

Architect as an Engineer

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Abstract—*Architecture is as much a part of our history as our civilization. Globalization has made it possible for the architect to operate anywhere in the world and today he has the ease to build in any part of the world, in any climate and under any social conditions. Architecture, like all man-made things, is seeing a transition from local to global scale. This change has enlarged the role and widened the responsibility of an architect. He has graduated from serving the need of his immediate community within limited means of material and technology to satisfy the long term requirements of an entire society. Contemporary architecture is an amalgamation of engineering, architecture and the visual arts. High quality sustainable buildings can only be built if good architecture and good engineering are fully integrated. Rapid industrialization and urbanization have thrown up challenges before the society which can be dealt only if architecture and engineering are seen as one.*

1. INTRODUCTION

Vitruvius, in the first of his ten books on architecture specified the requirements for the education of an architect. An architect should be ingenious and apt in the acquisition of knowledge. If deficient in either of these qualities, he cannot be a perfect master. He should be a good writer, a skilful draughtsman, versed in geometry and optics, expert in figures, acquainted in history, informed on the principles of natural and moral philosophy, somewhat of a musician, not ignorant of the sciences nor of the motions, laws and relations to each other of the heavenly bodies. [1]

The idea of buildings first evolved when humans adopted a sedentary lifestyle. The structures were close to nature as all the materials were provided by one's own environment. For a very long time buildings and the process of construction did not change significantly. Until then, the structures were built as an invention to satisfy the most basic needs of mankind: shelter and protection from weather, wild animals and the environment. Style, form and creativity came much later when man decided to make special monuments to express their social and cultural beliefs. These monuments - graves or houses of worship - were designed to make them stand apart from the rest and these specialized buildings were the stepping stone towards the birth of architecture.

The methods used to build were restricted by the demand and potential of these materials. Basic needs were unchanged and

architecture evolved at a slow pace. This is adequately revealed in the Gothic buildings, which reached its perfection after 100 of years of trial, error and failure.

Just like the form and style of the buildings, the architects also evolved little from one civilization to another. Architectural education was based on the apprenticeship system and young architect learnt about the needs, materials, and construction methods necessary during that time. Limitation in material and methods helped him to learn his art in totality. In the middle ages, buildings were constructed by craftsmen using their separate trades. The primary building trades of those times were masonry and carpentry. Through hard work, training and experience these craftsmen evolved into "masters" or "master builders"—a phrase that is used even to this day.

Beginning of nineteenth century brought dramatic changes in architecture. There were new needs of industries, commerce and transportation and also the emergence of new building materials of greater potential and together they provided new possibilities. Specialization of knowledge during the same time changed the face of architecture and different functions, once entrusted to an architect, started being performed by different men.

With changing times, today, every architect understands the importance of acquiring engineering knowledge, but finds its acquisition difficult due to the present education system. Auguste Perret, a French architect, once said that construction is the architect's mother tongue; the architect is a poet who thinks and speaks in construction. Today the architect is challenged by tremendous tasks. His creative background acts as a deterrent in his understanding of new methods of design forms based on mathematics and also rapid development of new construction techniques.

2. ARCHITECT: AN ARTIST, AN ENGINEER

Architect has always held a unique position throughout the history of civilization: that of an artist, a designer and a builder. Michelangelo was a painter, a sculptor, an architect, a poet and an engineer whose knowledge in all the said fields was exemplary. The contemporary architect, perhaps the last humanist of our time, should be conversant with esthetics,

engineering, sociology, economics, ecology, and, generally, with planning. Instead, under the influence of tradition, he is often trained primarily as an artist. His familiarity with the basic tools necessary to an understanding of modern technology is, most of the time, limited: mathematics, physics, and chemistry are not essential subjects in his curriculum. [2]

Just like an architect, an engineer too has limited knowledge in the field of architecture, aesthetics, and planning. This leads to a lack of common vocabulary and a dialogue between the two becomes almost impossible. The difference between an architect and an engineer is the difference between creation and invention. The dualities, and the parallels between one another, are crude, inexact and misleading, but they are also compelling and recurrent. In the world of construction, the duality between architect and engineer plays the same role. The two professions stand for contrasted facets of our common humanity. It is surely proper to regard art as a consolation for the stresses and damage imposed upon us by material progress, and the pleasures of architecture as a compensation for the efficiencies of engineering. [3]

Architect's journey till today has been a long one, from being directly involved in the building process in the past to evolving into a more specialized, professional role of designer today. A change in the education system and the training which focuses more on theory and design has lessened the involvement of an architect in the building process today. It is time for us to place greater emphasis on the process of design and construction together. According to Walter Gropius, "At the start, basic design and shop practice combined should introduce to the students the elements of design, surface, volume, space color, and simultaneously the ideas of construction, of building by developing three-dimensional exercises to be carried out with materials and tools. In succeeding years of training, the design and construction studio, supplemented by field experience during summer vacations, will coordinate further experience with the broadening of knowledge." [8]

One of the most essential qualities that bind the architect to the whole construction process is the act of thinking and making. Knowledge of materials and construction techniques offer opportunities for refinement and development of a project. Architects, like in the past, should get involved more in the process of making through more exposure to engineering services. Over the past few decades technological advances have given significant freedom to architects during the design process, particularly in the form finding stages. Today the architect has to be in sync with changing scenario and meet new design methodologies head on.

Globalization has played a very important role in the world of architecture. Today, the works of internationally famous architects has become accessible to each and everyone around the planet. The blending of design with the most up-to-date

technology has resulted in a magnificent synthesis of both. In contemporary architects, Renzo Piano has followed the mantra that the architect must command the design and build process efficiently. "Architecture is an art," said Piano at the White House. "It uses technique to generate an emotion, and it does so with its own specific language, made up of space, proportions, light and materials-for an architect, matter is like sound for a musician or words for a poet." [2]

Sensible design helps us to achieve elegance and also closes the gap with construction. As per Buckminster Fuller and Pier Luigi Nervi, Royal Gold Medalists in architecture, design and execution are reciprocal and not separate entities of the building process. The prevailing system of separating design and execution erects a barrier resulting in wider gap between the two. The present scenario allows construction to start before the design is completed leading to confusion, wastage of material and increase in total cost.

A good building is one which stands in complete harmony with its space, nature and requirements. Similarly, a good architect is one who can seamlessly flow between different aspects of engineering and different requirements of building a good structure. An architect must develop and exercise his creative skills, must know geometry to understand and manage form and must know as much engineering concepts as possible in order to design and build beautifully and innovatively. This can be achieved only if the fundamental upbringing and education of an architect is not compartmentalized but fully integrated with all the aspects of engineering and vice-versa. Our education system should ensure that an architect is also a good engineer and an engineer has a deep understanding of architecture. Else, present education and the apprenticeship system will not result in an architect as visualized by Vitruvius centuries ago.

3. IN A NUTSHELL

Rapid changes in architecture since the middle of the last century have increased the problems in architectural education at a surprising rate. The changes which have been introduced in the education system to counteract the changes in architecture globally have added more complexity to the problem and along the way have separated the study of subject from its practice. We have failed to anticipate and prepare for the future and we have failed to use the resources of knowledge, experience and technology for the betterment of our society. As per Mies van der Rohe: 'In its simplest form architecture is rooted in entirely functional considerations but it can reach up through all degrees of value into the realms of pure art.'

George Steiner, author and cultural philosopher, proposes an ideal education through one of his essays. He rates architecture, mathematics, genetics and music as the highest disciplines in his plan. As per him architecture has a high

value as it intersects with many other disciplines. He also says that everyone should have at least some basic instruction in the subject: “We find ourselves today, historically speaking, in a magnificent period of architectural achievement. Exceptional public and private buildings, as well as bridges of breathtaking beauty and innovation, are being erected around the globe. The theoretical considerations and technical aspects incorporated in architectural design embrace disciplines ranging from geology, material science, engineering and design to higher mathematics. The realization of an architectural design involves economics and sociology, transportation, urbanization and ecology...”

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Architectural engineers work closely with the architects, but their area of specialization is pure engineering. Their sphere of specialization is limited solely to the building process. Therefore, the career of an engineer attracts people with a solid mathematical background and scientifically inclined minds. To apply for a position in the field of architectural engineering, you should be a holder of at least a Bachelor of Science (BSc.). For students, it means four years of full-time study and academic assignments. Most of the BSc. curricular consists of the courses required for their career with less attention to general disciplines. As such, a list of the disciplines includes: Physics. Civil Engineering Theory. Technical Drawing. Calculus. Architect: Information Based Architecture. Engineer: Arup Associates. At 2,000 feet tall (610 meters), the twisting Canton Tower currently is the world's fifth-tallest freestanding structure and forms a distinctive landmark on the skyline of Guangzhou. The torqued steel lattice of the building is nicknamed the "Supermodel" by locals was designed by IBA's Mark Hemel in collaboration with engineering giants Arup. Set to surpass the Burj Khalifa as the world's tallest building on completion in 2020, the Kingdom Tower is on the rise thanks to the architects' close relationship with Langan International responsible for sub-grade construction and transportation planning and Thornton Tomasetti, consulting on structural engineering for the mega-tall building. To many people, the terms architect and engineer are interchangeable.[1] Both terms gained popularity during the Renaissance. For instance, Leonardo da Vinci, who painted The Last Supper, offered his services to various potentates as an architect for design of their buildings and as an engineer for design of war machines and water works. Yet today, when an architect is called an engineer and vice versa, nothing is more grating to that professional, or a surer sign of ignorance, by the layperson who caused the offense. What is the difference then? When solving a design problem, an architect's and engineer's viewpoints and methods start from different, and often times, opposite directions. Initially, an architect uses inductive reasoning; an engineer uses deductive reasoning.