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SINGULAR ARCHITECTURE CHALLENGED BY THE ENERGY TRANSITION CASE OF THE CFC TOWER IN CASABLANCA

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ABSTRACT

Technological progress and technological advances that are constantly and rapidly increasing drastically have impacted the practice of architecture around the world. Architects now have a wide range of techniques allowing them a wide range of expressions using complex structures with advanced construction technologies and materials. This situation has led to the production of spectacular constructions and singular buildings that become architecture "icons". Nevertheless, the issue of sustainable development and energy efficiency is now a priority, as is the singular architecture. This question also involves the singular building in its interaction with its urban environment. This research deals with the design of a building through the combination of three concepts: the singularity of its architecture, the relationship to its environment, and its energy efficiency. The choice of Casablanca Finance City tower (CFC) as a case study is mainly driven by the singularity of its architecture compared to its environment and its supposed energy efficiency. A conceptual approach related to the urban landscape and the environment of the tower was developed as a part of the analysis of the site studied by Morphosis Architects. Three-dimensional modeling and dynamic thermal simulation of some models of the tower, proposed by application of energy efficiency measures, allowed to optimize the energy consumption of the tower with a significant reduction compared to the reference model, and thus to ensure the comfort of users of indoor environments of the tower.

KEYWORDS: *Singular Architecture, Icon, CFC Tower, Urban Environment, Energy Efficiency*

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INTRODUCTION

Today, human settlements are witnessing an acceleration of the pace of their lives at all levels. On a spatial scale, our cities and our living spaces are confronted with economic, industrial, cultural, political and social changes, sometimes too fast and unpredictable, which challenge the different forms of management of these cities, creating the need to develop new approaches to architectural and urban designs to meet immediate needs, including socio-economic needs.

Indeed, due to various economic uncertainties, several cities are moving towards the reconstruction of the urban image as a strategy to improve their competitiveness and attract capital. Architecture, being the main tool of the urban image, is seen, nowadays, come back in priority to the ranks of the urban design especially for the cities in desire of international radiation.

Having always played the role of a symbol of civilizations, the singular or iconic architectural conception returns in force, especially after the technological revolution and the computer advance to become a representative benchmark of the cities on the national and international scale. In doing so, with the use of complex structures and innovative materials, many spectacular and singular buildings are emerging. However, the question of sustainable development and energy efficiency arises as a top priority, to see a label sought in this type of projects, with what it implies also as interaction of these projects with their environment.

In this sense, Casablanca, first economic city in Morocco, holds a special place in the vision of urban development of the country. Being a gateway between the East and the West and destined to become the center of Africa, it tends to consolidate its economic position as an international hub and thus embarks on the realization of major structural projects intended to reposition its image, in particular with the help of a unique architecture, signed by the stars of architecture to take up the iconic challenge of increasing the attractiveness of the city while playing a role in its revitalization.

It is in this context and to create a spectacular event, breaking with its urban and architectural context, the decision-makers endow the city of Casablanca with its Casablanca Finance City (CFC) tower [1]. This tower, which wants to be unique in its function at the scale of the African continent, takes as support an architecture playing the role of marketing tool of the new financial center hoping to embody an identifiable icon recognized on a worldwide scale.

This architectural image redesigning the city, faces, in its conception, the challenge of the energy transition that the country lives like the whole world.

In Morocco, the issue of energy efficiency is more and more topical and it is particularly the numbers that challenge. "The objective announced by the Moroccan Government is to achieve a primary energy saving of about 12% to 15% by 2020 through the implementation of an energy efficiency plan in the various economic sectors. Among these sectors, the building is the second largest consumer of energy with a 25% share of the total energy consumption of the country, of which 18% reserved for residential and the rest for the tertiary sector "[2]. This energy consumption is expected to increase rapidly in future following the evolution of the housing stock induced by major programmed projects[1].

In this paper, we will try to examine how the so-called singular big projects support the sustainability factor in terms of energy efficiency requirements? And how do they apprehend this energy transition in relation to the context and the environment?

To try to answer these two questions, we have selected a case study, the Casablanca CFC tower located in the new Casablanca urban finance center City. These questions are treated according to a methodological approach based on the combination of three notions grouped together in the design of the CFC tower, including its singularity, its relation to its environment and its energy efficiency. We based it on the analysis of available iconographic documents (architectural plans and authorized documents, advertising posters, leaflets, graduation projects, etc.) and the speeches around the project. We conducted qualitative interviews with the architects involved in the monitoring of the site and carried out the basic field work to appreciate the project in its context and its relationship to the environment and the urban environment. We also analyzed the energy performance of the tower through the results of the three-dimensional modeling on the BIM Revit software (2016 version) [3] and those of the dynamic thermal simulation by Design Builder (version 5.0) [4] for the

[1]We are referring here to the program of 150000 housing units per year. Other programs related to the tertiary buildings including the Azur plan for the hotel industry, the national education emergency program, the hospital rehabilitation program, and so on.

different models proposed from the reference tower.

Thus, the landscape of the CFC tower is supposed to be a part of a set of outdoor spaces as well as public spaces. These open spaces, in conjunction with the tower, aimed to develop and perfect the outdoor spaces, not only for the comfort of the users of the tower but also for the general public.

Conceptual Precisions

Beforehand, it is important for us to specify some fundamental notions that we are using, especially the singularity in architecture and the notion of energy efficiency.

The Singular Architecture: To Contrast To Stand Out

By seeking, to understand the notion of a singular architecture through a bibliographic research, we realized the abundance of terms that allow to designate an architectural achievement that contrasts with its environment and retains the admiration or even astonishment of users of the city. A term that comes back is the iconic, polysemic architecture; the first meaning of the term has a religious significance in the Eastern Christian tradition; in that an icon is a sacred image on the wood of holy characters, it obeys strict artistic rules. In semiology and linguistics, it designates a "sign having a relation of resemblance to the reality to which it refers" [5]. In the computer world, the icon takes on the meaning of visual cue facilitating the circulation in a multimedia tool. In Arabic the term used is "**أيقونة**" closer in its pronunciation of the Greek origin of the term "εικών", and has the same meaning as in French.

According to Ethier (2015), the iconicity of a building he calls "iconic value" [6] is divided into two phases, the "iconic shape" of the building, which is the process by which a monument is cut and in contrast to its environment, and the second phase which is the feedback of the building on its context and the effect it generates on the latter which it calls the "iconic function".

Authors link the iconicity of the architecture to the ease of its identification. In this sense, Broda (2006) defines the iconic architecture as "a large-scale structure whose revolutionary design makes it instantly identifiable by the public" [7]. She also adds that a "starchitecte" would increase her chances of becoming an icon; this term is used to refer the architectural designers who have gained some public renown, with identifiable styles and a recognizable signature on their projects. Sklair (2006) discusses the relationship between the iconicity of architecture and the globalization that prevails today, and which creates the need to singularize the architecture in order to define it as an architectural icon, a building destined to be unique and different, with remarkable aesthetic and symbolic specificities [8].

Also, other terms are used to describe the architectures that are distinguished from those "mundane" that surround them are "emblematic", "symbolic", "spectacular", "singular", "extraordinary". This awareness of distinguishing between "ordinary" and "particular" architecture is not new. Architectures of antiquity, by their disproportionate features, were described as marvels[2].

We opted, following several readings, to use the notion of "singular architecture", for methodological reasons; we consider it to designate any architecture that is easily distinguishable from its surroundings.

[2]The seven wonders of the world are limited in number (seven) and have the quality of marveling, they were: the pyramid of Cheops in Giza in Egypt, Hanging Gardens of Babylon, the statue of Zeus in Olympia, Temple of Artemis in Ephesus, the Mausoleum of Halicarnassus, the Colossus of Rhodes and the lighthouse of Alexandria.

In Morocco, we observe in recent years, in several cities, the emergence of architectural buildings where the interest was granted to the architectural plasticity combined with the signature of master of work of renown; the "Twin-center" towers in Casablanca (Jean Nouvel), the Maroc-Télécom tower in Hay Riad (Jean-Paul Viguier and associates), the BMCE bank branch network (Norman Foster) and recently the launch of the most major theaters in Africa and the Arab world in Casablanca (Portzamparc and Andaloussi) and Rabat (ZahaHadid) and the CFC tower (Morphosis Agency) in progress. These buildings offer a diverse palette of architectural styles.

These architectural achievements and others are surrounded by discourses on the cities that welcome them (Rabat light city, Marrakech the renewal, Tangier metropolis) or the new concerns of architecture (sustainability as an example). All of these projects share the desire to create a deliberately seductive and up-to-date image. They are constituted in urban landmarks. They create an imaginary and an urban ideal, the architecture is an entry for the city, or as so rightly said by Dervaux (1932), "architecture is the godmother of town planning" [9]. Architecture is a way to reshape the urban space or convey a message. An ambitious urban program has been launched to highlight the Hassan II mosque in Casablanca; the project of the Avenue Royale, as voluntarist act is imagined as emanation and exceptional urban continuity of an unprecedented architectural work, Cattedra, (2002) [10], Navez-Bouchanine, (2004) [11]. Theater Zaha Hadid sublimates the urban development project of the banks of Bouregreg in Rabat. Well before, the architectural building in the medinas (medersa, mosque...) organized the city even the life of its inhabitants. A little later, it is the turn of the colonial project to use architecture to express itself through the urban facades on its project of society.

The Singular Architecture and its Environment

Besides the singularity, we wonder about the relationship of this type of project with its environment. Returning to the old traditional and colonial fabrics, we notice that in the medinas as in the colonial cities, the architectural and urban productions were linked, because they both answered to a project of society, the architecture was at the service of the urbanism and vice versa, it allowed the expression of public and private uses. Links were established between man and architecture, which are manifested in the architectural composition and in the relations of the latter with the outside or the public space.

This link is expressed in a narrow and formal way by Le Corbusier when he integrates equipment in apartment buildings[3]. Ecochard, with its mission and its reference is inspired by the Athens Charter, started from a vision that linked the architectural building to the urban space.

Energy Efficiency, A Recent Problem

Energy efficiency refers to the state of operation of a system for which energy consumption is minimized for a service rendered the same. This concept also aims to reduce the ecological, economic and social (direct and indirect) costs of production, transportation and energy consumption. Energy efficiency helps to reduce the ecological footprint (by reducing the energy footprint and sometimes the carbon footprint). It increases energy security, and adaptation to climate change and the fight against greenhouse gas emissions, ecological transition and even more of the energy transition [12]. Thus, in recent decades, the question of energy efficiency has come into being by making the serious optimization of per capita energy consumption necessary.

[3]Example of the radiant city, residence built between 1947 and 1952 by the architect Le Corbusier in Marseille. Built as a bar on stilts, it tries to concretize a new form of city, a "vertical village", called "housing unit".

In Morocco, "the dynamic of development highlighted by major completed or underway projects in all economic and social sectors, leads to a sustained growth in energy demand that can only be met by strengthening the supply and control of energy consumption. Energy efficiency is considered today as a fourth energy after fossil fuels, renewable energy and nuclear energy »Kingdom of Morocco, Ministry of Energy, Mines, Water and Environment (2011). This is a law[4] aimed at increasing energy efficiency in the use of energy sources, avoiding waste, reducing the burden of energy costs on the national economy and contributing to sustainable development, has been established [13].

CFC Tower Case

The SCFC Tower, A Contextualization

The host city of the CFC tower is Casablanca, a city that was a real laboratory of architecture and urban planning in the first half of the 20th century. It has always distinguished itself by its striking architecture. Indeed, the colonial city of Casablanca is constituted as a distinguished architecture (compared to the medina) and distinctive (that can be appreciated due to its different architectural styles). Lyautey wanted, through architecture, to put forward the image of the new colonial regime, in terms of civilization, power and technological development. Casablanca therefore contained architectures that were in their day considered "singular", which are the part of the landmark buildings of the city as it is the case of the "building of freedom" popularly known by the 17th floor and was the Africa's tallest building, its iconic reach has made it emblematic of the Casamémoire association. Recently, we observe that the city revives its past as shown by large urban completed or underway[5] projects with architectures to say the least bold.

The CFC tower project is a part of a major urban operation that consists of development of the former airport of Anfa covering an area of 350 ha. The operation is a new upscale neighborhood dedicated to the business and luxury housing, 100 hectares of which have been reserved for the entity CFC with 50 ha for a landscaped park and 50 ha for offices, housing and shops. The tower at a height of 122 m includes 25 floors of offices, the last two will be occupied by CFC. It will be an economic and financial hub housing companies with CFC status accustomed to an environment with international standards: "In the context of the Kingdom's desire to promote Casablanca as a financial center with regional and international dimensions in line with international standards, a reform aiming at rationalizing Morocco's offer on financial markets has been launched, which consists of integrating the offshore activities of the Tangier market place into Casablanca Finance City. This reform will also contribute to improving the visibility of the Casablanca place to the foreign investors and enhance the transparency and supervision of offshore activities "[14].

Figure 1: CFC Tower's Situation.

[4]Law No. 47-09 on energy efficiency.
[5]"Casart" theater, vegetable towers, CFC tower ...

A Spectacular Designed Design

For the realization of the tower, a limited competition was launched and only architects holding a Pritzker Prize, the Nobel Prize in Architecture, were invited; in this case, Zaha Hadid, Koolhaas Rem, Pei Cobb Freed, Thom Mayne (Morphosis). This means that the initiators of the project were also looking for a singular signature. The winning project was that of the agency Morphosis, with the Moroccan architect Omar Alaoui. In terms of function, the CFC tower is destined to become the nerve center of African regional business and finance.

Figure 2: CFC tower.

The computer-generated images of the project show a tower that emerges from the ground in a complex prism found at the top. The volume at the top has a crystalline geometry. It presents a significant break with its context of implantation. A conical crown realizes the function of the tower as a new icon for the city. This inverted double crown allows the building to simultaneously serve as a symbol of the development of the city and social node that nourishes a city life active in the region. This is the concept developed by the project manager.

The CFC tower or the tower "Morphosis", is thus understood as an object whose logic consists in distinguishing itself in its environment (iconic form) and then retroacting on it in such a way as to transform it (iconic function), it stands, in landmark marked by its slender profile, in a different urban landscape drawing a new skyline of the city of Casablanca.

Field visits reveal a more nuanced perception, especially as the vast park around it diminishes its size. Indeed, the ground floor is transparent and offers a visual crossing from the street allowing an exterior interior continuum overlooking a vast landscaping.

Figure 3: CFC Tower In Its Urban Environment.

Figure 4: The CFC Tower In Computer Image And In Real Image (2018).

CFC Tower, A Singular Project Facing the Challenge of the Energy Transition

We start from the following postulate. Today the CFC tower is a singular project, because it distinguishes itself in its site of reception by its function[6] and form[7]. The idea of a signed tower was imposed to distinguish itself and offer the image of an emblematic building to the international companies as we were reported during one of our interviews. In addition, a new input comes into play that is energy efficiency; the producers of this project highlight energy efficiency as a label (LEED certified tower from the Silver level (minimum) to the Gold level[8]). Behind the rules of certification, there is a real environmental philosophy leading to the ecological development of spaces and sites, saving energy, efficient water management, the rational use of materials and resources, the mastery of indoor environments (air quality, light, acoustics, thermal), uses and dedicated parking spaces.

[6]The CFC tower is the first and the building currently in Morocco which is intended to house the nerve center of business and African regional finance.
[7]The Morphosis tower emerges from the ground in a complex prism found at the summit.
[8]The building meets the requirements of the US Green Building Council's LEED Gold certification standards. A quality label: Leadership in Energy and Environmental Design.

In fact, LEED certification specifies that the consumption of at least 10% must be reduced relative to the consumption of the reference building estimated in accordance with ASHRAE 90.1[9]. It has four levels of certification (Certified, Silver, Gold and Platinum) and is based on the required points. Table 1 and Figure 5 show the potential LEED points and the certification levels with the required points.

Table 1: Potential Leed Points

LEED Category	Possible score	Percentage
Ecological landscaping of sites	26	23.7
Effective water management	10	9.1
Energy and Atmosphere	35	31.8
Materials and Resources	14	12.7
Quality of indoor environments	15	13.6
bonus		
Innovation in the design process	6	5.5
Regional priority	4	3.6
Total	110	100%

Figure 5: Levels of LEED Certification (Required Score).

The CFC Tower is a minimum of Silver LEED certification, which equates to a minimum of 50 required points; we hope, through the introduction of other energy efficiency measures, modeling and dynamic thermal simulation, to achieve the performance of gold level LEED certification.

The tower, designed using a reinforced concrete structure, concentrating staircases, elevators, ducts and technical rooms in the center; its facades remain the main receptacle of hot and cold fluxes. Indeed, the building has a double skin woven in a three-dimensional pattern. It is at the same time a ventilation interface thanks to its opening glazed interior glazing and a controlled, adjustable sun breeze. The façades were treated in three parts (high, median and low) with the use of rockwool as insulation.

Figure 6: Double Skin Woven in a Three-Dimensional Pattern.

The energy concern continues in the interaction of the project with its environment. Indeed, it is implanted so to do together with the outdoor spaces and the public spaces that surround it. These open spaces, in conjunction with the

[9]The first measures in the United States on energy consumption developed by ASHRAE, the American Society of Heating, Refrigeration and Air Conditioning Engineers since the 1970s for tertiary buildings. ANSI/ASHRAE/IES Standard 90.1, Energy Standard for Building Exception Low-Rise Residential Building as mandated by the Texas Administrative Code.

tower, are aimed at developing and perfecting outdoor spaces. While currently the tower is clear and overlooks a large green park, but the limits designated by the palisade surrounding the project give a sense of confined space. Especially, as other buildings[10] are planned nearby, not only for tower users but also for the general public.

Analysis and Discussions According to the Three Issues: Singularity, Environment and Energy Efficiency

We started from the intention to analyze the singularity of the CFC tower through, the notion of the singularity of the form, its relation with the environment and its energy efficiency.

The Singularity

For the singularity and iconicity of the tower: The CFC tower presents an important break with its context of implantation. It is thus understood as an object whose logic consists in distinguishing itself in its environment (iconic form) and then retroacting on this environment so as to transform it (iconic function).

In addition, its future function, shape, height, location, the skyline that the tower draws make it a unique architecture in relation to its environment. However, the client does not want to communicate on the tower (construction) to avoid creating confusion because the objective of the mediatization and the communication are focused on the financial aspect in order to attract CFC companies. This is possible thanks to the connection to the city center and the motorway network, which allows easy access to the airport by car. Also, by regrouping the CFC member companies, the site will offer a real proximity to companies thus promoting synergies and the creation of business opportunities.

The Environment

For the relationship with its environment, the tower emerges as a landmark and symbol of modernism in an immediate context cleared and converted into green spaces according to the current situation. Indeed, the benefits offered by the site are numerous, according to its designers. Located in the heart of the Casa-Anfa project, the CFC zone forms a central axis of a hundred hectares with a strong environmental dimension illustrated by the presence of a large area of green space. This site is emblematic in which will mix living and working places and local amenities. Public transport is present, such as the tramway which has two lines at the site level.

Thus, the relationship of the tower with its environment was a concern clearly explained by the designers [15]. This relationship is not only limited to neighboring buildings, but it is considered as a part of a Casa-Anfa district-wide system, resulting in public spaces designed as a complementary program, which will offer a wide range of functions, such as meeting spaces, entertainment and relaxation.

However, surrounded by residential areas (buildings, villas, social housing, vegetable towers) in a nearby environment, the tower is likely to be immersed in the future in a set of planned towers nearby.

[10]Two new CFC towers are planned on the Casa-Anfa site by 2021.

Figure 7: Project Models Programmed Around the Tower.

Energetic Efficiency

For the energy component, any iconic architecture consumes more energy than an ordinary architecture, even considering the importance of its occupation and its use. The CFC tower is a Moroccan financial hub in Africa, so it hosts offices with all the necessary equipment which will consume a lot of energy.

The project has been studied from a regulatory and certification point of view, including the ASHRAE 90.1 standard for Dynamic Thermal Simulation (STD), French standards for the study of electrical installations, and LEED for environmental certification. A comparative analysis made between different tools and software led to the selection of REVIT for the three-dimensional modeling of the tower and DesignBuilder for the STD [16].

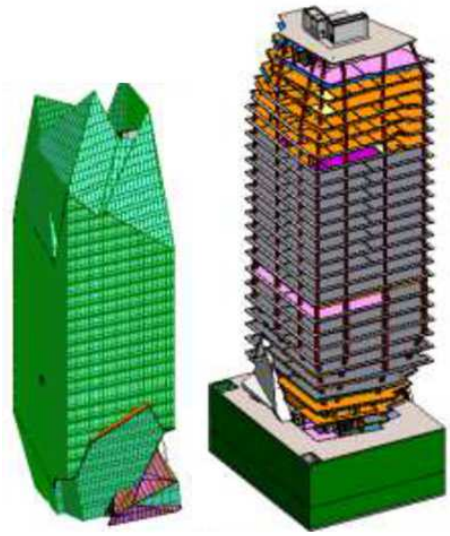

Figure 8: Models of the Tower: 3D Views of The Interior and Exterior with the Basement Part [16].

The choice of the reference tower envelope was made on the basis of ASHRAE 90.1 requirements on the envelope whose thermal characteristics (thermal transmittance or U value) are given in Table 2.

Table 2: Coefficient of Heat Transfer of the Tower Envelope

Designation	Coefficient of Heat Transfer or U Value
Facade and semi-exposed wall	0.30 W/m².K
Roofs and Terrace	0.24 W/m².K
Double glazing	1.60 W/m².K

The results of the STD obtained by DesignBuilder from the model of the reference tower modeled and imported using REVIT, made it possible to estimate the energy consumption of the building declined mainly in percentages of lighting, HVAC systems (Heating, Ventilation and Air Conditioning) and equipment. As shown in Figure 9, STD clears three positions relatively energy-intensive and which are lighting, air conditioning (cooling) and equipment.

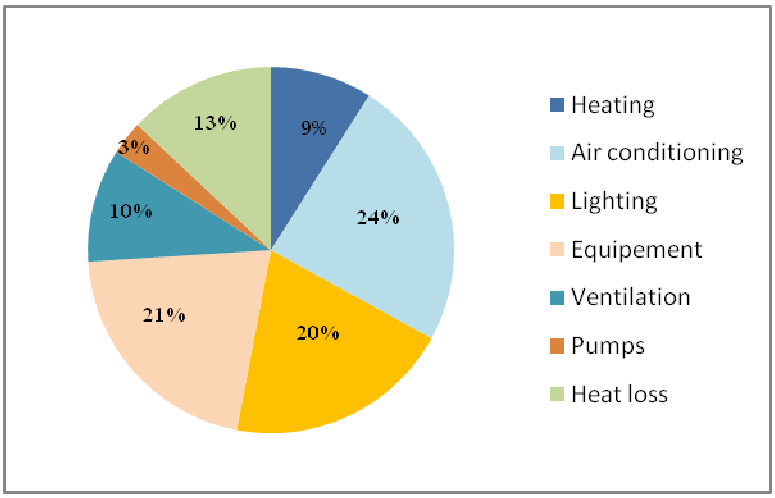

Figure 9: Proportions of the Electrical Consumption of the Reference Model Tower

This estimation will act to optimize consumption by proposing another model of tower, through energy efficiency measures: a double glazing of solar breeze is proposed for the facades of the envelope of the tower with the following characteristics: the heat transfer coefficient or U value: 1.6 W/m²K; the solar factor: 15%; the light transmission: 30%.

The sun breeze integrated into the tower envelope in this proposed model as well as the proper sizing and rational operation of the HVAC and lighting system can reduce the heat input of the tower, and thus reduce cooling energy consumption.

Another proposal makes it possible to reduce consumption by 15% compared to the last model, and can be a way towards the building with positive energy, by integrating a photovoltaic double glazing on the facades of the tower and by slightly modifying the thermal characteristics of the building's envelope.

Currently in Morocco, the Thermal Regulation of Constructions in Morocco, and the simulation software Binayate developed by the specialized institutional agency (AMEE)[11], are limited to the envelope of the building. Actually it is the envelope of this tower which was the object of study and design by a classic double glazing orientable which could have been at the same time innovating photovoltaic on the three facades (south, east and west), well sure after study and modeling, and allow the building to become not only LEED certified, but certified LEED positive energy even if it is not yet in Morocco.

[11]Moroccan Agency for Energy Efficiency.

CONCLUSIONS

In a context of globalization, constant evolution and economic competitiveness of the cities, the recurrent looking for a modern urban image encourages innovation for a so-called iconic or singular architecture, by imposing itself in a "banal" urban fabric, which would place the city in international competition. Architecture, therefore, exceeds the notion of being a response to a feature, becomes a product presented to submit its hosting space to the laws of territorial marketing to optimize its competition.

Thus the architect must surpass himself in this test, and propose daring forms, leaving aside the standards of aesthetics known to all. On the other hand, a singular or iconic building must expect criticism from specialists and the media, a discussion and even a refusal by users. This is not a guaranteed strategy, as it is not enough to want iconic architecture and to hire a renowned architect. The building must be recognized as such by its public. The CFC tower will not escape this rule. It will really become an "architectural icon" only if space users perceive it as such.

Its expected iconicity or its singularity compared to its current urban environment will not prevent it from being confronted with the challenges of responding to the possible thermal discomfort of its users linked to the vagaries of the climate. Certainly, the discourse communicated around the project implies that its respect for the environment and energy efficiency allow the building to meet all the requirements of the international certification "LEED Gold" of the World Green Building Council. However, it is only after use that it can be checked and appreciated.

The comparative analysis, cited above, between different tools and specialized software for the three-dimensional modeling of the tower and its dynamic thermal simulation, have shown that it would have been possible to further optimize the consumption of the tower, and this, to through energy efficiency measures such as double-glazing with additional heat transfer coefficients or by integrating double photovoltaic glazing on the tower facades, and by slightly modifying the thermal characteristics of the outer casing, thereby opening up market opportunities for the positive energy building.

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Some Publications:

- N. Tlemçani Mekaoui, Communication On "The Urban Approach To Sustainable Development" In the Green Zone At Cop22 November 12, 2016.
- S. Slaoui, Assoc. Prof. Dr. K. Karibi, Arch. N. Tlemçani Mekaoui And Prof. Dr. K. El Harrouni, “Sustainable Architecture And Energy Efficiency. A University Campus Project In Fez City, Morocco”, Proceedings of 3rd International Sustainable Buildings Symposium (ISBS 2017, 14-16 March 2017, Dubai), Vol. 1, Lecture Notes in Civil Engineering 7, 2018, pp. 65-79, Springer International Publishing AG.
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- S. Mounir, A. Khabbazi, K. El Harrouni, Y. Maaloufa,Performance of Cork and Composites Joints, in Reference Module in Materials Science and Materials Engineering, Elsevier ScienceDirect, 2019
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