

An Approach towards Energy Efficient Building Through Integrated Design Studio

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Abstract

A design educator needs to deal with many issues while teaching. Design studio is an important subject of architecture education. The conventional approach to design education follows teaching techniques that are completely different from the realities of design in practice. In design studio, the students develop a solution without investigating, identifying or even understanding the problems to be solved. There is a definite process involved in creation of architecture. Right from the movement when the thought of a requirement of a building steps up in the mind, till it is finally complete there are various steps involved, which are the parts of the process.

Design is not to be seen as a 'subject' of learning but an application of what is learnt from support subjects to design. The concept of an integrated studio is not necessarily new but innovative approaches need to be adopted in its implementation. The rigid format that has been established and followed till date will have to be loosened up. Dealing with various issues and integrating the knowledge acquired in various subjects of architecture curriculum in design studio must deal systematically at appropriate stages. The design process should be organized accordingly as a procedure to solve problems stage wise. While designing any building, our main aim should make a building habitable and comfortable. We must be able to control climatic elements such as daylight, humidity, air movement, thermal conditions etc., by evolving a design process that utilizes these climatic parameters. The climatic approach should be integrated with the design process from the beginning.

So, this paper is an attempt to develop a systematic design process for design studio teaching with climate responsive approach to design energy efficient building.

Keywords

Design process, Design Studio, Climate Responsive Architecture, Experiential Learning

Introduction

We should change our attitude about the environment. Environmental architecture should become the focus and goal of architectural education worldwide.

Architectural education should be more responsive to environmental issues. The academic community should be involved in providing opportunities for future architects and urban designers to develop more socially and culturally

responsible and environmentally responsive architecture. Architectural educators should strive to balance the way in which students view relationships with the physical and social worlds. Architecture students should be made aware of alternative viewpoints including the view of the material world as something to be respected rather than to be conquered and controlled.

In the process of architectural design, we often observe difficulties in resolving the forces that affect the skin of the building. These forces are thermal, luminous, acoustic and aqueous environment, which need to be addressed at the schematic design stage. Because most decisions that affect building's energy use occur during this stage. Each of these factors needs to be confronted in a serial discipline, using scientific method. The process could be followed using analysis techniques, design strategies, evaluation techniques.

Design is a reiterative process of analysis, design, evaluation, redesign and re-evaluation. Initially the designer works primarily in the synthesis mode, bringing ideas together and not in an analysis mode. The schematic design then precedes rapidly involving experimentation with many ideas and combinations of ideas.

Energy requirement of a building can be reduced by using passive, climate responsive design strategies.

It is therefore imperative that we produce design solutions that are eco-sensitive, energy efficient, and climate responsive, user-friendly, and cost effective too. Climate is an important context which greatly influences the amount of energy; a building would use and therefore needs to be analyzed accurately.

Architecture Pedagogy

Architecture education is one of the most distinctive branches of education, which requires various capabilities. The subjects included in architecture curriculum can be broadly divided into three types of subjects,

1. Skill related subjects, e.g. Visual arts, Graphics etc.
2. Knowledge related subjects, e.g. History, Climatology, Building services etc.
3. Application related subjects, e.g. Design, W.D. etc.

All these three types of subjects need to adopt different methods of teaching.

In education we need to proceed from the simple to complex. Each branch of instruction must proceed from the empirical to the rational. The students needs to be told as little as possible and induced to discover as much as possible through self-

instruction. We also need to recognize that drawing is an element on education.

Role of design subject in architecture education

Design is an important subject in bachelor of architecture course. It is the primary space where budding professionals explore their creative skills, which are so prized by the profession. Teaching architectural design has been criticized in the last three decades. A growing dissatisfaction with the current situation in design education appears to be the main concern of researchers and academicians who have voiced the thought that the education of future architects needs to be more responsible to the social demands of the contemporary societies. Such criticism is concerned with making analogies, between the way architecture is approached in the design studio and the way of developing architecture in professional practice.

Certain problems have identified in design studio teaching, such as, the design studio focuses on the 'how' of design, which is characterized by creating and manipulating configuration and forms in response to hypothetical architectural problem the 'how' of design means the act of design itself. It does not take into account the 'what' of design, which is characterized by proposing human activities that are appropriate for certain types of buildings- the 'what' of design means the exploration and the elaboration of the built environment. On the other hand, the design studio does not take into account the 'why' of design, which is characterized by thinking of why a certain type of space and form is appropriate for a certain type of human behavior – the 'why' of design means investigation.

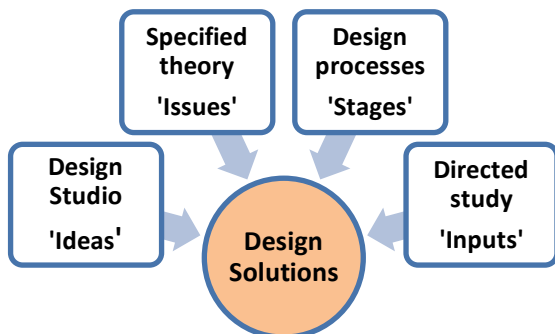


Figure1. Design Studio Components

Importance of process in design:

Process of design in architecture is no different from the documented definitions of process. It could be said as the transformation of an idea from the concept to the design solution. A process could be said to be responsible for the nature of the product. Architecture is generally said to be both the process and product of planning, designing and constructing form, space and ambience that reflects functional, technical, social and aesthetic considerations.

Architecture when thought of at deeper levels of consciousness appears to be a continuous never ending process which speaks of social, economic and geographical factors as parameters influencing it. Another perspective of architecture as a process could be contemplated as all the change that the society undergoes, inventing and reinventing the forms and functions

of buildings with respect to time. The design process is intended to function based on intuition, logical treatment and rigorous reasoning. A design process is a reflective conversation between the materials of a given design situation. In this respect, one could argue that it is a process that involves phases of analytical understanding, critical thinking, and creative decision making. However, design does not occur in a linear manner; it involves integrated thinking where continuous interaction between the phases takes place. (Salama A.,2005)

Design process has been studied for quite a long time. Many theories have expressed their views on design process. Many conferences and societies were formed for research work. The consensus was on design process to be a problem solving procedure, with a three phase sequence of,

Analysis \rightleftarrows Synthesis \rightleftarrows Evaluation

Final product of the design is too assumed by the designer before the means of achieving it can be explored. There are certain common steps necessarily involved in any type of design, though the emphasis may differ.

- Acquiring knowledge
- Setting objectives
- Counter checking
- Implementing

There is a definite process involved in creation of architecture. Right from the moment when the thought of a requirement of a building shapes up in the mind of a sponsor till it is finally complete there are various steps involved, which are the part of the process.

Process and the architecture design studio:

The nature of application of the Process of design in the Architecture design studio has always been discussed and debated. Recent literature suggests that architectural design pedagogy stands accused of focusing more on form issues, while oversimplifying programmatic and contextual contexts within which buildings are created. Traditional teaching practices suggests that typical architectural design pedagogy adopts a product based approach, where emphasis is often placed upon exploring solutions and development of form manipulation skills, while students design actions continue to be tacit and internalized. (Salama A., 1999)

Some common observations made on a similar note from the current scenario of the Architecture design studio in India with due respect to exceptions could be summarized as follows:

1. Missing theoretical base for design: The current design studio speaks more of self expression and fantasy manifested as the design thus crippling the students ability to answer the "how" aspect of design.
2. Emphasizing more on the design outcome than the process: The judgments in the design studio seem to be more on the quantity and quality of the design outcome than on the process that shaped the outcome.
3. Believing the notion, "Design cannot be taught it has to be learned": It is a common belief within the design instructors that they are mere facilitators. Their role with respect to the design produced by the students begins after the student comes equipped with ideas or options or concepts.

In the backdrop of picture painted through the above

observations a few fundamental enquiries become inevitable:

- What does our architecture education system intend to produce? Good architects or draftsman?
- Does design reproduce itself as something out of intuition or instinct?
- If we have something as abstract as an intuition as the driving force for design, will the student be able to analyze the outcome.
- Isn't the design instructor responsible to enhance the creativity of architecture students?

An attempt to answer the above enquiries emphasizes the importance of process of design in the architecture design studio. Consciously following the process will not only enable the students to answer all possible questions pertaining to their design but also equip them with reasoning for the same thereby minimizing their dependence on intuition or instinct as the only base for designing.

Integrated approach in design studio:

A design studio is an environment that enables both the teacher and the pupil to explore the domains of cognitive, affective and psychomotor skills.

Design is not to be seen as a subject of learning but an application of what is learnt from support subjects to design. The studio is like a crucible where all applied knowledge melts into one another to obtain a unified whole. This is what we call as the 'total integration', -Integration of applied knowledge.

Integration of faculty

Integration of students

Every teacher therefore can be treated as a 'Design Teacher' contributing to the integration of the cognitive domain of adjunct subject at various levels of teaching. The concept of an integrated studio is not necessarily new but innovative approaches need to be adopted in its implementation. The rigid format that has been established and followed till date will have to be loosened up. As we all know, design is an interactive process, involving research, reflection and the integration of knowledge. It takes time, space and careful mentoring to acquire the practical and mental ability, the complex interaction of skills, knowledge and creativity that is central to the practice of architectural design. But what about studio culture? How does one start to define such a thing? What are its identifying features?

Management of the Design studio requires prerequisites of visual inputs of the basic requirements, involvement of teachers and co-teachers, understanding of the 'learning process' and an attitude of experimenting and learning from experience. Above all, a realization that they are dealing with fresh sensitive minds is of great importance.

Conventional Design Studio Approach

The conventional approach to design education follows teaching techniques that are completely different from the realities of design in practice. Techniques like, "the written program", "activity chart", "area chart", "circulation within spaces", "the concept formation", "the sketch design", and "the finished presentable drawings" have very little to do with the action which is going on in practice. Large part of what an

architect's provides as a service for society is investigating and formulating client needs.

In design studio, the students develop a solution without investigating, identifying, or even understanding the problem to be solved. The procedures that characterize the design activity in practice differ from the procedures taken in the studio. Design as an application in the studio should be grounded on theories that should be tested with respect to the problem at hand. Design can also be regarded as an "action-reaction" activity, since the action is the process and the reaction is the investigation of the result, which can be questioned and tested.

Although architecture, in professional practice, is always a result of group work and collaborative effort, the teaching style in the conventional approach to design education does not encourage this view. It focuses on individualistic work that does not provide a learning experience for groups, or for the whole studio group.

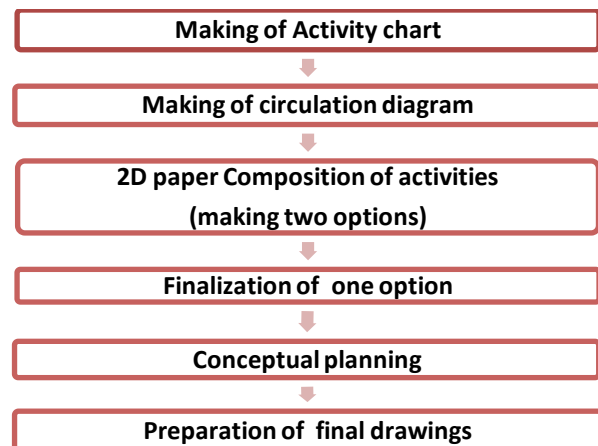


Figure2. Conventional design process

Inferences:

- Stages of working are predefined, teacher simply introduces the task and students work on it.
- Objective less learning process.
- Black box approach of design.
- Cognitive domain based learning.
- Learning by thinking only.
- Not considered climatology in designing.
- Mainly focuses on circulation, composition and presentation.

The conventional approach to design education does not provide adequate knowledge and does not offer a tutorial environment where students acquire and apply knowledge simultaneously. Knowing what and why of design and acquiring knowledge pertaining to the content variables to the design problem can provide a better environment for man and society. To achieve this end, the design studio should aim at simulating the interaction with clients and providing a body of convincing knowledge for understanding users' values. Political and social aspects and the contexts in which buildings are built should be confronted in the design studio.

Implication of energy issues

Energy efficiency in buildings can be achieved through a multipronged approach involving adoption of bioclimatic architectural principles responsive to the climate of the particular location; use of materials with low embodied energy; reduction of transportation energy; incorporation of efficient structural design; implementation of energy-efficient building systems; and effective utilization of renewable energy sources to power the building. Buildings, as they are designed and used today, contribute to serious environmental problems because of excessive consumption of energy and other natural resources. However, buildings can be designed to meet the occupant's need for thermal and visual comfort at reduced levels of energy and resources consumption. Energy resource efficiency in new constructions can be affected by adopting an integrated approach to building design. The primary steps in this approach are listed below.

- Incorporate solar passive techniques in a building design to minimize load on conventional systems (heating, cooling, ventilation, and lighting)
- Design energy-efficient lighting and HVAC (heating, ventilation, and air-conditioning) systems
- Use renewable energy systems (solar photovoltaic systems / solar water heating systems) to meet a part of building load
- Use low energy materials and methods of construction and reduce transportation energy

Thus, in brief, an energy-efficient building balances all aspects of energy use in a building – lighting, space-conditioning, and ventilation – by providing an optimized mix of passive solar design strategies, energy efficient equipment, and renewable sources of energy. Use of materials with low embodied energy also forms a major component in energy efficient building designs.

The approach towards sustainable architecture design helps to establish positive and appropriate contributions to social environment. It has small ecological footprints and the energy efficiency in buildings is affected by decisions to be taken at all the stages i.e. Design, construction (materials & techniques) and maintenance / management. Design is all about optimum resource usage. Sustainability need not have some extra efforts to be put in but it has to be intrinsic in designs. Solar radiation and wind are two important aspects that could be favorable with respect to the context.

The use of appropriate building design and building techniques, as well as external inputs, such as the local environmental conditions, solar energy, wind and water, to improve the indoor climate of buildings, without using mechanical means, is a relatively new field of science, called 'passive space conditioning'.

Climate responsive approach in design

The architect's main aim is to make a building habitable and comfortable. He must be able to control climatic elements such as daylight, humidity, air movement, thermal conditions etc., by evolving a design process that utilizes these climatic parameters. The climatic approach should be integrated with the design process from the beginning, that is, the climatic parameters should be looked at simultaneously with other aspects of building design. Climate and built form are two key

issues directly related to the environmental set-up. While a building design is conceived, visualized in terms of detailed drawings, and executed as a built form, there exists a gap between its form and function, the function here being thermal comfort. The climatically responsive design is that it should modulate the conditions so that they are always within or as close as possible to the comfort zone. Thus a major prerequisite of good building design is to have adequate knowledge of the climatic conditions of the given location. Besides climate the design process involves many parameters including cultural, physical, social, economic and other characteristics of the location. These parameters often need to be taken into account simultaneously, and in a cyclical manner.

Climate Responsive Designing:

Climate plays a pivotal role in determining the design and construction of a building.

Both weather and climate are characterised by the certain variables known as climatic factors, they are as follows:

- (A) Solar radiation
- (B) Ambient temperature
- (C) Air humidity
- (D) Precipitation
- (E) Wind
- (F) Sky condition

The idea of climatically responsive design is to modulate the conditions such that they are always within or as close as possible to the comfort zone. Designing is not a linear process. Design parameters are interrelated and interactive. Often they need to be considered simultaneously and in a cyclical manner. Any process of design must, therefore, allow for this flexibility and dynamism. This process and the design tool are outlined in later sections. Climate responsive design involves considering climate as a parameter of design in every aspect of the building and built environment. These various aspects or parameters should follow a logical sequence. The sequence should proceed from macro level details to micro level details.

Following is the design considerations sequence to be followed while designing, which is framed by Arvind Krishnan, in his book 'Climate Responsive Architecture, A design handbook for energy efficient buildings'.

Climate responsive scientific process of design

Design sequence:

- Landform: topography and slope orientation
- Vegetation type and pattern
- Water bodies
- Street widths and orientation
- Open spaces and built spaces
- Ground character
- Plan form
- Plan elements
- Building orientation
- Surface area to volume ratio
- Roof form
- Fenestration pattern and configuration
- Fenestration orientation
- Fenestration controls
- External colours and textures
- Roof materials

- Walls
- Internal layouts and partitions
- Internal materials
- Internal finishes.

If we see all the design criteria's, they are ranging from macro level to micro level of building design. Hence, the design considerations for climate responsive architecture should follow majorly three levels study i.e.,

1. **Site Level Considerations:** Landform, vegetation, orientation, ground character, water bodies, etc.
2. **Building Level Considerations:** Building orientation, plan form, building volume, roof form etc.
3. **Building Component Level Considerations:** Openings, shading devices, building materials, finishes etc.

In architecture design studio, implementation of these design criteria's could be achieved, with systematic approach. Stage wise inputs starting from site planning, then building planning and detailing will help students in better understanding and its application. Precedent studies, and other climatology related inputs could made their ideas clear.

A properly designed studio schedule could result in better working and output. Time management also plays a vital role in the process. Inputs could be given through books, presentations, live examples, precedent studies, model studies, experiments etc.

Hence with knowledge and use of proper input medium, at a proper time with a proper directed theory, we could frame a systematic design process for climate responsive design studio working.

Defining a Design Process

In the book "New Trends in Architectural Education – Designing the Design Studio", Prof. Salama begins by an introspective view of the current scenario of architecture profession. He presents the spectrum of innovative concepts and practical methods for teaching architectural design, together with examples of different studio teaching. The systematic stage wise design model has been proposed by the author named as Energy Conscious Model.

Energy Conscious Model

This model has been developed by Raymond Cole in the mid 1970's. The teaching /learning format of this model is a combination of a seminar class and a design studio. According to this model, the studio is not a place where everything is knowingly synthesized at the same time. Rather, it is a place where different issues are stressed and explored in a wider context. Cole argues that experience develops when theory is incorporated with design. The main focus of this model is to examine energy issues. Students are encouraged to think within energy terms to influence the manner in which various design solutions are directly and indirectly explored. The model attempts to combine a specified theory with design solutions. The studio work goes concurrently with a directed study, since ideas, issues, and processes are discussed in the context of the evolving design solutions.

To design an energy efficient building, students must enter the process committed to that end. If the student is thinking in

energy terms, this will influence the manner in which design solutions evolve. The process of energy conscious design involves parallelism between the studio exercise and the directed theoretical course. This model focuses on three general phases, each of which has underlying steps that govern the process. The phases are separate; after each one, students are asked to respond to the information and ideas within their design proposals.

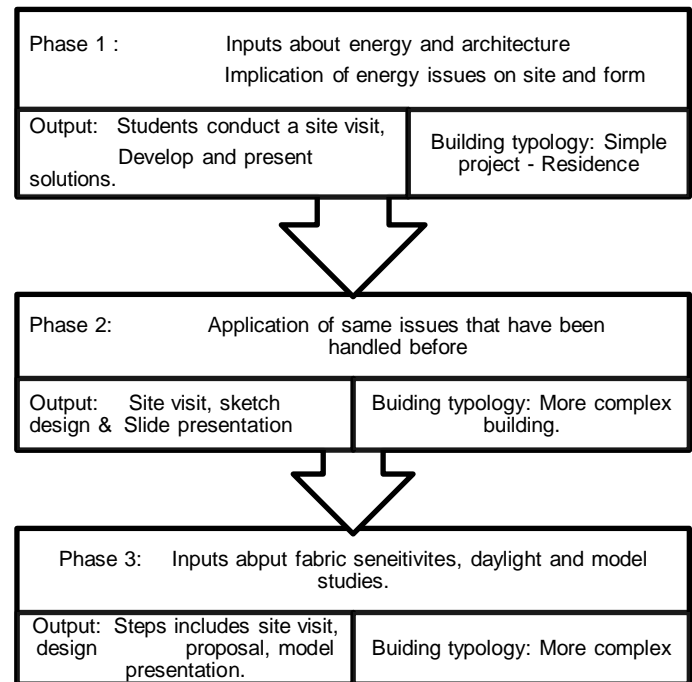


Figure3. Phases of Energy Conscious Model

According to this model, it is important to introduce and apply energy related information to students, taking into account the following pedagogical concerns:

- If the information accessible to, or provided for, the students is inconsistent with the needs of their designs, it is an inefficient, and thereby, ineffective method of teaching.
- If the information is seen as irrelevant, frustrations will be created, the overall credibility will be lost, and the information will quickly evaporate.
- If too much information is presented a tremendous difficulty will exist on the part of the student to digest it all.
- If specific information is introduced too early, the influence may be too strong, since the student may adopt a text book solution and fail to produce the most appropriate energy efficient solution in the face of other design constraints and potentials.

The overall teaching /learning style focuses on the significance of knowledge and how and when it should be introduced. The model also focuses on the appropriate amount of information, and on the thinking of moving from general to specific information. Raymond Cole points out that design teaching depends not only on sensitivity to a formative architectural idea, but also upon the student's expectations of the instructors. The learning of design can be jeopardized if a non

designer has the responsibility of criticizing design decisions. The energy conscious model tries to enhance the ability of students to translate theory into design, since it is based upon combining theory and knowledge into a practical situation. The approach to design is individual, where each student explores different facets at different times. The student / teacher dialogue is important in determining the relative success of this model.

Proposed Design Process

After studying all the parameters, the energy conscious model and climate responsive design strategies, following are the design studio stages framed, based on directed theory and studio work.

Objectives:

- Glass box approach in design with externalizes thinking.
- Objective oriented learning process.
- Teacher decides the stages of working as per progress of work.
- Stage wise input giving and working.
- Follows three phases of working, Analysis- synthesis- evaluation.
- All three cognitive, affective, psychomotor based learning.
- Learning by doing – experiential learning, increases involvement, participation and enthusiasm in the studio.

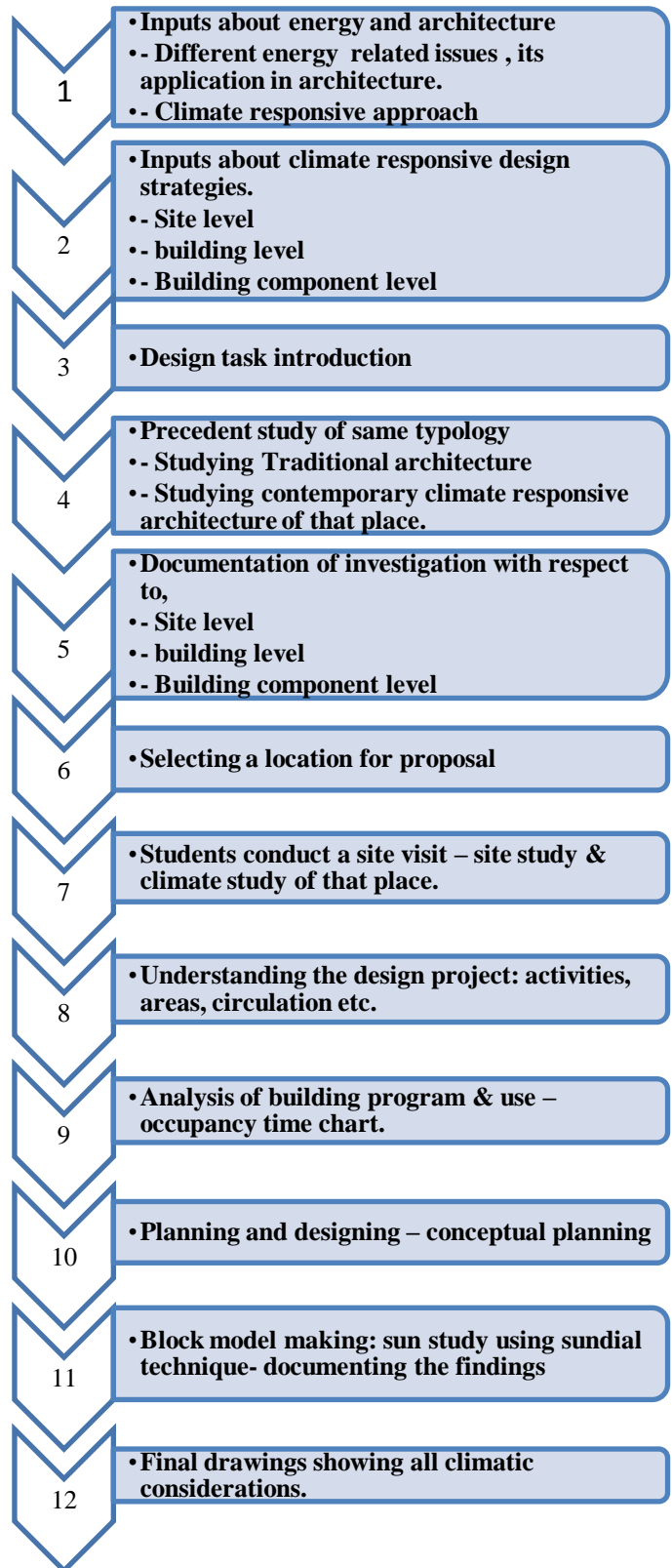


Figure4. Proposed climate responsive design process

Conclusions:

- An educator could develop his own design process for integrated studio, to deal with many issues.
- A systematic approach is necessary in design studio working, which we could achieve through a design process.
- The incorporation of theory with design, results in better understanding of the issues, than the simple theory teaching.
- Application of the energy conscious model help students to know about different energy related issues.
- The precedent studies help students to analyze the design and synthesize the findings.
- Students could learn different design strategies for climate responsive approach from macro level to micro level and could apply them in design.
- Systematic stage wise climate responsive approach in design process, results in effective solutions and better understanding of the issues.
- Systematic design process helps students to follow the stages of analysis, synthesis and evaluation.

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