ASSESSMENT OF COMPUTER APPLICATIONS IN ARCHITECTURE

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ABSTRACT

The study was to assess the computer applications in architecture. Architects throughout the ages have communicated via a pen or pencil and a piece of paper. Computer technology has provided architects with new efforts through its computational tools: computer-aided drafting, enumerating, modeling, and analysis, which are increasingly considered essential to architectural practices. A new generation of structures and concepts is being created that recognizes the computer not only as a drafting and rendering tool, but also as a potentially powerful tool in the generation of designs themselves; in other words, an intelligent drafting machine. The study concluded that the use of computers for automating the processes of design and manufacture has significantly brought about improvements in designers' productivity and products' quality. It saves a lot of time from having to do voluminous and complex architectural work. With computer applications, a new era of computational methods in architecture has emerged. New design processes and concepts such as generic algorithmic design, parametric design, and isomorphic surfaces have improved the visualization skills for new architectural forms and indeed changed the face of architecture in the contemporary world. There is a paradigm shift from the traditionally missing views and orthographic projections to accessible freeform visualization. More complex forms have been thought of and have been turned into buildings through computer technology. One of the recommendations made was that, with the increasing use of digital technology, one has to ensure that learning and teaching do not shift from the fundamental skill set required of an architect.

KEYWORDS: Computer Applications and Architecture

INTRODUCTION

Throughout the ages, architects have communicated via a pen or pencil and a piece of paper. They have a quick ability to identify their projects' functioning and particularities with a simple doodle. Although this method of working has not completely changed, it is now

complemented with the introduction of computer technology. A computer, according to Wikipedia, (2021), is a machine that can be programmed to carry out sequences of arithmetic or logical operations automatically. Similarly, the Cambridge English Dictionary for Advanced Learners defines a computer as an electronic machine that is used for storing, organizing, and finding words, numbers, and pictures, for doing calculations, and for controlling other machines. Computers can perform a wide range of tasks based on instructions provided by software or hardware programs. A computer is a programmable machine. The two principal characteristics of a computer are that it responds to a specific set of instructions in a well-defined manner and that it can execute a prerecorded list of instructions (a program) (Norton, 2021). Modern computers are electronic devices used for a variety of purposes, ranging from browsing the web, writing documents, editing videos, creating applications, playing video games, etc. They are designed to execute applications and provide a variety of solutions by combining integrated hardware and software components (Techopedia, Inc., 2020). Today, within architecture, digital tools — from machine learning to fabrication technologies, from artificial intelligence to big data — are becoming more and more ubiquitous and pervasive, and quickly (Claypool, 2021). Computer technology has had a tremendous impact on virtually all spheres of professional life, including architecture, and the rate at which information technologies (IT) are being applied is affecting all industries and professions, including architecture. It is believed that digital computer technology has a strong impact on architectural design, architectural teaching, as well as in practice (Soliman, Taha, & El Sayad, 2019).

Computer technology has provided architects with new efforts through its computational tools: computer-aided drafting, enumerating, modeling, and analysis, which are increasingly considered essential to architectural practices. A new generation of structures and concepts is being created that recognizes the computer not only as a drafting and rendering tool, but also as a potentially powerful tool in the generation of designs themselves; in other words, an intelligent drafting machine. From augmented reality for construction to 3D printing architectural models to using artificial intelligence within the design process, it is becoming increasingly rare that an architectural project does not use some kind of digital tool either for design or fabrication. This is also the case throughout how we experience the built environment. From the infrastructure we use to navigate the world to the objects we use to communicate, digital is everywhere. This fundamental shift is not lost on the architecture (Claypool, 2021). However, simultaneously combining traditional design approaches with digital technology is effectively improving architectural practice. The computer allows for the creation of architectural pieces, 3D modeling, renderings, and visualizations that could never have been rationalized using pen and paper alone (All Answers Ltd., 2018).

Architectural design is modeled as a search process in a space of alternative solutions, seeking one or more solutions that satisfy certain design criteria. Design is shown to be a special case of general problem-solving processes and is thus comprised of two major components: design states and the generator/test cycle that facilitates transitions between them. It is then shown that the symbolic representation capabilities of computers qualify them to simulate such design states and generate/test cycles, using techniques that were developed independently in the fields of geometric modeling and artificial intelligence (Claypool, 2021). The relevance of

computer technology to architecture cannot be overemphasized. As such, this paper seeks to highlight the applications of computers to architecture from academia to practice.

COMPUTER TECHNOLOGY AND ACADEMIA

Computer technology includes all computer applications, whether they are integrated within the design studio or are stand-alone courses, both in architectural design as well as in urban planning courses (Soliman, et al. 2019). Computer technology has begun to displace traditional design technologies and has provided architects with efficiency, control, and intelligence. These various technologies include computer-aided drafting, enumerating, modeling, and analysis. Nassar, Mostafa, & Rifki (2010) posited that the increased use of digital technology is continuously changing the practice of architecture, mirroring the paradigm shifts in the world it builds for. Technologies have started to shape the overall shape and curricular structure of architectural education and practice. In the Departments of Architecture all around the world, there is a process of re-investment in computer technologies (Ghanimeh, Zgoul, Abu-Ghazalah, & Al-Azhari, 2016). Ghanimeh et al. postulated that three major changes are occurring within the Departments of Architecture. First, the physical environment of studios and classrooms is transforming to allow for the incorporation and more progressive use of information technology. The studio is becoming increasingly unrecognizable to former graduates. Second, the design, planning, and historical analysis of the built and natural environments are subject to new computer-based methods of visualization, observation, and analysis. Third, the curriculum itself is being reconsidered and tested in unprecedented and exciting ways. An experiment in architectural education conducted by Angelil (2003) shows that computer technologies have been involved in the education process to replace traditional tools of teaching at least in the three final years of the educational schedule, making the integration of complete digital teaching the main subject of educators and researchers.

The advance of the information computer technology revolution and the accompanied digital technologies has changed the traditional context of architecture as a profession and in education (Breen, 2004). According to Soliman et al. (2019), computer applications have been used by schools of architecture to transform architectural imagination and architectural practical possibilities. A study prepared by Andia (2002) suggests that digital technologies have been used in architectural schools to challenge the modernizing view of architectural practice. Andia indicated that computer applications have affected both practitioners and students in terms of their skills and the setting of educational and professional culture. Therefore, simultaneously, combining traditional design approaches with digital technology is effectively improving architectural practice. It has become obvious that students have increasing tendencies toward computer applications and are becoming more skilled and involved in using various design media in their design processes, which, in turn, has affected the traditional design studio culture (Al-Qawasmi, 2005). Al-Qawasmi emphasized that digital media, as used in the e-studio, can bring important changes to the architectural design process but might have unintended restricting effects. In contrast, Achten (2003) in Carpo, (2011) warned that this transformation towards digital architecture should be reconsidered, whether in terms of practice or education. First, digital tools could replace the traditional design tools, such as manual sketching, that often provide the necessary direct physical link between the hand and the brain. Second, digital tools have provided an alluring, easy, and inexpensive alternative to physical architectural models and

have replaced them with a set of seductive graphics that are usually designed to impress the audience (juror or client). According to Guney (2015) in Soliman, Taha, and El Sayad (2019), the disadvantage of using computer applications is that it causes students to become addicted to them and causes them to design their projects without creativity. The use of computer application tools by students came as early as the conceptual stage in the investigation of specific formal themes. However, many educators and practitioners have called for a combination of both physical and digital design methods rather than the use of either method separately. Breen (2004) indicated that the combination of both techniques gives the designer added insights and more "real" approaches to develop, reconsider, and refine any design. Breen also emphasized that the combination of both techniques should be actively incorporated into the educational curriculum to prepare the students as they move toward practice (Al-Qawasmi, 2005).

Computer disciplines found in some school's curriculum are:

- 2D&3D representation
- BIM
- Parametric design
- GIS
- Digital fabrication
- Simulation
- Environmental technology
- Building technology
- Communication
- Programming, Coding and Scripting

THE GROWTH OF ARCHITECTURAL AND DESIGN VISUALIZATION INDUSTRY

Computer applications have been used in the profession over the past three decades to enhance existing practices by facilitating the production of vast quantities of drawings with high accuracy and in less time. In elucidating the early digital explorations in architecture, Claypool (2021) writes thus:

> *The economic crises and recessions of the mid-1970s and 1980s drove architects to recalibrate the way they practiced. Many architects, particularly ones embedded in the relative safety of academia, began to investigate other forms of more experimental practice and looked to other industries for inspiration.*
>
> *The shipbuilding, aeronautical, and automobile industries have been using computer-aided design (CAD) software for several decades to design complex forms. The utilization of these tools by architecture firms such as Greg Lynn FORM, Foreign Office Architects (FOA) and NOX transformed architectural design practice: for the first time, architects were able to achieve 3D, complex, variable curves using a type of curve called a spline instead of just straight 2D lines along an X or Y axis.*
>
> *As complex forms designed with digital tools became more pervasive in the architecture and design industry over the late 1980s and early 1990s,*

> *computational tools became more essential to not only the design process but also the production of drawings. These tools enabled architects to rationalize form—to make it more efficient, but also to assist with producing information for the construction process. As Greg Lynn, who worked on the Biocenter project, later recalled, the calibration of the computer that they used was such that you could understand the processes of what it was computing because it was iterating design outcomes at the same speed as humans would. In a sense, the computer was just as critical to the design process itself as the human lungs were to Using computers enabled the architect to express what he called a morphological diagram that explored possible design solutions. The project's focus on the generation of forms placed computers into the design process. This allowed for repetitive, differentiated, and adaptive form-making in a way that had not been seen before in architectural design.*

Claypool further explained that the period of the late 1990s and early 2000s was marked by the realization of the concepts explored in the previous decades on an architectural scale. With the boom in the financial market, a huge amount of money was poured into architecture. There was another recession in 2008, but at the time, it was extremely exciting. Architects who had otherwise only explored their work in the form of drawings and animations, or at the scale of installations or small buildings (if they were lucky), were able to compete for large-scale projects. These advancements in digital and construction technology enabled architects to express and realize forms that could previously only be imagined.Also, with these advances in technology, an increasing number of digital designs are now being published and praised by critics as meaningful and influential in the architectural field. The emergence of "paper" and theoretical architecture is rapidly expanding, with many architects adopting a research approach to practice, led primarily by computers as a means of experimenting with forms and aesthetics and expressing the results of their investigations.It is notable that many of the designs we see in today's architectural world could not have been achieved without the use of computer visualization and extensive 3D graphics.

BENEFITS OF COMPUTER TECHNOLOGY IN ARCHITECTURE

Computer technology plays an important role in the fields of architecture, namely: interior and exterior architectural design, urban planning, landscape design, execution drawing, site supervision, as well as the academic field. It is a well-known fact by now that architecture is a technology-intensive discipline. It uses technology both in the process of design and also in production (Soliman, Taha, & El Sayad, 2019). Computers simply assist in reinforcing our creativity and making us capable of doing things that would be considered impossible by traditional means. CAD programs assist in helping an idea be physically realizable, creating a new dynamic solution. For a long time, architecture was thought of as a solid reality and entity: buildings, objects, matter, places, and a set of geometric relationships. But recently, architects have begun to understand their products as liquid, animating their bodies, hyper-surfacing their walls, crossbreeding different locations and experimenting with new geometries (All Answers Ltd., 2018). With computer technology, the terms, concepts, and processes that seem inconceivable, unpredictable, and impossible to a designer can be explored, implemented, and tested into new design strategies and solutions within the digital world. This experimentation has

given rise to new design processes and concepts such as genetic algorithms, parametric design, and isomorphic surfaces. This rise of algorithmic design as a result of digital design may be particularly beneficial to urban master planning for the future of our cities.

Computer programs help with new research projects. Many architects adopting a research approach to practice are today led dominantly by computers as a means of experimenting with forms, aesthetics, simulations, and expressions of the investigations achieved. The emergence of computer simulation programs has caused a generational shift in architecture. It has opened up new possibilities in design and helped to push architectural skills in a direction previously not possible via pen and paper. It is enlightening to know that new CAD programs have implemented change in the design discourse in terms of freedom of experimentation. As a result, what appeared to be impossible is now very much a possibility. Collaborative practice is one important benefit of computer technology. With the coming of the Internet and new communication technologies, collaboration — inherent to any architectural practice — could now happen at a pace faster than ever before. No longer did one have to wait for architectural drawings to arrive in the post, which made the design process painfully slow. Instead, they could be emailed, uploaded, and worked on almost in real-time by people in different locations (Carpo, 2011). CAD can be seen as a form developer, visual agent, and general helper in the design process. According to Kalay (1985) in Soliman, et. al. (2019), digital technologies act as almost organic rather than prosthetic and provide an extension to the hands of the maker, freeing up time for other important work to be done. The many benefits of computer applications to design in Architecture can be as listed below:

i. Increases Productivity

ii. Higher Quality Designs

iii. Reuse and Easily Change Designs

iv. Easier to Read

v. Simplified Sharing

vi. Documenting the Design

vii. Skill of the Designer

viii. Designing Physical Objects in a Virtual Workspace.

DETRIMENTS OF COMPUTER APPLICATIONS

The emergence of digital realms as a result of computer-formulated design has led to architecture being produced as a mass media image rather than a piece of beautifully crafted, functional and creative architecture. This notion of extremely visual 3D architecture has, however, been condemned by many critics, with many believing that the actual computer image is surpassing the reality of the building itself, and as an image produced on screen, it can often be misleading and act as a misrepresentation of the actual materiality. Research conducted by Boucherenc (2006) has shown that digital media produced by computer software has a profound influence on the cognitive development of architects, particularly from the pedagogical standpoint, despite being "unsurpassed in ability to draft, correlate, coordinate and mass-produce many architectural artifacts" (Callieri, Cignoni, Gori & Risaliti, 2006). Results of such studies showed that traditional media had advantages over digital media, such as supporting the perception of visual–spatial features and organizational relations of the design, the production of alternative solutions, and a better conception of the design problem. (Bilda & Demarkin, 2003). Additionally, and from the realm of practice, manual media has been shown to facilitate and enhance the cognitive

design process, preferably over digital media (Nassar, Mostafa, & Rifki, 2010). Computer-generated virtual worlds have been shown to "catch the attention of the viewers, making them more interested in the narrative and engaged with the visual elements, but does not necessarily enhance their critical awareness (Neto, 2003).

Another worry by many critics is that architecture is becoming more about novelty as a result. There is this sense among the generation of school leavers that because they have mastered software, they are sufficient as architects and they almost immediately seem to be leaving to set up their own practice, which usually turns into a graphics company for websites. Also, so many graphics designers and draftsmen who can use 3D software have tended to turn themselves as architects, thereby increasing the woes of architects' firms and organization in the fight against quackery. For many designers, the computer is just an advanced tool running programs that enable them to produce sophisticated forms and to better control the realization of a design. Architects can become lost in their designs with a loss of control over the fundamental solution to their problem due to the nature of complexity in many 3D programs. A computer does not have the ability to reflect and respond to an environment set by the user; in other words, the computer output is simply a response to the designer's input. All Answers Ltd., (2018) posited that "in whatever capabilities a computer may have it lacks any level of criticality and its visual effects are nothing but mindless connections to be interrupted by a human designer." As such, he posited that "Let humans control architecture and allow a combination of sketches, CAD or virtual models and computation control our future worlds.

Furthermore, with the development of the architectural and design visualization industry, many architects believe that the traditional hand renderings and conceptual sketches have now become a lost art to the cost of architectural design. There is this fear that the age-old two-dimensional flattened image will give way to intelligent three-dimensional digital models as a means of communication. The question therefore arises whether architects and designers have maintained the "hands-on" approach associated with the discipline, or whether this has been abandoned in favor of computer graphics as a visual tool. Are computers taking away from the traditional methods?

It is undoubtedly evident that advanced rendering and 3D systems can help to envisage what architecture might be like. However, the computer is not a human being and should not be treated as such. Ultimately, it is the architect who controls the ideas, programming, and concepts, and the computer merely facilitates instructions. Therefore, the computer is just a way of copying, simulating, or replacing manual methods of design; it is simply a tool to replace the pencil. Computers are not aware of their environment, unlike humans. While architects are constantly striving to generate and introduce a new way of thinking about design, the problem is that often neither the designer is aware of the possibilities that conceptual schemes can produce nor the software packages are able to predict the moves or personalities of individual designers. The result, therefore, is that the computer is used more as a medium of expression than as a structural foundation for architectural experimentation.

COMPUTER APPLICATIONS (SOFTWARE) IN ARCHITECTURAL PROFESSION FIELDS

In order to enable the development, modification, and optimization of the design process, many types of software have been introduced for use in different areas and disciplines of architecture, engineering, and construction management. There are many notable software programs that architects and building design professionals opt to use; some of them are:

i. Autodesk AutoCAD
ii. ArchiCAD
iii. Autodesk REVIT
iv. Autodesk 3D MAX
v. Adobe Photo shop
vi. V-Ray
vii. Microsoft Office.
viii. Sketch-up
ix. Lumion
x. GIS
xi. Adobe Illustrator
xii. Rhinoceros
xiii. Grasshopper
xiv. InDesign,
xv. Blender 3D,
xvi. Rhino 3D
xvii. Dynamo
xviii. Fusion 360
xix. Coral Draw
xx. Design Builder and
xxi. Ecotect Analysis

In a research conducted by Soliman, et al. (2019) it was discovered that, internationally, the highest applications worked with in Architectural profession is Autodesk AutoCAD software. This was closely followed by Adobe Photoshop, Autodesk 3D MAX, Microsoft Office, Sketch-up, Autodesk REVIT and Lumion in that order. And the least used soft-ware is Sketch up, GIS and In-design. In terms of Architectural phase of design development, Soliman, et al. discovered that about 75percent of the professionals is using computer applications. While 46 percent use it in the Schematic Design, 43 percent use it in the Conceptual design and 40 percent in the Execution and Fabrication. Then about 28 percent of the professionals use computer applications for preparing the construction documents. In the end, the least respondents use computer applications in Construction Administrations as well as for Academic Research. Generally, Autodesk AutoCAD software received the most used software by both undergraduates and professionals.

AutoCAD software has been a fixture of the architecture sector since its release in 1982. The Software has come a long way since those early days. Students and professionals have used AutoCAD for decades. Many people use AutoCAD as a first step on the way to creating 3D models. It allows users to develop drawings that represent buildings at the more basic level. As such, learning how to use it often proves helpful when searching for jobs in engineering or architecture. Designers will often transfer these drawings to other software packages to work on the more advanced modelling concepts. Because of AutoCAD's popularity, most other design packages are compatible with its files. Further, AutoCAD is a useful teaching tool. Users can change preferences and use it to learn the basics about line weights and design layers. Architects can even access an industry specific version of the software. This allows for more efficient drawing of base models.

However, in the development of sustainable buildings, **Autodesk Revit** Architecture software comes to bear. The software focuses on providing the tools for effective building information modelling (BIM), which is the key to modern architecture. It is a relevant instrument for today's world where environmental awareness is at an all-time high, as well as sustainability, which is a major agenda for many clients. Revits' key feature is automation. Changes users make to models get recorded throughout the project. The software coordinates these changes to ensure that users create complete projects that consider BIM at every turn. As such, if the user makes a change in the 3D view, those changes are reflected across the plan, elevation, and section views. The same goes for changes made to any other view. The software offers automation elsewhere. For example, it allows one to create libraries of parametric objects. One can access these objects across all designs to quickly implement common models into their projects. Revit architecture also allows for greater teamwork. The user can schedule separate project elements to ensure they get completed on time. The software also allows the user to pull in team members from multiple disciplines into the project. All of this while keeping the core concepts of BIM at the forefront.

In addition to the aforementioned AutoCAD and Revit software, **ArchiCAD** is another widely used software in our environment. This could properly be because of its user-friendly nature. Its users can learn the basics of the software with minimal effort. This has made it a favourite with students and those just starting out in architecture. It offers a time-effective way to create detailed models. As such, it is good for projects where time is a factor. Besides, the software offers several tools for automating complicated processes. For example, it has an inbuilt library of stairs and railing designs. Better yet, one can match these resources to the building that has been created. Many architects agree that designing staircases can prove difficult in large projects. ArchiCAD removes much of this difficulty through automation. Many people point to ArchiCAD as offering everything a designer would need. It proves useful in creating both 2D and 3D models. Furthermore, one can integrate other software packages into it. A common favourite is pulling V-Ray into ArchiCAD. This allows designers to create photorealistic models. Even those who do not integrate V-Ray into ArchiCAD can create realistic models. The new versions of ArchiCAD feature CineRender for creating lifelike models.

In order to use parametric design to improve the efficiency of architects' workflows, the software called **Grasshopper** is well recommended. Grasshopper was designed by David Rutten in September 2007. It is now a plugin for common design software called Rhino. Grasshopper uses a visual, node-based component interface to create generative algorithms that can be used to create 3D geometry and other functions. The simplicity and ease of the Grasshopper interface in comparison to other available programming languages quickly appealed to many digital designers for its drag-and-drop, on-and-off, input-output system. Grasshopper instigated an explosion in generative design tools: Ladybug, Honeybee, Geco, Kangaroo Physics, Karamba, BullAnt, Hummingbird, Heliotrope-Solar, Mantis (yes, almost all named after animal species). Many of the outputs of these tools are recognizable to well-versed architects today. Grasshopper has several tools that help the user automate menial tasks. In most design software, the user will need to copy and paste basic elements, such as lines, if he wishes to use them again. Some software uses matrixes to reduce the time these tasks take. Grasshopper's use of variables makes such actions easier. The user only needs to enter a number into your variable to create the desired number of elements. Moreover, he can create modules centered on these common tasks. Over

time, Grasshopper allows the designer to create a full library of previously used ideas and elements. He can access these modules with the click of a mouse. Grasshopper also benefits from being an open-source piece of software. It has a community around it that constantly develops new plugins. Coupled with that, Grasshopper links closely with Rhino 3D. This integration eliminates the need to understand coding when using Rhino 3D.

Rhino 3D was created in 1998, and since then it has become one of the most popular tools for design in architecture. With Rhino 3D, users can enter drawings or physical models into the software. From there, Rhino can create 3D models and provide documentation for the design. One can even scan real-world data into the newer versions of the software. Beyond that, Rhino offers all of the tools a designer needs to edit designs. Beyond the base models, the user can create animations and professional renders. It is also one of the most flexible design packages around. Designers can translate solid objects and surfaces into the software. It even allows users to work with point clouds and polygon meshes. Because of this, the software is usually favoured by those who do not want to spend a lot of time learning about the complexities of computer-aided design (CAD). Users with programming expertise can adjust the Rhino workspace. Using Rhino Script, they can create their own plugins. Those who cannot program also have access to a database of pre-built plugins. Furthermore, one can export Rhino designs into the real world using 3D printers or laser cutting. This separates Rhino from other packages that do not offer a manufacturing aspect.

Dynamo often comes as a free plugin for use with Revit. However, there is also a standalone version of Dynamo. This means the user may choose to use it independently of Revit, though this requires payment of a subscription fee. Much like Grasshopper, Dynamo is open source software. This means it has a large community around it that constantly builds new features for the studio. Dynamo is well regarded for having one of the best geometry engines of any design package. This makes working on complex elements easier. Further, the software slots well into the BIM workflow. Dynamo allows the user to make quick changes to the designs. Furthermore, it allows the user to customize his designs on the fly. This saves a lot of time that you would otherwise spend on editing designs and saving them as separate files. The software also works with a large number of file types. As such, one can use it as a support tool for a range of other software. One of the most common uses of this is exporting Revit design information into Microsoft Excel files.

For real-world applications, many architects favour **SketchUp**. SketchUp was purchased by Google in 2006, though it has since sold the company. Google implemented a lot of useful features. For example, the user can pull topographical images from Google Maps into SketchUp. The same goes for satellite images. The key benefit of SketchUp is its price. SketchUp may be downloaded for free. It may lack some of the features of other software packages. Still, it provides enough to help the user create professional models. However, the base package has most of the exporting features turned off. Even so, this offers the user flexibility. One can choose the features that suit the project. Thus, the user only invests in what he needs. The cost makes it ideal for students and those operating on slim budgets. Many use SketchUp to get to grips with 3D modelling before moving onto other software. Speed is also a key aspect of SketchUp. The user can create simple 3D models quickly. With the right features, the user can even create complex models ready for presentation.

COMPUTER TECHNOLOGY FUNCTIONS IN ARCHITECTURE

i. In structural analysis for the design of buildings and other engineering structures, computers are used to execute complex calculations.

ii. Computers are used for inventory and stores management in many engineering projects including industries, construction sites and warehouses.

iii. In the past, physical models are built to verify the behavior of new structural systems. Such tasks are now handled by computers through simulation.

iv. Control of environmental conditions in a building can be achieved through the use of computers.

v. Getting Updated Site Plans for Survey Purposes.

vi. Developing Detailed Working Plans for the Construction Process.

vii. Showing Top-Notch Digital Elevation Drawings for a Project Presentation.

viii. Using for Cost and Material and material estimates.

CONCLUSION

The use of computers for automating the processes of design and manufacture has significantly brought about improvements in designers' productivity and products' quality. It saves a lot of time from having to do voluminous and complex architectural work. With computer applications, a new era of computational methods in architecture has emerged. New design processes and concepts such as generic algorithmic design, parametric design, and isomorphic surfaces have improved the visualization skills for new architectural forms and indeed changed the face of architecture in the contemporary world. There is a paradigm shift from the traditionally missing views and orthographic projections to accessible freeform visualization. More complex forms have been thought of and have been turned into buildings through computer technology.

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Computer technology in architecture has come to stay. With the revolution in this area, we should be expecting more collaborative practice, virtual to physical reality, and parametric explosions. More of the augmenting reality of one’s experience of the built environment through exploration of the extent to which physical architectural elements could respond and adapt to people’s behaviours, changing needs, programmatic or environmental conditions through digital architecture should also be expected. There is going to be a revolution in digital fabrication, artificial intelligence, radical rethinking, and robotics. It is also expected that the revolution in computer technology will bring about digital or factory-set construction of buildings, where buildings are made as 3D models but become a reality for one to live in.

RECOMMENDATIONS

1. However, with increasing use of digital technology, one has to ensure that learning and teaching do not shift from the fundamental skill set required of an architect.

2. The cognitive development which occurs through manual problem should be brought to bear while using computer technology. In fact, it should be all about moving between two worlds of the real and the virtual in order to achieve a homogenous whole.

3. Finally, with access to these technologies, in combination with the urgent need to learn from the failures of previous generations, especially in a post-Covid environment, and scientific innovations in data and computation, meant that younger generation has the potential to rethink the role of the architect. They could reconsider what architecture was made of, what it was meant to do, and who it was meant to serve - resurging a sense of socio-political urgency in the industry.

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