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Virtualization in Information Technology Science and Its Integration to Develop Future Architectural Design Tools (Comparative descriptive research case study of BMW showroom building)

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Abstract

The increasing availability and utilization of information are the defining characteristics of the information age. While the industrial revolution focused on material production, the information revolution focuses on the production of ideas. Countries with more information are the most dominant in the world, and over the past thirty years, we have witnessed the tremendous development of the information and communication sector, leading to various changes in the modern world, including the replacement of some jobs with new technologies. This has had a profound impact on society, concepts, and beliefs, and the field of architectural engineering has been significantly affected by the advancements in information technology, resulting in changes in the way architects think, analyze, and design buildings. The digital revolution has also had a significant impact on various disciplines, giving rise to new ideas and trends in each of them. One of the most important outcomes of this revolution is virtual representation, which allows multiple applications to run on a single device. This has led to several ways of understanding and interpreting the concept in different fields. (1) The architectural product is directly influenced by digital technology in all areas, as architectural design increasingly moves into the realm of virtual reality, which is expected to become more logical and realistic. (2) Simulating virtual reality is one of the evident effects of the technological revolution on architectural design and can be referred to as "digitalizing architectural design. (3) This study presents a model for integrating the new elements resulting from the technological revolution into visions and approaches for dealing with future architecture, through the reciprocal relationship between architecture and technology.

Keywords: *Visualization- Digital Design- Thin providing (TP) - Digital revolution- Information technology*

1. Introduction

The recent advancements in the digital revolution have had a profound impact on various disciplines, including science, social fields, and even architectural thinking. They have introduced new elements, ideas, and trends in each specialization. One significant outcome of the digital revolution, which has a wide-ranging and undeniable influence, is Virtualization allows multiple applications to run on a single device, (4) with its vast and diverse applications contributing to multiple entry points for understanding and reinterpreting this term in various fields.

Architectural development has undergone various attempts throughout different periods, such as the evolution through interacting with the surrounding natural environment, known as "Organic Architecture School." (6),(5) This evolution has continued in different directions, adapting to the requirements and evolving user needs over time. However, architectural production is no longer limited to traditional design methods and the use of computer programs for architectural visualization. It has expanded beyond that and has become a product of an integrated design process directly influenced by digital technology at every stage. (7), (8)

Theories of architectural design have taken a different direction, considering the interaction between different fields of science, technology, environmental sciences, and virtuality as the basis for a new statement and principle. **"**Manifestation of a principle.**"** [(9)]

Digital design is considered one of the most advanced approaches in the field of architectural design. It has its unique theoretical foundation supported by technology. [(10)] It has also contributed to the growth and reinforcement of the reciprocal relationship and integration between different sciences, studying the impact of integrating new methodologies derived from one field into another scientific field, and then using the results and outputs of this integration to improve and develop those methodologies in their original field.

One of the distinctive features of digital design, or what can be referred to as the era of digital architecture, is its unique ability to interact with various scientific domains on a theoretical level and to interact with users through an applied perspective. In the field of architecture, in particular, the process of digitalization with its unique and new cultural vocabulary has exposed the design product in its various details through what is known as the promulgation of a digital design culture. [(11)]

The entire aspect of architectural engineering can be integrated with digital technology, not only in the design and planning stage but also in the execution or manufacturing stage of the product. Furthermore, the theory of digital architectural discourse, written by Deleuze and Guattari, reveals that "digital media only contribute to the invention of meaning, removing public spaces and designing unlimited inputs and outputs. [(12)]" Koerniawan also mentioned that "we will witness a shift from artistic work to the artistic event, from simulation to simulation itself, from simulation to virtuality, from interpretation to interaction, and from image to interface." [(13)]

Digital technology can simplify and enhance the aesthetics in architectural engineering through computerized devices and systems, shaping a more diverse pattern of contemporary architecture.

Problem:

The research problem is revolving around the continued existence of a state of overlap in the use of architectural elements of different origins and their integration with each other in the design product, whether they are architectural spaces or building facades, with alterations made to their original proportions. This leads to a loss of authenticity of these elements and creates a state of confusion for viewers and users, resulting in the desired effects of these elements in buildings on users being diminished, thus reducing their usability or quality of living.

Furthermore, the study sheds light on the need for more diverse and renewed readings and insights to keep up with the rapid advancements in other fields, such as information technology. These advancements are followed by the rapid evolution of user needs and the architectural design intended to meet those needs.

Therefore, researchers have recently been led to assume the necessary requirements for establishing the theoretical foundation and conceptual framework for digital design by re-examining the structure and history of architectural theories. This re-examination aims to clarify and highlight the characteristics of the new design compatible with the requirements of the new architectural era and contribute to the creation of a manifesto for the paradigm shift in digital thinking. “Manifestation process of the new digital thinking Paradigm Shift"

Objective:

This research aims to explore the impact of integrating new units and elements imported from the digital revolution into the field of architectural thinking. This is achieved through a set of sub-objectives:

- Providing a new interpretation of the interrelation between science and architecture at different levels by examining this thinking in light of its integration with a recently announced modern data processing technology by a globally recognized technology company, such as IBM's "Thin Provisioning." [(14)]

- Adding a new horizon to the development of architectural thinking and accelerating the process of evolution and response to human needs by keeping up with the rapidly evolving information technology revolution.

- Enhancing the reciprocal relationship between architecture and technology by monitoring behavioral impacts, user feedback, and the influence of these factors on architectural thinking and design, as well as enriching the use of artificial intelligence technology in the design process.

Research Questions:

1. What essential component can be added to new architectural theories within the digital era direction [(15)], such as new virtual simulation methods in data processing in information technology?

2. To what extent has the emergence of new human needs in the twenty-first century allowed the smart technology revolution to shape architectural thinking in a way that satisfies users?

3. How can virtual reality and augmented reality be used as elements of virtual simulation to reinterpret and read architectural theoretical history? [(16)] Can future readings of historical movement provide valuable insights into its development and significance?

2. Literature Review

Important terms:

- **Virtual Reality**: Virtual reality is a computer technology that allows users to interact with a three-dimensional environment in a natural way, typically through head-mounted displays. Gloves are sometimes used to track hand movements.

- **Digital Revolution**: The digital revolution is the transition from mechanical and analog technologies to digital electronics, which began sometime between the early 1950s and late 1970s with the adoption and increasing use of digital computers and digital recording devices, and continues to the present day. [(17)]

- **Information Technology**: Information technology is a business sector that deals with computing, including hardware, software, as well as communication and everything related to information transfer systems that facilitate communication. It also includes the study of data management in its various forms, whether they are texts, images, sounds, or others. The internet is part of technology and a specific field within it. It is currently an integral part of people's lives and continues to spread worldwide. [(18)]

- **Digital Design**: The process of designing through digital media, conceived as an intersection of five dominant ideas that produce a reinterpretation of the design process, with the formulation of methodological characteristics related to ideas and traditional design models of design thinking .[(19)]

Information Technology:

Informatics refers to a wide range of fields and specialties related to various aspects of information and computing. This includes both tangible and intangible aspects, as well as vital and non-vital aspects. Thus, informatics encompasses everything from data processing to the creation of new information [(20).]

Although information and data are closely related, the concept of information differs from the concept of data. Data represents anything that can be stored in any way, including numbers, words, names, and symbols. Information is the useful data for decision-making. In the current age, information and data have become essential resources for organizations when making decisions.

Virtualization in Information Technology:

Virtualization is the process of using software to create a higher-level abstraction layer over physical computers. This layer allows for the division of the components of actual computers into multiple virtual machines. Each virtual machine runs its own operating system and acts as an independent computer, even though it only utilizes a portion of the physical computer's resources [(21).]

• Thin Provisioning Technology:

Thin provisioning is a method of storing data where the allocated storage space for a user is based on their actual needs, rather than a pre-defined amount of space. This can be done in storage area networks, central storage disks, and virtual storage systems. In thin provisioning, larger storage space is allocated to users as they consume the designated space, and when files are deleted or data is moved, the resulting free space is reclaimed and used for other workloads that need to be stored [(22).]

Thin provisioning technology is an attractive option for companies looking to maximize their infrastructure. It is cost-effective and can easily accommodate future data growth. Simply put, it is the most flexible choice to handle the rapidly changing data landscape.

Virtual Reality Technology:

Virtual reality technology is one of the most important tools in information and communication technology due to its ability to create visual, auditory, and tactile representations of events and facts. The ability to interact, participate, and immerse oneself in the simulated reality created by AVR systems

is crucial for education and other forms of knowledge transfer. This technology provides a way to transform information into sensory and cognitive experiences, making it possible to bring imagination to life. The linguistic definition in the Oxford English Dictionary states that virtual reality is an undefined or realistic reality, but one that depicts something real or has actual existence. It is produced by the computer and its units, inputs, and capabilities at work [23], [24], [25].

Virtual reality can be categorized into:

1. Full Presence: The user feels that they are part of the virtual environment they are experiencing, achieved through advanced immersive visual, surround sound, and sophisticated sensor systems.

2. Limited Functionality and Location: This system is used in simulation devices and simulates specific properties within the real world, such as the effect of gravity, particle material properties, or the impact of high speed on certain objects.

There are several general features that virtual reality systems share:

• Immersion in the environment: The system used for immersion in virtual reality creates a sense of depth and surrounding space by isolating the auditory and visual senses from the real world and replacing them with computer-generated sensory inputs.

• Interaction with the environment: Interaction with the environment involves using various interactive devices to transmit and receive information in the virtual reality setting. This includes devices such as data gloves, controllers, special goggles and masks, as well as full-body suits.

• Visual realism: Most virtual reality experiences are visual and displayed on a computer screen or through specialized display screens. However, some simulation processes also involve additional sensory information, such as sound through speakers and audio devices (26).

- Virtual Reality Tools:

Using virtual reality tools requires the availability of a wide range of sophisticated devices, including input and output devices that enable the user to interact with the virtual environment. These tools can range from simple to complex, including:

• Head-mounted display systems: These systems consist of a headset equipped with small screens and a lighting system that displays images from the screens to the user's eyes.

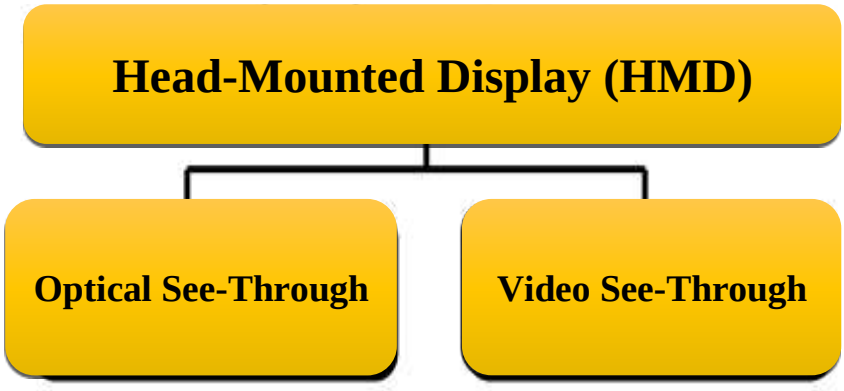

Figure 1: Classification of head-mounted display devices - **Source**: Researcher

- CAVE (Cave Automatic Virtual Environment): The virtual reality robotic environment cave is a computer-generated space that gives the illusion of immersion. It is created by projecting three-dimensional images onto the walls and floor of the cube, and people wearing 3D glasses can enter and move freely [27].

Figure 2: Shows the types of display booth

Source :https://www.researchgate.net/figure/A-CAVE-TM-based-Immersive-Gaming-Platform_fig1_266654659

- The peripheral display is similar to a head-mounted display, except that it is not worn on the head but rather positioned in front of users. It is a dual-surface stereoscopic display device. The two screens and the optical device are housed within a box connected to multiple linkages. The user looks into the box through two openings to see the virtual world. [28]

Figure 3: shows the peripheral monitor

Source :https://www.researchgate.net/figure/The-Kinesthetic-HMD-head-based-force-feedback-enhancing-self-motion-sensations_fig1_354088192

- Desktop displays: In this setup, the virtual environment is displayed on an inclined or horizontal table. It can also be displayed on curved screens in front of the user. These systems provide a scale for interaction when the represented environment is horizontal, such as tabletops or viewing seascapes. This system is the most cost-effective way to achieve immersion, but it only works if the user is wearing glasses or masks. [29], [30]

Figure 4: Shows the types of desktop displays

Source :https://www.evl.uic.edu/pubs/1224

Holographic projection systems: The virtual world is typically displayed on a holographic projection screen to expand the field of view for multiple viewers simultaneously without direct participation from them. This method is typical for group presentations that do not require or may not be suitable for direct group interaction. (31), (32)

- 3D Viewing Glasses: With the increase in the size of television devices, viewers began to sit farther away from the screen to achieve a more immersive experience. There is a trend among consumer electronics manufacturers to reduce the size of the screen and bring it closer to the viewer, just a few inches away from the eyes.

Figure 5: shows the shapes of glasses for 3D vision
Source :http://wn.souvr.com/Item/68672.aspx

- Touch and control systems: These systems rely on providing information and sensations that are transmitted to the user through one or more senses.
- 3D Keyboard and Mouse: Both the keyboard and mouse are effective input devices for use with virtual environment applications.
- Data Gloves: Special gloves are used to connect the user's hand to the virtual reality system, allowing them to interact with the virtual environment. The data glove measures the curvature of the user's finger. The user can manipulate imaginary objects through touch or grasp, and can move them from one place to another. It can also be used for eating and gesturing. We can also see our hands and hold objects that exist in virtual reality but are not physically present.
- Control Stick: One of the simplest control interfaces is a stick with a set of keys and buttons. The stick indicates the desired command, and then beams are emitted that interact with the image of the object.

Figure 6: Shows the shapes of the control stick

Source :https://www.siliconera.com/sony-developing-a-colorful-led-wand-for-the-ps2/

- Virtual Reality in Architectural Design:

The e digital revolution has had a significant impact on the methodology of architectural design through virtual representation of the design reality and the use of simulation techniques. This has enabled designers and clients to discuss and study projects using a realistic environment before their implementation. This has been beneficial in identifying potential problems and issues in the design prior to construction.

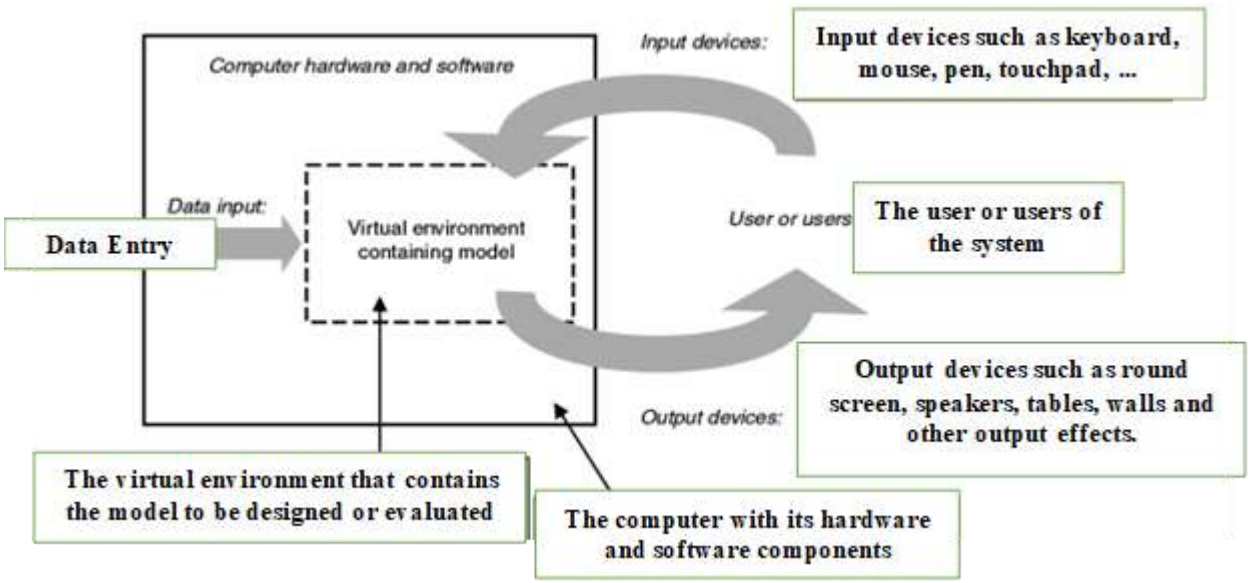

Figure 7: Components of the virtual reality system

In contemporary architecture, which coincided with the third wave of modernity characterized by communications and digital information, there has been a profound impact on architecture. (33) Deconstruction, the third generation of architectural language, relies on producing an architectural form that operates in parallel with cultural law. Contemporary architecture is characterized by the lack of technical constraints, the use of nanotechnology, and the integration of architectural design with technological manufacturing. This has led to a shift in focus from purely technological and technical aspects of architect ural engineering to the importance of human values in the design process. (34),(35) Contemporary architecture is characterized by the abundance and diversity of architectural movements that unify it. There seems to be a trend towards harnessing the results of the global technological revolution in the fields of quantum physics, bio-molecules, and computer science. In order to create a responsive and interactive structure that harmonizes with its natural, social, and economic environment, contemporary architectural movements attempt to simulate human intelligence and behavior for learning and adapting to the environment. Through the utilization of new technologies, these movements hope to achieve their goals. This may be one of the important considerations when transitioning to these architectural movements, but there has not yet been a clear and integrated understanding or concept of architecture that suits humans in the future due to the succession of scientific and technological discoveries. The societal values that are usually taken into account, in addition to these developments, have a direct impact on this. New techniques are required to pave the way for an architectural breakthrough that can accommodate all the ongoing profound developments and not neglect ethical values, but rather employ and build upon them in order to create an architectural leap and transition towards a future that may be introduced by neutralizing all the negative effects of industrial technology on the world.

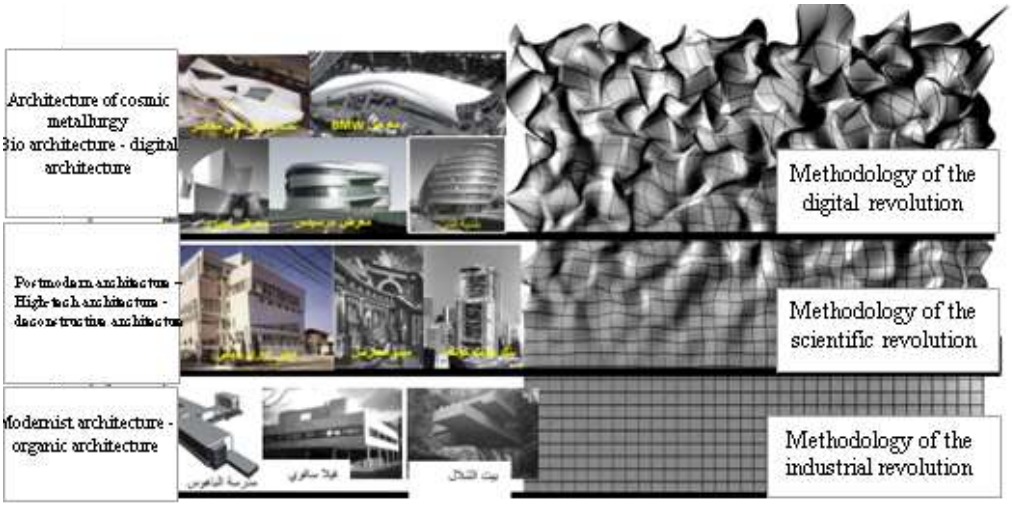

Figure 8: shows the geometric network of morphology for generating architectural form in relation to design approaches and architectural movements

Source: Al-Jabri, Dr. Ali Hussein (2010), Contemporary Civilization: From Necessity to Becoming, Dar Al-Farqad,

Information Technology in Architecture:

The emergence and rapid expansion of information technology have significantly transformed daily human life, with many experts believing that the world will be dominated by information technology, leading to the globalization of all societies. (36)

Architecture and its education are not exceptions to this trend, as the integration of information technology through new definitions of space, place, and innovative tools has had a profound impact on the structure of architecture and its teaching. The creation of modern and smart buildings is a good example of the importance of technology in this field. The art of architecture, utilizing the infinite knowledge of information technology, aims to create an environment that meets the needs of its users. (37)

Today, information technology is recognized as a primary design tool in architectural education. "The speed provided by the concept of design through information technology can eliminate delays between the idea concept by the designer and the stakeholders, serving as a starting point for new ideas."

Over time, this field has established its position as a member of the architectural engineering process, alongside other members and tools of architectural design.

Integration of Information Technology in Architecture: (38)

Information technology entered architecture seriously after the industrial era and led to an update in the present age. An age where humans tend to fulfill their material and physical needs. Thus, the boundaries of architecture, which were limited to providing suitable shelter for human life, became a tool in the economic market to maximize efficiency and profits.

"The emergence of software and systems for expressing, organizing, and monitoring data and information in the field of architecture has caused a professional change in architecture, where one must know the design processes and also be required to know how to apply design tools. Information technology is linked as a tool to architecture and architectural education and integrates with both. For this reason, it has assisted architects in design processes and provided the possibility of simulation and calculations on a broad management level."

The Role of Information Technology in Architecture: (39)

Information technology provides designers with various tools that can be useful in this regard. Examples of such tools include AutoCAD, computer models, and computer modeling. Some of these tools are used in the design process, while others are technical, such as AutoCAD, which is primarily used for detailed drawings that cannot be considered as essential design tools, but rather as tools for creating original designs.

Information technology allows designers to use solid, mesh, or surface 3D models that do not face such problems. The method used by the computer to create a 3D model, utilizing the capabilities of information technology and advanced software, closely resembles the manual method, which has two main advantages. First, these models are fully automated, with precise and perspective measurements. Second, the perspectives provided by the computer model are more realistic than the three-dimensional model of manual models and can be presented in the end.

Architectural animation is a fantastic presentation of the small and general parts of a building using three-dimensional computer graphics, which is not possible with traditional manual tools because this tool uses three-dimensional movements without points. It is an immovable view that is impossible with the traditional two-dimensional method. With all these descriptions, it can be understood that information technology will have a significant impact on the quality and efficiency of the architectural engineering process by providing various tools and utilizing the latest knowledge and technologies.

The Role of Information Technology in Architectural Visualization: (40)

Information technology serves as a tool or platform that enables designers to better understand design and concept, strengthens and aids in manual techniques, and increases the speed of concept transfer and idea generation. While information technology is a pure technological aspect, it provides strong support for qualitative concept transfer and architectural processes.

Traditionally, the main approach in architectural design was predominantly physical, but with the entry of information technology in this field, these approaches have undergone substantial changes, and we are witnessing better and more advanced design processes.

In addition to enhancing architectural processes and idea development, information technology has found other applications in the field of architecture, such as drawing, information modeling, creating virtual buildings, and more powerful qualitative and detailed architectural steps. On the other hand, as a tool, it provides the possibility of communication and information transfer to the public and the use of various materials and components.

The role and function of computers in structural computation can be highly significant. Detailed parts and execution details indicate that it has made it possible to design and implement sustainable structures through computer-aided design and documentation, 2D drawings, computer modeling, and increased idea transfer to others, reducing the time and cost of mapping and constructing physical models. The selective increase and final use, thus, information technology, with its wide-ranging facilities for architects, saves time and money and reduces human errors.

Virtuality in Architecture: [41]

Virtuality does not mean a complete replica of real vision. It means an abstracted encoded model that allows integrative perception, cognition, and psychological mechanisms. In contemporary philosophical discourse, reality is not merely a faithful simulation of external visual data, but it has more complex and fundamental characteristics. The condition of the word "Virtual" is derived from the Latin word "Virtus," meaning inherent "potential" or "power" of something real, which can become realistic, tangible, and practical. Virtuality is not simply the possibility of reality, not an opposition to reality, but it is already real in itself, while its activation is achieved through dispersion and differentiation.

By using various techniques for spatial representation, architects perform spatial evaluation of their projects, communicate with clients and collaborators, and represent project stages at different levels of execution, from concept to final presentations

In architectural engineering, objective representational forms such as orthogonal projections and isometric views like floor plans, elevations, sections, and scaled perspectives have great importance in precise technical description, but those images have limited potential for activating attention and emotional response, which is closely related to proposing the project to a human user. They also have low potential for dynamic operations involving more complex levels of information, including visual spatial location and time.

The invention of perspective as a method of creating a pictorial representational space provides in some way an impression for the eye of the full three-dimensional spatial dimension and is often regarded as techniques of presentation that simulate natural vision.

The representation of perspective in the light of new scientific theories of calculation is not just deceptive display techniques but the geometrical code of visual information and spatial organization, taking into account the external position of objects and the internal position of the subject, enabling a sense of realism and differing from other representation systems based solely on the external objective properties of models. The encoding of perspective drawing relies on the representation of digital space and the local positions of informational digital point numbers.

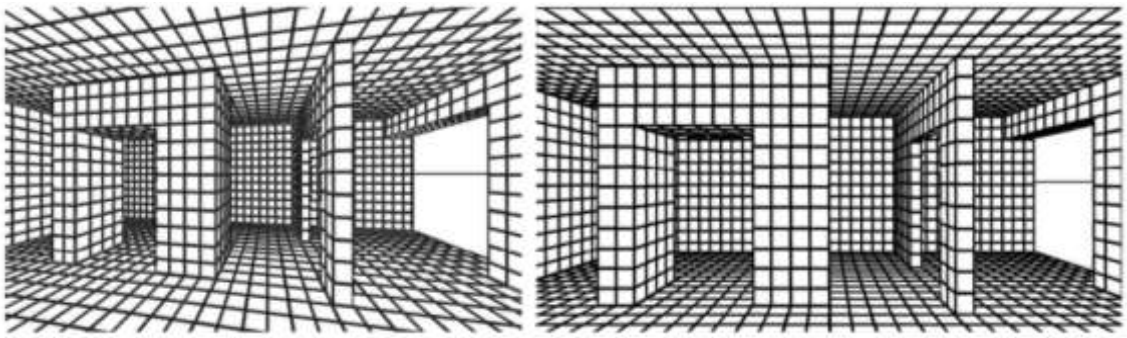

Figure 9: shows a perspective of a virtual space

Source :https://universes.art/en/echigo-tsumari-triennial/2022/esther-stocker

Photorealistic images are not equivalent to direct visual perception of the retina as a simulated vision, and they are not just conventions, but rather visualized information matrices that share common characteristics with direct perception of the world. Human perception is not just construction, but also selection, processing, and creation within compositional data.

Virtual reality and virtual environments have become synonymous with real-time computer-generated three-dimensional graphical environments. Real-time 3D computer environments.

Virtual reality today evolves from pre-planned three-dimensional computer animations, such as a negative cognitive experience of the designed space, to interactive exploration. Currently, computer-generated visual representation enhances representational capabilities, not only providing visual information but also enabling direct user participation, interaction, and exploration of the created space, in both initial and final project stages. Virtual performance encompasses not only the cinematic space associated with reality but also actions and experiences that are impossible in reality.

Figure 10: Illustrating the expansion of perceptual and mental experience through active spatial participation in alternative dimensions of space, expanding the creative imagination.

Source :https://www.pxfuel.com/en/desktop-wallpaper-xilys

-Virtual Reality Visualization: (42), (43), (44)

Virtual reality offers new useful capabilities for evaluating building design in relation to the following:

A. Thermal Pathway:

The airflow and air temperature can be visualized through a three-dimensional model. The movement around specific locations of the building can be examined to understand the direction, speed, and temperature of the air. Precise values can be measured and compared against the required standards.

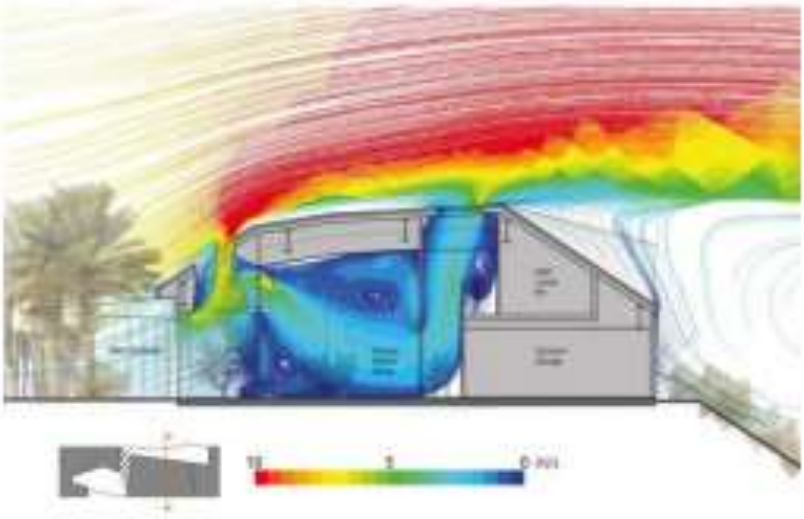

Figure 11: Illustrating the use of thermal analysis using the Ecotect program for a public facility

Source: https://www.design.upenn.edu/architecture/phd/work/urban-conscious-rapid-wind-downscaling-model-early-design-stages

B. The structural path of the building

It is possible to observe the places of pressure and tension for structural parts by adding a color gradation to a specific pressure or tension value in order to reach knowledge of the behaviors of the various forces of the building's structural structure, and the exact values can be compared with the standards that must be adhered to, with regard to the safety factor, the building's tensile strength, and its cohesion.

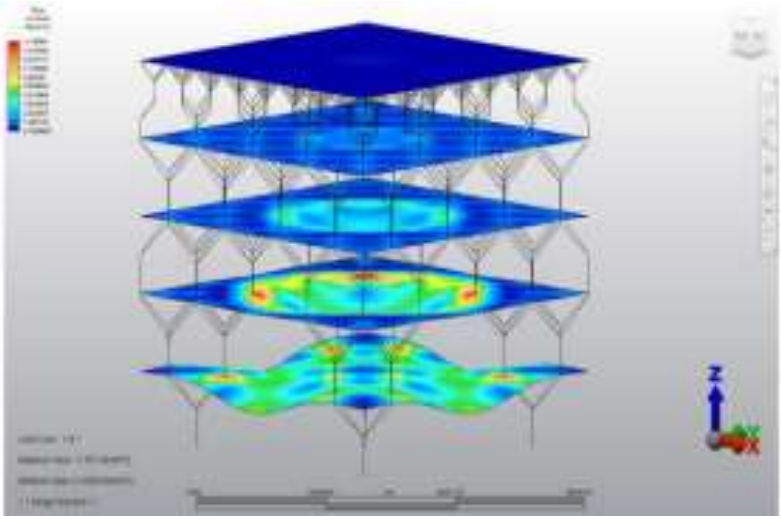

Figure 12: shows the use of SAP2000 to build and analyze a structural structure for a residential building.

Source :https://dfabnus.wordpress.com/2010/09/17/p2-model-image-and-algor-simulation/

B. Human behavior

The way people will walk around the building can be observed. Statistical or empirical data are used to describe the methods used and the time taken to move from one place to another. This data can be compared to fire regulations and exit points, for example, to achieve a practical and safe flight path. Separate packages already exist for thermal route, structural route, human route, etc., and computer-based design packages are sometimes used as a front-end tool.

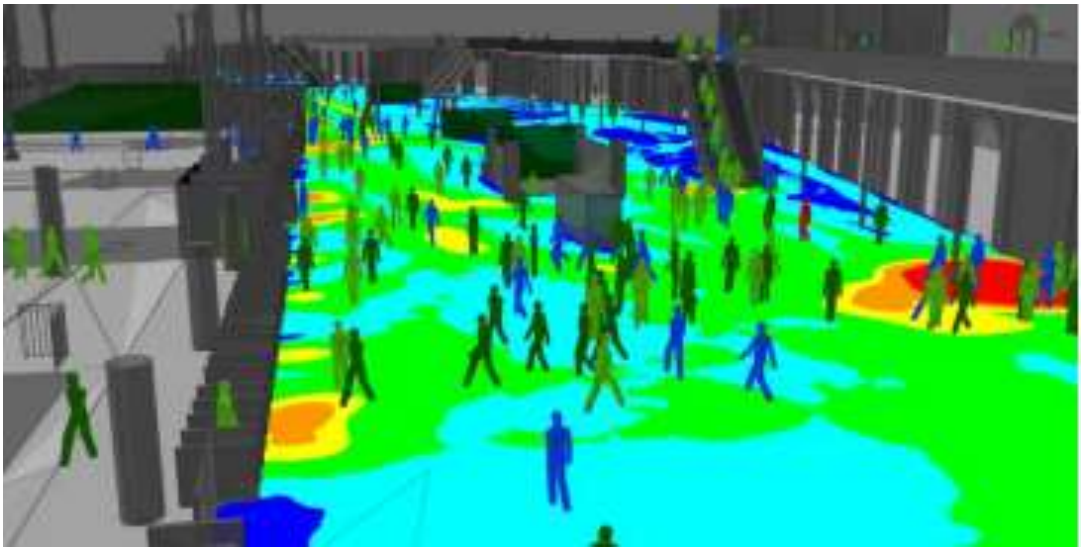

Figure 13: Using the Design Builder program to build and analyze pedestrian movement for a public station

Source :https://pigeon-tech.com/features/heat-maps-pigeon-tech/

New Design Tools in the Information Technology Era:

Information technology has introduced a range of tools used by information systems or their participants to perform work. These tools include hardware and software used by information systems. It is important to understand that information technology has no impact unless it is used in data processing. To be effective, information technology must support the information process. Hardware refers to the

physical equipment used in data processing, such as computers, networks, and data storage devices. It refers to things you can see and touch.

Computer applications in design studios can be categorized into three main levels:

Basic Level:

- Digital Design Media: This level covers a wide range of computer-based design applications at an introductory level. It includes interactive communication (web development), basic engineering modeling, digital image processing, and production of mixed media involving the use of digital video, scanning, and output media. It explores general principles and fundamental concepts of the design process.

Intermediate Level:

- Modeling and Engineering Visualization: This field examines the full range of three-dimensional modeling and visualization applications from basic to advanced levels. It includes color manipulation, image processing, digital modeling, and basic animation. It involves file management (smart labeling terminology, etc.) and data conversion (importing and exporting).

- Digital Media and Drawing: This field explores the relationship between photography, 2D drawing, and digital media, including technical issues of scanning, image resolution, color models, and file formats.

- Structural Analysis: This field examines a complete set of structural analysis tools, including finite element modeling and other advanced simulation techniques.

- Digital Film and Animation: This field explores digital film production and animation as a means to critique and redirect design proposals. Consideration is given to narrative or storytelling aspects. Special attention is given to panoramic projections.

- Parametric Design: This field explores the quantitative basis and invisible geometrical arrangement of forms found in nature and architecture, as explored through computer programs. It deals with the use of algorithms (evolutionary) within the generative context as powerful inputs for digital shape generation.

- Spatial Simulation Techniques: This field studies the appropriate use of analog techniques for digital models, which can enhance the depth of evidence and realistic content of "under construction" designs through simulation.

Advanced Level:

- Computer-Aided Manufacturing (CAM): This field explores the capabilities of numerical control processing, rapid prototyping, and manufacturing building components. It focuses on the advancements in generating digital models that are later realized in physical products.

- 3D Digitization: This field emphasizes three-dimensional scanning of physical models, resulting in accurate digital three-dimensional representations for the creation and development of complex engineering models.

- Laser Scanning: This field explores a range of computer applications that provide realistic images and accurate three-dimensional models created from field data and sites.

- Energy Performance Simulation: This field studies the use of particle flow analysis, energy simulation programs, HVAC design software, and other computer applications used to assess, analyze, and meet heating, cooling, and air handling needs in buildings.

- Digital Acoustic Simulation and Synthesis: This field covers topics in digital sound analysis and simulation as a specialized area within design disciplines.

- Digital Performance Simulation and Daylight: This subject analyzes lighting at various stages of the design process, examining specialized laboratory setups such as artificial skies.

- Digital Technology and Communication Media: This field explores communication based on a dynamic blend of digital design media and is used through collaborative remote work in Virtual Design Studios as a basis for testing design alternatives. Communication relies on video conferencing.

- Building Calculation: This field explores the mathematical relationship between structural engineering and architectural design, with the use of infinite elements being an area that can be explored at an advanced level.

- Geographic Information Systems: This field studies the use of polygon overlay techniques for site analysis, area information management, and possibly extends to spatial planning and facility management.

- Spatial and Data Analysis Methods: This field explores the subject of setting up and implementing relational databases as an aid in design, where cost estimates in this context serve as a case study.

Changing Architectural Design based on its Influence by Information Technology: [48], [49], [50]

In contemporary architectural design, information technology tools, especially computers, are increasingly used not only as presentation tools but also as generative tools for deriving design models and transformations to achieve the design concept. This marks a radical departure from old and traditional standards of architectural design, where new forms and concepts are not created or drawn using traditional methods but are calculated through selected generative mathematical methods.

Digital generative processes have produced new types of concepts, forms, and explorations, and in general, this chapter will discuss how computers are used to "find the model" as an implementation of the concept, using various digital generative techniques.

Architects find it easier to shape and sculpt material and three-dimensional space using computer-aided design (CAD) modeling software and direct processing operations. They discover that designing with computers can help them create radically new shapes for existing buildings, all of which deviate significantly from the traditional forms designed by computer-aided design programs.

Interesting previous models were created using modeling software, and later on, another method of creating models emerged, which can be called "mathematical model creation," or writing computer programs that result in three-dimensional engineering and using this computational means to explore architectural forms.

In general, the use of digital processes relies primarily on two types of programs: pre-designed model configuration programs or writing algorithms using programming languages (a small design program that executes models).

If one wants to create three-dimensional models computationally, they must choose between two main alternatives:

It is relatively easy to learn the macro facilities and scripting languages within CAD designers, but they are limited by their nature as programs that one can write (and thus the models one can create).

Programs created using programming languages like C and Java are powerful but require more effort to learn. Creating three-dimensional engineering requires paying attention to many features of the programming language that do not have a direct impact on the model.

Analytical Study:

• Dynaform by Architect Bernard Tschumi: [51], [52]

The new BMW pavilion was designed to express the core marketing philosophy of BMW, which emphasizes enjoyment. The idea in designing this pavilion is to give the sense that the displayed cars are in motion, yet they are presented and displayed in a completely stationary state. The concept of the design was achieved by drawing inspiration from the Doppler Effect.

Doppler Effect: The apparent change in the wavelength of sound or light resulting from the motion of the source, observer, or both. Waves emitted by a moving body as received by an observer will be blue-shifted and compressed if approaching, while red-shifted and elongated if receding. It occurs in both sound and light. The frequency shift that occurs depends on the speed of the body moving towards or away from the observer. The architect simulated the displacement of air by moving the car in a vacuum, and the result of this bending of space was translated into the shape of the building.

First Step: Creating the main forces used in building the model, the forces resulting from the movement of the car due to the displacement of air (Figure 14). The air forces were sucked out (Figure 15).

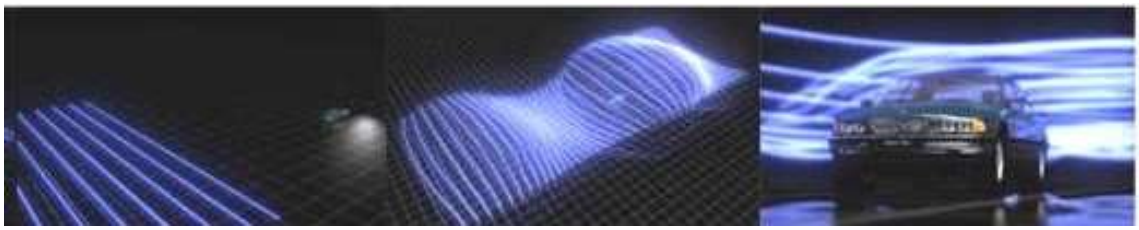

Figure 14: Air displacement due to car movement

Source :https://franken-group.com/projects/dynaform

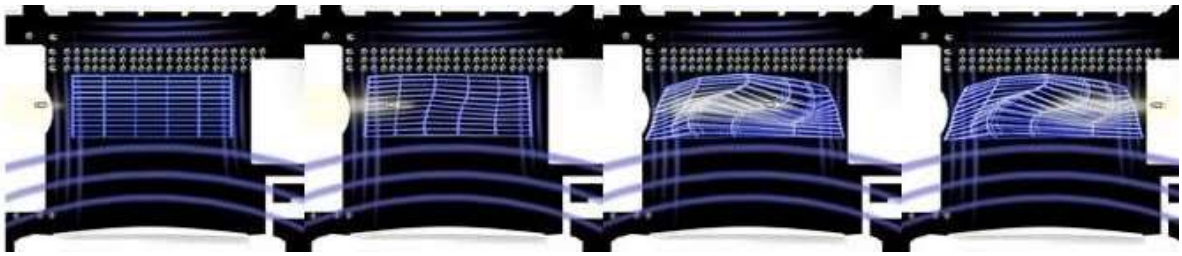

Figure 15: The shape of the vacuum forces of the atmosphere, distorted due to the displacement of the car.

Source :https://franken-group.com/projects/dynaform

Second Step: Form follows force: By overlapping forces (vacuum forces, forces resulting from air displacement) through the overlapping of the environment, they create a Dynaform model**.**

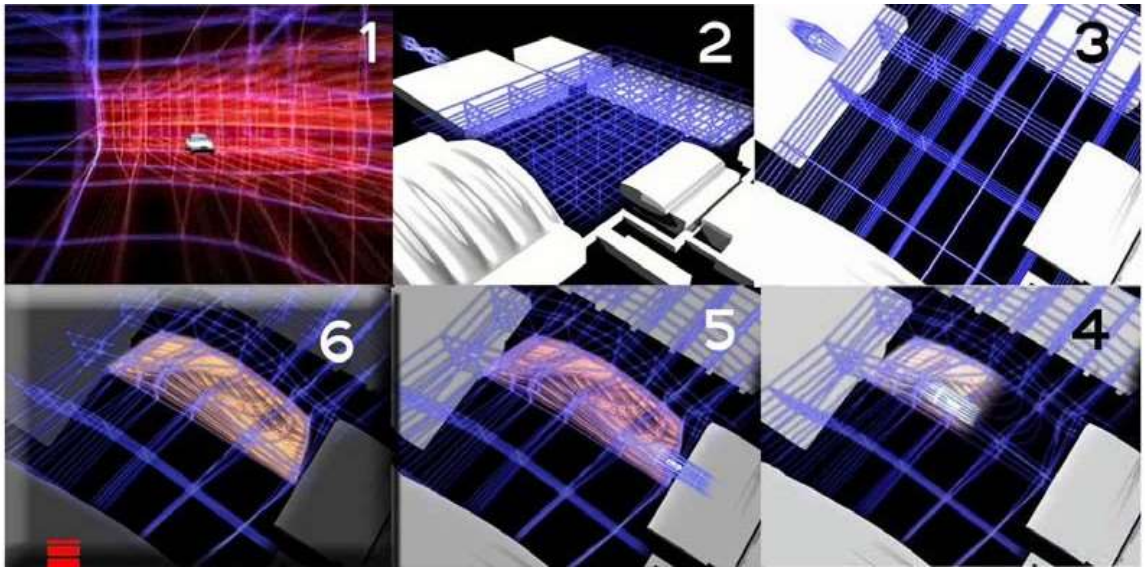

Figure 16: A series of frames from an animation of a BMW car traversing a force-free environment. Forces appeared due to the movement of the car, and the forceless atmosphere formed the main form of the building.

Source :https://franken-group.com/projects/dynaform

Figure 17: The shape resulting from the previous simulation process became the main geometry. This main geometry was then divided to become smoother, and thus the final shape was created.

Source :https://franken-group.com/projects/dynaform

Figure 18: Shows the final appearance and subsequent nature

Source :https://franken-group.com/projects/dynaform

3. Materials And Methods

The methodology of this research is based on a set of research questions, study objectives, and the knowledge provided by the literature on the topic. It examines the future trends of architectural thinking, the diverse human needs in the 21st century, and the re-understanding and reinterpretation of architectural theories through the integration of various fields of science and architecture.

The qualitative approach is chosen as the appropriate method to investigate, identify, and measure the development in new architectural thinking and its correlation with the latest technologies that lead to identifying suitable directions for integrating new units in architectural design thinking. This research involves data collection and analysis regarding the characteristics of the new intellectual era, trends, and needs in both the information technology and architecture fields. [53]

3. Results and Discussion

Theoretical study:

Architectural trends, urban expansion, and architectural ideas have evolved in an exciting manner from the Industrial Revolution to the digital revolution. The increasingly globalized architectural reality and the growing reliance on computer technology have had a significant impact on the development of new concepts in architecture, such as digital architecture. Architects have realized that the design thinking scope of any new direction is constrained by the nature of the technology associated with that direction. This has led to the emergence of a new generation of architects who interact with this new mindset, resulting in the emergence of new design thinking in contemporary architectural trends such as green architecture, genetic architecture, amid architecture, exo-structural architecture (Exodesic), emergent architecture, and more.

The extent of the impact of intellectual battles on practical aspects becomes evident when humans discover cognitive or scientific laws and try to apply them to their reality and benefit from them in improving their living environment. They then adopt it as a design approach, organizing mechanisms to adapt technology to serve humanity. In the field of architecture, this leads to the creation of a new vision for architecture and, consequently, a change in the nature of architectural form and the determinants that govern it. This process involves scientific and intellectual events, followed by technological advancements, and their relationship to design methodologies, ultimately shaping the architectural form.

Analytical study:

The results of analytical studies have shown the superiority and transformative power of information technology compared to its predecessors as a factor influencing future engineering. The digital revolution has led to the emergence of contemporary architectural trends characterized by innovative formations that integrate architecture with other sciences such as biology, genetic engineering, and environmental sciences.

Digital technologies have had a wide-ranging and detailed impact on architectural outputs, including internal and external elements, functionality, form, architectural features, building materials, and even building envelopes and roofs. The face of architecture has changed due to its influence on technological advancements. There are numerous contemporary trends where design ideas merge with the construction of modern architectural forms.

In the era of the digital revolution, we expect architectural elements to be characterized by lightness and agility, and some elements to become more transparent and capable of changing their properties. The characteristics of the built environment are changing to achieve environmental, plasticity, technological, and climatic goals.

4. Conclusion
Recommendations

Information technology has advanced significantly and has had a profound impact on various fields, including architectural engineering. Here are some recommendations for using information technology in architectural engineering:

1. Building Information Modeling (BIM): BIM is a powerful tool for improving design, construction, and project management processes in architectural engineering. BIM allows for the creation of accurate 3D models of architectural projects, aiding in better coordination between different teams, data analysis, sustainability analysis, and information management.

2. Virtual Reality (VR) and Augmented Reality (AR): VR and AR techniques can be used to enhance the design experience and interaction with architectural projects. Clients and architects can explore interactive and realistic 3D interfaces of buildings and future projects, helping them understand details and make better decisions.

3. Engineering Analysis Tools: Advanced engineering software and tools can be used to analyze structural performance, thermal analysis, lighting, acoustics, and other aspects of architectural design. This allows architects to evaluate and improve performance, sustainability, and comfort in projects.

4. Computer-Aided Design (CAD): The use of Computer-Aided Design (CAD) software is crucial in architectural engineering. CAD tools facilitate the creation of accurate and detailed architectural drawings, making modifications, improvements, and enhancing communication between different teams.

5. Environmental Analysis and Sustainability: Environmental analysis and sustainability techniques can be employed to evaluate and improve the environmental, economic, and social performance of buildings. This analysis helps in making sustainable and resource-efficient design decisions, achieving better environmental performance in architectural projects.

6. Enhancing Communication and Collaboration: Online communication and collaboration tools can be used to improve communication and information exchange between different teams in architectural engineering. Email, cloud platforms, and collaborative applications can facilitate collaboration and improve work efficiency.

7. Keeping up with Technological Advancements: Architectural engineers should stay updated on technological advancements in their field and adopt new technologies and tools that help improve performance and achieve innovation in architectural design.

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