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Architectural Education in India: Focusing on Technology Integrated Education

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Abstract: This paper provides an overview of the fundamental issues regarding the adoption and integration of Computational thinking in Design process along with BIM in Architectural Education. This paper recognizes the core elements that can be addressed during the integration into the five-year under-graduate program- B.Arch. The paper also attempts at looking into computational design thinking as one of the options towards integrating technology in Architectural Education.
Keywords: Use of technology in architectural education, BIM

I. INTRODUCTION

Technological engagement across all sectors of diverse professions in an innovative way has now made working more efficient, effective and "smart". It has brought about a huge positive transformation in the working methodology and output driven approach including education system. This transformation clearly indicates that, the adoption and up- gradation to newer technical advancements both in practice and academics, has been assisting in gaining a better working edge, both as a process and a technique or combination of both. Educational Institutions are the root for any change that can be brought about in any industry. It is here that young minds are nurtured and new ideas developed. Every academic discipline has a set of epistemologies with its own established knowledge, typical learning and working methodologies as well as desired professional and social output from the graduating students who are ultimately referred as professionals belonging to different fields. For this matter, even Architectural Education is not an exception.

II. ARCHITECURAL EDUCATION AND ARCHITECTURAL PRACTICE

Architecture, as a building science has experienced unremitting change owing to diverse contextual, climatic and cultural factors. The influence of this change is seen in Architectural education and practice. Therefore, Architectural education and practice both need to be mutually complementing that supports in the adoption of advancements in the related interdisciplinary fields.

Architectural Education and practice place distinctive emphasis on the design process that integrates "Concept, Form and Function" in the design of built-envelope which is specifically referred as Architectural Design. This design process has been comprehended into reality through various set of drawings both in two and three dimensional formats generated manually as well as with the aid of computational techniques. However, market driven forces, global collaboration and integrated- interdisciplinary- collaborative approach have become decisive factors for the Architects to adopt advancements in computational technologies, not just as software but as an approach and methodology into professional practice. These swift technical advancements have influenced thinking process, efficiency in design, and quality in building construction that affects building life cycle to a large extent. This particular aspect requires Architects, both practicing and in academics to be abreast with these computational technical advancements that emphasize in better understanding of the building design process that leads the way in defining newer set of design ideologies eventually resulting in upgraded Architectural pedagogy.

Thus, computational technologies have become necessary and integral part of the architectural design process both in education and practice. This particular aspect emphasizes the fact that the architectural education curriculum must reflect the integration of architectural design and computational technologies across all semesters so that the graduating students are better equipped and competent enough to face the multifaceted challenges of architectural practice.

III. PRESENT SCENARIO

Architectural practice has been swiftly adopting the advancements in computational technologies and new methodologies of "Integrated Systems" as compared against to the Architectural education. This is leading to a widening gap between academics and practice. It is inspiring to know that certain Architectural schools have tried to fill in this gap through changing and upgrading their curriculum. Unfortunately, the number of such schools is very limited on a global scale. Majority of architectural schools are still following the traditional architectural curriculum which has less engagement with computational technologies.

Major reasons that are posing obstruction in the integration of computational technologies in architectural curriculum are:

A. Architectural design process is a creative exploration of different spaces. So, computational technologies might not support this exploration.
B. Architectural curriculum is already encumbered and there might not be any scope for inclusion of computational technologies.
C. Academicians and practitioners might feel the incompetency to get acquainted with ever upgrading computational technologies there by affecting the key role played by an architect in the building induatry.

However, it is a relieving sense to know that these above- mentioned reasons are more skeptical than reality. This means, there exists a tremendous scope for Integration of computational technologies into architectural pedagogy.

IV. SCOPE FOR INTEGRATION OF COMPUTATIONAL TECHNOLOGIES:

Integration of computational technologies in education is not just mere usage of new software. Similar to any other proposition, computational technology too comes with its own methodologies which need to be adopted. This will have a huge impact on the curriculum in two main areas:

A. Implicit proposition so as to how design and project partners should collaborate.
B. The way information (geometric and non-geometric) can be modelled, embedded and shared during active building life cycle.

Computational technology should be able to compliment the holistic growth of students and not be treated as a separate segment. Indian architectural education focuses on various aspects of development at different years throughout the five years of an Under Graduate program. During these five years of Architectural education, a student is made to focus on new techniques and requirements which aid better design thinking process. They are also to take forward with them the learnt aspects in future projects. This is where we can imbibe in students a new way of thinking and working with conditions. Technologies like BIM- Building Information Modelling and Computational design using BIM help students integrate their knowledge of each aspect of design better. This is the true essence of Integrated Systems. This is where every requirement, existing conditions, techniques and ideas come together at once, thus being able to eliminate conflicts and addresses issues in a holistic manner. However, using these tools doesn't automatically ensure a superior level of collaboration and design unless conditions for a successful collaboration are met which are not only through software. Similarly, the ability to virtually build a model with geometric and non-geometric project information doesn't immediately bring maximum efficiency unless the representations are modeled and shared properly, the information needs in the process are understood correctly and a robust technical infrastructure and a proper system for project progress are present.

Table-1: Architectural Design objectives for Under Graduate program (B. Arch)

Year	Architectural Design Objectives	Methodology / Procedure followed	Example for Software
I	Spatial Elements, Colors, Textures, etc.	Visualisation	Sketchup
II	Circulation, Integration of form and function, multifunctional spaces with volumetric analysis, etc.	3D rationale and connecting elements	Revit Architecture
III	Services, Climatic Responsive architecture, etc.	Multi-disciplinary focus, Computational	Revit MEP & Structure, Dynamo

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		Design	
V	Campus design, large	Analysis tools	Ecotect,
V	Professional practice	Project	Primavera

Therefore, technology as only software is unsustainable and superficial. Integrating computational technology in architectural education poses fundamental changes like handling and creating information rich models, new ways of working with other disciplines, realigning disciplinary roles and responsibility, opportunities for new additional roles for architects. Universities must also encourage the use of computational technology for collaborative working practices and are currently not meeting the needs of the industry.

A cursory glance at the under-graduate level, there are few Architectural schools who have courageously tried to integrate computational technology in their curriculum. Nevertheless, most of these attempts have stopped looking at technology as a separate, independent course which is neither integrated nor complimenting to other core subjects.

Computational design thinking is not restricted to usage of single software alone. This approach is not sustainable and not effective. Software undergoes many revisions and adapting to software will not help us win any situation. It is required to understand the concept and adopt the methodology required for this concept. This understanding along with technical aids and tools will help in better, more comprehensive design thinking approach. This integration will help in achieving an integrated, information-rich model which will help better performance of this building lifecycle.

A mile stone in Architectural Segment is the advancements in computational design. A few tools like dynamo now question the "form-only" idea.

Computational design aims at being able to have a meaning, a purpose to every edge, every line, every corner and every opening in a designed space. Meaning to say, that form is an outcome of / a mix of all the necessary functions, services. In Computational Design, form follows function and is only a bi-product that we automatically get by adhering to all the necessary functions, the climatic responsive needs and services.

Computational Technologies can also draw several parallel avenues of specialization to architects. It could be in various areas like animation, eco-spatial geographical interfacing related, digital media, etc.

There are many facets that technology now is present in and contributes in its own little way to change the way things would otherwise perform. Many new methodologies are bringing to forte the "integrated systems" concept. Amongst them in Architecture is BIM- Building Information Technology. All along, when a designer had to present his/her ideas, it always was to be converted from a 3D space to a 2D format, which was more commonly used and then drawn.

During this transformation, there was always a chance of an idea not being translated completely or an idea not even grown to its fullest because of its lacking in expression. This can very easily be won over with BIM.

In BIM, a designer is to only design and build his design in a 3d manner. Translation is to be done by technology. This enables a fluid approach to thinking and looking at designing as well. This also eliminates the need for a designer to also be able to convert his idea in his mind and only then communicate; lacking which a possibly brilliant idea would never be expressed.

V. BIM- BUILDING INFORMATION MODELLING & INTEGRATED SYSTEMS: A REVOLUTIONARY TECHNOLOGY CONCEPT.

Computational Technologies like BIM- Building Information Modelling and Computational design using BIM help students integrate their knowledge of each aspect of design better. This is the true essence of Integrated Systems. This is where every requirement, existing conditions, techniques and ideas come together at once, thus being able to eliminate conflicts and address issues in an all-inclusive manner.

BIM is an intelligent, information rich model based process that provides insight to help us plan, design, construct and manage buildings. It simply is the means by which everyone can understand a building through the use of a digital model. Modelling a building in digital form enables those who interact with it to optimize their actions, resulting in a greater life value of the building. Use of BIM goes beyond the planning and design phase of the project, extending throughout the building lifecycle. BIM is a process of working. A few of the advantages using BIM will be:

A. Improved visualization capabilities
B. Improved productivity due to easy retrieval of information
C. Increased coordination of construction documents
D. Embedding and linking of vital information. E. Increased speed of delivery
E. Reduced costs

A BIM model will also have most of the data required for building energy performance analysis. The building properties in BIM can be used to automatically create the input file for building energy simulation and save a significant amount of time and effort. Also, automation of this process reduces errors and mismatches in the building energy simulation process.

BIM Models and manages not just graphics, but also information- information that allows the automatic generation of drawings and reports, design analysis, schedule simulation, facilities management and more-ultimately enabling the building team to make better-informed decisions. BIM supports a distributed team so that people, tools, and tasks can effective building lifecycle, thus effectively share this information throughout the building lifecycle, thus eliminating data redundancy, data re-entry, data loss, miscommunication and translation errors.

Adapting to BIM will help students gain a better advantage.

1) Helps visualize ideas better. Enhances Visualization skills thus enabling better design thinking ability.
2) The need to think and build virtually allows for students to tackle design requirements holistically, considering the building as a whole unit and not as individual views alone.
3) Errors during the conversion of an idea into 2D views are also overcome by using BIM as there is no need for a student to convert before they build their model
4) Better understanding of inter-disciplinary combination
5) Assimilation of analysis information
6) Integration of existing site features
7) Understanding larger impact of a project on its surroundings.

VI. COMPUTATIONAL DESIGN

Computational Design is an intelligent model-process that provides a framework for negotiating and influencing the interrelation of internal and external building parameters. In relation to design, computation involves the processing of information and interactions between elements which constitute an environment. Computational Design with BIM provides a framework for negotiating and influencing the interrelation of both internal and external properties, with the capacity to generate complex order, form and structure. By combining the principles of computational design, a fundamentally new method of building design is made possible.

VII. ADVANTAGES OF COMPUTATIONAL TECHNOLOGY

A. Integration With Architectural Education

There are many advantages of including computational technology in architectural education. To list them would be:

1) *Design*- Digital Technology allows complex calculation, a variety of complex forms to be created with great ease using algorithms and increasing the possibilities in architecture design, rather than simply production. Digital Technologies are enabling a direct relation between what can be designed and what can be built, also they enable a real image for the building before it is actually built and we can see is it looks nice or ugly.
2) *Cost*- Computational Technology has a direct impact on cost. Enabling more accurate drawings and data, helps in increasing productivity. To be able identify and fix several error and interferences helps in reducing re-work and maximizes the quality of construction. To be able to see the model and generate information like the amount of materials and man power required helps in effective planning, thus avoiding snags in construction.
3) *Management*- Maintenance and building management are hugely benefitted by use of computational technology. This helps in correct identification of any problem, its location and severity. This level of diagnosis helps in providing a quick and the right solution for any situation. Identifying these problems not only helps in efficient management of buildings but also helps in saving material, resources, energy and time.
4) *Time*- Computational Technology enables drawings and data to reach its destination on time. This helps in timely completion of assignments and projects according to schedules.

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VIII. CONCLUSION

The paper has attempted to give an insight into the latest technologies in Architectural education as well as practice and the need to adapt to its fast-changing methodologies and processes. It is required for the Architectural Education and practice to work together closely to be benefitted out of this change. This will assist remarkably in the elimination of errors while integration amidst multidisciplinary solutions. Use of Computational Design thinking process along with BIM is one of the significant ways towards integrating latest computational technology into Architectural Education. Across the five years of Architectural education, the paper has analyzed the ways of integrating computational technology into the existing system, thus making the implementation easier. Re-alignment in methodologies is also simple and the design thinking process will make way for better, holistic computational design thinking. Architectural Educational Institutions must be able to inculcate into every student the strengths of use of computational technology. This will not only help a student get a better edge in the industry but also allow them to express their ideas in a more practical manner addressing the contextual challenges.

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