. This uses a simple touch sensing technology to trigger digital patterns that overlap with the patterns of the Sun when interacted with, at the right moment.

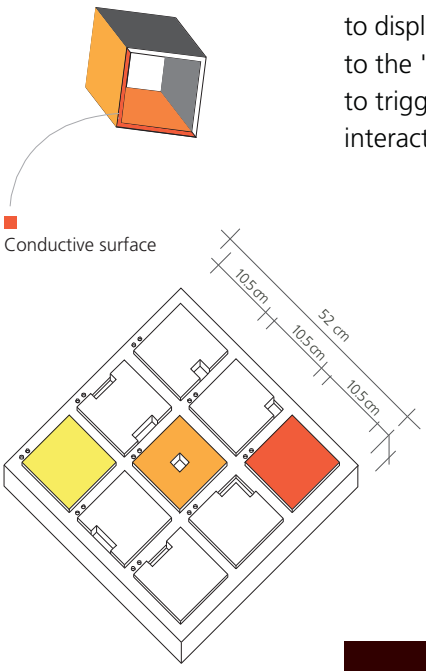


fig. 59

Drawing of the physical prototype with 9 square base and the cubic space frame on top

Physical model interface

A 52cm x 52cm square base made in cardboard serves as a platform for 9 squares of 10.5 cm side each arranged on a 3 x 3 grid. These squares when mounted on a transparent cube of 10.5 cm display information related to each square. In this conceptual prototype each square is indicative of the position of Sun at that time. The transparent cubic space is representative of an inhabitant moving in the real atrium space. A LCD screen represents the wall surfaces in the atrium, showing constantly moving patterns representing the Sun moving at a scaled down rate in time and space. When the cube is placed on one of the squares, it completes the space and triggers graphic patterns displayed in harmony with the patterns of the Sun.

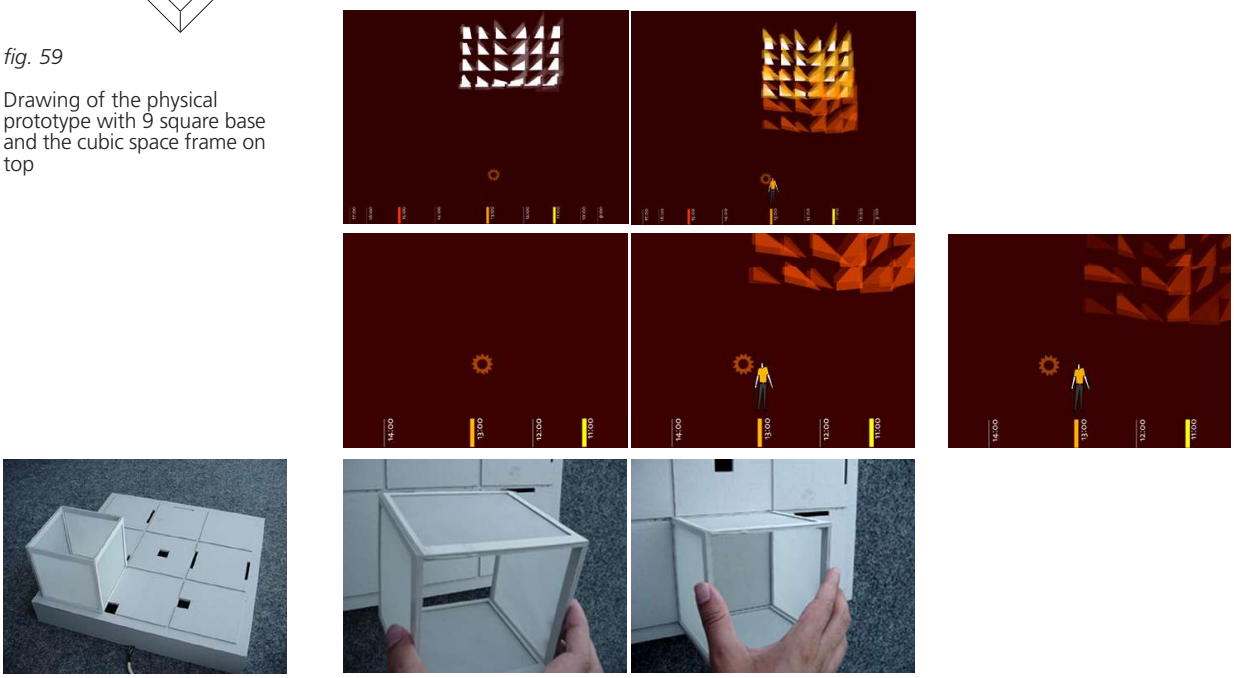


fig. 60

Pictures demonstrating the working of Sunscapes with physical prototype triggering patterns overlapping with simulated Sun on the screen

Digital simulation

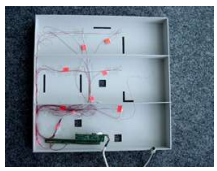
A screen-based simulation of changing patterns of Sun through 9 working hours of a day is created. On top of the Sun's pattern is a parallel track indicative of 9 different triggers from 9 squares. This is revealed when the cube is placed on the right square at the right moment with a margin of few seconds for assessing the right position of Sun's patterns. This simulation is seen responding to the interactions performed at the right moments with the cube and the 9 squares base marking a momentary experience of living in harmony with the forces of nature.

3.3.5 Implementation & technology

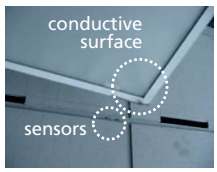
The thematic prototype of 'Sunscapes' works on the same principle as it would at true scale in a real atrium space. The difference is that in the real scenario touch sensors with a sensitive surface area of 4 square feet each are embedded in the floor or on top of the informal seating created through level differences depending on the positions and their significance in the context as described in the concept.

In the prototype, a set of 9 keys (extrapolated from a computer keyboard) representing the 9 possible interactive positions in the real space have been laid out on a square base. The cube acts as a key to trigger information on the screen once it is placed on one of the squares of the squares base. This cube has a conductive material that completes the circuit as soon as it touches the sensor on the base. This triggers graphic patterns on screen superimposed onto the Sun's patterns if placed in time. Each position is programmed to remain active for five seconds, so a position of the Sun has to be caught in that time and the cube has to be placed on the right square.

Sensors of keys in a computer keyboard



Embedding 9 keys into the 9 square base, assigning a key to each square



Conductive surface on the cubic space frame & the sensor of a square on the base

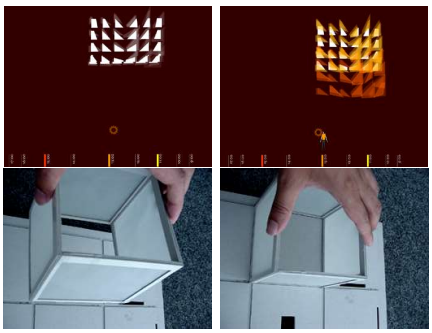


fig. 61

Pictures showing making of the physical prototype

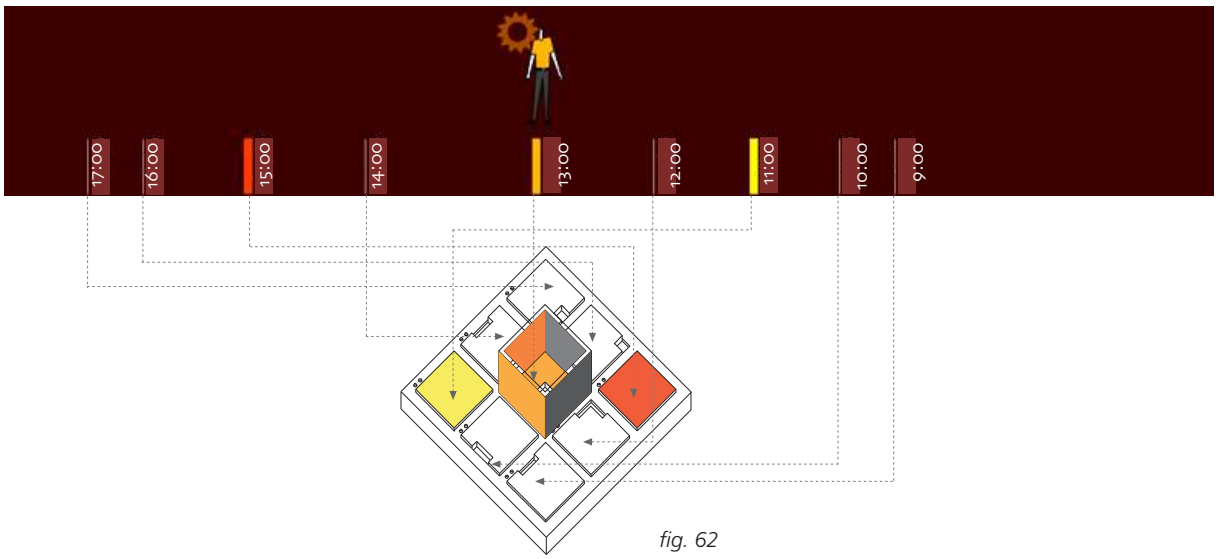
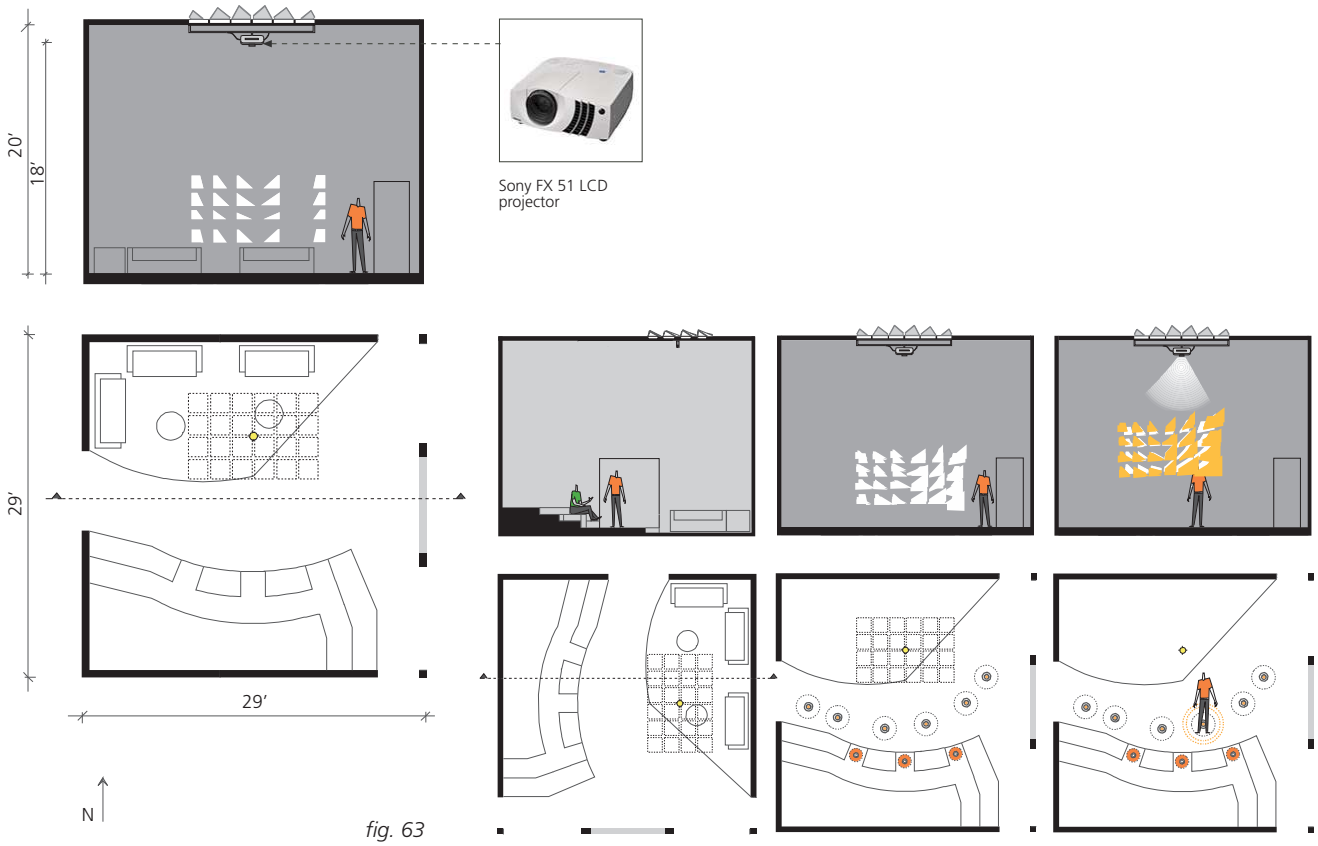


fig. 62

Drawing showing mapping between the positions on the physical prototype interface to the onscreen simulation

The interface is designed to be a bit ambiguous as the intention is not to inhibit the character of the space by marking positions. The building itself is used as an interface with designed arrangements of levels, where the furniture or landscape maximize the chances of matching the position of the Sun. This retains the character of the place and makes it a discreet and playful activity with lot more fun than that of an ordinarily mapped interface.

A Sony FX 51 LCD projector with short throw wide angle lens mounted at a height of 18' in a double height atrium projects image of size 14' x 10' 6". This projects digital patterns that overlap with Sun's patterns. The real set up will be in a space of 18'x18'x18' cube with the skylight right in the center as shown in the drawings.



Sony FX 51 LCD projector

fig. 63

Drawings showing the working details of 'Sunscapes' atrium space

Re-designed atrium layout showing embedded touch sensors

Projected digital patterns on the wall in reaction to the action on the floor

This space is ideal for digital superimpositions at nine key positions of the Sun, from 9:00 am in the morning to 5:00 pm in the evening, every hour. This phenomenon is active every hour in between 9:00 am and 5:00 pm. So in total there will be nine positions with an active time of 10 seconds (5 seconds before and 5 seconds after) each non-key (in between) position in an hour. Two tea breaks, one at 11:00 am and another at 3:00 pm and a lunch break at 1:00 pm are special positions with more vibrant digital patterns. A grand vibrant display of all collective harmonious moves on a given day occurs at 6:00 pm at the end of the day at work.

4 Evaluation & analysis

To create a new experience of living in harmony with the forces of nature is the main premise that was set forth in the introduction of this thesis. This is supported by discussing ancient traditions and new technologies in the context and background section and also by documenting a study of the basic interactions in an architectural space.

Working through the process has raised issues of balancing tradition with the modern and to create these experiences based on existing interactions. These were helpful in guiding the process of design. This is clearly a point of entry into a space that is essentially traditional and is getting increasingly technological. Corporate architecture in India is observing a great deal of investments, opening up opportunities for interactive technologies at a large spatial scale.

4.1 Overview

The setup in an atrium reacts to the regular movements of the inhabitants that are subtly guided by arrangements of levels and objects in the space. The Sun, the representative of the cosmic force encourages inhabitants to be aligned in this space. Movement in harmony with the changing patterns of the Sun is represented by the overlapping digital patterns triggered by the inhabitant's movements through a sensitive, defined path in this space. These designed coincidences mark a moment of harmony with the forces of nature. Such coincidences will no more be coincidences as the boundaries between logic and intuition will get blurred soon in this case. It is a rather simple and demonstrative example of how interaction design would manifest itself in such a context. It is essential to design interfaces for architecture rather than add a layer of interactivity over it. This requires a look into existing interactions and adjustments. This would serve the purpose of the interface in interacting with the mediations. The interface and responses to the interactions are designed in a way to maintain the quality of coincidences with nature. By making the interface a bit ambiguous it clearly leaves nature as a dominant factor over the human.

Considering that that a story is told through a context, background, design process and personas, it is a reasonable achievement towards supporting the premise that is established in the introduction. Though practical and

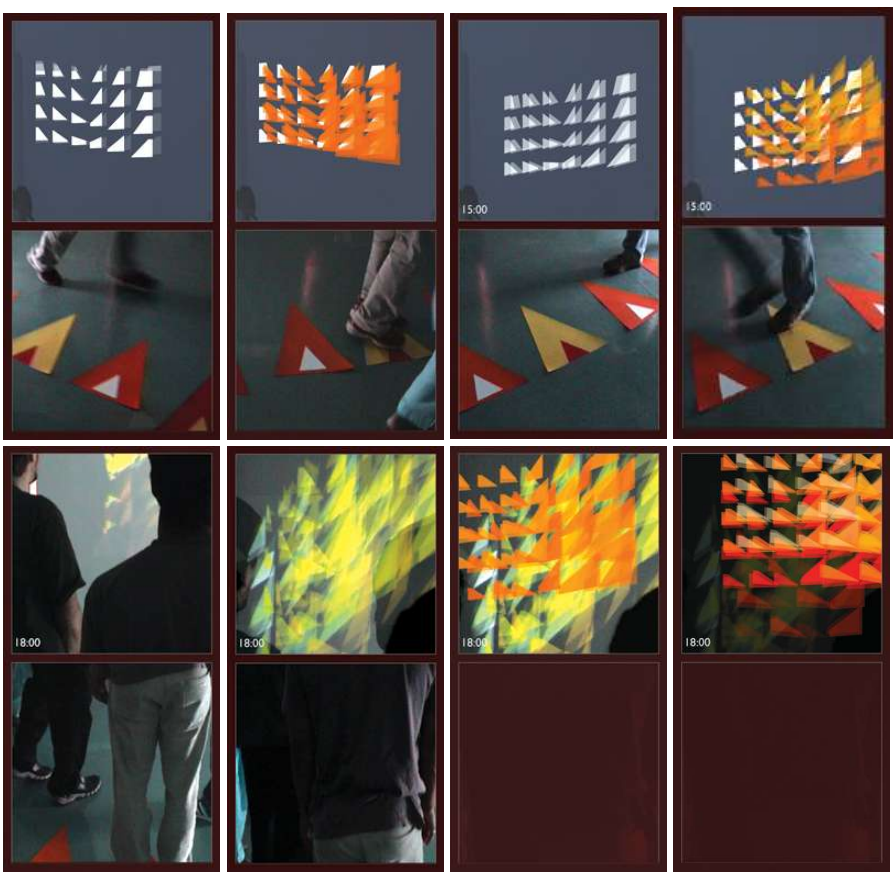
demonstrative limitations have restricted the final design to overlap the digital projections, it would have been more satisfying had this issue been addressed more naturally. Even with the mediation of interactive technologies, it would have been more natural if it were possible for the skylights in that space, to respond to human movement and enable nature to reflect inside.

4.2 Mock up scenario

A group of four users were chosen to run through a mock up scenario. This was setup in a space in the Interaction Design Institute Ivrea. The attempt was to simulate the actual scenario as if it were happening in the atrium of a corporate building. This scenario began with two people walking across the space that is marked with triangles indicating the nine positions of the Sun. They are laid out in the form of Sun's path. The patterns of the Sun created by the skylight are projected on the opposite wall. Then the third person happens to step on the second position and nothing happens. At the same time his colleague walking along with him, and steps on the first position triggering digitally generated graphic patterns. Then another two peoplerush into the space holding a teacup in their hands trying to step into the special position. One of them steps into it to create patterns overlapping that of the Sun. This time the patterns stay for a long duration. After a while, towards the end of the day one user stands on the centre position where the rest of them stand behind, him watch all the patterns triggered through the day in a grand play.

fig. 64

Images from the mock up scenario of 'Sunscapes' showing how it works in the actual space



This mock up is done to see and understand the issues of interface in the space. This run through helped to realize that even though a marked interface helps in identifying the exact positions, it mars the element of fun in it. It seems to have made the interface all the more mundane. It creates more complications at the interface level, as it interrupts the flow of people through the space and forces them to stand in position. This is clearly not the intention of 'Sunscapes' even though the interactions are natural and intuitive like walking across the space. This brings up the issue of mapping the markings on the ground. As the movement of the Sun creates a shadow on the opposite side, the triangles used as marks can be directional signs. This is again a little restrictive as compared to an unmarked interface. This mock-up helped to realize that other architectural ways of defining the sensitive zone as discussed in the concepts section would be better. The idea of the amphitheatre discussed in the concepts section is one of the better ideas of building as an interface. The level difference in the space acts as an interface guiding inhabitant movement leaving coincidences of creating overlapping patterns with that of the Sun as a less coincidence and giving it a dimension of unpredictability.

4.3 User testing the prototype

The objective of this test was to see if the interaction between the physical interface and the screen works well. This prototype is tested with two, one from India and another from Israel, a country with plenty of Sun. The idea is to see how they react to the slow interactions in of the nature manifested in Sunscapes.

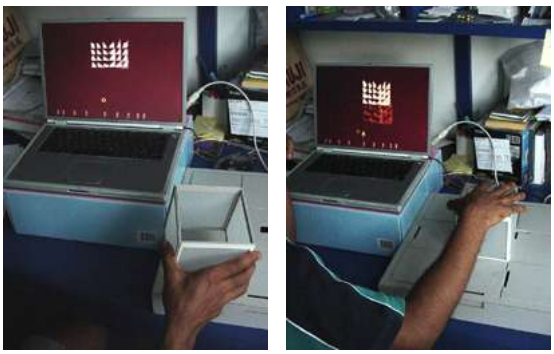


fig. 65

Deepak Pakhare trying the prototype

Deepak Pakhare, an interaction designer from Mumbai, India. He is aware of the importance of Vastu Shastra and its set of rules to live and inhabit spaces. He is the first test user of this working prototype. He was given a brief introduction of the scenario he was about to experienceand a brief explaination about the system. He was also told that the cubic space frame he is holding represents a human being in actual true scale architectural space.

Here is his feedback after he tried to position himself in alignment with the position of the Sun with the small scale prototype. He says, though this prototype is based on the 9 square grid of Vastu, it takes a couple of trials to get the positions right, the mapping right. But a linear interface would have been uninteresting. It would have made it too simple and unlike its true architectural interface version devoid of markings.

This cubic space frame, even though it represents a human being, it would have been appropriate with a scaled human being model on it. The entire square base can have a skylight cut roof hanging from top, as all this is happening under a skylight.

Then Yaniv Steiner, the big hand in making this prototype work is tried as a test user. Yaniv is from Israel, he says they have lot of Sun in Israel. He was chosen as a test user to get inputs of a designer and maker. Also to check similarities between Indian and Israeli culture. He loves visiting India any number of times. He is a gaming expert and believes in instantaneous responses for his interactions. But he too found it hard to match with the Sun's patterns on time. Even though he worked on the prototype he lost his way after placing the cube correctly in the first two positions. Here he suggested markings to the three key positions on the square base.

fig. 66

Yaniv Steiner trying the prototype

Here is his feedback after trying to experience wit h the prototype. He says that working on this prototype is a refreshing experience, as normally he is used to working on interactions that demand immediate responses. He says, "Here you have to wait for the Sun to show up, one has to behave according to the nature. It takes a couple of trials to get the pace and position of the slow moving Sun with the prototype. I would imagine it to be in an oval space at true scale. The colors of Sunscapes are very close to the warm yellow pastel shades of the Sun light in Israel."

4.4 Findings & future steps

Findings

Harmony in Architecture might sound like a native phrase for architecture and architectural practice. The process and work described in this paper is an attempt to see how interactive technologies manifest themselves in a context with traditional values. Some of the findings are discussed here that could have influenced the course of the project.

This project has adopted a visual way to bring harmony in to architecture to display. It would have been more challenging to work on and probably more interesting to experience harmony in architectural way. In a sense interactive technologies can subtly get into the fabric of architecture and enable new experiences by retaining the hidden harmony in architecture and design.

In such a frame this project is partially successful, as it could retain architectural interfaces through digital mediations. Even the display of the interactions is partly architectural and predominantly digital. It would have been more satisfying had the display also been architectural instead of visible digital interventions making it a complete experience of building as a self contained machine and not just an interface.

Working on the thematic prototype at a reduced scale reminded me of my graduation days when I used to work on scaled models in paper. This prototype has filled the gap between physical scaled models and online simulations of interior spaces. It demonstrated the connection between physical forms and on screen demonstrations of the interiors of these forms. This can find application in tools for practicing architecture.

> It is always important to involve a third person's opinion in the project work. Yaniv's contribution has been valuable much beyond the workings of the physical prototype. Working with him helped me communicate the project better and simultaneously refine it with his inputs whenever we worked on the prototype together.

Future steps

Projects based in the context of new technologies and ancient traditions should try to achieve a balance between both. Traditions have to be understood and efforts have to be made to work on the essence and values of the tradition, and not just on the apparent practices.

Working with space as an exclusive medium instead of working with digital displays would be the next step in this direction. To setup Sunscapes in the proposed site in India and see how it works is an immediate next step to learn things. Sunscapes might be mistaken as an attempt to make the unseen forces visible. But it must be noted that the visual medium is used here to show synchronous moments between nature and human interactions. This can find practical applications in galleries and atriums of important large-scale buildings in Indian architecture. Sunscapes is an example of work based on one of the influences of the ancient science - the cosmic influence. Working on the concept ‘Float’ to demonstrate the dynamics of natural forces through qualities of interaction design is a direction to explore this influence.

A design process should reflect the qualities of the theme it is based on. Working on cubes and light, the representative of cosmic force falls in line with the cosmic influence on architecture as referred to in the ancient science. The cube refers to the square based grids as suggested in the *Vastupurusha Mandala*.

> The solutions to the design issues in the intersections between new technologies and architecture will be hidden in architecture itself. Efforts have to be made to identify them, enabling interactive technologies to become a part of architecture's hidden harmony. Interactive technologies when applied, should help inhabitants to experience the hidden harmony in architecture.

5 Conclusion

This thesis presents harmony in architecture within the context of new technologies and ancient traditions. Beginning with a model-based study the process followed on the way to *Sunscapes* is discussed in detail. A method of evaluating and user testing is presented and explained. Hopefully in near future, architects and space designers will look into their regional and traditional values for better contexts to design applicable interactive architecture that will flourish as meaningful expressions. The architectural context of intersections between new technologies and ancient traditions reminds one of the questions that has to be answered time and again to bring some substantiality issues into this domain. What is the role of interaction design in such a scenario, where inhabitants desire new experiences of living with tradition along with interactive technologies?

> As more interactive technologies span into architectural spaces and as we begin to interact with the buildings and building typologies, building as an interface acquires prominence. Interactivity in architecture will look beyond the surfaces and facades, to come up with experiences in architecture as a medium. Hopefully interaction design is practiced towards maintaining and bringing hidden harmony in architecture to our experience.

6 References

Angelika Taschen. *Indian Style*. Taschen. Koln. 2001

Casey Reas. *Behavioral Kinetic Sculpture*. M.S. Thesis. Massachusetts Institute of Technology. 2001

Chris Johnson. *Geometries of Power, Imperial cities of Delhi*. University of Sydney. 2002

Gaston Bachelard. *The Poetics of Space*. Beacon Press. Boston, MA. 1994

Gianni Ranaulo. *Light Architecture, New Edge City*. Birkhauser. Basel, Switzerland. 2001

Kevin Lynch. *The Image of the City*. MIT Press. Cambridge, MA. 2002

Luis Fernandez-Galiano, Gina Carino. *Fire and Memory*, On Architecture and Energy. MIT Press. Cambridge, MA. 2000

Mark Lamster. *Architecture and Film*. Princeton Architectural Press. New York. 2000

Pro Architect. *Toyo Ito*. PA Bimonthly Journal of Pro Architect. June 1999

Robert Venturi, Denise Scott Brown, Steven Izenour. *Learning from Las Vegas*. MIT Press. Cambridge, MA. 1972

Roger Connah. *how architecture got its hump?*. MIT Press. Cambridge, MA. 2001

Steven Holl. *Parallax*. Princeton Architectural Press. New York. 2000

Web references

Andrew Dahley, Craig Wisneski, Hiroshi Ishii. *Water Lamp and Pinwheels: Ambient Projection of Digital Information into Architectural Space*
<tangible.media.mit.edu/papers/Ambient_Fixtures_CHI98/Ambient_Fixtures_CHI98.pdf>

Anneke Hackman. *Rules to Build By: The path taken to understanding Adolf Loos*
<http://www.anneke.net/Loos/Paper.html>

Ben Rubin. *Sonic Garden*
<http://www.creativetime.org/sonicgarden/a_rubin.html>

CAST(ARTLAB Prospect2-*Moeller's Works*)
<http://www.canon.co.jp/cast/artlab/pros2/works/aline-01.html>

India Infoline.com. *Hyderabad's Commercial Sector*
<http://www.indiainfoline.com/pefi/hous/hyc6.html>

Galinsky. *Institut du Monde Arabe, Paris - Jean Nouvel*
<http://www.galinsky.com/buildings/ima/>

Marcos Novak. *Transmitting Architecture, The Transphysical City*
<www.ctheory.net/text_file.asp?pick=76>

Marco Susani. *Fluid, personalized, interactive, mobile spaces*
<http://www.teco.edu/huc/keynote4.html>

Michael Fox, Alan, Gray. *Interactive Design: Kinetic Facade of Glass Panels*
<http://people.sd.polyu.edu.hk/~sdmafox/sss/p07.html>

Navitar Buhl LCD Lenses. *Sony*
<http://www.navitar.com/buhl/projectors/lcd_sony_356.html>

Nikos A. Salingaros. *Pattern language and Interactive design*
<http://www.math.utsa.edu/sphere/salingar/PatternInteractive.html>

Pedro Sepulveda. *Digital Shelters*
<http://www.crd.rca.ac.uk/research/projects/digital-shelters/projects.html>

Phil Tabor. *A space for half formed thoughts*
<flow.doorsofperception.com/content/tabor_trans.html>

Rafael Lozano-Hemmer. *Relational Architecture 3 - Re:Positioning Fear*
<http://www.rhizome.org/artbase/2398/fear/>

Serena Lin. *metaphors, architectures, and cyberspaces - an introduction*
<http://research.umbc.edu/~slin1/paper/page2.html>

Tetsuro Fukuhara. *Tokyo Space Dance*
<http://spacedance.sitego.to/en/essay_e.html>

William W. Gaver. *Affordances for Social Interaction, the social is material for design*. < www.cs.ubc.ca/~danilkis/fusion/publications/related/gaver96.pdf>