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Haptic Teaching-Learning Practices in Architecture Education

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ABSTRACT

In any teaching-learning setting, understanding the applicability of concepts becomes ambiguous if they are communicated only through verbal and visual methods. In this context, architecture, being the most powerful visible expression of human spirit, is no exception. Research by cognitive scientists places high emphasis on the fact that physical connection of students to their work results in improved teaching-learning processes to get them involved in the work and further prepares them well to make informed decisions while dealing with professional challenges. Hence, haptic (kinaesthetic sensitivity) way of teaching-learning practices is the most appropriate methodology as it combines verbal and visual matter to help in concretising concepts in real time. Against this backdrop, the paper discusses various significant haptic teaching-learning processes and techniques that can be developed to support student's ability to formulate better methodologies to propose pragmatic design solutions that respond positively to context, temporal and the ever-advancing construction technology. Further, this paper discusses the positive implications and integration of haptic practices in the curricula through a workshop cum competition held for the undergraduate students of architecture.

1. Introduction

In any teaching-learning settings, understanding and applying the concepts become ambiguous if they are communicated only through verbal and visual methods. In this context, architecture, being the most powerful visible expression of human spirit, is no exception. Research by cognitive scientists places high emphasis on the fact that physical connection of students to their work results in improved teaching-learning processes and not only get them involved in the work but also prepares them to make informed decisions while dealing with professional challenges later. Hence, haptic (kinaesthetic sensitivity) way of teaching- learning practices are the most appropriate methodology as it combines verbal and visual matter to help in concretising concepts in real time.

Haptic from the Greek means 'pertaining to the sense of touch'. Haptic, in the broadest sense is any form of interaction involving touch. Haptic perception also known as kinaesthetic sensitivity refers to the process of recognising objects through touch by applying forces, vibrations or motions. Design-build projects, field/site visits, documentation of works, hands-on workshops, full scale model making are the most relatable haptic techniques commonly used in architecture education and practice. Despite the vital relevance of design-build and

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hands-on practices, several architecture programs are yet to make these techniques mainstream. Sometimes, even though the institutions are willing they may not get opportunities to holistically incorporate it into the curriculum owing to numerous organizational and administrative limitations. Therefore, adoption of haptic teaching-learning practices in the curriculum of architecture education under diverse project scales especially in the building construction technology studios would combine verbal and visual aspects to create more exploratory and experiential opportunities. This training also in turn advances to the professional practice.

Under haptic practices, students can experiment with projects of varied scale and nature to understand the structural systems, construction techniques, detailing and materials along with their probable limitations. These projects give the students prospects to conceptualize, design and build their potential ideas while integrating all the processes to create architecture which is structurally creative, functionally feasible and aesthetically interesting. To help establish such practices and to leverage its benefits to the community, it is significant to understand the personalities of the current and future students of architecture education who are also the future face of the architecture profession.

2. Configurations of Student Body

The current student demographic cohort of architecture institutions is consisted of millennials having a completely different outlook towards professional courses. Hence, understanding their different traits (existing and required in future) to be able to engage them in the learning processes that harness these traits would result in highly rewarding experiences. This also helps in imparting the most impactful integral facets of architecture education (such as architectural sketching, drawing, drafting, graphical representations, model making, design justification, etc.) through exploratory and experiential ways.

Table 1.

Millennial students of architecture - Traits and Attributions

Sl. No.	Traits	Attributions
1	Integration of planning, designing and detailing	Enabling to integrate planning (long and short term), iterative designing and much required relevant detailing.
2	Irrelevance of lecture and rote based learning	Passive and information overloaded teaching-learning sessions are no longer relevant as the flood of wide variety of information is easily available and accessible.
3	Education and amusement hand-in-hand	Demands for active enjoyment while teaching-learning can be addressed through engaging and intriguing methodologies
4	Critical thinking and analytical problem solving	Architectural design studio being the centre of learning and demonstration of applicability of knowledge would aid in instilling critical thinking and analytical problem solving.
5	Flexibility and adaptability	Ability to being flexible and adaptable to various challenges of architecture education and profession needs to be nurtured through real time hands-on experiential learning opportunities.
6	Team work	Creatively conceptualised and well planned design-build projects encourage team work among students of different calibre. This not only helps in integrated approach towards project development but also enhances the skill sets required for engaging as well as developing networks with the community.

Source: Authors

These students would want to experience the information and knowledge in order to conform to it. Hence, haptic method of teaching-learning is relevant as well as appropriate to the education of future architects. Paradigm shift towards evolving passive and lecture based courses into engaging haptic practices will help students in actively developing their knowledge than passively just accumulating it.

The workshop discussed in the following section highlights the engagement of students to explore the concept of reciprocal frame roof construction through haptic technique.

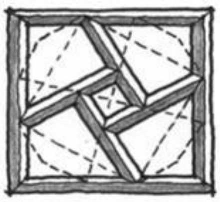
3. Reciprocal Frames -Workshop

Reciprocal Frames Workshop was conducted at National level student convention (NASA) held for under graduate students of architecture (studying in II, III & IV year) from various schools of architecture across India in the year 2019 at Bengaluru. Workshop was planned as a 'Workshop cum Competition'. It was planned for three hours in total including introductory session where the students are introduced to the concepts of Reciprocal frames followed by design conceptualisation of a large span roof for a space and building models of the designed roof structure.

The primary objective of this workshop was to expose students to the little known structural and Architectural Concept, Design and Construction of Reciprocal Frames. To build scale down models to explore the Reciprocal Framed roof structure, to understand the principles of rhythm, proximity, axis and finally the whole composition as an alternative roof structure. The workshop brief was conceptualised to be a design-build haptic approach. Hence, an interesting and challenging dimension was added to the design brief. Students were asked to deliberate their design concepts of roofing system based on the exploration of three selected basic design principles.

3.1 Reciprocal Frame – An Alternative Roof Structure

A much-simplified description of reciprocal frames is 'a structure made up of mutually supporting beams in a closed circuit'. The reciprocal frame principle has been used throughout history especially in the form of a flat configuration. In this variation, beams are connected in the same plane forming a planar grillage (Refer Fig.1, 2, 3 & 4). However, these were not named as reciprocal frames. The name, reciprocal frame was quoined by Graham Brown because of the way the beams mutually support one another. Graham Brown developed these types of structures in the UK.



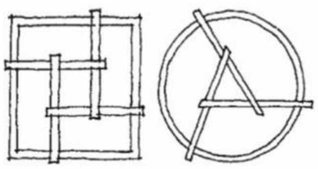
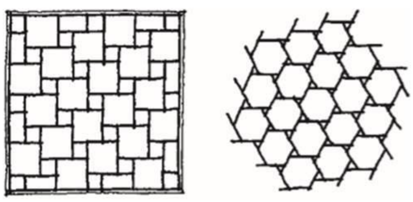


Fig. 1 Planar grillage structure *Fig. 2* Three & four beam reciprocal frame assemblies (Source: Larsen, P. O. (2008), Reciprocal Frame Architecture. Architectural Press, ISBN: 978-0-75068263-3)



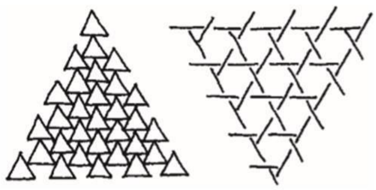


Fig. 3 & 4 Planar morphology of grillage structures (Source: Larsen, P. O. (2008), Reciprocal Frame Architecture. Architectural Press, ISBN: 978-0-75068263-3)

In the context of architecture and construction technology, the reciprocal frame is a three-dimensional grillage structure representing the appearance and behaviour of the unified structure in which each beam supports and in turn is supported by all the others. It is mainly adopted as a roof structure, consisting of mutually supporting sloping beams placed in a closed circuit. The inner end of each beam rests on and is supported by the adjacent beam. At the outer end the beams are supported by an external wall, columns or ring beam. The mutually supporting radiating beams placed tangentially around a central point of symmetry form an inner polygon which offers numerous architectural possibilities for designing roof lighting. The outer ends of the beams form an outer polygon or a circle.

Unlike the other roof forms over circular buildings which have radial members meeting at the highest point of the roof, the beams forming the reciprocal frame do not meet at a central point completely eliminating the need for internal supports. Hence, the architectural organization of the internal functional spaces is highly flexible. The most appropriate building plans adopting reciprocal frame are circular, regular polygonal and elliptical because of the geometrical characteristics of the structure. With the help of appropriate materials glued laminated timber, trusses, RCC or steel beams, the reciprocal frames can support most type of spans. Diverse architectural expressions are possible by varying the geometrical parameters of the reciprocal frame structure such as number and length of beams, combination of single or multiple units, radii of inner and outer polygons, slope of the beams, etc.

4. Workshop Description

Reciprocal frame roof structure workshop cum competition was planned for a duration of three hours. This was commenced with an introductory session on reciprocal frames (Refer Fig. 5 & 6). Through the lecture with a power point presentation, participants were introduced to the concept of reciprocal frames, historical precedents, diverse possible architectural expressions, geometrical parameters of the structure and structural behaviour with the help of several demonstrations using appropriate techniques and different materials. Further, various case examples set in diverse contexts highlighting the correlation between reciprocal frame structure and architectural character were discussed in detail. This session set the stage for the participants to embark on the exploration of reciprocal frames as alternate roofing structure.

Students were then grouped with three or four members per group in such a way that each group consisted participants from different semester and different colleges. This was done to bring not only the synergy and sharing of learning experiences among the participants, but also to encash on each other’s potentials while developing design proposals. This helped the team to understand the importance of collaborative approaches in designing and building model together not just for the day but learning and takeaway for their professional practice in future.

Participants applied the learning from the lecture to conceptualise and design a reciprocal frame roof structure for a space that they wanted to cover through haptic techniques such as manual drawing which included the entire process of the conceptualisation and design and building the model for the same.


Fig. 5 & 6 Introductory session on reciprocal frames (Source: Authors)

The first step was that the group would come up with a typology of a building space with specific function for which they would design the Roof structure. The first objective of the design proposals was to determine and highlight the design principles used such as rhythm, proximity, axis to arrive at a composition for the reciprocal roofing system. Participants started with initial conceptualization of the space for which reciprocal frame roofing system needs to be designed. Space planning and organization was designed by the groups along with form and functions of the space. In the next stage, participants drew the plan and sectional elevations of the finalized space to a scale appropriated by them with the help of the workshop leaders (Refer Fig. 7).

Fig. 7 Discussions to finalise concepts and spatial organization (Source: Authors)

These were refined further and finally reciprocal frame roof structure was detailed out graphically and through architectural drawings. Participants then set off to build the smaller scaled models of the reciprocal roof structure for their proposed spaces. They used noodle sticks (as the structural members) glue or tie bands to build their model (Refer Fig. 8).

Fig. 8 Building scaled models of reciprocal frame structure designed for the proposed spaces (Source: Authors)

These models helped in the analysis of the form and geometry of the roofing structure. Drawings and models were reviewed for their design, constructability and more importantly how they have manged to build the roof with minimum vertical support members. These were further refined based on the review and discussions. The three-stage planning was significant as they helped participants to understand the crucial relationship between design and construction. In the concluding stage, participants within the given time frame revised the drawings and built final scaled models with an enhanced understanding of the applicability aspect of the reciprocal roofing structure as an alternate roofing system. The final designs and scaled models were judged to announce two winning groups and one group as a special mention (Refer Fig. 20, 21,22,23,24 & 25).

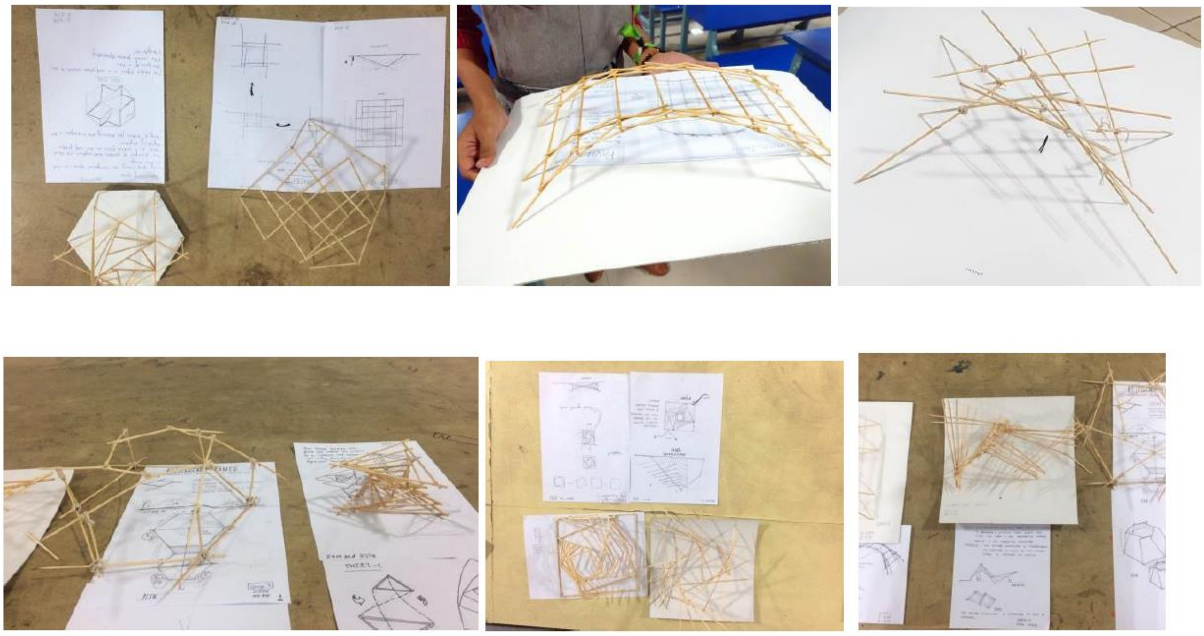


Fig. 9 Few sample works of proposed reciprocal frame structure designed for the proposed spaces (Source: Authors)

4.1 Workshop Outcome

Workshop highlighted the potential possibilities for studio-lecture based courses can be actively engaging through haptic teaching-learning techniques. It also helps in having deeply involved students while augmenting learning and exploration. The process followed in the workshop cum competition not only helped students to hone the skills of the participants in their ability to draw as a form of communication, but also provided insights on which information is significant while drawing their designs for them to be constructed as they were designed.

As much as 90% of the participants commented that they would strongly recommend this workshop to other students. Participants also expressed that discussions, better communication with regard to concept evolution with team members, sketching, design development, drawings, making models as well as supporting lecture session which was an integral part of the haptic technique largely helped in the active involvement and the learning processes. Students further commented that they would take the key learnings forward into not only their academics but also to professional practice. Overall, participants responded positively to the haptic techniques which were expressed through their active engagement as well as enthusiasm resulting in a good number of diverse set of concepts, designs and models in a short span of three hours.

5. Way Forward

Exploration and experimentation are the two key factors for structuring the creative and analytical thinking capacity of architecture students. A more effective and engaging course curriculum can be developed through the understanding and encashing on the strengths of the students in architecture education which will also further advances into their professional practice. The haptic teaching-learning techniques help students with not only their academic works but for future professionals who possess better knowledge about the fundamental correlation between design and construction. The processes and techniques of haptic approach also supports in developing the student's ability to formulate better methodologies to propose pragmatic design solutions that respond positively to context (physical and socio-economical), temporal and the ever-advancing construction technology.

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