The reciprocal relationship between the transfer and localization of digital technology and free architectural formation

Mohammed A. Soliman
Architectural Engineering Department, Faculty of Engineering, Al-azhar University, Cairo, Egypt, m.soliman.19872011@gmail.com

Khaled M. Khorshied
Architectural Engineering Department, Faculty of Engineering, Al-azhar University, Cairo, Egypt.

Adel A. Radwan
Architectural Engineering Department, Faculty of Engineering, Al-azhar University, Cairo, Egypt.

Abdel Salam A. Soliman
Architectural Engineering Department, Faculty of Engineering, Al-azhar University, Cairo, Egypt.

Abd El-Awal A. Abd ellah
Architectural Engineering Department, Faculty of Engineering, Al-azhar University, Cairo, Egypt.

Abstract

The topic of the research deals with "the reciprocal relationship between the transfer and localization of digital technology and free architectural formation" by studying the reciprocal relationship between the transfer and localization of digital technology and the return of this technology to the architectural formation, and the production of a new type of non-typical formation, which is the free formation that deviates from the forms of Euclidean geometry. to free lines and models, and the research clarifies some concepts related to digital technology and the role of digital technology in preparing engineering studies related to projects with free formation, The research also studies the concept of free architectural formation, and the extent of the need for it and the software used in it, then the research moves to present the most important reasons behind the lack of spread of the use of some advanced digital technology applications at the local level, and is there a need for the spread of such technology? The research also examines the concept of technology transfer and localization and the mechanism of the process of transfer and localization, and then studies some similar experiences globally in the process of developing, adapting and transferring technology.

Keyword: *Digital technology- Architectural free form- Technology transfer- Technology localization.*

1. INTRODUCTION

Each era has its own tools, which are called the technology of the age, and over the ages and periods of time, this technology takes development as much as new science and knowledge in this era, until a huge revolution occurred with the entry of the era of industry and the discovery of machines, then the discoveries rolled as a result of the development of science, and developed With modern technologies, we have reached an advanced stage of technological development at the end of the twentieth century and the beginning of the twenty-first century. With the emergence of digital technology, which had a positive impact on the architectural movement, the architect has the unlimited ability to realize his unlimited ideas in all its forms and complexities. Presenting a sample of the projects that were affected by the applications of digital technology during the stages of the construction process.

2. Digital technology.

With the beginnings of the twenty-first century, many changes appeared in the technological field of the so-called digital revolution, which arose from the escalating convergence of several paths of technical development, when it was possible to integrate communication and information technology through a single technical means of communication represented by the so-called Bit, One of the components of the digital revolution is digital technology, which has been integrated into all areas of life, including architecture, where many architects around the world have used digital technology in preparing digital calculations for their designs, parametric equations, logarithmic relationships and formal transformations, which contributed to transforming complex shapes into a visual reality used in it. Digital modeling, and also supported architectural thought with new models and methods of design with unconventional forms (Soliman M. A. 2018).

2.1. A Technical and Architectural Product

As a result of using traditional techniques, the general framework of architecture was just a simple and pure form that resulted in a homogeneous building, which made architecture look similar in terms of capabilities in general in the surroundings, so architects and designers have an urgent need to develop their tools that enable them to translate their architectural creations, which are no longer valid traditional tools For this purpose, both in terms of technical level and in terms of the time factor.A subsection

Some text (Soliman M. A. 2018).

2.2. A Methods of translating architectural creativity

The architectural creativity of the designer is translated through two methods, one of which is called (the auxiliary medium) by interacting with this medium and these two mediums are (paper - digital media) and there is a continuous interconnection and interaction between the designer and the tools. Dimensions and the design stages are carried out with organized steps and scientific methodology, and in the case of the paper medium, it depends only on the designer’s mind, creativity, ideas, and experiences without any interaction from the paper, medium to show the positive or negative aspects or to clarify areas of conflict or results in the project, but in the case of the digital medium there is interaction mainly, and as a result of this interaction the designer is affected by the medium with which he interacts, making him in a continuous development stage of the design, as the medium is The digital medium is a dynamic medium and not a static medium like the paper medium. It is clear that the digital medium has a major role in helping the designer to study

the project as a real study, unlike the paper process (Kolarevic, B. 2005).

2.3. The role of digital technology in the study of construction solutions.

The applications of digital technology are used to represent the arithmetic and construction operations of the building. It also contributes to the representation of the international units between the structural elements, the necessary distances between them, the distribution of different loads, and the identification of places where deviations and bends are likely to occur through the use of advanced digital programs in the construction calculations, identifying and seeing these areas. Through three-dimensional digital models, it is also possible to take out all the structural elements of the building, explaining the methods of implementation and the stresses on them. It also contributed to saving design time and obtaining the most accurate and safest design results (Willem, K.2008).

2.4. A Types of digital software in this study.

Table No. (1) shows a brief definition of some types of digital software and how to benefit from them in architectural projects.

Table 1: shows Types of digital software.

Reference: https://3dsman.com/catia-pricing/ , https://www.autodesk.com/solutions/cad-cam {online}

Program name	About the program
CAD	AutoCAD is a drawing program of general use in many fields, used by engineers of various disciplines to create drawings and engineering designs and used by project managers, in addition to many other professions and industries.
BIM	Building Information Modeling is a building information modeling program for architects, landscaping engineers, structural and electromechanical engineers, designers and contractors. The various aspects of the building's life cycle, from the initial idea stage of the project to construction and subsequent maintenance , This collaborative strategy encourages engagement to improve project performance and deliver better results more quickly, resulting in better project decisions.
Rhino	The Rhino program is a three-dimensional drawing program that is used in the design of complex products. The program is characterized by the ease of dealing with drawing complex and curved surfaces. Through the Rhino program, more than one product can be designed at one time by modifying the basic design. An assembly can be made by numbering each part in Design to be carried out by CNC machines.
Grasshopper	It is an addition to the Rhino program. This program creates algorithms and visual software, through computer programming languages, and allows designers to make a variety of designs that are very complex, through the use of different elements that are linked in the .program's drawing space in different ways so that they are multiple shapes.
Catia	The CATIA program appeared through Avinos Marcel Dassault, a French company working in the field of aircraft manufacturing, which produced this program for the manufacture of aircraft and was later introduced in the field of automobile and ship manufacturing, then it was sold to IBM to be the owner of property and development rights, and then entered the field of architecture by architect Frank Geared and used in the design .and production of buildings with complex and complex configurations
CAM	CAM is a digital manufacturing program that was used for the first time by the French company Renault in the manufacture of car bodies, and it is a program that helps engineers and manufacturers to facilitate and produce complex elements and shapes through the .programming language and coding.

3. Free form architecture.

Free formation is the formation that results from multiple curves and unconventional patterns, and free formation emerges from organic formations, and the term free formation is used to describe buildings with curved and arched surfaces, moving away from blocks and projections with explicit geometric formations, which are called Euclidean formations, and free formations exceed formations The traditional design process, and produces free formations thanks to the applications of digital technology through mathematical equations that determine their features.

3.1. The need for free formations.

This type of formation has become a fait accompli and a new trend in the field of architecture, so it is necessary to expose and study it and study its characteristics, methods, and tools, and it becomes clear through the following points the extent of the need for this type of formation.

- Based on the civilized development of societies, we find it very important to keep pace with technological development and constantly strive to keep pace with everything new and modern, and we note this in all areas and requirements of countries.

- Countries need at times to establish quality projects that meet their needs, express their civilization, and chart their future. When this opportunity is provided, architects try to open the way for their awareness and imagination to make these national projects to be unique and iconic projects with a symbolic image, and the best example of this is what is happening now in Egypt from the boom Unprecedented in the establishment of new cities and urban communities, especially the new administrative capital, the new city of Alamein and the city of Galala These major projects are interspersed with iconic iconic buildings such as the tallest skyscraper in Africa, the El Alamein Towers, the Grand Egyptian Museum, the Museum of Civilization, and before them the Library of Alexandria. ages.

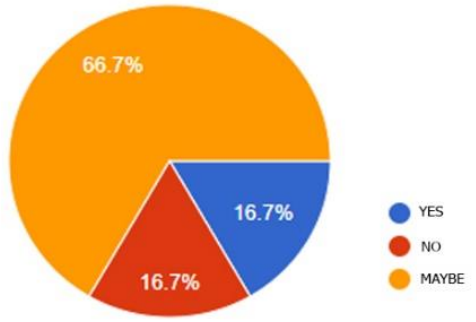
- This type of formations is a kind of review of the architect's creative thought, technological capabilities and digital tools in implementing and finding such type of formations on the ground.

- This type of formation is suitable for national and unique projects, as it carries many symbolic meanings for the countries of origin in it with ease of visual perception and leaves a distinct mental image, linking this formation to the country of origin and to the creative architect and examples of that are many (Sydney Opera, Australia - Heydar Aliyev Cultural Center in Azerbaijan - Museum Guggenheim Bilbao, Spain - Bibliotheca Alexandrina and the Grand Egyptian Museum in Egypt).

- At the level of study for students of architecture departments and schools, this trend of formation has become essential in the students' work, and we notice this in the graduation projects of the final academic teams without the presence of these projects in the materials of shop drawings and building technology materials.

- The result of the questionnaire directed to major architectural consulting offices came about the following question: Can you, as a designer, adopt the concept of free formation and then use it in your designs? The indicators were as shown in the following diagram Figure (1), which reinforces the existence of a strong motivation to adopt this trend, but after identifying its mechanisms and tools, and then we move on to the next element to study the reasons for the lack of these mechanisms and tools:

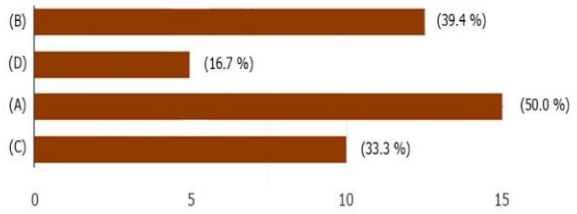
Figure (1): Scheme No. (1).



4. Reasons for the low spread of some advanced digital technology applications locally

By conducting a survey of specialists from major architectural consulting offices and practitioners of architectural design by making a questionnaire, there was a question that is through your architectural practice. What are the reasons for not using some advanced architectural programs in your work according to Table (1)? The indicators were, as can be seen from the following diagram, Figure (2):

Figure (2): Scheme No. (2).



- (a) Lack of trained expertise: The scarcity of trained and qualified expertise to use such digital systems and applications ranked first by 50%, which reduces the possibility of using the system and resorting to alternative systems.

- (B) The high economic cost of purchasing these systems: The economic cost and the high price of some of these software came in the second place with a rate of 39.4%, meaning that some of these systems have a high cost compared to the size and number of projects that will be using them.

- (C) The quality of the projects using this technology: This answer came in third place with a rate of 33.3%. By studying the quality of the architectural product that adopts the principles of free formation, it becomes clear that the majority of these projects are iconic national projects with high budgets and funding that allow them to use such advanced technology, These projects range from museums, sports facilities and cultural centers.

- (D) Unavailability of the system: It came in fourth place with a rate of 16.7%.

5. A vision for technology transfer and localization.

5.1. A technology transfer

The process of transferring construction technology is the process of transferring this technology from the country producing this technology (developed countries) to the country using this technology (developing countries), whether this use of this technology is similar to or different from the use of the same technology in the country of the producer. Selection, development, adaptation and modification (domestication) as well as the process of diffusion (localization) (Karam, A. 1991).

5.2. A technology localization

The stage of technology localization comes after the process of technology transfer, which is a transition to have a local feature of the transferred technology and adapted to make optimal use of it, as well as to enter into competition with the updates that building technologies may face, and this technology must be appropriate to the surrounding environmental conditions (Abdel-Fattah, H. 2005).

5.3. A Technology Transfer Channels

•Government sector.

• Financial and economic institutions.

• Scientific and research institutions.

6. Previous and similar experiences in digital technology transfer.

There are many previous experiences in transferring digital technology in the architectural field and adapting this technology to serve design purposes, and these experiences include:-

6.1. Frank Gehry's experience.

where Frank Gehry took advantage of the CATIA program, which was used in the field of the French warplanes industry, where Jerry transferred this technology and made some modifications to it (adapting it) with the aim of serving his architectural design purposes and succeeded in adapting and localizing this technology (https://www.foga.com/home.asp {online}).

6.2. The experience of the Dutch NOX office.

The NOX office is one of the consulting offices interested in the applications of technology in its work and its development while linking it to the principles of modern architecture (Spuybroek, Lars. 2004).

6.3. Experience of the United Architects Group Un Studio.

Where the United Architects Group led by the architect Ben Van Berked and the architect Caroline Bos, the group has developed software to help design and study the initial ideas, including a program through which the project elements are distributed while linking them to the movement paths and the density of visitors who use the spaces throughout the course Hours of the day, so that the extent of space utilization is determined throughout the day and the times during which congestion can occur and for the spaces to be linked together optimally (https://www.unstudio.com/ {online}).

7. Case study.

The analytical study deals with a model of global architectural projects, which used digital technology in the stages of its establishment to illustrate the impact of the digital software that was used in the design and implementation of this project.A subsection.

7.1. Objectives of the analytical study.

The analytical study aims to study and analyze a model of buildings, through which it becomes clear the extent of the impact of the available digital technology on the architectural formation process of the building.

7.2. Methodology for conducting the analytical study.

The research depends on a scientific approach based on a set of steps based on induction, analysis and observation to reach the objectives of the study, through research in depth in the scientific sources of various references from relevant books, specialized research, and websites on the international information network.

7.3. The criteria for selecting the study sample.

• A project with a distinctive mental image.

• A project with a giant structural structure.

• A project affected by the applications of digital technology in the design and implementation stages.

• A project with complex architectural blocks and formations.

• A project that has been implemented in reality.

7.4. Analytical study tools.

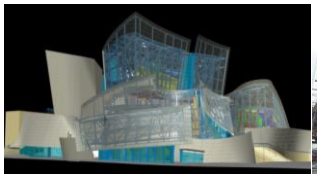
• Architectural and Structural Drawings.

• Previous studies.

• web sites.

Walt Disney Concert Hall Project	
The project Location.	Los Angeles - California - America.
owner.	Los Angeles Music Center
Architectural designer.	Frank O Gehry
Structural engineer.	John A. Martin & Associates, Inc.
Outer cover consultant.	Gordon H. Smith Corporation
The project area.	Total area = 25083.82 m2
building function.	concert hall






7.4.1. The impact of digital on design technology.

Gehry's creative forms present a new and unfamiliar challenge to contractors, Gehry found a solution to realize his design; He used the software used in the design and construction of French combat aircraft (Mirage). Called CATIA, this program translates organic shapes into actionable diagrams and drawings. Gehry began to design his idea using all the tools and methods that would show and clarify the idea and convert it into engineering drawings, starting from manual sketches and maquettes from simple materials to the digital model, as shown in Figure (3) , which shows the sequence of the different stages to obtain the design.

Figure (3): The different stages of the design process sequence and the use of the sketch to show the idea.

Reference: walt disney hall concert - Bing images {online}


7.4.2. The impact of digital on implementation technology.

Digital technology represented in the CATIA program played a major role in the implementation technology stage, as Gehry used it in the process of developing the structural system used in the hall and selecting the optimal system, as well as in performing many complex structural calculations, as well as in the digital manufacturing process to form the materials used in the external cladding For the building, a structural system was used in line with the shape of the external block, where flat trusses were used in the steel structure of the building, and the steel structure consists of a basic network of different iron sectors formed in accordance with the external shape, According to the dimensions, sizes, and details shown in the executive drawings, the CATIA program was used after conducting an electronic survey of the physical models and converting them into digital models in determining the primary and secondary structural network of the structure and differentiating between several structures and choosing the optimal structural system, as well as making structural analysis and structural calculations for each element and articulated connection And digital models were also used to know the smallest details,

whether for the structural structure or the work of internal and external cladding (Fig. (4) and (5).

Figure (4): The digital model and structural design using CATIA software.

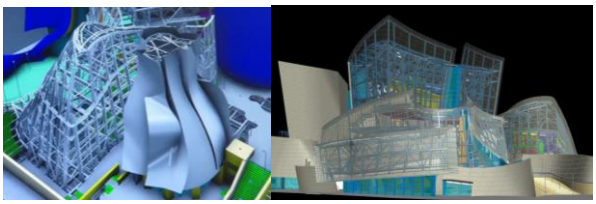
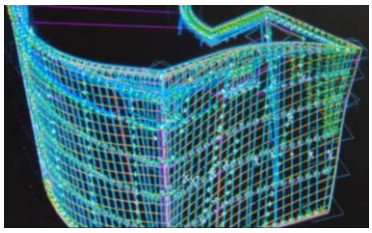


Figure (5): Structural analysis of structural using CATIA software for each element.



Reference: walt disney hall concert - Bing images {online}

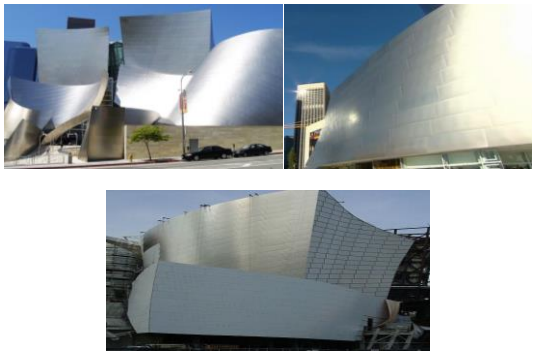
7.4.3. Obstacles and challenges faced by the project.

During its implementation, the project faced a number of obstacles, including:

• The use of shiny stainless surfaces on the external facades: - The use of stainless steel panels in the external facades of the hall caused a number of problems, including strong reflections of sunlight resulting from the concave surfaces of some external walls, which worked to collect, intensify and amplify the glare of light and increase the heat emission as The external walls became mirror-like, which affected the traffic on the street overlooking the hall due to the high glare. The high glare also affected the users of the buildings adjacent to the hall from residential and administrative buildings, causing inconvenience to residents and users. A number of complaints were submitted to Gehry Partners from In order to come up with a solution, Gehry's team worked a temporary treatment until the final treatment was completed, in which materials were used to darken the reflected glare as shown in Figure (6).

Figure (6): The glare from the stainless steel panels in the hall building and the use of light cloth as a temporary solution to treat glare.

Reference: walt disney hall concert - Bing images {online}



7.4.4. Using digital technology to solve some of the problems that faced the project.

In solving the aforementioned problem (the problem of glare from metal surfaces and the problem of heat emission as a result of the reflection of sunlight from these surfaces), Jerry's team used the applications of digital technology represented in a digital analysis to identify the number and locations of reflective units by making a simulation of the mass and studying the brightness of the sun. The result: This problem was resolved in 2005, two years after the project's inauguration.

7.4.5. The digital software used in the project.

Table (2) shows the percentage of used and unused digital programs in the different stages of the project. It is clear that the percentage of used programs is higher and more influential than unused software, which proves the effective role of these programs in the production and implementation of these free configurations.

Table (2) shows the digital software used in the different phases of the project.

digital program	Rhino	Grasshopper	CAD	BIM	CATIA	CAM	Tekla Structure	Other programs
Used	–	-	•	–	•	•	•	•
Un used	•	•	–	•	–	–	–	–

8. Conclusion.

The main objective of this study is to study the interrelationship between the transfer and localization of digital technology and the impact of this technology on the architectural composition. For this reason, the research studied the most important digital software used in the architectural formation process and the reasons for the non-proliferation of some advanced digital technology applications at the local level. Is there a need for this technology to spread? This was through conducting an opinion poll for a number of major architectural consulting firms The results of the questionnaires concluded that there are several factors to the non-proliferation of some of these programs, including the lack of trained expertise and the economic rise. The cost of purchasing these systems and their unavailability locally, so it was necessary to develop a future vision for the transfer and localization of this technology locally so that it can be traded and benefited from in national projects locally.

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