Digital Space

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***Abstract*— The digital era reached by the technological developments in different fields of science influenced the field of architecture, just like the others. Thus, a new kind of spatial and tectonic quality in architecture is emerging with the lately introduced design tools and materials that are novel to the building industry, while redefining the role of architect in this contemporary medium.**

With the aid of developments in various fields of science, design and construction abilities of contemporary architects have gone far beyond of the Industrial Age's. This new potential of design merits are being used since the digital information revolution, which took place in the field of architecture parallel to the widespread expansion of computer use in design studios. Computer use in the studios extended from being limited to representational tool to the single source of both design and manufacturing processes. This period, with the advances in the material and construction industries, has drawn attention to complex-shaped forms and highly curvilinear surfaces, which were, until recently, very difficult and expensive to design and produce using traditional methods.

This Research intends to explore the Computer softwares and how we use them to Make Digital Spaces .

***Index Terms*— computer aided design (CAD) , computer aided manufacturing (CAM), geometric modeling, Digital design , Digital design strategies , Digital spaces , 3D modeling Future of Architecture Digital learning .**

I. INTRODUCTION

This research aims to analyze and evaluate the influence of digital technologies on the interaction of design and manufacturing processes by representing an outlook of digital technologies through developments in modeling capabilities, manufacturing techniques, material science, and design strategies.

II. SOFTWARE PRODUCTS:

A. AutoCAD2016

With AutoCAD software, you can create and edit 3D solids and surfaces with ease to explore ideas in almost any shape imaginable.

Features

 Explore: Explore design ideas in both 2D and 3D with intuitive CAD tools that help concepts become real.

 Document: Drive projects from concept to completion with documentation tools, moreover work faster with automation, management, and editing tools that minimize repetitive tasks and speed time to completion , that tools include:

- **Parametric Drawing**: Define relationships between objects.
- **Dynamic Blocks**: Save time when using standard, repetitive components.
- **Annotation Scaling**: Spend less time sizing and resizing annotations.

 Communicate: Share critical design data securely, efficiently, and accurately, furthermore experience the native DWG support, allowing you to keep everyone in the loop at all times.

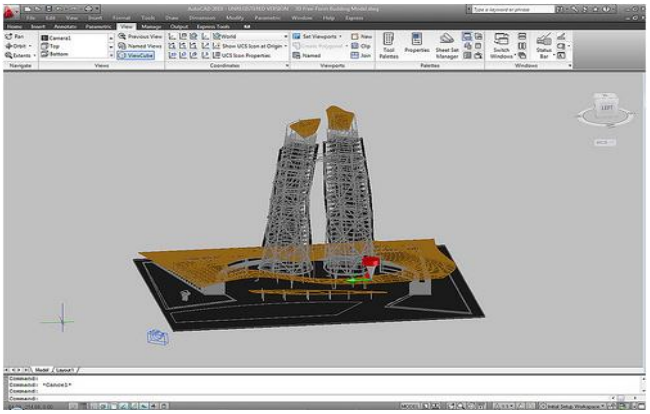

Figure 1–The AutoCAD 2016 showing a 3D Model designed by Guillermo Melantoni in AutoCAD 2016 using the new Free Form modeling feature

B. Structural Modeler V8i-BIM for Design and Documentation of Structural Systems

 Is part of Bentley's integrated suite of building information modeling (BIM) applications, which is provide seamless integration between design, engineering, analysis, construction, and operations for the entire lifecycle of facilities.

 Provides engineers the ability to easily explore design alternatives with flexible interdisciplinary coordination and interoperability with industry leading structural analysis software products.

 Is suitable enough for use on any type of structural project. Structural systems can be created for buildings and industrial plants in steel, concrete, and timber with unlimited freedom.

 Provides the ability to automate the creation of construction documentation across a project. This provides a

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significant time savings over a 2D workflow.

- Reducing time, schedule, and costs across a wide spectrum of engineering projects. (Bentley, products, 2010)

C. -Autodesk Revit Architecture

Purpose: built for building information modeling (BIM), Autodesk Revit Architecture building design software helps architects and designers capture and analyze early concepts, and then better maintain designs through documentation and construction. moreover it provide a more collaborative, integrated building design process by sharing essential BIM data with your partners, and use BIM workflows to help drive more efficient sustainable design analysis, clash detection, construction planning, and material fabrication.

Features

- **Conceptual design tools**: Define conceptual forms and geometry as real building components for a smoother transition to design development.

- **Bidirectional associativity**: Any information that gets changed is changed throughout the model.

- **Parametric components**: The basis for all building components designed in Autodesk Revit Architecture.

- **Revit Building Maker**: A more seamless way to turn conceptual forms into functional designs.

- **Schedules**: A change to a schedule view is automatically reflected in every model view.
- **Detailing**: An extensive detail library and detailing tools.

- **Design visualization**: Capture design ideas in a photorealistic state. (Autodesk, Products, 2010)

D. Autodesk 3ds Max 2016

Autodesk 3ds Max Design software enables architects to better explore, validate, and communicate conceptual building designs through 3D visualizations created directly from AutoCAD and Autodesk Revit designs. (Autodesk, Products, 2010)

Features

- **Extensive 3D modelling toolset**: More than 100 advanced polygonal modelling and freeform 3D design tools, Such as NURBS and Subdivision Surface.

- **Shading and texturing**: Wide range of texture painting, mapping, and layering options.

- **Animation**: Sophisticated toolset for creating characters and high-quality 3D animations.

- **Dynamics, effects, and simulation**: high-performance toolsets for creating dynamics and simulation effects.

- **Powerful 3D rendering capabilities**

- **Collaborative workflows**: Collect and share data in complex scenes, enabling multiple users to collaboratively contribute to the workflow. (Autodesk, Products, 2016)

Figure 5. The Bubble, BMW's exhibition pavilion by Bernard Franken and ABB Architekten

(Kolarevic, B. Digital Morphogenesis, in: Architecture in the digital age: Design and manufacturing. (pp. 11-28). Branko Kolarevic, ed. Spon Press, New York. 2003.)

E. CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Dassault Systems and marketed worldwide by IBM. Written in the C++ programming language, CATIA is the cornerstone of the Dassault Systems product lifecycle management software suite. The software was created in the late 1970s and early 1980s to develop Dassault's Mirage fighter jet, then was adopted in the aerospace, automotive, shipbuilding, and other industries, CATIA started as an in-house development in 1977 by French aircraft manufacturer Avions Marcel Dassault, at that time customer of the CADAM CAD software, Now In 2016, Dassault announced and released CATIA V6. While the server can run on Microsoft Windows, Linux or AIX, client support for any operating system other than Microsoft Windows is dropped.

CATIA can also give a schedule of the construction process to ensure that all com- ponents of the structure are completed on track. In the Walt Disney Concert Hall case, the general contracting company decided to integrate the fourth dimension of computer modeling and marry the building's curvilinear geometry to the planned schedule. The output is an animated four-dimensional CAD visualization tool that plays out the construction sequence.

Features

- Commonly referred to as a 3D Product Lifecycle Management software suite, CATIA supports multiple stages of product development (CAx), from conceptualization, design (CAD), manufacturing (CAM), and engineering (CAE).

- CATIA can be customized via application programming interfaces (API). Moreover it adapted in the FORTRAN and

C programming languages under an API called CAA (Component Application Architecture). Basically V5 can be adapted via the Visual Basic and C++ programming languages, an API called CAA2 or CAA V5 that is a component object model (COM)-like interface. (Bernard, 2003)

- Although later versions of CATIA V4 implemented NURBS and it principally used piecewise polynomial surfaces. CATIA V4 uses a non-manifold solid engine.

- CATIA V5 features a parametric solid/surface-based package which uses NURBS as the core surface representation.

- V5 can work with other applications, including Enovia, Smart team, and various CAE Analysis applications. (Systems, 2002-2016)

- CATIA is a manufacturing tool and it has an extremely comprehensive toolset, but tends to require a path of production that leads directly from design to manufacturing with a minimum of revisions. (Cichy, 2006)

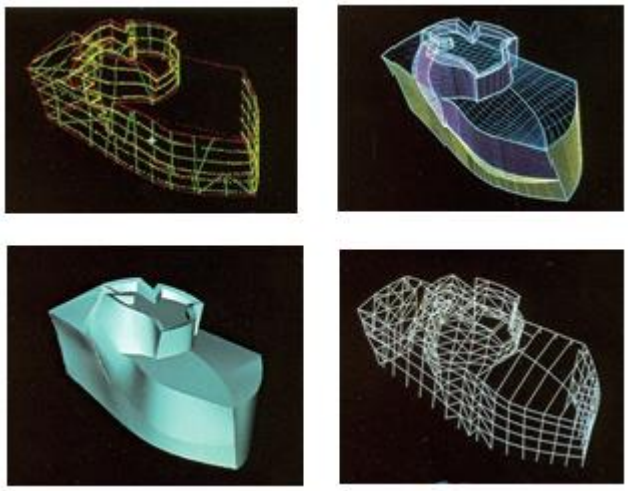

Figure 6. Digitizing sequence of Guggenheim Museum developed in CATIA
(Raghep, J. F., K. W. Weg. *Frank Gehry, architect.* Guggenheim Museum Publications, New York. 2001.)

F. Autodesk Maya

3D Modelling and Texturing: Advanced Polygon, NURBS, Subdivision Surface Maya includes a suite of advanced polygon.

Brushed-Based Technologies: 3D Paint Effects, Paint technology for creating natural detail on 2D images including textures, or 3D objects attached to polygonal and NURBS surfaces.

3D Animation: Keyframe, Nonlinear, and Advanced Character Animation Editing Tools Create, animate, adapt, and repurpose animation data and edit realistic digital characters.
3D Rendering: Five additional Mental Ray for Maya batch rendering enables the architect to use other networked computers to render your sequences faster.
Advanced Simulation Features: Maya create a wide range of sophisticated particle effects among of them: Maya Fluid Effects, Simulate and render atmospheric, pyrotechnic, viscous liquid and open ocean effects. (Autodesk, Products, 2016)

G. Autodesk Alias

Features in Autodesk Alias industrial design software products support concept exploration, design modeling, surface modeling, reverse engineering, data integration, and design visualization and communication.

- Provides tools to develop and communicate product design. It is also available in a version designed specifically for users of Autodesk Inventor software.

- Provides a subset of dynamic 3D surface modeling capabilities for virtual modelers.

- Includes the features in Alias Design and Alias Surface, Autodesk Alias provides a comprehensive set of visualization and analysis tools for the entire shape definition process, from concept sketches through create surfacing. (Autodesk, Products, 2016)

III. DIGITAL SPACES EXAMPLES:

Figure 7. Walt Disney Concert Hall, Los Angeles (Raghep, J. F., K. W. Weg. *Frank Gehry, architect.* Guggenheim Museum Publications, New York2001.)

Figure 8. Experience Music Project (EMP), Seattle (JBL. *Press room*. http://www.jblpro.com/pressroom/images/aeriel_view_72.jpg. Last accessed in December 2005.)

Figure 9. Barcelona Fish for the Villa Olimpica (Lindsey, B. Digital Gehry: Material resistance / digital construction. Birkhäuser, Berlin. 2001.)

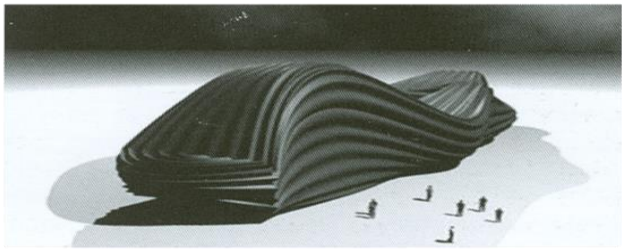

Figure 10. The Trans-Ports 2001 designed by Oosterhuis Associates, is modified via sensors and automatic mechanisms in the building.
(Luca, F. D., M. Nardini. *Behind the scenes: Avant-garde techniques in contemporary design*. Birk- häuser, Berlin. 2002.)

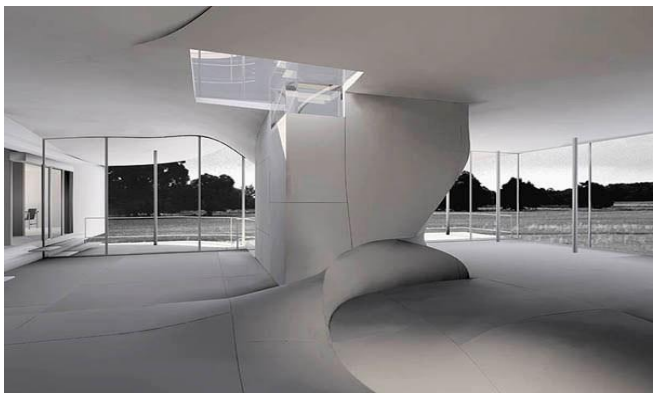

Figure 11. Torus House (Cohen, P. S. 100 architects, in: *10x10*. (pp109-111). Iona Baird ed. Phaidon Press Ltd., London. 2000.)

IV. RECOMMENDATIONS

- Architects need to understand the concept of computer aided architectural design and to apply its methods in their creation of design suggesting solutions at an earlier stage of the process, And they in order to use these tools in an explorative design context needs to be geometrically aware and computationally enabled.
- Architects need to be taught the basics of programming, multiple types of software, knowledge of scripting languages, and the manipulation and maintenance of complex data models and logical approach to a problem solving.
- Architects need to use digital techniques throughout the curriculum to understand how computing can support architecture's diverse endeavour and thinking modes. In particular, students must be able to explore and communicate design ideas fluidly using digital and traditional media suitable to specific queries.
- Faculty with broad knowledge are needed as well as instructors experienced in specific software applications. Peer tutors and small student-teacher rations can make training exercises work for individuals of differing abilities. A positive learning community is crucial to making computers effective in architectural education.

6-Future work

- Digital Spaces opens up a new line of theoretical discourse in architecture that differs from the traditional metaphoric understanding of the relationship between architecture and the sciences, new line of applicable projects of the computational process in architecture and new line of digital approaches on architecture.

- Innovative digital approaches are emerging that offers some unexpected new conduits to an important discipline of architecture. Topic nodes within this research are evolving with a particular set of important distinctions from one another. Thus, we contend that the digital architecture is augmented by further specificity such as: Digital Pedagogy, Digital Tools, Digital Production/ Fabrication Digital Visualization, Digital Projects, Digital Design, Digital Representation, Digital Practice, Digital Thinking, computational models, parametric models, generative models, performance etc. which need to be developed by future researches.

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