PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION
AND SCIENTIFIC RESEARCH

UNIVERSITY 8 MAY 45 GUELMA

FACULTY / SCIENCE AND TECHNOLOGY

DEPARTMENT OF ARCHITECTURE

Master dissertation for obtaining master degree in Architecture

Option: ecological architecture

Theme

Biodynamic Facades

Entitled

The Impact of Biodynamic Facades on the Thermal Comfort of Workspaces in Guelma

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University year 2018-2019

ABSTRACT

The major role of the building facade is to separate its user from the surrounding climate. This is not only an ornamental piece but also an active component in the building system. The growing demand for energy needs an environmental performance that induces energy efficiency in the building; as a result, building design become more and more complex task.

New technologies adapted to the architecture allow it adapting to its surrounding environment. The new design approach of biodynamic façade is expressed through the behavior of building's adaptation to their environment.

In general, all materials change depending on the ambient temperature and the surrounding water content. This change is dependent on the physicochemical properties of the material. The present research aims to establish the possibility of integrating a biodynamic façade in the workspace building and show how would be its impact on the thermal comfort of the officers.

KEY WORDS

Biodynamic façade- biomimetic architecture- reactive architecture- energy performance- comfort.

RÉSUMÉ

Le rôle principal de la façade du bâtiment est de séparer son usager du climat ambiant et le mettre en confort. Il ne s'agit pas seulement d'une pièce d'ornement, mais d'un élément actif du système de construction. La demande croissante en réduction de la consommation énergétique nécessite une performance environnementale induisant l'efficacité énergétique du bâtiment ; de ce fait, la conception des bâtiments et de son enveloppe devient une tâche de plus en plus complexe.

Les nouvelles technologies adaptées à l'architecture lui permettent une reconfiguration de son environnement. La nouvelle approche de la conception des façades biodynamiques s'exprime à travers le comportement des bâtiments en fonction de leur environnement.

En général, tous les matériaux changent en fonction de la température ambiante et de la teneur en eau environnante. Ce changement dépend des propriétés physicochimiques du matériau. La présente recherche vise à établir la possibilité d'intégrer une façade biodynamique dans l'espace de travail et à déterminer son impact sur le confort thermique des agents.

MOTS CLES

Façade biodynamique- architecture biomimétique- architecture réactive- performance énergétique-confort.

ACKNOWLEDGEMENTS

In The Name of Allah, The Most Merciful the Most Gracious

First, I would like to thank God Almighty for the success and the help throughout all my academic life especially in the five years I spent majoring in architecture, during which I learned to curiosity, perseverance and patience.

I would like to thank all my distinguished teachers, especially my dear advisor Miss. KHALIL, Sara who has spared no effort in our formation and guidance.

I would like to acknowledge all the examiners who would read this thesis and I am gratefully indebted to them for their valuable comments on this thesis.

Finally, I must express my very profound gratitude to my parents, brothers and all my dear family for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them.

Thank you.

BENSEDIRA Manal

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INTRODUCTION

Gunter Pauli is the new promoter of the "blue economy", a color that is not chosen at random, but that of the planet which, seen from space, is "globally blue." Director of the Zero Institute Emission Research and Initiatives (ZERI), It is often featured in the media as the "Steve Jobs of Sustainable Development". He says: "*It's not up to nature to produce like our factories it's up to our factories to produce like nature* "(Pauli,2018).

By his curiosity, necessity or need, man has never stopped discovering his environment from his first step on earth. During his continuous development progress, he has always considered nature as a source of raw material and is not a source of knowledge, he invented built and responded to different needs relying on this principle.

At the heart of a very important technological progress; man has realized that he has exploited almost all the non-renewable resources of the earth, the consumption of these has produced in the course of centuries several degradations in the environment and considerable climate changes it is by As a result, man has become aware that his "big blue house" is in danger, and that is why the term "sustainable development" has emerged, based on "the social economy and the environment": the pillars of sustainable development.

Architecture as an indispensable necessity it is among the first influenced by this doctrine; several theories have emerged to answer the relevant question "how can one achieve not only beautiful and functional architecture but also ecological and sustainable? "

Among the most recent thoughts in ecological architecture is that of biomimicry; this way of thinking is not only applied in architecture but also in social life, economics etc ...

For bio-mimicry *"... means the act of taking inspiration from nature to renovate sustainably ..."* Idriss Aberkane professor at central-supélec, researcher at polytechnique, researcher affiliated to Stanford and UNITWIN / UNESCO ambassador for the section " complex system "he thinks it is" *an art of extracting from the knowledge of nature within the framework of the knowledge economy. It is infinite unlike the raw material; immaterial knowledge allows an exchange that multiplies, it is not linear but it takes time to be transferred ...*

We lived in a room full of books but we did not know that they are books, we burned them to make a big fire. Today we wake up, we see what they are books containing the technique the medicine the technology the schemas the social organization, we make them come out of the fire (books half burned) full of knowledge, this library is the nature and the bio mimicry is the science which says: the nature is a library read it instead of burning it " (Aberkane,2015), and that changes everything!

In architecture, designers can use biomimetic as a method of exploring the adaptation mechanisms of living organisms for the architectural design of space, structure or skin. The reactive architecture can synthesize artificial mechanisms to obtain real-time adaptation characteristics observed in natural mechanisms. The complete biomimetic reactive architecture with methods of using digital tools technology, machines and mechanisms specific to interactive, kinetic and programmable devices.

The realignment of building envelope design in air, light and heat measurements has made possible a form of inventive practice whose benefits far outweigh the measurement and analysis parameters. For starters, the way in which building envelopes are no longer separators and barriers between the interior and exterior conditions of a building, but rather "spatially" defined environments that fully engage all of the engineering systems of a building.

For many of its more advanced practitioners, the biodynamic design of facades engages the true potential of "energy performance" when it deepens, expands and complicates the theoretical dimension of this extremely liminal surface. Adaptive biodynamics can be developed as an intersection of biomimetic and reactive architecture to achieve performance-oriented architecture goals.

PROBLEMATIC

The first decade of the twenty first century has witnessed a tremendous increase in the demand of sustainable buildings mainly due to mounting energy costs and growing environmental concerns. Using less energy to perform the same task it’s the energy performance. In the building it consists the energy actually consumed or estimated to meet different needs related to a standardized use of the building; heating, hot water, cooling, ventilation and lighting these lasts may be improved by the newest type of skins the bio-inspired dynamic facades (biodynamic facades).

Much of the current discourse on energy efficiency and architectural design has focused on the theme of building skins. As highly technological devices, this architecture relies on performance tests based on data, virtual simulations and the laws of computer fluid dynamics. They are increasingly responsible for conserving energy, maintaining thermal comfort and optimizing the distribution of daylight and fresh air. They are therefore designed, built and operated to meet ever more stringent objectives.

The biodynamic facade is the newest type of skin connecting a biomimetic design and a reactive architecture technique to achieve a building with high energy performance.

How would be the impact of bio-dynamic façades on the thermal comfort and the energy efficiency of workspaces?

HYPOTHESES

The bio-dynamic façade presents a great solution to optimize the energy efficiency of administrative buildings by its shape, mechanism and efficiency.

OBJECTIVES

Investigate the impact of the biodynamic façade on the thermal comfort of work spaces, and realizing and energy efficiency by minimizing the energy consumption in heating, cooling and lighting.

THE SCOPE OF THE RESEARCH

"When we look at what is truly sustainable, the only real model that has worked over long periods of time is the natural world." (Benyus,2016).

Biomimetic architecture is a contemporary philosophy of architecture that seeks solutions for sustainability in nature, not by replicating the natural forms, but by understanding the rules governing those forms. It is a multi-disciplinary approach to sustainable design that follows a set of principles rather than stylistic codes. It is part of a larger movement known as biomimicry, which is the examination of nature, its models, systems, and processes for the purpose of gaining inspiration in order to solve man-made problems. (khoshtinat,2015).

The newest modern architecture design concept is called Dynamic Architecture. Modern architecture skyscrapers will keep moving, forever changing their shape to better fit nature and your imagination. Dynamic Architecture reveals three major innovations: changing shapes, industrial production of units and self-production of clean energy.
Dynamic Architecture buildings follow the sun and move to the wind, making modern architecture design more efficient and environment friendly. Dynamic Architecture buildings keep modifying their shape. As each floor rotates separately, the form of the building changes constantly, bringing new views and experiences; from now on, modern architecture will not be confined to rigid shapes; construction will have a new approach and flexibility. Cities will change faster than we ever imagined.

The construction method and the ability to produce energy on its own are two of the most outstanding features of Dynamic Architecture buildings. These buildings are made of prefabricated units, custom-made in a workshop, to fit very high quality standards, resulting in fast construction, cost savings and fewer people on site. (Busyboo;2007)

STRUCTURE OF THE DISSERTATION

The thesis starts with introductive chapter, then the first chapter talks about the different concepts of the theme with examples; meanwhile the second chapter is for analyzing examples of the application of biodynamic façade. The third one is about environmental and climatic context.

The last chapter is about the office building with example analysis and elaborating the program and design intentions.

METHODOLOGY OF THE RESEARCH

1. **Real world phenomenon** Question about the big picture (biodynamic façade and energy performance of work spaces)
2. **Background and theory** Concepts and explanations (bio dynamism, biomimicry, dynamism, energy performance, workspaces)
3. **Choosing design and method** Proposing hypothesis
4. **Data collection** Collect information and specific examples about concepts
5. **Results statistical analysis** Analyzing examples and data
6. **Discussion** Elaborating the relationship between different concepts
7. **Conclusion** Recommendations extracted

INTRODUCTION

In architecture, the facade of a building is often the most important aspect from a design standpoint, as it sets the tone for the rest of the building. From the engineering perspective of a building, the facade is also of great importance due to its impact on energy efficiency. For historical facades, many local zoning regulations or other laws greatly restrict or even forbid their alteration.

I. ARCHITECTURAL FAÇADE

1. DEFINITION

Each of the exterior faces of a building is called “façade”; (main facade, posterior facade, side façades).

Or it’s the front of a building on which opens the main entrance (frontage on street, on court, as opposed to facade on garden). (Larousse;2019)

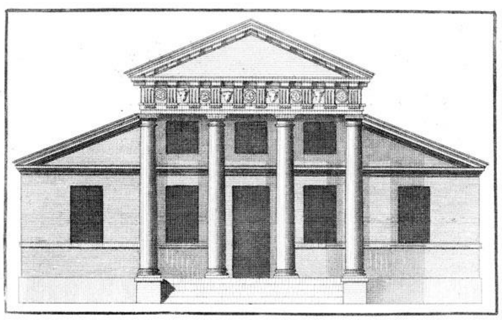


Figure 1. a main facade of a villa according to Palladio

(http://www.vam.ac.uk)

Figure 1.b Rear facade of Villa Caldogno

(https://www.villacaldogno.it/)

2. THE EVOLUTION OF THE FACADE SYSTEM

Building Facade started its journey way back in 807 B.C in Japan where wooden logs were used as facade material and traveled to most of the world and used local building material as clay, lime, wood and stone to create a facade.

The Prominent facade material was clay, wood, stone and glass also started making an inroad by 1800 Century in Europe. Most of the world’s popular buildings have best facade designs and one of the reasons for its popularity. With Inception of Modern technology in building construction stone and glass took an important position as preferred faced material and stayed for a long period in 1900 century. With help of western designs and space crunch in major cities, Natural Stone, Glass, and aluminum composite panel has got favored as preferred facade material and as on date most preferred material. (masterbuilder;2017)

The facade of the buildings passed through several historical stages:

2.1. The envelope in vernacular architecture

Since ancient times, men have always been strongly impregnated with the natural environment in which they established themselves and to which they identified. It is in this spirit that N. Schulz declared that: "Identification means becoming a friend of a given environment".

Since man cannot escape the nature that surrounds him, obliged to collaborate with it, he will try to transform it, or at least integrate it with profit, the analysis of the envelope. Vernacular reveals that behind the simplicity of the form there are complex causal relationships, probably these envelopes have begun with simple forms used for shelter against wind, sun and rain.

But gradually, as the desire for better shelter has increased, the appropriate materials have been identified and the construction of skills has been acquired, where the primal mineral shell takes on a protective aspect, the plant envelope takes it, a camouflage aspect, and the animal envelope, a form of dressing, in this sense it has been found that everywhere in the world, vernacular architecture is usually characterized by the judicious use and the beneficial use of materials available space and climate experience.(BENBACHA;2017)

Figure 1.c Wigwam of north Amerindians

(Https://www.tripadvisor.co.uk)

2.2. The envelope in ancient civilizations

When man begins to develop the space, after the natural envelope he added an envelope shaped by the hands of the man in order to adapt his habitat to new uses. The extension of the natural envelope makes it possible to enlarge the space invested by shed of branches, an enclosure of stones paired, to open its habitat towards the outside causing escapes of air (for the evacuation of the fumes) and lights to illuminate the enveloped.

-The Greco-Roman civilization

During the Hellenistic period, the architectural envelope took on another dimension where its structure is based on a regulated system of logical and dimensional relations between its various constructive components, an arithmetic and geometric system, and a beginning of dissociation between external ordinances. and structure of buildings.

Vitruvius clearly distinguishes the architectural discipline from the simple art of building. Solidity and utility, where the envelope has become a heavy and massive facade. (BENBACHA;2017)

Figure 1.e Insula. Ostia. Italy. Photography: Dennis Jarvis.

Figure 1.d The museum was founded in 300 AC.

(https://sites.google.com) *(http://www.e-olympos.com)*

2.3. The builders of the middle ages

During the Middle Ages, the architectural envelope continues to become more complex, with an architecture that has developed with different techniques and styles in the world, medieval architecture was used in particular for the construction of major military works, like castles and ramparts; such as churches, cathedrals, abbeys and cloisters.

Figure 2 the Cathedral Church of Saint Peter in Exeter

Figure 2 Castle of Foix, built in the late 10th Century

(http://spmarchitecture.com) *(https://www.buycostumes.com)*

At that time, the building envelopes and facades were compact and massive, with thick, low walls. Outside, the walls are punctuated by the Lombard bands, joined at their summit by blind arches, it is even necessary to strengthen them outside by buttresses. Only a few openings can be made that allow only limited light to enter the building.

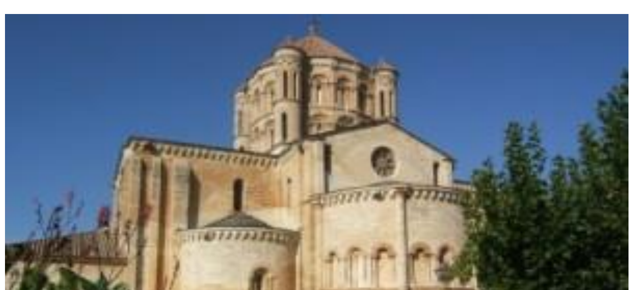


Figure 3 collegiate church of santa maría la mayor (http://toutartfaire.com)

The Gothic architecture that develops from the late twelfth to the early sixteenth century, gives increasing interest to man and nature and is expressed through the architectural envelope by the recess of the walls, the multiplication of windows and the accentuation of verticality, transforming the buildings into a dynamic system of abutments and counter butts, which is frankly expressed. The construction can be seen in the same way that the carved decoration that adorns the facades with very fine vertical and oblique supports reveals the lines of force of the structure.

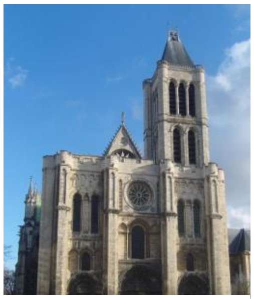


Figure 4 West facade of Saint Denis basilica

(https://www.pinterest.com)

While the design of a Romanesque church was based on a symbolism, numbers referring to the biblical message and its interpretations, the design of cathedrals gives an interest to geometry. This geometry differs from that of Vitruvius, which is based on the dimensional relationships between the whole and the parts. (BENBACHA;2017)

2.4. The architectural envelope in Islamic architecture

Islamic architecture was based on many ethical, religious, and quintessential climate-based issues, and one of the most striking features of all the monuments of Islamic architecture, according to history, is to focus on Islamic architecture. enclosed spaces, inside rather than outside, for this the Islamic architectural envelope was introverted so that the main facade is inside the buildings.

Figure 5 Mustapha Pasha's house, Algiers (https://www.tripadvisor.fr)

The Islamic building was characterized by interior facades on the courtyard. On the contrary, the external facade has been solid in order to overcome difficult climatic conditions and to avoid a direct sunshine, as a result the exterior and interior facades work together the climatic role, it is rare that a facade gives an indication of the internal organization or purpose of the building in question. (BENBACHA;2017)

2.5. The envelope and facade in the renaissance: towards external aesthetic principles

The rebirth that is born in Italy, rediscovers the humanist, political, philosophical and artistic ideal of antiquity, and it no longer has a technical purpose. The architectural envelope is transformed into a facade that is based on superior aesthetic principles, abstract concepts such as symmetry and proportions, the use of a strictly regulated language in its vocabulary and syntax, and the system of orders. Placing "beauty" at the center of her concerns, she represents a regression for architecture, the order system, and she made new calls, for residential buildings, to decorative elements of the façades borrowed from the representative buildings of antiquity. The centered, axial organization of the facade was developed, the application of this principle to several houses allows to confer a more accentuated rhythm to the front line.

Figure 6 The Louvre of the Renaissance
(https://www.cvld.fr)

The architecture of the renaissance refuses all performances such as the excessive elevation of the volume, the lightening of the walls or the opening to the light. It condemns the last style of the Middle Ages and its "*monstrous and barbaric works that can be called confusion and disorder*». (BENBACHA;2017)

2.6. The envelope in baroque architecture: the art of staging

Baroque architecture combines the elements and forms known surprisingly and according to new rhythms, accentuating the volumes, exaggerating the decoration, varying the plans, adding a colossal sculpture.

Figure 7 The Trevi Fountain
(https://www.cvld.fr)

The baroque spirit lies in the freedom to modify the original classical forms in such a way as to make them permeable to all the nuances of emotional expression; underbody breaking, doubling of columns, curvature of pediments, trompe-l'oeil effect. (BENBACHA;2017)

2.7. The envelope in functionalist architecture

Regarding the facade or the architectural envelope in functionalist architecture we can see a reduction in its importance, both from the economic point of view and from the aesthetic point of view. It becomes abstract and repetitive, expressing only its own manufacturing process, for which the building is no longer expressed as an independent unit, each facade resembling the fragment of a gigantic fabric and not a finished composition. (BENBACHA;2017)

Figure 8 World Trade Center 1 et 2 (Bruxelles)

(https://www.wtca.org)

2.8. Chicago architecture school

The Chicago architect Louis Sullivan was famous for summing up in one sentence the word principle of functionalism (form follows function), summing up his thought that the size of a building, its mass, its spatial grammar and all other characteristics of its appearance must derive solely from its function. (BENBACHA;2017)

Figure 9 Wainwright Building

(https://www.archdaily.com)

2.9. The envelope in the modern movement

At the beginning of the 20th century, the facade is considered a light membrane, with an elevation of a separate plan of the structure, a simple and pure form, transparency with the use of glass, and the absence of ornamentation.

The widespread use of the "post - beams - slab" reinforced concrete structure frees the interior spaces of the load-bearing walls and opens the apartments to the outside with bays, balconies and terraces, for this they appear therefore constructions that have in common their cubic appearance, flat roofs for terrace use, unadorned façades and sometimes windows in length favoring the illumination of the rooms. This new architecture manifests itself all over the world and reveals such a homogeneity that we speak quickly of Style International. (BENBACHA;2017)

Figure 10 Villa Savoye *(http://www.villa-savoye.fr)*

2.10. The envelope in the high - tech

In the second half of the 20th century, a trend commonly known as "high-tech", which has its roots in the iron architecture of the 19th century, is affirmed. The design of these architectures bases its aesthetics on the expressiveness of constructive elements derived from engineering and technology.

The high-tech envelope often relies on total or partial transparency to show the outside world the activity going on inside. Generally, their overall appearance is light, in a combination of dramatic curves and straight lines. (BENBACHA;2017)

Figure 11 The Pompidou Center in Paris, designed in the style of high-tech architecture

(https://fr.123rf.com)

2.11. Adaptive climate envelopes

In recent years, innovative building envelopes have appeared with flexible and interactive forms with the climate. This adaptive architecture assists the user's convenience, or even the improvement of the building's energy performance by offering him opportunities for adaptation.

The ability to change or adapt the building envelope to the sun's course (either blocking its rays to prevent overheating and glare, or allowing them to control radiation penetration for passive heat gain and / or daylight), which was the main cause of a purely technological historical innovation, called the intelligent building envelope. (BENBACHA;2017)

Figure 12 Arab world institute (http://www.paris-autrement.paris)

3. TYPES OF FACADES

3.1. Masonry facade (classic)

Masonry facade, so-called heavy in modern construction as opposed to light, consisting of walls with bays. Included are doors and degrees of access, porch, shuttered windows and balconies with guardrails, awnings, downspout, ornaments (railing, etc.), all possibly topped with pitched roof with skylights, chimneys, ducts and channels that are not in the plan in the broad sense of the elevation.

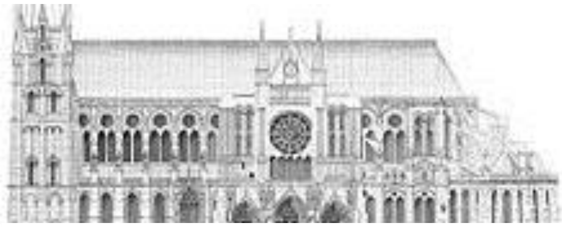


Figure 13 Lateral facade of Chartres Cathedral (https://www.latlong.net)

3.2. Light façade

Facade consisting of elements that are not part of the supporting structure slab post or slab but can still be part of the structural work for the fills.

Figure 14 Curtain wall in Paris

(https://www.futura-sciences.com)

3.3. Suspended façade

Facade anchoring systems allow to hang facade plates to the basic construction. Thus, the thermal insulation and the weather protection are clearly separated.

Figure 15 The office building of the BPO France, 1990 (http://www.odiledecq.com)

3.4. Steel

A variety of steel components may be used in modern facade systems, such as Steel profiled sheets and composite (sandwich) panels, Flat and rigidized cassette panels with folded edges. Steel Facade system offers a variety of colors and surface textures is possible. It also minimizes the loads on the supporting structure. It also an installation in lesser times. As steel is non-combustible and robust to damage in façade panels. A high level of thermal and acoustic insulation can be provided. (The master builder;2017)

Figure 16 Sephora Star hill Gallery, Kuala Lumpur (https://www.archdaily.com)

3.5. Panel framing

Panels are framed by mullions on the vertical edges and transoms on the horizontal edges. Mullions and transoms are thermally broken to prevent cold bridging through the element so that condensation does not occur. Unitized curtain walling is identifiable by the presence of split mullions and transoms on the panel perimeters. These structural shapes are cheap to manufacture in large quantities once a die has been made.

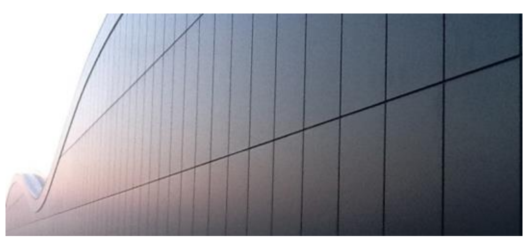


Figure 17 new terminal 2b heath row airport

(http://www.mkfltd.com)

3.6. Curtain walling

Curtain walling is the generic name given to metallic lightweight cladding or glazed cladding systems that are directly supported by a structural frame. Curtain wall systems are an assembly of factory-made components which are either made up into panels in the factory and the interlocking units brought to the site and installed (unitized curtain walling) or brought to site as components and assembled on the building (stick curtain walling). (The master builder;2017)

Figure 18 The Omni San Diego

(https://www.designingbuildings.co.uk)

-Curtain façade design

There are two facade cladding designs: multi-ply walls panels (sandwich elements) and suspended or anchored facade panels.

Figure 20 Curtain wall in Paris

(https://www.metroenbogota.com)

Figure 19 Andaz Hotel Singapore

3.7. Clay façade

Clay facades are the outcome of sophisticated technology and advanced firing processes and hence are highly resistant to the exterior environment. When compared to paint, which can look smudgy with dust and dirt, clay facades, retain the color for a longer period of time. Since they are made of terracotta. Their weather resistance power makes them highly durable which last for decades. (The master builder;2017)

Figure 21 Mansfield

(http://www.rueletfrere.com)

3.8. Steel and glass facades

Steel and glass are synergistic materials and are often used in facades and roofs of multi-storey buildings. The glass panels are generally supported by separate vertical steel elements to the main structural frame of the building that may be internal or external to the building. Stainless steel and hollow steel sections are often used in combination with glass. (The master builder;2017)

Figure 22 Bombay sapphire distillery glasshouses

(http://www.bellapart.com)

3.9. Glazed facade systems

The glazed walling system is designed to provide the necessary functions of weather-tightness, natural lighting and shading, and thermal insulation. (The master builder;2017)

Figure 23 TAMEDIA in the heart of Zurich's media district.

(https://www.wicona.com)

3.10. Double-skin facades

The two skins form a thermal buffer zone and passive solar gains in the cavity reduce heat losses in winter. If the cavity ventilation is integrated with the building services, air heated by the sun can be introduced into the building, providing good natural ventilation and reducing the heating load and vice versa during summer.

Figure 24 The Gherkin in London. *(https://www.britannica.com)*

Windows open on the outer skin to allow air to enter the cavity between the inner and outer skin. (The master builder;2017)

3.11. Aluminum Composite Panel

Aluminum Composite Panel Cladding (ACP) is a widely-used term, describing flat panels that consist of thermoplastic core bonded between two aluminum sheets. (The master builder;2017)

Figure 25 Melbourne's Lacrosse tower (http://epicprojects.com)

3.12. Solar shading systems

There is a wide variety of solar shading systems that may be used and incorporated as part of the building façade. There are: Oval shaped horizontal steel elements that span horizontally between external columns and their size and spacing is designed to reduce the intensity of solar gain. (The master builder;2017)

Figure 26 The dynamic solar shading of Kiefer Technic Showroom (http://www.designindaba.com

3.13. Rain screen cladding

A rain screen cladding system is usually drained and ventilated and consists of open-jointed, rail-mounted panels with an air-gap behind. Rain screen panels are made from durable materials and are chosen by the architect to achieve the desired visual effect. (The master builder;2017)

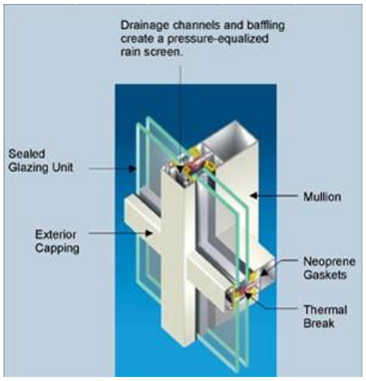


Figure 27 rain screen

(https://www.canadianarchitect.com)

3.14. Insulated wall panels

Insulated wall panels are interlocking, composite metal-faced sandwich panels or concrete panels with insulation between internal and external concrete elements. (The master builder;2017)

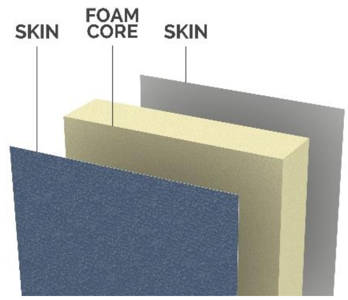


Figure 28 Insulated Metal Panels

(http://www.metalconstruction.org)

3.15. Precast Concrete Panels

Masonry facades are also formed by supporting brick or natural "hand-set" stone panels from storey-height precast concrete panels. Stainless steel support brackets and restraining pins are used. Thicknesses of handset stone vary from 20 mm to 70 mm, depending on the wind load, the tensile strength of the stone and the spacing of fixings. Continuous areas of masonry cladding have naturally low air permeability so generally air permeability is controlled by good detailing at interfaces with windows and doors and other penetrations through the wall for building services. Solar gain, light levels and views out are balanced by choosing appropriate window type, size, and arrangement with suitable shading. (The master builder;2017)

Figure 29 Precast concrete panels as shear walls

(http://www.esolution-pt.com)

3.16. Development of self-cleaning facade system

Self – cleaning facade is nowhere, making it easy for the applicator as well as for the end -user. The efficiency and long -term benefit is far reaching. Self-cleaning surfaces have become a relevant product type because of photocatalytic coatings containing titanium dioxide (TiO_2) nanoparticles. Self-cleaning Nano coatings have been used to treat everything from concrete and stone, to glass and ceramics, to textiles, wood, stainless steel, aluminum, and plastic. (The master builder;2017)

Figure 30, Hospital Manuel Gea Gonzales. (http://www.elegantembellishments.net)

3.17. System analogy of self-facade system

Nowadays facades have turned into the intelligent façade is a complete façade system with an integrated self-cleaning function. This façade system offers all the benefits of using prefabricated facade elements. With the success of this concept globally, there has been a further development of robotic self-facade system. (The master builder;2017)

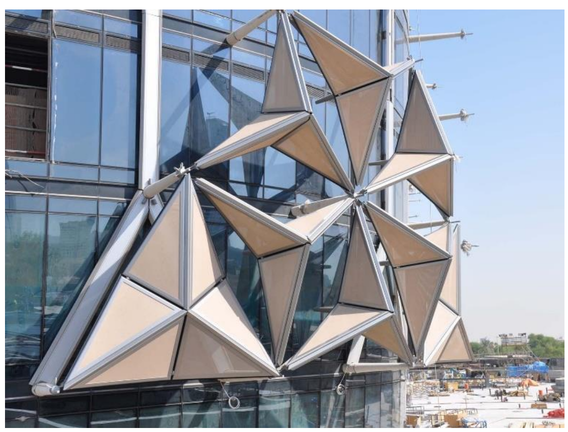


Figure 31 Al Bahar Towers - Exterior Sunscreens (https://www.modlar.com)

4. FACADE VS NOISE, LIGHT, HEAT, AIR QUALITY ...

4.1. Acoustics

The use of certain absorbing or reverberant materials or devices, but also the design of the facades themselves, will bring a real improvement to the impact of noise. Fraunhofer IPB. (Busa, Secchi, Baldini;2010)

Figure 32 DG bank, Frank Gehry, Berlin, 2001

(https://www.researchgate.net)

4.2. Light and heat

As much illumination is desirable in winter, it can become a nuisance in summer. It is useful, on the one hand, to avoid that the light is too much reflected towards the frame (its energy can indeed participate strongly in the increase of the heat), on the other hand, to make sure that it does not disturb the interior ambience by its intensity. (Marion Villard;2016)

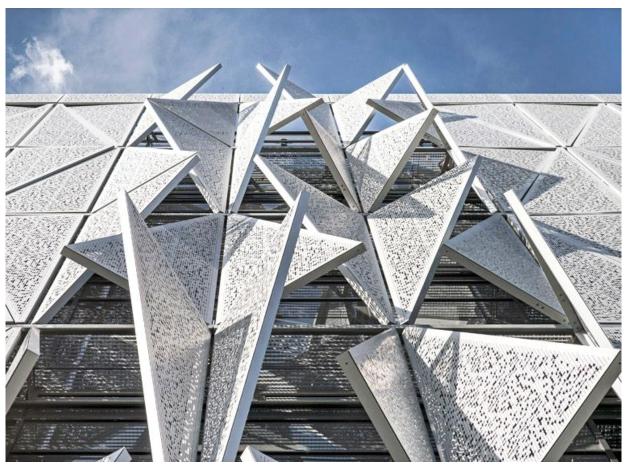


Figure 33 Syd Dansk University communications and design building in Kolding, Denmark

(https://www.researchgate.net)

4.3. Vegetation: multiple effects

Very effective also to fight against the warming and better still to take part in the regulation of the temperature, the revegetation also has the merits to provide an interesting support to the biodiversity, to create important surfaces of CO2 sensors, and thus of act for the reduction of air pollution. It also contributes to the fight against the effects of noise. There are also materials with reflective effects allowing temperature drops of a few degrees, enough to bring a better-being. Other processes may have their place as the integration of collector water in the facade. (Marion Villard;2016)

Figure 34 Vertical Forest by Stefano Boeri Architetti *(https://www.lostateminor.com)*

II. BIOMIMETIC FAÇADE

For bio-mimicry *"... means the act of taking inspiration from nature to renovate sustainably ..."* Idriss Aberkane professor at central-supélec, researcher at polytechnique, researcher affiliated to Stanford and UNITWIN / UNESCO ambassador for the section " complex system "he thinks it is*" an art of extracting from the knowledge of nature within the framework of the knowledge economy. It is infinite unlike the raw material; immaterial knowledge allows an exchange that multiplies, it is not linear but it takes time to be transferred ...*

*We lived in a room full of books but we did not know that they are books, we burned them to make a big fire. Today we wake up, we see what they are books containing the technique the medicine the technology the schemas the social organization, we make them come out of the fire (books half burned) full of knowledge, this library is the nature and the bio mimicry is the science which says: "the nature is a library read it instead of burning it "*and that changes everything! ... (Aberkane,2015)

II.1. DEFINITION

"Biomimicry or biomimetic is the examination of nature, its models, systems, processes, and elements to emulate or take inspiration from in order to solve human problems. The term biomimicry and biomimetic come from the Greek words bios, meaning life, and mimesis, meaning to imitate. Other terms often used are bionics, bio-inspiration, and bio gnosis". (MKK Publication;2019)

II.2. HISTORY

Humans have always looked to nature for inspiration to solve problems. One of the early examples of biomimicry was the study of birds to enable human flight. Although never successful in creating a "flying machine", Leonardo da Vinci observer of the anatomy and flight of birds The Wright Brothers, who finally did succeed in creating and flying the first airplane in 1903, also derived inspiration for their airplane from observations of pigeons in flight.

Otto Schmitt, an American academic and inventor, coined the term biomimetic to describe the transfer of ideas from biology to technology. The term biomimetic only entered the Webster's Dictionary in 1974.

In 1960, the term bionics was coined by psychiatrist and engineer Jack Steele to mean "the science of systems which have some function copied from nature".

The term biomimicry appeared as early as 1982. The term biomimicry was popularized by scientist and author Janine Benyus in her 1997 book Biomimicry: Innovation Inspired by Nature. Biomimicry is defined in her book as a "new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems". Benyus suggests looking to Nature as a "Model, Measure, and Mentor" and emphasizes sustainability as an objective of biomimicry.

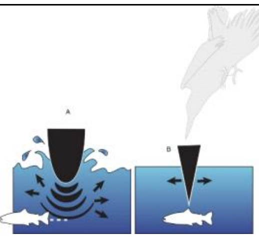
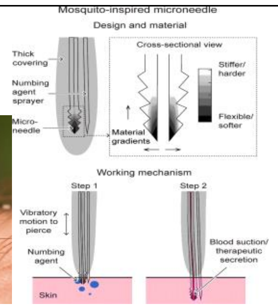
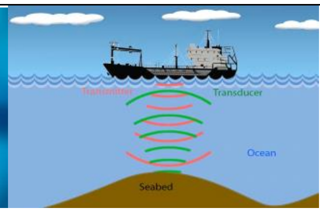
Researchers, for example, studied the termite's ability to maintain virtually constant temperature and humidity in their termite mounds in Africa despite outside temperatures or modeling echolocation in bats in darkness has led to a cane for the visually impaired. (MKK Publication;2019)

3. BIOMIMICRY

3.1. FIELDS OF BIOMIMICRY (see next schedule)

Table 1 fields of biomimicry (source; author)

Field	Example	Application
Energy and biomimicry Humpback whale and wind turbine fans.		A company called Whale Power is applying the lessons learned from humpback whales to the design of wind turbines to increase their efficiency, while this natural technology also has enormous potential to improve the safety and performance of airplanes, fans, and more.
Architecture Termite mound and natural ventilation system		the East gate Building, an office complex in Harare, Zimbabwe, has an internal climate control system originally inspired by the structure of termite mounds.

Transportation King ficher’s beak and fast train design	 	Modeling the front-end of the train after the beak of kingfishers, which dive from the air into bodies of water with very little splash to catch fish.
Agriculture Ducks and rice fields		Ducks in China carry a special mission; they guard crops from insect attacks and are responsible for weeding. With ducks tearing up weeds, preying on pests and leaving their manure behind as organic plant food, rice growers like farmers can eliminate the need for artificial fertilizers, herbicides and pesticides. (COCO LIU;2016)
Medicine Mosquito and neurosurgeon utensils	 	The biomimetic design of these utensils required the least amount of force to move. The less force a neurosurgeon can use, the more they can be certain to leave your brain undamaged, thus preserving your memories.
Communication Dolphins and sonar system	 	Emulating dolphins’ unique frequency-modulating acoustics, a company called EvoLogics has developed a high-performance underwater modem for data transmission, which is currently employed in the tsunami early warning system throughout the Indian Ocean.

3.2. BIOMIMICRY AND ARCHITECTURE

In the field of architecture, one can see many examples that is influenced/ learned from the nature. Constructions like branches of a tree, analogies of flowers, network configurations, etc. inspired the architectural design thinking since the ancient times. This inspiration can be observed in two ways; to reproduce the form with the concern of form finding, or to transfer the process of emergence of a living entity (like material, form, structure, etc.) to design thinking. The first is as it is just a concern of form finding and most of the time does not refer to a functional and an ecological approach. The second way is a different approach though, which offers to observe and understand the functionality and harmony within the nature. (THE BIOMIMICRY INSTITUTE;2018)

Biomimicry inspires architecture in different levels as biology does in the nature and these levels can be summarized under three categories:

A Framework for the Application of Biomimicry (Zari, 2007)

Level of Biomimicry		*Example - A building that mimics termites:*
Organism level (Mimicry of a specific organism)	*form*	The building looks like a termite.
	material	The building is made from the same material as a termite; a material that mimics termite exoskeleton / skin for example.
	construction	The building is made in the same way as a termite; it goes through various growth cycles for example.
	process	The building works in the same way as an individual termite; it produces hydrogen efficiently through meta-genomics for example.
	function	The building functions like a termite in a larger context; it recycles cellulose waste and creates soil for example.
Behaviour level (Mimicry of how an organism behaves or relates to its larger context)	*form*	The building looks like it was made by a termite; a replica of a termite mound for example.
	material	The building is made from the same materials that a termite builds with; using digested fine soil as the primary material for example.
	construction	The building is made in the same way that a termite would build in; piling earth in certain places at certain times for example.
	process	The building works in the same way as a termite mound would; by careful orientation, shape, materials selection and natural ventilation for example, or it mimics how termites work together.
	function	The building functions in the same way that it would if made by termites; internal conditions are regulated to be optimal and thermally stable for example (fig. 6). It may also function in the same way that a termite mound does in a larger context.
Ecosystem level (Mimicry of an ecosystem)	*form*	The building looks like an ecosystem (a termite would live in).
	material	The building is made from the same kind of materials that (a termite) ecosystem is made of; it uses naturally occurring common compounds, and water as the primary chemical medium for example.
	construction	The building is assembled in the same way as a (termite) ecosystem; principles of succession and increasing complexity over time are used for example.
	process	The building works in the same way as a (termite) ecosystem; it captures and converts energy from the sun, and stores water for example.
	function	The building is able to function in the same way that a (termite) ecosystem would and forms part of a complex system by utilising the relationships between processes; it is able to participate in the hydrological, carbon, nitrogen cycles etc in a similar way to an ecosystem for example.

Figure 35 frame for biomimicry application (Yedekci Arslan;2014)

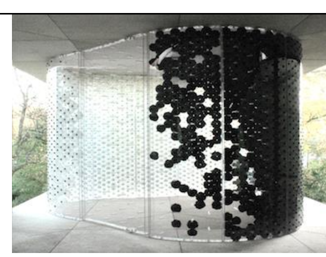
3.3. Biomimetic architecture examples (see next schedule)

Table 2 examples of biomimetic architecture (source ;author)

Example	Inspiration	Application
Waterloo International Terminal and glass panels	 Over lapping,flexible,sharp,scale,extra defense, regulating the temperature allow to air circulation.	 the roof structure moves dynamically as the 800 tons trains travel along on the platform below.
East gate tower in Zimbabwe	 Passive ventilation chimneys and air passages.	 Passive ventilation and skin climate adaptive skin.

3.4. Biomimetic façade examples (see next schedule)

Table 3 examples of biomimetic facades(source; author)

Example	Inspiration	Application
Depolluting Quasicrystal facade / elegant embellishments	 Sponges use chemicals to prevent other sponges from growing near them.	 The modules contain superfine titanium dioxide (TiO_2), a pollution-fighting technology that is activated by ambient daylight(Formakers;2018)
Biomimetic plastic skin allows building façade to “breathe”		

	140 pneumatic 'muscles' per square meter, which regulate the amount of incident light, views, and air that pass though Mimicking human's skin permeability. (Karen Laird;2016)	Tobias Becker came up with the idea of creating a breathing building facade skin using transparent solid sheets of Makrolon polycarbonate. (Karen Laird;2016)

III. DYNAMIC FAÇADE

III.1. DEFINITION

Dynamics is a branch of mechanics that is concerned with the effect of forces on the movement of objects. Buildings that follow a Dynamic Architecture modify their shape constantly. This creates a visual attraction immediately caught by the human eye, which focuses its attention in movement while being surrounded in a static environment. Dynamic Architecture involves the fourth dimension: time. As the environment changes this architecture would change and adapt. (Andrés de Antonio Crespo; 2007)

III.2. EXAMPLES OF DYNAMIC ARCHITECTURE

In the world there are some structures that change their configuration. Some floors in the top of landmark buildings rotate but this is done within the structure of the building, no movement can be seen from the exterior of the structure. (See next schedule)

Table 4 examples of dynamic architecture (source; author)

Example	Illustration	Goal
CN Tower in Toronto, Canada (left). WTC Mexico City (right).	 	Tourism goal rotating restaurants that have a 360-degree view of a city gather a lot of attention. (Andrés de Antonio Crespo;2007)
A shape-shifting, rotating skyscraper is set for Dubai by 2020		Comfort goal Residents will be able to control the rotation speed and direction of their individual luxury apartment. (Antonio Crespo;2007)

III.3. HISTORY OF DYNAMIC FACADES

Within the scope of the technologies of their time, traditional farmhouses had already made optimum use of energy-saving potentials. The heat generated by the livestock was used for heating the building, and straw and hay were not merely bedding and feed but provided insulation. Energy consumption caused by burning firewood was kept to a minimum. Windows had folding shutters that created a thermal buffer between the glass and the shutter at night, very much like a double-skin façade today. Double skin structures make up one of the most widely employed functional principles used to protect against exterior environmental influences through the façade envelope. In modern times, glass has been used more frequently, however, this has increased the issue of excessive cool down in winter and overheating in summer.

As early as 1929, Le Corbusier formulated a concept for a building envelope with positive impacts on the indoor climate in Precisions: "Mur-neutralisant": 'We have seen that these neutralizing walls are in glass, in stone, or in both. They are made up of two membranes with a space of few centimeters between them…A circuit in that narrow interval between membranes, hot air is pushed if in Moscow, cold air if at Dakar".

Le Corbusier's thoughts were never conveyed into a satisfactory result. His ideas were far ahead of his time. Today his "Mur-neutralisant" can be seen as the predecessor of the exhaust-air façade. This type of façade allows regulating the environment of the usable spaces individually independent on the exterior environment by employing a combination of a double skin structure and an air-conditioning unit. Whereas Le Corbusier aimed to moderate the room adjacent to the façade with an artificial environment in the building envelope, modern environmental concepts used the gap between the façade layers to create a buffer.

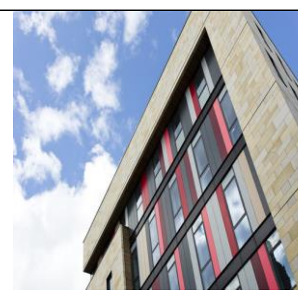
In other words, the regulation and the adaptability of skin were achieved with control system that is intelligently planned and easy to operate. (Nady;2017)

III.4. PARAMETERS FOR DESIGNING DYNAMIC FAÇADE

The concept of dynamic facades is not new, however, it is only during the last few years that architects and engineers have started to trust these systems and use them in building. Facades focus on feasibility systems for developing the quality and economy of this technology to be sustainable in the future. (Nady;2017) (see next schedule)

Table 5 parameters for designing dynamic façade (source; author)

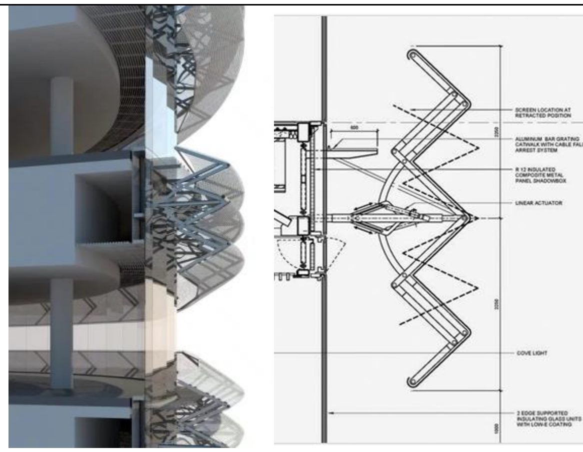
Parameter	Impact	Example	Illustration
Sun control	The amount of light admitted to a building correlates directly with an increase in interior temperatures, affecting the comfort level of the users within.	The dynamic patterns in the façade of Henning Larsen's University Building	

Natural ventilation	The building skin plays an important role in terms of the natural air exchange in buildings.	Bloomberg new office in London	
Daylighting	The use of natural daylight is important, both in terms of the comfort and contentment of the users and with regard to reducing the requirements for artificial light.	Arabe institute (Paris)	
Connection to outdoors	The aim is to blur the boundary between the interior and exterior space, enhancing the feeling of building in nature.	Huaxin business center (China)	
Thermal insulation	A particular insulation's make up and placement within the layering of the building skin can have large consequences that are observable in the thermal performance and aesthetics of the building skin.	Co2mfort building in Nijverdal, Netherlands	
Moisture control	There are two kinds of moisture to contend with when trying to keep the building dry: rain and condensation. When large temperature differentials occur between the interior space and the exterior, condensation forms on the colder surface.	BENCHMARK Façade Systems	

Structural efficiency	It is important to integrate structure into the building skin. the diagonal lateral bracing of the building is expressed as part of the skin, helping to define the character of the building.	The vertical extension of Hearst Headquarters' Art Deco building.New York.USA	
Material choices	Materials play a primary technological role and have a tremendous effect on the comfort of the building.	Doubletree by Hilton project located in Kocaeli. Turkey	
Possibility of energy generation	Photovoltaics or flexible solar thin films can be integrated into facades to simultaneously generate power and shade a building.	Futuristic and Benchmarking Turnkey Projects	

III.5. DYNAMIC FAÇADES see next schedule ;*Table 6 examples of dynamic facades (source;author)*

Example	Illustration	Application
the Kiefer Technic Showroom Austria (2007)		The facade itself is functioning as a shading device but given the users to control the angle of the panel, and amount of light transmitted into the interior space. (arch2o;2018)

CJ R&D CENTER KINETIC FACADE Seoul, South Korea		Based on the simple umbrella, the perforated steel strips installed on scissor actuators can open or close automatically to ensure proper natural light levels while reducing overheating. (Yan Krymsky;2011)

III.6. FUTURE DYNAMIC FAÇADE PRINCIPLES see next figure

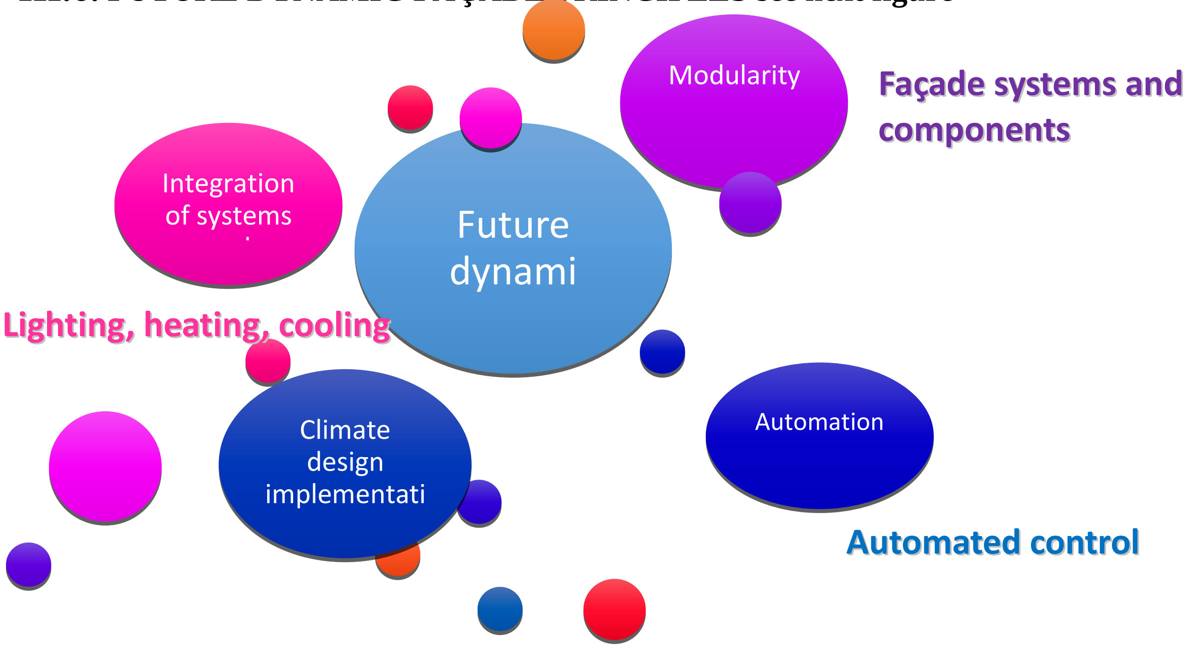


Figure 36 examples of dynamic facades (source; author)

CONCLUSION

Facades are the main constitute of the building envelope and a boundary between external and internal environments, considerably impact the environmental conditions of indoor spaces, the thermal performance of buildings and subsequently the user's satisfaction. Hence, thermal comfort conditions depend not only on the external environmental factors but also mainly on the architectural parameters and design elements. Thence, design and selection of facades during the design process of building should be considered as one of the major tasks in order to support the quality of visual and thermal sensations in indoor environments.

In essence, biodynamic facade can be developed as an intersection of biomimicry, and responsive architecture to achieve these performance-oriented goals in architecture.

INTRODUCTION

"*The integration of biomimetic and responsive architecture can realize a complete synthesis of artificial mechanisms which can perform adaptations similar to their natural counterpart. This synergetic result expands the boundary of both biomimetic and responsive architecture beyond the limits of biological and technological scope, with enhancing dynamic performance of architecture open to continuous interaction with climate, energy, and forces within the biosphere.*" (Chung,2011)

Biodynamic façade is the type of façade biomimetic designed with dynamic motion for different aesthetic and energetic goals working with:

-The knowledge of the earth and universal energies surrounding us and the planet.
-The knowledge of the energies of our body and the aura.
-The measurements about the electric-radiation of all the electronic equipment and installations people are using.
-The facts of the radioactive radiation as well the ancient constructions theories.
-Ancient spiritual knowledge, and also with new technologies and developments, renewable energy resources and sustainable solutions. (revolvy.com;2018)

I. EXAMPLES OF BIODYNAMIC FAÇADE APPLICATION

1. THE THEMATIC PAVILION "ONE OCEAN"

1.1. Identification of the work: presentation of the project and motivation of choice

The Thematic Pavilion "**one ocean**" for the EXPO 2012, Yeosu, South-Korea / SOMA

It's one of the latest building with a biodynamic façade.

Figure 37 the one ocean pavilion (http://www.evolo.us)

1.2. Situation and analysis of the immediate environment

The building is on an artificial island in southern east of South-Korea.

The permanent building is being built along a new promenade in a former industrial harbor basin. Following the Expo, the promenade will serve as an urban beach offering leisure activities for tourists and locals. (evolo;2012)

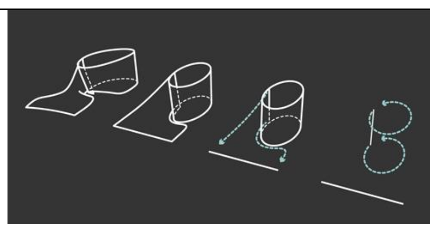
Figure 38 situation of the pavilion (https://www.google.com/ 2018)

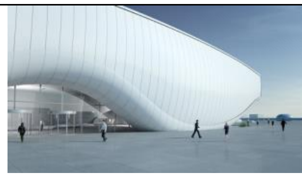
1.3. Climate and average weather in south Korea

South Korea has a temperate climate with four distinct seasons. Winters are usually long, cold and dry. Summers are very short, hot, and humid. Spring and autumn are pleasant but also short in duration. Seoul's mean temperature in January is -5 degrees Celsius to - 2.5° Celsius and in July the mean temperature is about 22.5° C to 25° C. (weather-and-climate;2018)

And here are the major pillars of the design (Florian Maier;2012) (see the following schedule).

Table 7 the design of one ocean (source; author)

Element	Illustration	Application
Design concept of the building		The experience of the sea as an endless surface and as depth was the conceptual basis for the design of the exhibition modules. Continuous surfaces warp from vertical cylinders into horizontal planes, generating two different exhibition areas.
Bio-inspiration of the façade shape		Organism level was adopted in the wave-like design in form(the façade has the wave shape)
Bio-inspiration of the façade dynamic mechanism		Organism level was also adopted in the wave-like design in function (the façade lamellas open and close according to the daylight like the motion of sea wave)

		
Energy efficiency		By day, the lamellas of the kinetic facade control the input of solar energy. Solar panels on the roof supply the power for operation of the service engineering installations. The climatic properties of the building were analyzed in depth and simulated by Trans solar in order to reduce energy consumption and increase efficiency.

1.4. The mechanism of the kinetic façade

The spears move when actuators apply compressive stress to the top and bottom of each one.

The pressure creates a complex elastic deformation in each segment, causing the facade to open.

The wall's 216 actuators, each of which consists of a servomotor that drives a ball screw spindle, are activated by a coordinating control unit.

Sensors continually check each lamella's position, relaying information back to a server. the system can feed energy back into the local system to operate more efficiently. (Jennifer Krichels;2012)

Figure 39 the mechanism of the lamellas. (YouTube;2013)

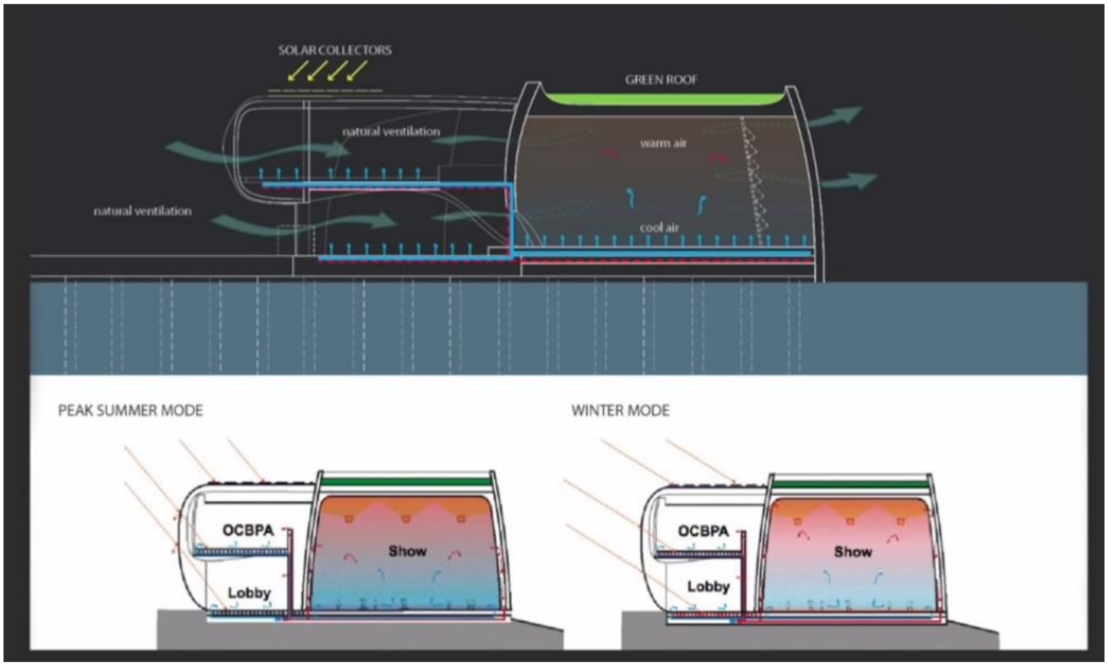


Figure 40 importance of the biodynamic facade in the thermal comfort of the pavilion(winter/summer) (YouTube;2013)

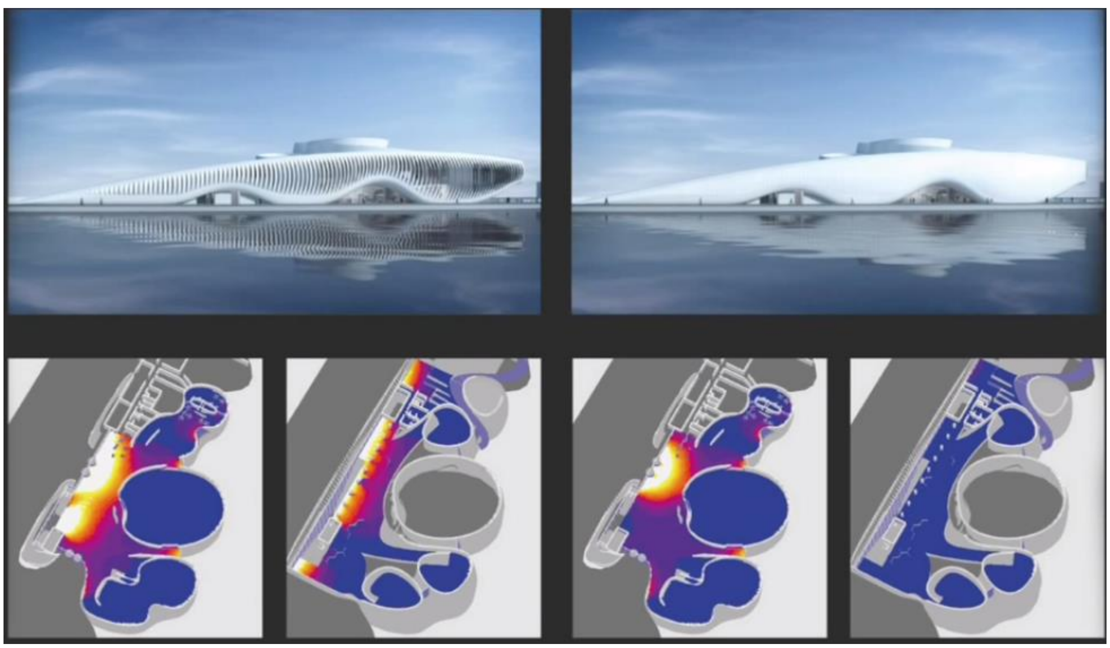


Figure 41 the impact of the shading devices (dynamic lamellas) on the entry of light and regulation of thermal comfort (YouTube;2013)

2. **ALBAHAR TOWERS**, Abu Dhabi. Emirates

2.1. Identification of the work: presentation of the project and motivation of choice

While many buildings in the Middle East have attempted to deal with the consistent issue of solar gain in such a hot, arid climate, Al Bahar Towers has taken a dramatic approach to addressing the issue. The towers themselves are simply clad curtain wall buildings, but instead of relying on tinted or highly reflective glazing to mitigate solar effects, they utilize an intricate and dynamic external shading system referred to as the "mashrabiya." (Skyscrapercenter;2012)

Figure 43 albahar towers (Skyscrapercenter.pdf)

2.2. Situation and analysis of the immediate environment

The site where was the building implanted is very important, From the western north there is AL NAHYAN's properties. From western south there is ABU DHABI Men's college higher. From east there is MANGROVE NATIONAL PARK.

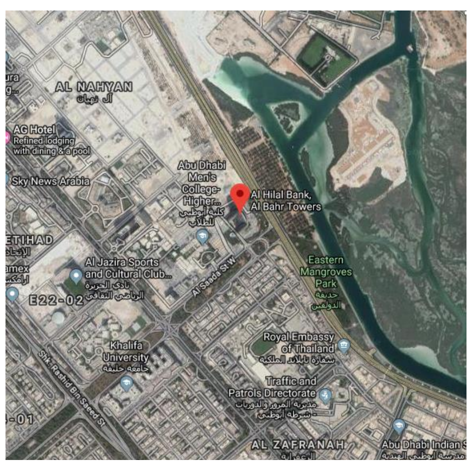


Figure 44 situation of the building (https://www.google.com/maps- 2018)

2.3. Climatology of the site

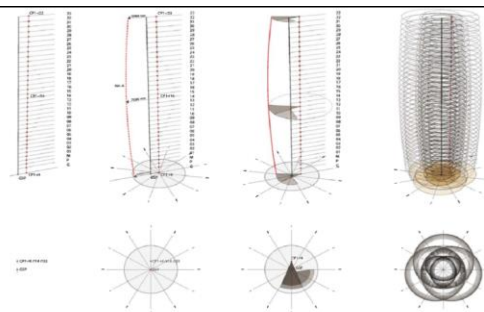
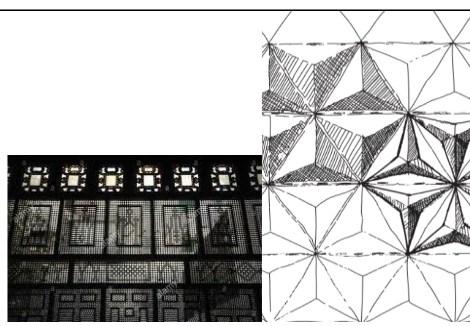
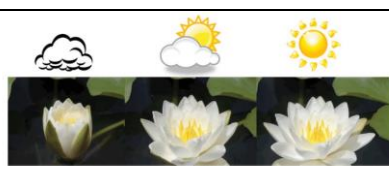
The United Arab Emirates (UAE) has a **desert climate**, characterized by pleasantly mild winters and very hot and sunny summers, when the humidity of the Persian Gulf makes the heat unbearable.

The annual precipitation is almost everywhere below 100 millimeters (4 inches) and is concentrated in the winter months. The rains are rare, but they occur in the form of showers or downpours, which sometimes can be intense. (climatestotravel.com;2018)

Figure 45 the desert of the EMARATES (https://www.climatestotravel.com)

2.4. There are some design elements of the al bahar towers (Skyscrapercenter;2012) (see the following schedule)

Table 8 the design of al bahar towers (source; author)

Element	Illustration	Application
Design concept of the building		A circular form was proposed for its efficiency of wall-to-floor area and reduced amount of surface area, which was then refined iteratively to get the final form. The towers taper at the top and bottom and widen toward the middle, and was generated from a pre-rationalized geometry derived from the Islamic composition. This process was undertaken by means of parametric and algorithmic computer studies.
The inspiration of the façade shape		The façade shape was inspired from the mashrabiah a traditional sun protection in local construction.
Bio-inspiration of the façade dynamic mechanism		Dynamic mashrabiya-inspired from adaptive natural systems-folding and unfolding concept following the movement of the sun under the functional organism level.

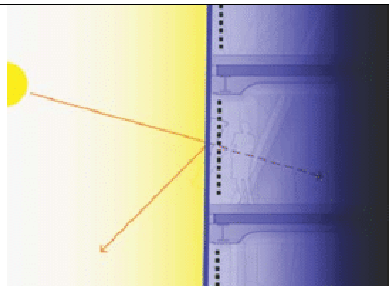
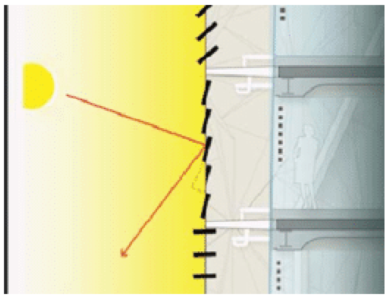
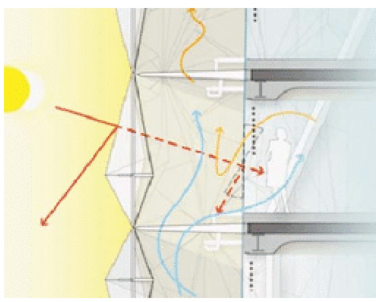
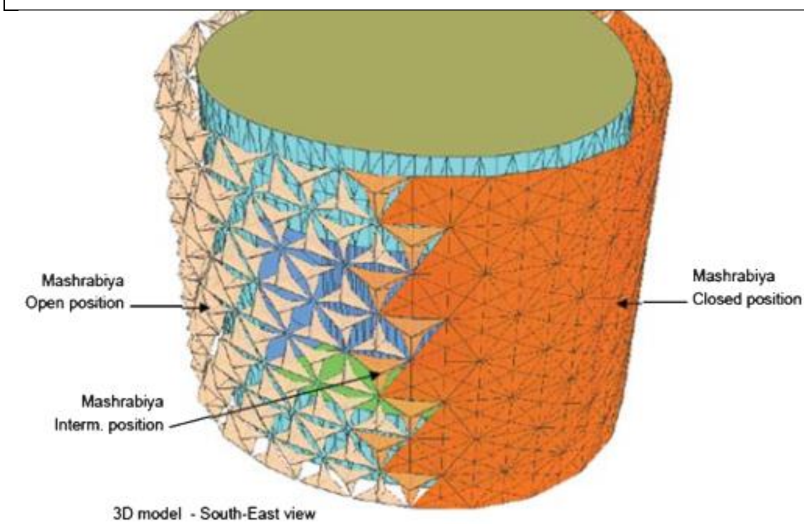
Energy efficiency	  	This comparison between common systems and the dynamic Mashrabiya system illustrates the different effects of the facade type in terms of visibility, admission of natural diffused light and overall internal working space quality. This double skin façade design and its dynamic adaptation to the sun path minimizes the solar exposure for internal spaces allowing at the same time internal ventilation.

Table 9 gains due to conduction in the mid-season at 9:00am (A. Karanouh and E. Kerber;2015)

Element of facade	U-value	External temp.	Interieur temp.	Data temp.	Internal gains	Total gains /(m) of facade
	(W/m²K)	(K)	(K)	(K)	(W/m²)	(W/m)
Vision area	1.75	36	23	13	23	71
Spandrel area	1.95	36	23	13	25	28
				Solar game on the inner façade (W/m)		98



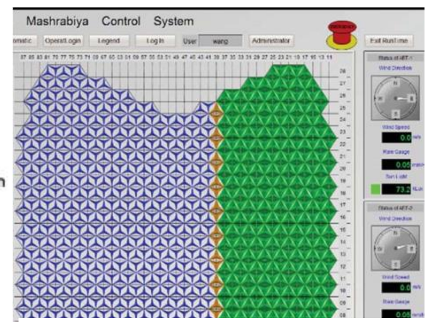


Figure 47 the mashrabya control system (Journal of Facade Design and Engineering-2015)

Figure 46 the different state of the façade depending on weather conditions (Journal of Facade Design and Engineering-2015)

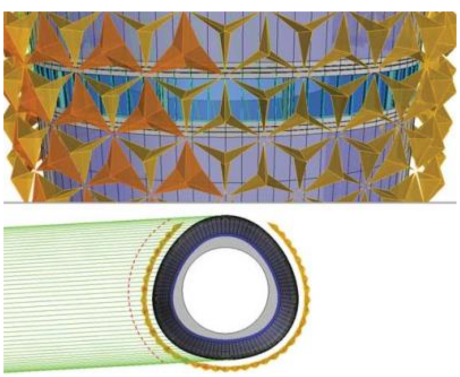


Figure 48 ST 29: Time: 13:30, 79 < Sun-Angle < 83◦

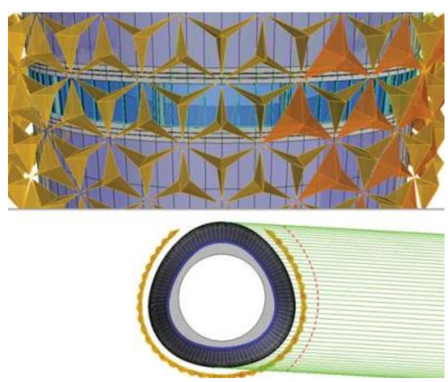


Figure 49 ST 27: Time: 09:07, 79 < Sun-Angle < 83◦.

(Journal of Facade Design and Engineering-2015)

Details of the façade element

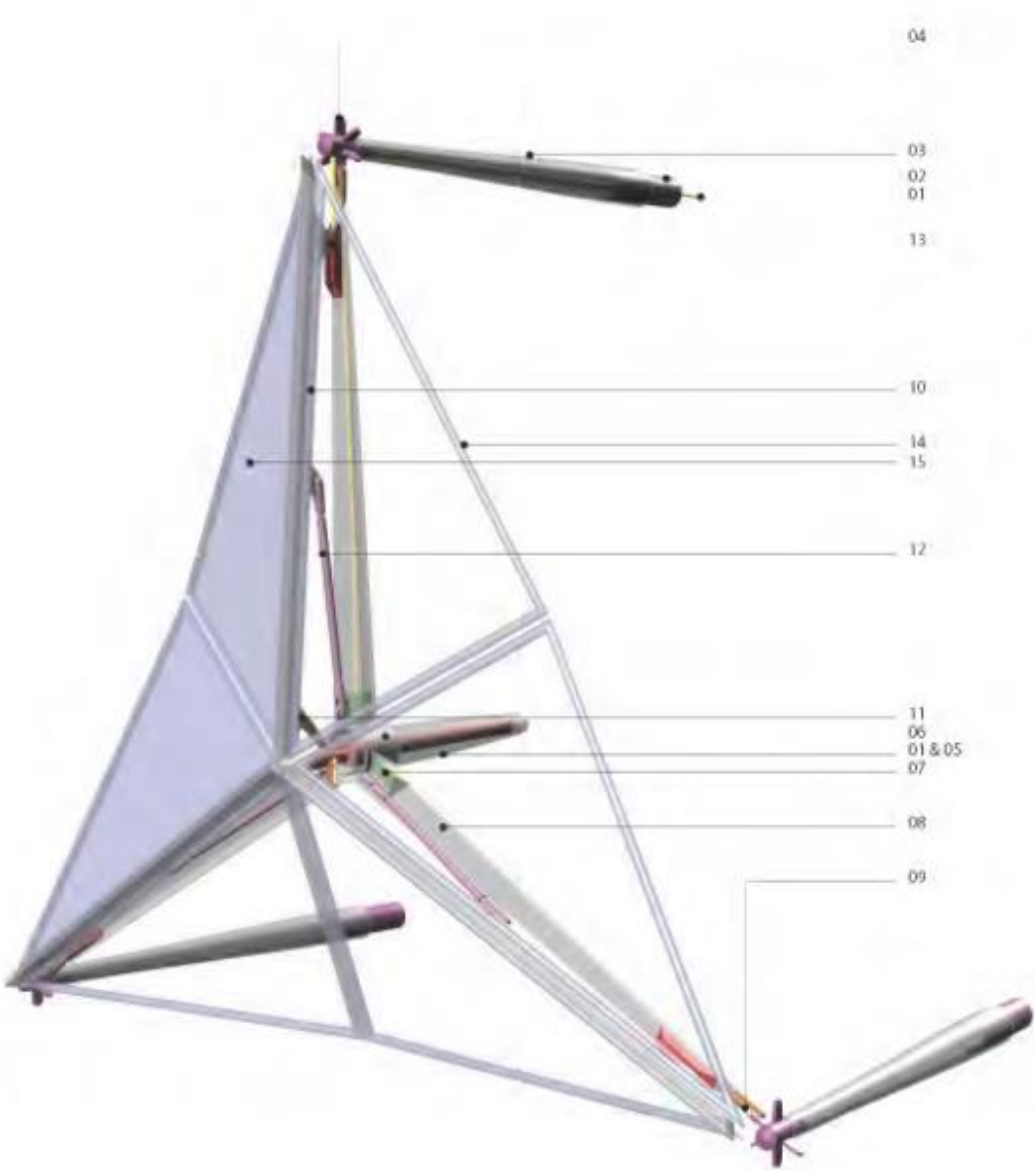


Figure 50 mechanism of a single facade panel of al bahar towers (Journal of Facade Design and Engineering-2015) key

1.actuator+power & control: cable connection back to the tower

2.strut sleeves: penetrates the curtain wall & connects to the main structure

3.supporting cantilever struts: hooks on the sleeves

4.star pin connection: receives the unitized y-arm ends

5.actuator casing: protects the actuator

6.y-struccture ring hub: joins the y-arms and actuators together

7.y-structure sleeves: connects y-arms to the hub

8.y-structur arms: supports the whole mechanism

9.y-mobile tripod: drives and supports the fabric mesh frames

10.actuator head pin connection: pins the mobile tripod

II. CONCEPTUAL IDEA FOR MY BIODYNAMIC FAÇADE

SOURCE OF INSPIRATION

First the bio-inspiration

I entered the University of May 8, 1945 Guelma and I was only 10 years old to attend a graduation ceremony. I was amazed by the entrance, full of pine trees. I was amazed by what I called the wooden flowers. I never expected it to be part of my graduation project.

The southern region where my project is located is adjacent to the down town of the city of Guelma characterized by the type of pine trees inspired by the interactive interface Biotic strategies of the steadfastness of this tree beyond the trunk and leaves to the "wood flowers", which are sensitive to climatic conditions to close in the cold-wet air and open in the hot-dry air to drop seeds and this process is repeated dynamically.

Figure 51 photos taken by the author for pine trees in the site

-The bimetallic effect

Pine apples open in dry weather and close in wet weather. How can humidity variations put matter in motion?

When a pine cone is placed in a warm, dry environment, its scales bend and the pine cone opens. Diving a few minutes under water, the pine cone closes. This action is totally reversible. (amaco.org;2018)

Figure 52 author's experiment about the bimetallic effect; in wet environment(left), in warm hot environment(right)

-The mechanism of pine apple scales

Cone of conifers (Pinophyta) in (A) high moisture content and (B) low moisture content (dry condition). Even after the cone has fallen off the tree, the material's intrinsic performance within the cones scales remains. The moisture content in the scales changes as it finds equilibrium with the surrounding humidity level. (Reichert, Menges, Correa;2014).

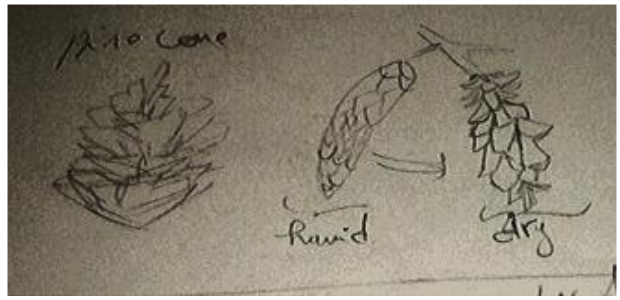
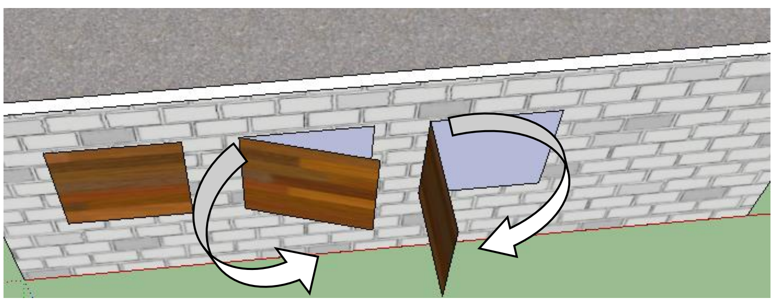


Figure 53 dynamic scales of pine apples (elsevier.com)

Figure 54 author's drawing of natural mechanism of the pine cone

To prevent overheating, the facade panels move dynamically they move up-down in southern facade meanwhile in the east & west the panels move right-left, left-right like sun blockers.



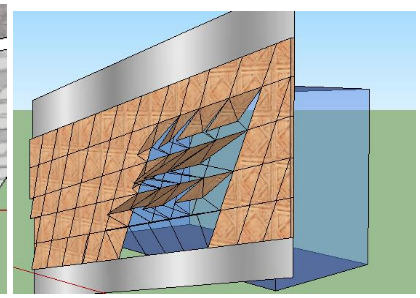


Figure 55 the panels open or close according to weather conditions (sketchup.pro 8)

Figure 56 the mechanism of the facade panels (sketchup.pro 8)

Second; **cultural inspiration** The main characteristic of cultural context is Islamic religion which I want the façade to present it by the mashrabieh pattern in the façade biodynamic panels.

Figure 57 the frame inspired from the mashrabieh inspiring from the mashrabieh

The system used to control the kinetic facade is the indirect system by multi input; the process and motion control is a result of a number of input devices through a combination of sensors that can receive data from various sources to take the optimum decision to move one element. (Elkhayat;2014)

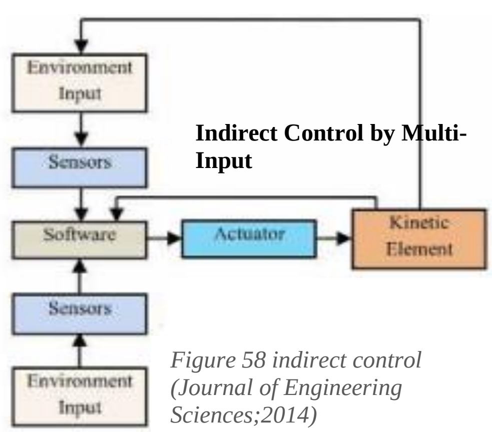


Figure 58 indirect control (Journal of Engineering Sciences;2014)

CONCLUSION

The biodynamic façades are not designed just for aesthetic reasons but they are mainly designed to solve serious architectural and comfort issues; the previously analyzed facades have numerous in common characteristics, the most important one is the design inspiration which was born from cultural natural and climatic context.

INTRODUCTION

Every new building occupies an important part of its environment where it will affect and be affected.as a result the first step in creating a new building is analyzing the environmental a climatic context to extract specific recommendations this is what this chapter is about.

I. PRESENTATION OF THE CITY

Guelma is situated at the heart of a major agricultural region, 290 m above sea level and surrounded by mountains (Maouna, Dbegh, Houara). The region is very fertile because of the Seybouse River and a large dam that provides a vast irrigation scheme. It occupies a strategic geographic position as a crossroads in north-eastern Algeria, linking the coast of Wilaya of Annaba, El Taref and Skikda to inland areas such as Wilaya of Constantine, Oum El Bouagui and Souk-Ahras.

The city of Guelma covers 44.74 km² and has The total population of the district is estimated at 31 December 2013 at 518,224 inhabitants, a density of 141 Hab/ Km².The minimum altitude is 256 m, the maximum altitude is 321 m, the average altitude is 256 m. (Tawfiq Wag;2010)

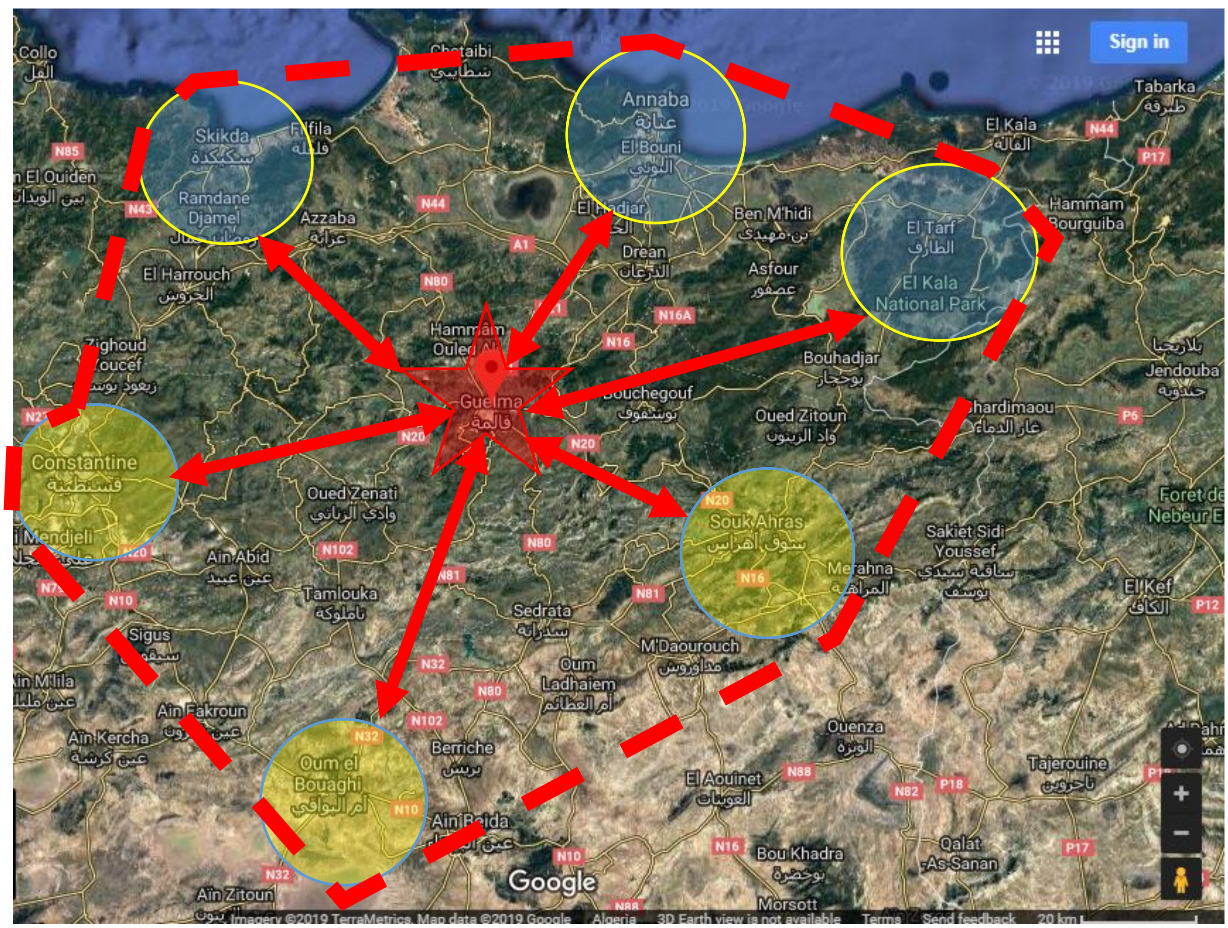


Figure 59 geographical situation of Guelma and its importance

II. HISTORY

II. 1. ANTIQUITY

Though Guelma was settled from early prehistory, it was first established as a town under the Phoenicians, who called it *Malaca*, Later, the Romans settled the area and renamed it *Calama*, part of the Roman province of Numidia. Calama prospered during the rise of Christianity. Later, the Vandal invasion devastated the area until the coming of the Byzantines, who settled the area and built city walls to protect it from further invasions. It was located in the Byzantine Exarchate of Africa. However, after the successful Islamic conquest of Algeria, the area was abandoned as a formal settlement, even later, during Ottoman rule.

II. 2. FRENCH RULE

Guelma was re-established as a formal settlement during the French invasion of Algeria, after seven centuries of abandonment. The annexation of the area began with the advancing of the French Army going to Constantine from Annaba who discovered (and temporarily occupied) the ruins of Calama from 10–15 November 1836 under the command of general Bertrand Clausel. (Guelma.org;2018)

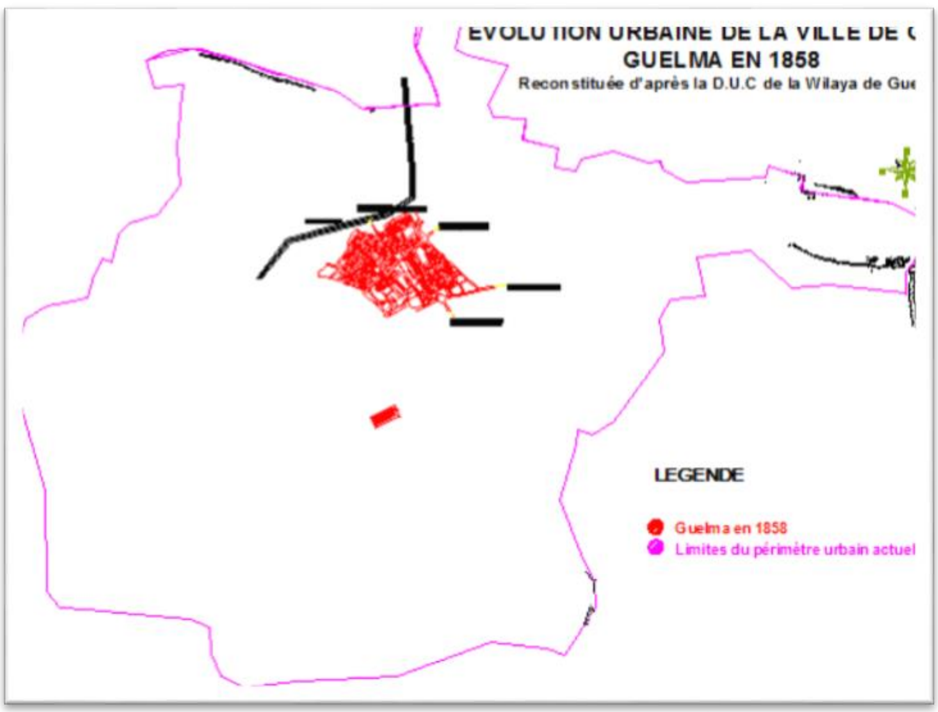


Figure 60 urban evolution of Guelma city in 1858 (DIRECTION OF URBAN PLANNING AND CONSTRUCTION of Guelma)

Figure 61 People in front of Guelma's train station (19th century postcard) (https://howlingpixel.com)

Guelma was established as a city in 1836. Its communal constitution dates from 17 June 1854. A modern city quickly developed around the Roman ruins, first inside the restored Byzantine city walls, later also outside the walls, which continued to function during these times, and near the railroad which crossed the city from the west to the east. The city had a high percentage of European settlers during these times, supported by the French colonial policy. (wikipedia;2018)

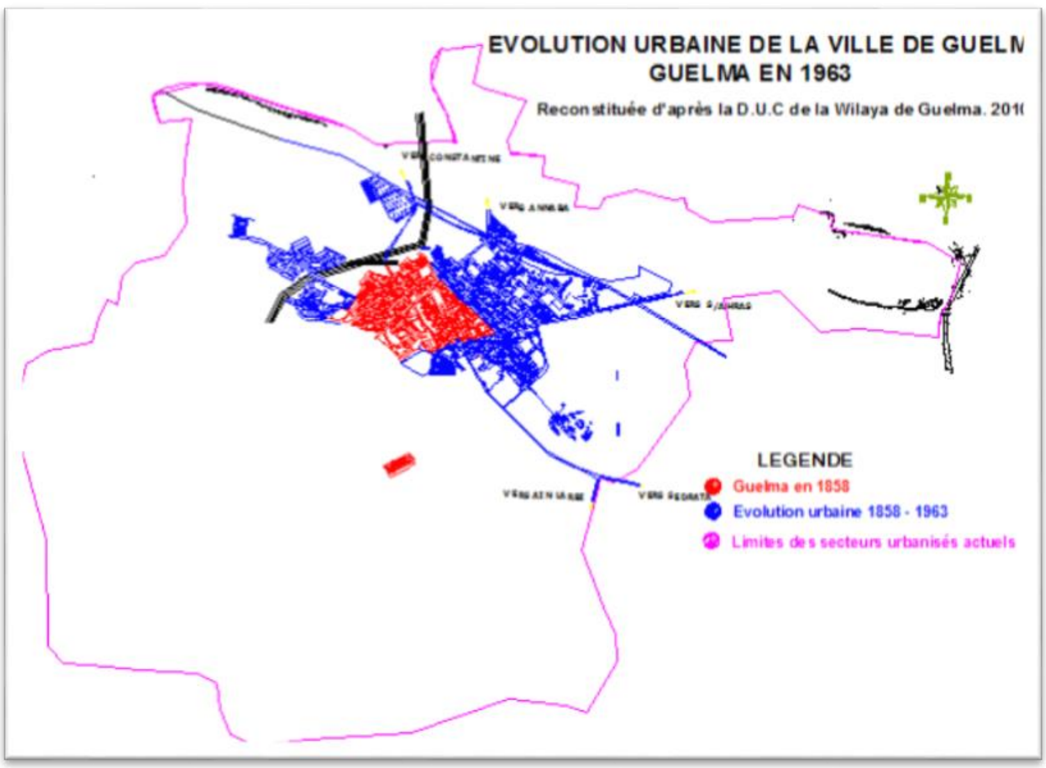


Figure 62 urban evolution of Guelma city in 1858-1963 (DIRECTION OF URBAN PLANNING AND CONSTRUCTION of Guelma)

II. 3. POST-INDEPENDENCE

Figure 63 general view of Guelma (https://howlingpixel.com

After the Independence of Algeria, both the European settlers and the indigenous Jews left, and the synagogue and the church were converted into mosques. The population of Guelma grew at a rapid pace.

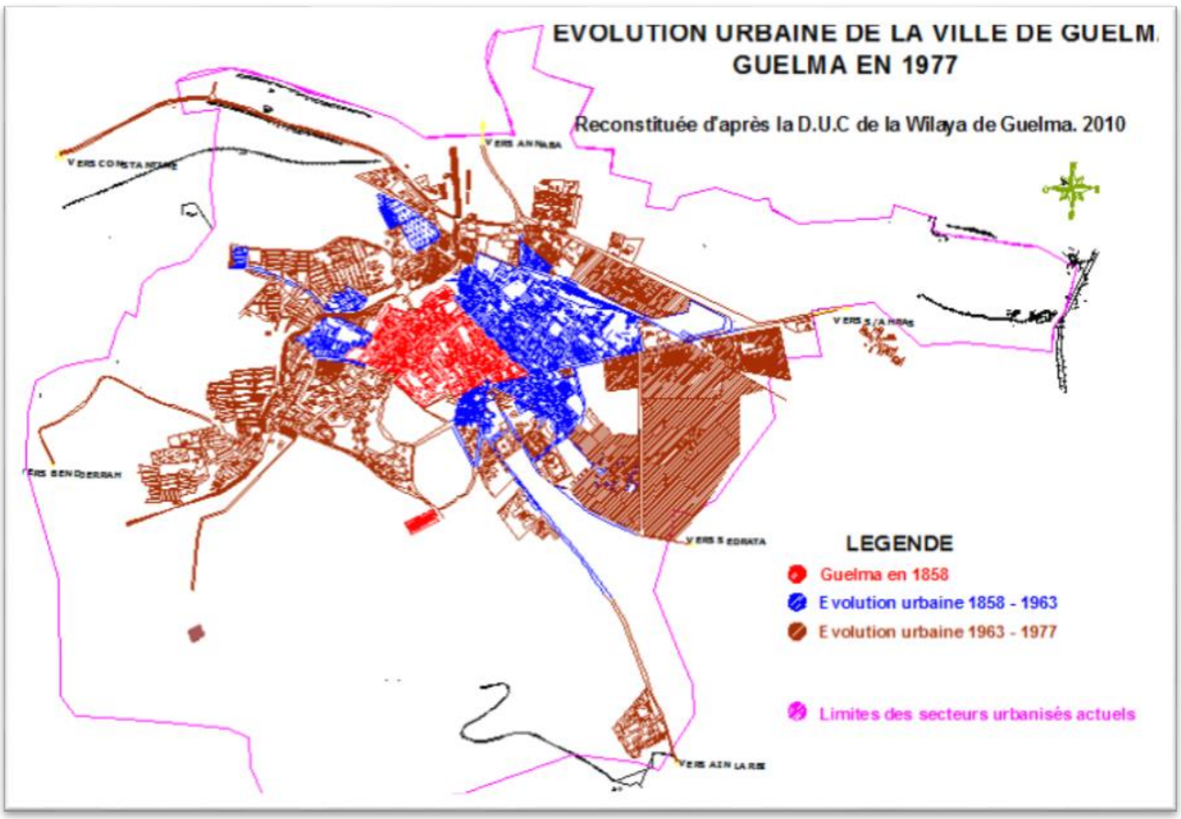


Figure 64 urban evolution of Guelma city in 1858 (DIRECTION OF URBAN PLANNING AND CONSTRUCTION of Guelma)

Guelma has inherited an eclectism of architectural styles due to the succession of different civilizations since the antiquity to the post-independence era; the downtown is characterized by the regular urban fabric classical architectural style Interspersed with roman ruins since the new urban fabric adopted after independence is burst nibbling agricultural lands with a modern and standard architectural style. (Guelma.org;2018)

III. CLIMATIC ENVIRONMENT

The climate is warm and temperate in Guelma. In winter, there is much more rainfall in Guelma than in summer. The climate here is classified as Csa by the Köppen-Geiger climate classification. The average temperature in Guelma is 17.2 ° C. The rainfall here averages 557 mm. (meteoblue;2018)

III. 1. TEMPERATURES AND AVERAGE RAINFALL

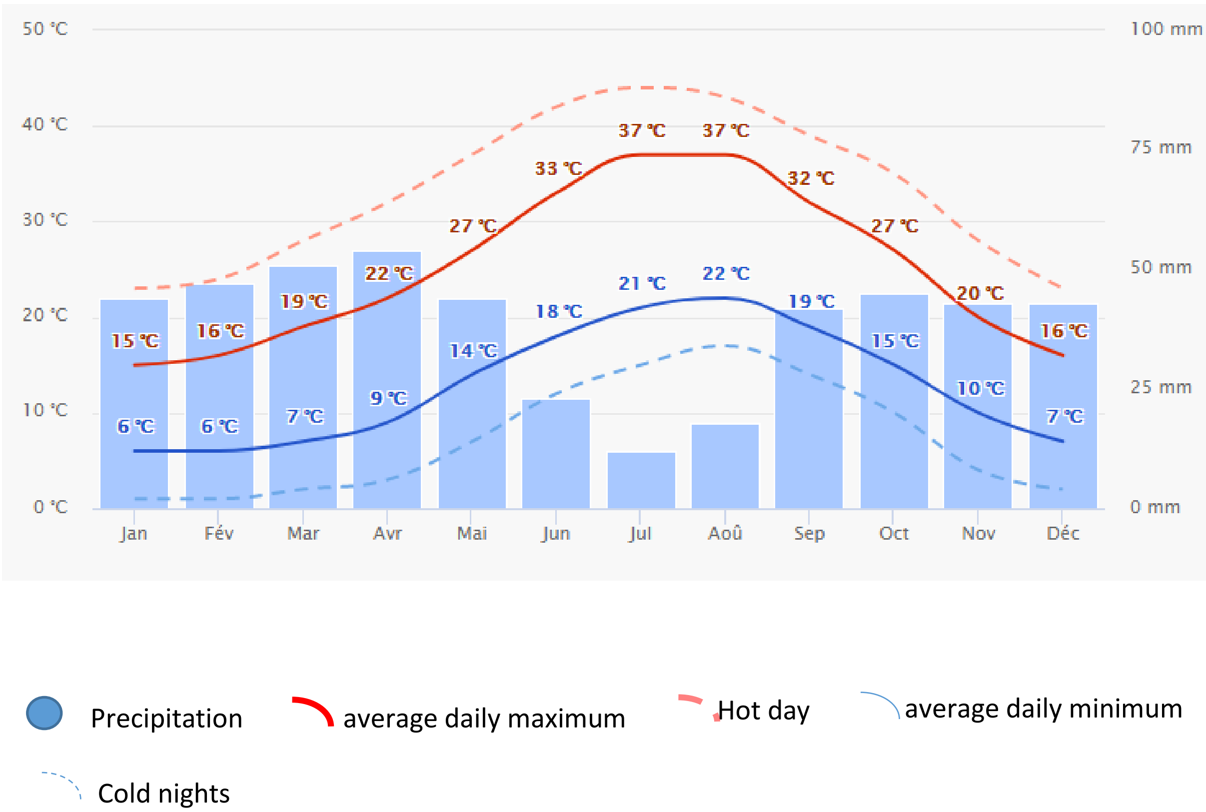


Figure 65 temperature and precipitation in Guelma (https://www.meteoblue.com)

We can see clearly that the hottest day in the summer of Guelma is in July since the coldest one is in January. Also the monthly rainfall above 150mm are mostly wet, below 30mm usually dried so in Guelma the climate is dry only in the summer season.

III. 1.1. Cloudy sky, sun and precipitation days

The brightest and the sunniest days are in July since the cloudiest ones are in January also the rainy days are in January and the driest days are in July this why the winter is wet and the summer is dry in Guelma.

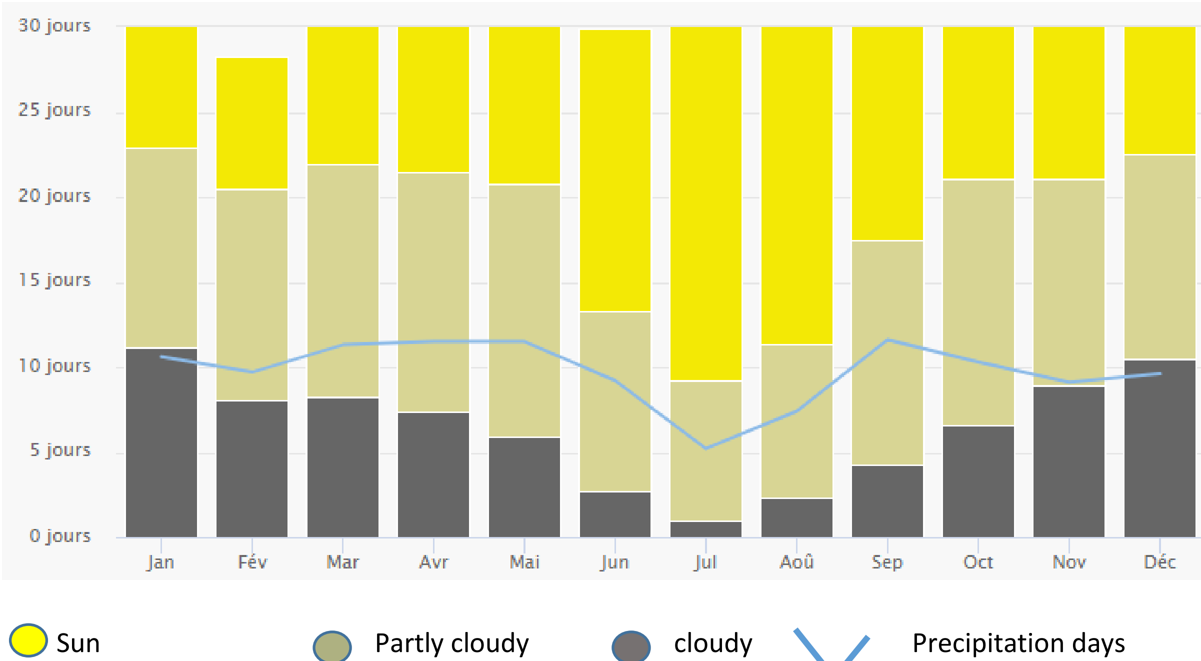


Figure 66 sunny and cloudy days (https://www.meteoblue.com)

III. 1.2. Maximum temperatures

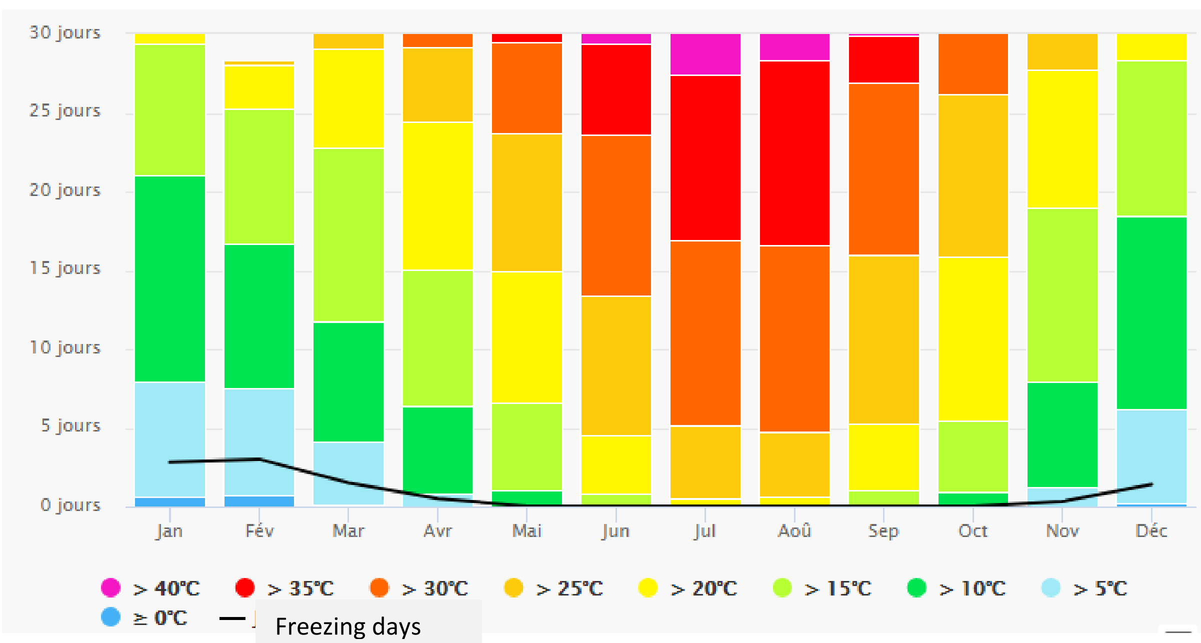


Figure 67 maximum temperature (https://www.meteoblue.com)

The Guelma maximum temperature chart shows the number of days per month reaching certain temperatures; in the summer it may be over 40 degrees since in January and December it reaches the freezing degree for three to four days.

III. 1.3. Rainfall amount The rainiest month of the year is January since the driest one is July the snowy days are almost zero.

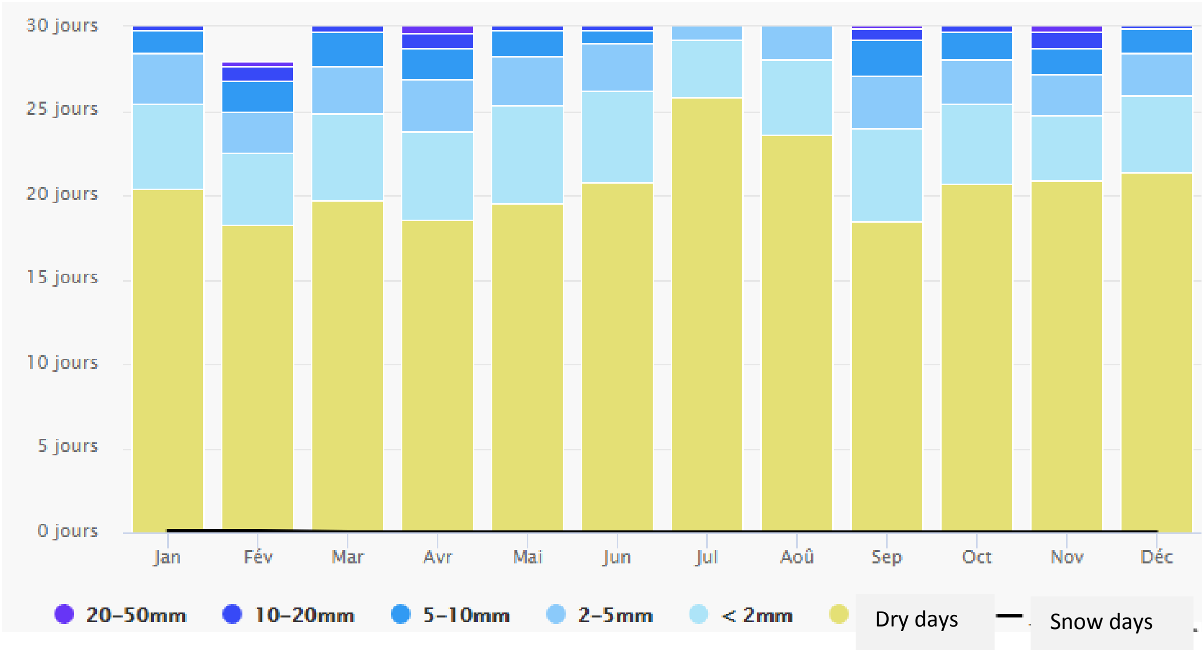


Figure 68 rain amounts (https://www.meteoblue.com)

III. 2. WIND SPEED

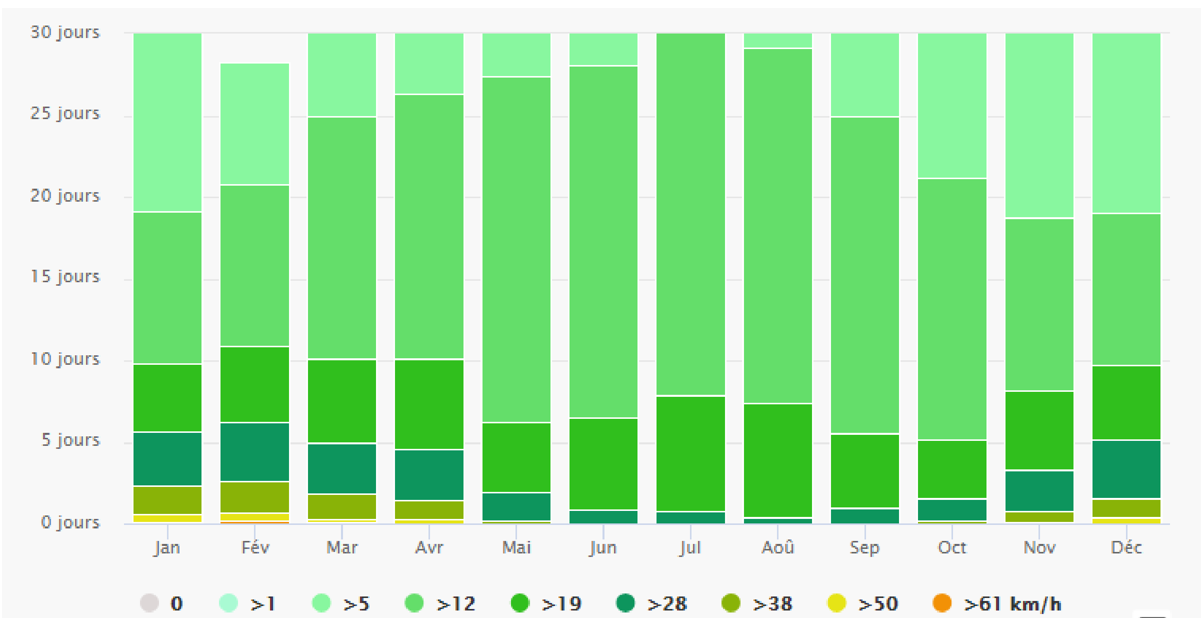


Figure 69 wind speed (https://www.meteoblue.com)

The Guelma chart shows the days per month, during which the wind reaches a certain speed; the period between May to October the wind is calm and it doesn't exceed 38km/h, but in the period between November to April the wind is relatively stronger and exceeds 61km/h.

Rose of the winds

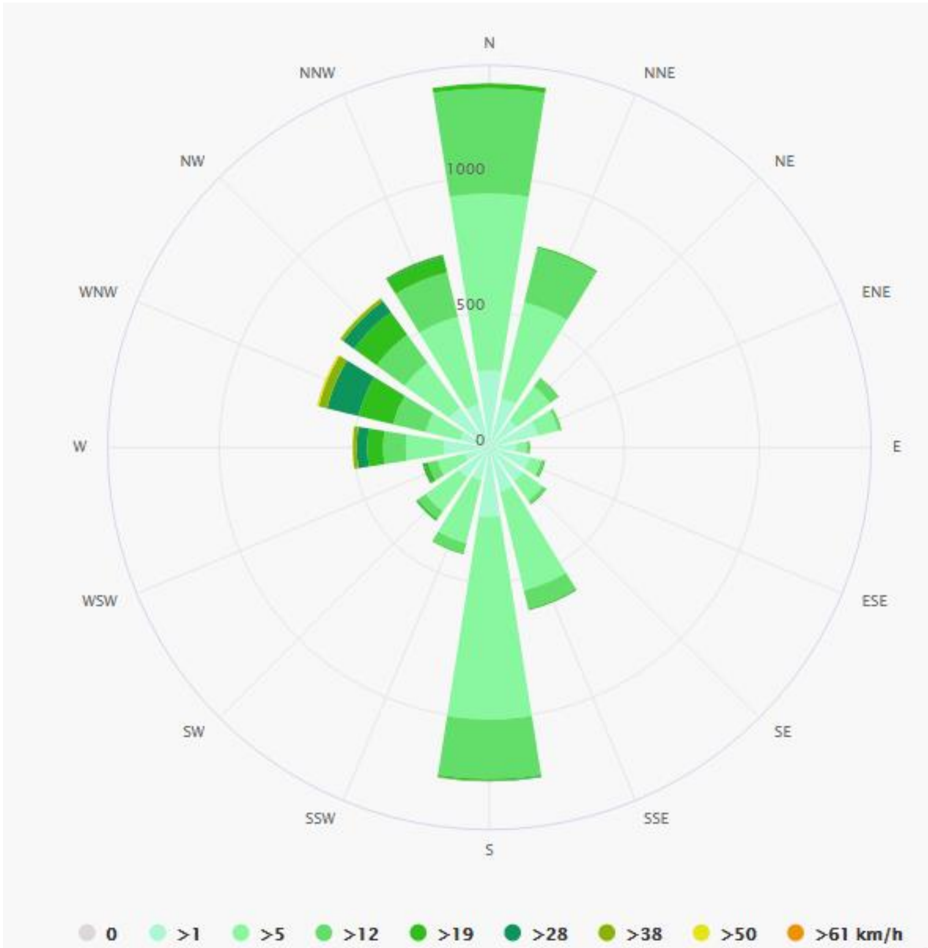


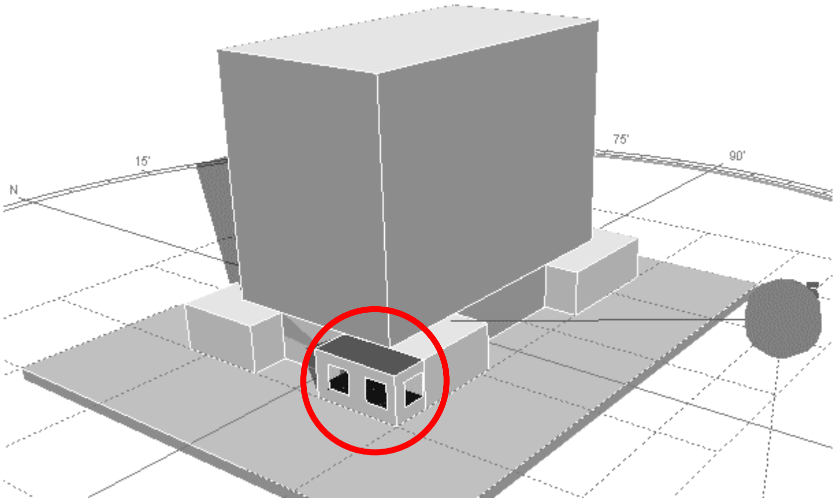
Figure 70 wind rose (https://www.meteoblue.com)

According to the rode of the wind of Guelma we can see that the strong wind in the season (November to April) comes from west to NORTH-WEST direction but in the calm season (May to October) the wind comes from the south to SOUTH-EAST direction.

IV. CLIMATIC ANALYSIS OF AN EXISTENT BUILDING IN GUELMA

V.1. PRESENTATION OF THE WORK

The building to be analyzed is the rector ship of university of Guelma, I took one work space and analyzed it with ECOTECT in two cases the first is the with the actual façade and the other is with a biodynamic façade and see its impact on the thermal comfort of the work space.



The analyzed zone

Figure 71 a caption for the model in ECOTECT_V5.5

V.2. ANALYSIS OF THE MODEL 1. In the summer season

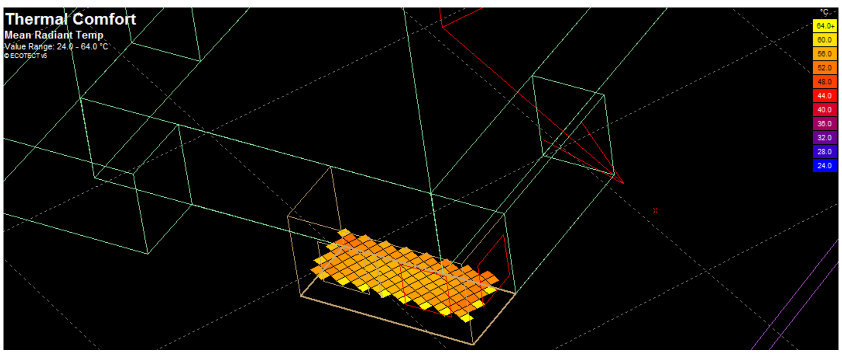


Figure 72 thermal comfort analysis in the hottest day of the year ECOTECT_V5.5

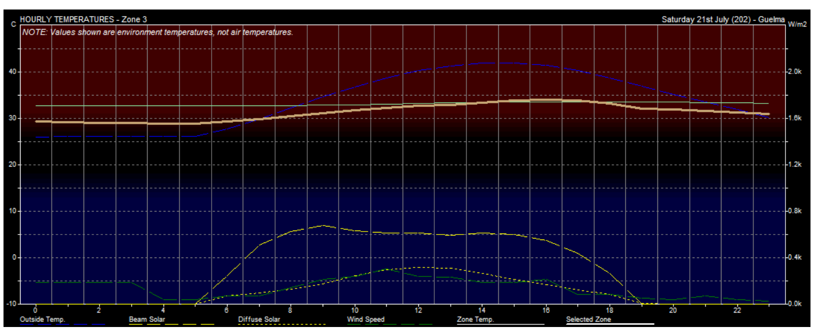


Figure 73 hourly temperature ECOTECT_V5.5

Hourly temperatures - Saturday 21st July the hottest day

Zone: the work space

Table 10 hourly temperature of the hottest day in Guelma ECOTECT_V5.5

Hours	00	01	02	03	04	05	06	07	08	09	10	11
Inside temp.(C°)	29.3	29.3	29.2	29.1	29.1	29.1	29.4	30.3	31.3	32.2	32.6	32.9
Outside temp.(C°)	25.9	26.1	26.1	26.1	26.1	26.1	27.7	29.8	32.2	34.7	36.8	38.7
Temp-diff.(C°)	3.4	3.2	3.1	3.0	3.0	3.0	1.7	0.5	-0.9	-2.5	-4.2	-5.8

Hours	12	13	14	15	16	17	18	19	20	21	22	23
Inside temp.(C°)	32.9	32.7	32.4	32.5	32.6	32.5	32.3	32.0	31.7	31.5	31.3	30.9
Outside temp.(C°)	40.2	41.2	41.8	41.9	41.4	40.3	38.7	36.9	35.2	33.5	31.9	30.2
Temp-diff.(C°)	-7.3	-8.5	-9.4	-9.4	-8.8	-7.8	-6.4	-4.9	-3.5	-2.0	-0.6	0.7

The optimum temperature of an office space in the summer season is 24.5°C with an acceptable range of 23-26°C, but the Average Temperature: 29.7 C° in this case had exceeded the limit of the thermal comfort acceptance in an office.

V. 2.2. In the winter season

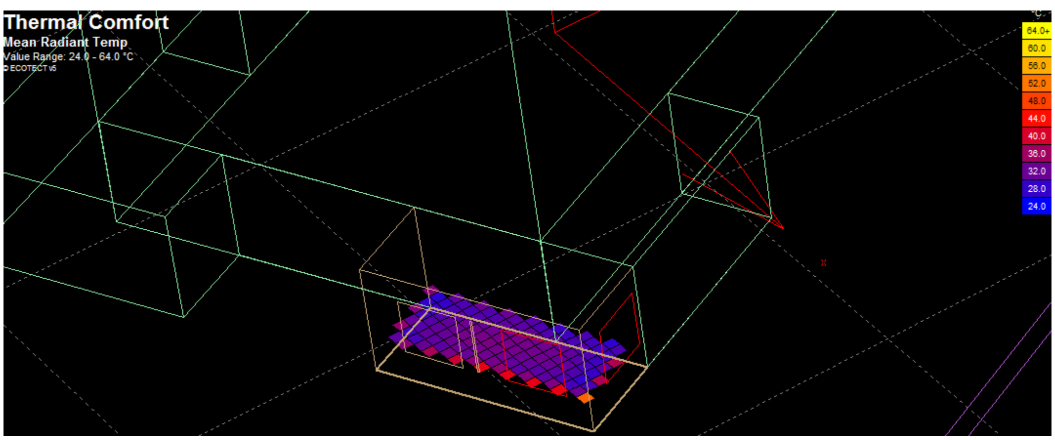


Figure 74 thermal comfort analysis in the coldest day of the year ECOTECT_V5.5

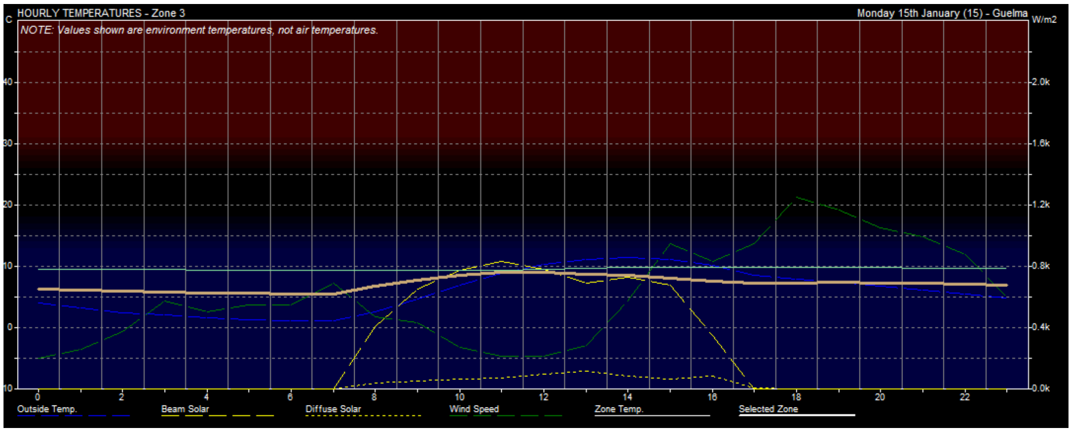


Figure 75 hourly temperature in the coldest day ECOTECT_V5.5

Hourly temperatures - Monday 15th January

Table 11 hourly temperature of the coldest day in Guelma

Hours	00	01	02	03	04	05	06	07	08	09	10	11
Inside temp.(C°)	6.0	5.8	5.6	5.5	5.4	5.3	5.2	5.1	7.4	9.1	10.2	10.7
Outside temp.(C°)	4.0	3.3	2.5	2.1	1.7	1.4	1.1	1.1	2.6	4.7	6.9	8.9
Temp-diff.(C°)	2.0	2.5	3.1	3.4	3.7	3.9	4.1	4.0	4.8	4.4	3.3	1.8

Hours	12	13	14	15	16	17	18	19	20	21	22	23
Inside temp.(C°)	10.4	9.7	9.2	8.3	7.3	6.7	6.9	6.9	6.9	6.8	6.7	6.5
Outside temp.(C°)	10.3	11.1	11.4	11.2	10.2	8.6	8.0	7.4	6.8	6.1	5.5	4.9
Temp-diff.(C°)	0.1	-1.4	-2.2	-2.9	-2.9	-1.9	-1.1	-0.5	0.1	0.7	1.2	1.6

The optimum temperature of the office space in the winter season is 22°C with an acceptable range of 20-23.5°C, but Average Temperature: 6.5 C° in this case it's lower than the limit of comfort acceptance.

V. 3. PROBLEM

Poorly insulated windows (single glazed) can create a cold area in the winter, and directly exposed ones to the sunshine (without sun protection) can create a warm area in the summer. This is why the inside is hot in the summer and cold in the winter.

V. 4. SOLUTION

Guelma has a hot summer and a cold winter as previously mentioned, and there are architectural strategies for both seasons to get a comfortable space occupancy.

V. 4.1. cold Winter Strategy

1- Receive:

Large windows to the south with, rather the living rooms to the south and rather the service rooms in the north. Avoid the masks with solar entries of winter (masks owns the building as much as the close masks).

2- Store:

This is to distribute the solar input entered by the openings to the south: By walls and slabs used to store inputs and being in contact with spaces not receiving the sun.

3- Distribute:

Absorption inertia for direct solar capture to have a good recovery performance • Paving, slabs, masonry slabs.

4- Preserve:

This is to avoid losses to the outside of solar gains and contributions from the heaters. Means: •To have a good insulation of the envelope (walls, roof, ground) of the habitat (insulation, double glazing, to avoid the thermal bridges, quality joineries put to the right of the insulation, etc.) (advantage of wood structures) • Have a compact habitat to reduce the ratio between the surfaces in contact with the outside and the interior volume. This is the form factor:

Only glaze in accordance with the standards of natural lighting except south (1 / 5th of the surface of the floor approximately) • Have buffer spaces north (rather the service rooms, storage, workshop, garage ...) - But also double skins, etc. (Tixier;2017)

V. 4.2. Hot summer strategies

1- To be protected:

This is to protect the maximum solar inputs through the openings. By: • Horizontal sunshades in the South (calculated) - Balconies, - Roof passes - Horizontal leaf blades located outside • Vertical sunshades in the East and West (calculated) -Valets (pay attention to the positioning of the hinges for the simple shutters: in the south) -Stores vertical to the Outside-Mode natures of vertical facade-But also trees • Do not do zenithal opening.

2- to avoid:

This is to avoid the transfer of heat inwards by the materials: • By the insulation of the walls • By the insulation of the roofs • By the ventilation of spaces under roof • By the presence of plants, on vertical walls or green roofs (but also with a gap for the ventilation of trellises, double skins).

3- Minimize
4- Dispel:

This is to dispel the warm air entering the building during the day, or the warm air produced by the activities inside the building • By natural night ventilation (the air is cooler) only during the day) • The ideal is to have a cross ventilation (crossing all the building) • One can also have a vertical ventilation and benefit from a natural thermosiphon (combinable with the ventilation through) • The nocturnal ventilation allows refreshing interior materials with strong absorptive inertia, allowing them to store cool at night and "make it" during the day.

5- Refresh:

It is a mechanical or natural device to bring freshness in the building. Some simple possibilities: • Presence of water (air movement> evapotranspiration) - Basin, but also high porosity jar, wet tissue, wet straw, etc.) • Presence of vegetation (air movement> evapotranspiration) • Provencal well. (Tixier;2017)

V.4.3. Thermal comfort by the façade

In the winter the façade receives the solar gain by large windows and stores it by its material preserves it by insolation systems, in the summer the façade protects the building by its sunshades (horizontal in the south and vertical in the east and the west, avoids overheating by its insolation (double skins) and façade openings to dispel the hot air and refresh it.

Goal / purpose	Responsive function	Operation	Technologies (materials & systems)	Response time	Spatial scale	Visibility	Degree of adaptability
Thermal comfort	Prevent, Reject, Admit or Modulate (Store, Distribute) solar gains, and conductive, convective and long-wave radiant heat flux	Intrinsic	Shading	Seconds	Building material	No	On-off
		Extrinsic	Insulation	Minutes	Façade element	Low	Gradual
			Switchable glazing	Hours	Wall	High	
			PCM	Day-night	Fenestration		
				Seasons			

Figure 76 Matrix of descriptive characterization concepts for facade adaptivity (Design for façade adaptability – Towards a unified and systematic characterization-october2015)

V. APPLICATION OF THE BIODYNAMIC FAÇADE SYSTEM

V.1.FIRST MODEL WITH CLOSED PANELS

V.1.1. Summer season analysis Hottest day peak (Guelma) 21st July

The dynamic façade panels close to reduce solar exposure of the workspace as a result the inside temperature lower than if it's open.

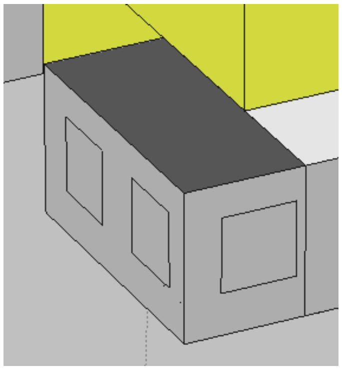


Figure 77 the facade when the panels are closed ECOTECT_V5.5

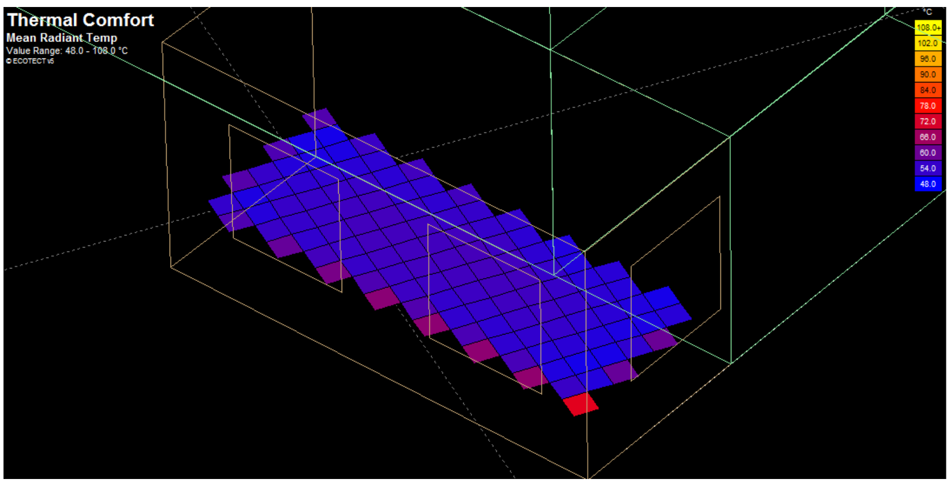


Figure 78 thermal comfort of the work space when the panels are closed ECOTECT_V5.5

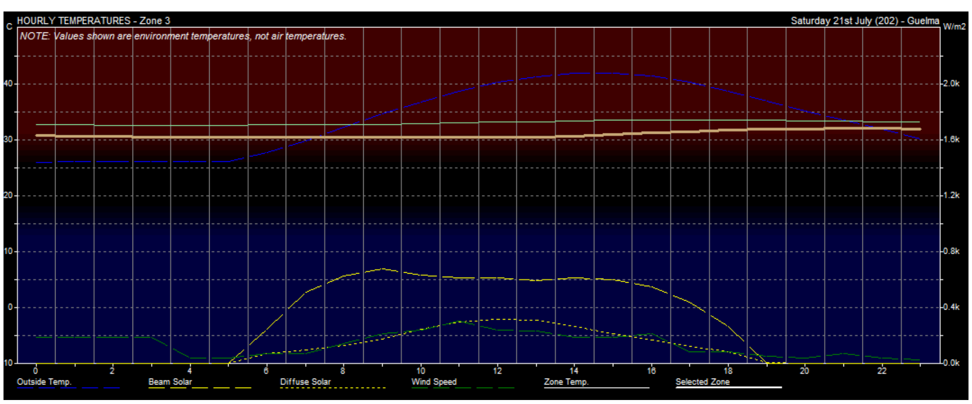


Figure 79 hourly temperature in the hottest day when the panels are closed ECOTECT_V5.5

Hourly temperatures - Saturday 21st July

Average Temperature: 29.7 C° (Ground 18.2 C°)

Table 11 hourly temperature in the hottest day in Guelma

Hours	00	01	02	03	04	05	06	07	08	09	10	11
Inside temp.(C°)	30.8	30.7	30.6	30.5	30.5	30.4	30.4	30.4	30.4	30.4	30.4	30.5
Outside temp.(C°)	25.9	26.1	26.1	26.1	26.1	26.1	27.7	29.8	32.2	34.7	36.8	38.7
Temp-diff.(C°)	4.9	4.6	4.5	4.4	4.4	4.3	2.7	0.6	-1.8	-4.3	-6.4	-8.2

Hours	12	13	14	15	16	17	18	19	20	21	22	23
Inside temp.(C°)	30.5	30.5	30.6	30.9	31.2	31.5	31.7	31.9	31.9	32.0	32.0	31.9
Outside temp.(C°)	40.2	41.2	41.8	41.9	41.4	40.3	38.7	36.9	35.2	33.5	31.9	30.2
Temp-diff.(C°)	-9.7	-10.7	-11.2	-11.0	-10.2	-8.8	-7.0	-5.0	-3.3	-1.5	0.1	1.7

V.1.2. Winter season analysis

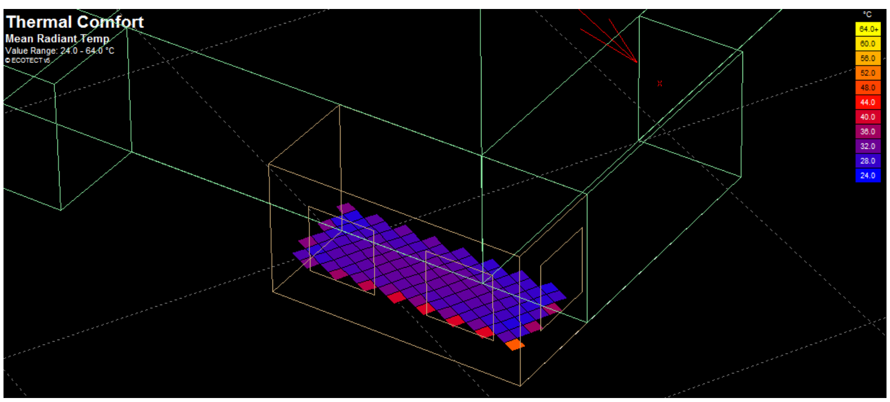


Figure 80 thermal comfort of the workspace with closed panels in the winter ECOTECT_V5.5

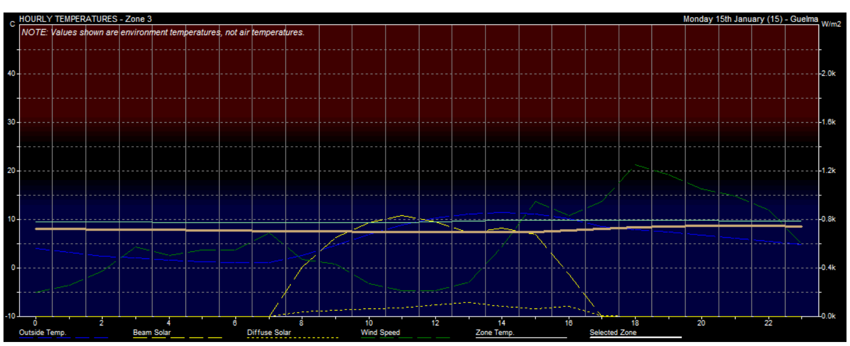


Figure 81 hourly temperature in the coldest day

Hourly temperatures - Monday 15th January

Average Temperature: 6.5 C° (Ground 18.2 C°)

Table 12 hourly temperature in the coldest day in Guelma

Hours	00	01	02	03	04	05	06	07	08	09	10	11
Inside temp.(C°)	8.1	8.1	8.0	7.9	7.9	7.8	7.7	7.6	7.6	7.6	7.5	7.5
Outside temp.(C°)	4.0	3.3	2.5	2.1	1.7	1.4	1.1	1.1	2.6	4.7	6.9	8.9
Temp-diff.(C°)	4.1	4.8	5.5	5.8	6.2	6.4	6.6	6.5	5.0	2.9	0.6	-1.4

Hours	12	13	14	15	16	17	18	19	20	21	22	23
Inside temp.(C°)	7.4	7.4	7.4	7.4	7.7	8.1	8.4	8.6	8.7	1.9	8.7	8.6
Outside temp.(C°)	10.3	11.1	11.4	11.2	10.2	8.6	8.0	7.4	6.8	6.1	5.5	4.9
Temp-diff.(C°)	-2.9	-3.7	-4.0	-3.8	-2.5	-0.5	0.4	1.2	1.9	2.6	3.2	3.7

V.2.SECOND MODEL WITH OPENED PANELS

V.2.1. Summer season analysis

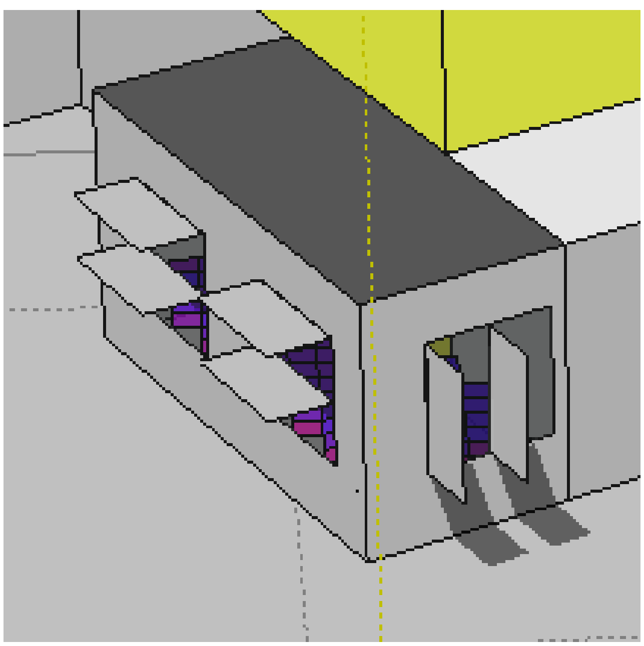


Figure 82 the facade with opened panels ECOTECT_V5.5

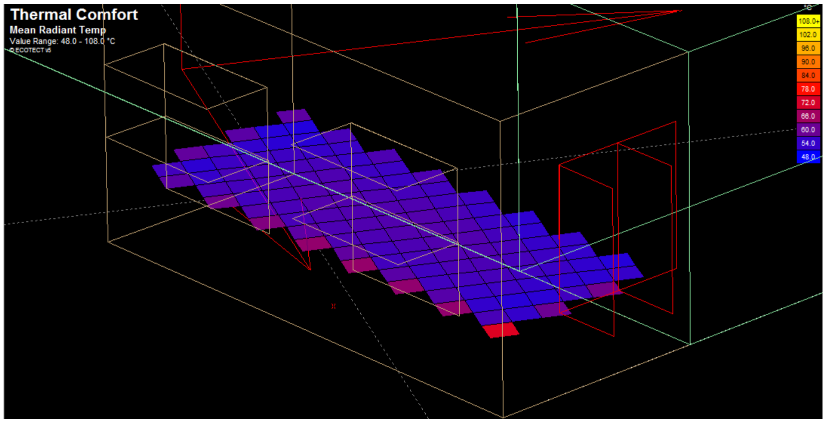


Figure 83 thermal comfort in the summer ECOTECT_V5.5

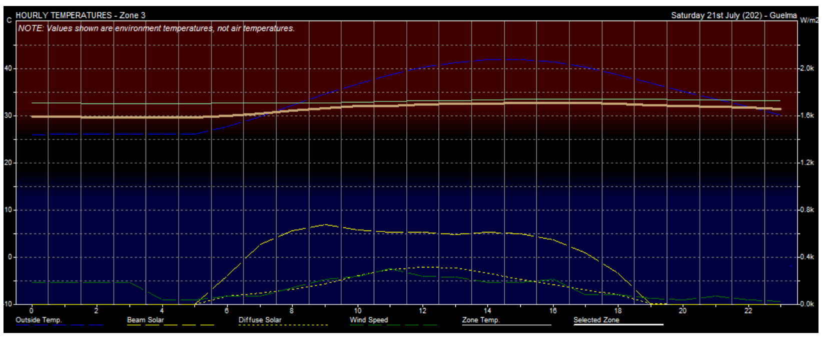


Figure 84 hourly temperature in the hottest day in Guelma ECOTECT_V5.5

Hourly temperatures - Saturday 21st July

Average Temperature: 29.7 C° (Ground 18.2 C°)

Table 13 hourly temperature in the hottest day

Hours	00	01	02	03	04	05	06	07	08	09	10	11
Inside temp.(C°)	29.8	29.8	29.7	29.7	29.6	29.6	29.9	30.5	31.2	31.6	32.0	32.1
Outside temp.(C°)	25.9	26.1	26.1	26.1	26.1	26.1	27.7	29.8	32.2	34.7	36.8	38.7
Temp-diff.(C°)	3.9	3.7	3.6	3.6	3.5	3.5	2.2	0.7	-1.0	-3.1	-4.8	-6.6

Hours	12	13	14	15	16	17	18	19	20	21	22	23
Inside temp.(C°)	32.4	32.5	32.6	32.7	32.7	32.7	32.5	32.3	32.1	31.9	31.7	31.4
Outside temp.(C°)	40.2	41.2	41.8	41.9	41.4	40.3	38.7	36.9	35.2	33.5	31.9	30.2
Temp-diff.(C°)	-7.8	-8.7	-9.2	-9.2	-8.7	-7.6	-6.2	-4.6	-3.1	-1.6	-0.2	1.2

V.2.2. Winter season analysis

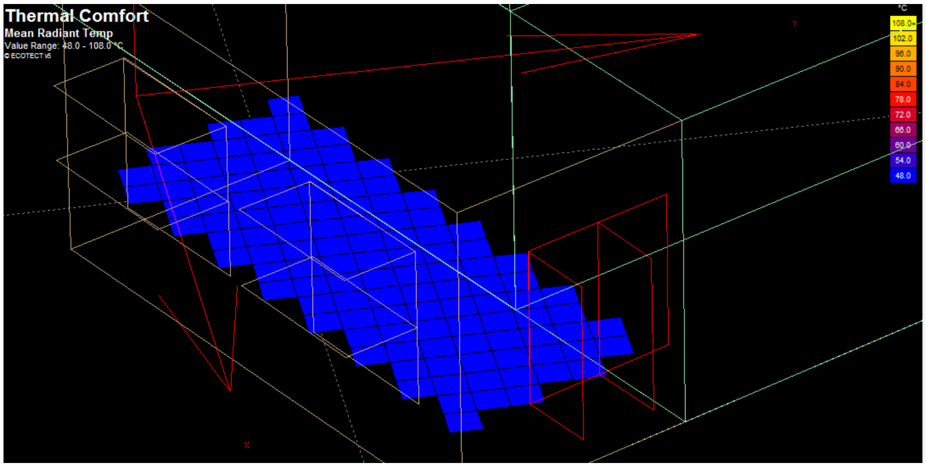


Figure 85 thermal comfort in the winter ECOTECT_V5.5

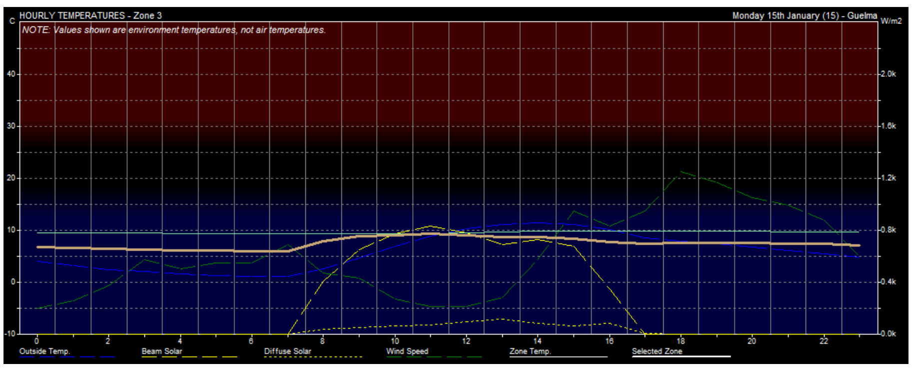


Figure 86 hourly temperature in the coldest day in Guelma ECOTECT_V5.5

Hourly temperatures - Monday 15th January

Average Temperature: 6.5 C° (Ground 18.2 C°)

Table 15 hourly temperature in the coldest day

Hours	00	01	02	03	04	05	06	07	08	09	10	11
Inside temp.(C°)	6.8	6.6	6.4	6.3	6.2	6.1	6.0	6.0	7.9	8.9	9.0	9.4
Outside temp.(C°)	4.0	3.3	2.5	2.1	1.7	1.4	1.1	1.1	2.6	4.7	6.9	8.9
Tempdiff.(C°)	2.8	3.3	3.9	4.2	4.5	4.7	4.9	4.9	5.3	4.2	2.1	0.5

Hours	12	13	14	15	16	17	18	19	20	21	22	23
Inside temp.(C°)	9.0	8.8	8.8	8.3	7.8	7.4	7.5	7.6	7.6	7.5	7.4	7.2

Outside temp.(C°)	10.3	11.1	11.4	11.2	10.2	8.6	8.0	7.4	6.8	6.1	5.5	4.9
Temp-diff.(C°)	-1.3	-2.3	-2.6	-2.9	-2.4	-1.2	-0.5	0.2	0.8	1.4	1.9	2.3

V.3. THIRD MODEL WITH HALF OPENED PANELS

V.3.1. Summer season analysis

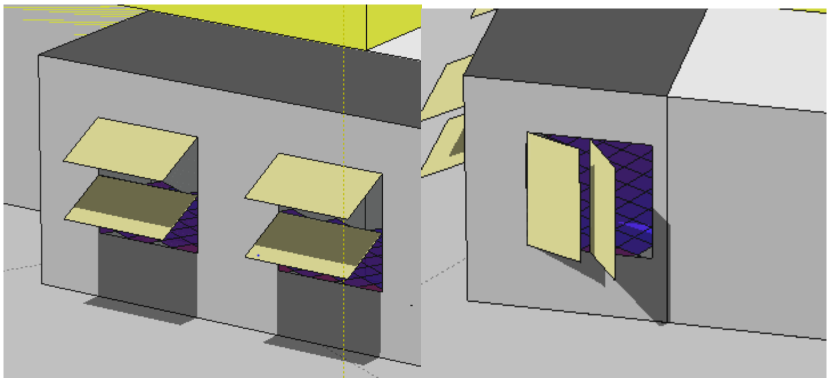


Figure 87 the facade with half opened panels ECOTECT_V5.5

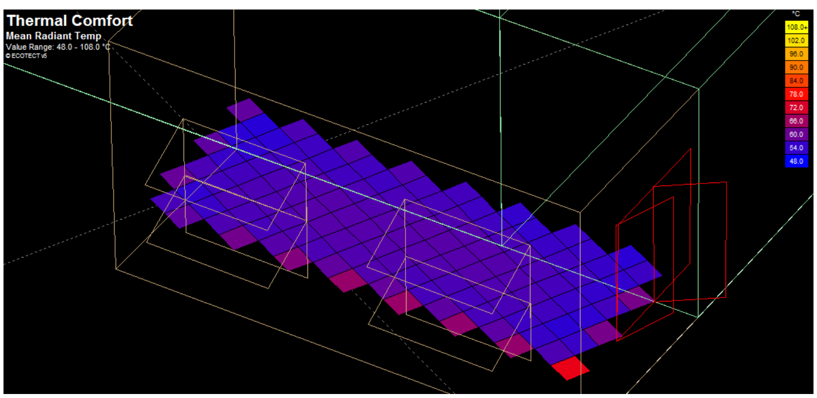


Figure 88 thermal comfort in the summer ECOTECT_V5.5

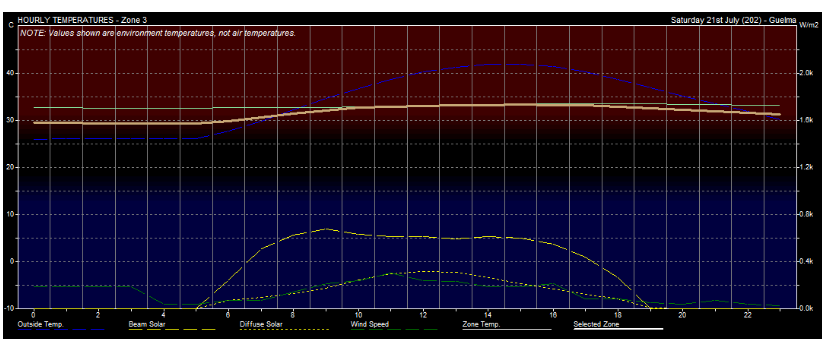


Figure 89 hourly temperature in the hottest day in Guelma ECOTECT_V5.5

Hourly temperatures - Saturday 21st July

Average Temperature: 29.7 C° (Ground 18.2 C°)

Table 14 hourly temperature in the hottest day in Guelma

Hours	00	01	02	03	04	05	06	07	08	09	10	11
Inside temp.(C°)	29.5	29.5	29.4	29.4	29.3	29.3	29.7	30.6	31.5	32.1	32.6	32.9
Outside temp.(C°)	25.9	26.1	26.1	26.1	26.1	26.1	27.7	29.8	32.2	34.7	36.8	38.7
Temp-diff.(C°)	3.6	26.1	3.3	3.3	26.1	3.2	2.0	0.8	-0.7	-2.6	-4.2	-5.8

Hours	12	13	14	15	16	17	18	19	20	21	22	23
Inside temp.(C°)	33.1	33.2	33.2	33.3	33.3	33.1	32.9	32.5	-4.4	31.9	31.6	31.2
Outside temp.(C°)	40.2	41.2	41.8	41.9	41.4	40.3	38.7	36.9	35.2	33.5	31.9	30.2
Temp-diff.(C°)	-7.1	-8.0	-8.6	-8.6	-8.1	-7.2	-5.8	-4.4	-3.0	-1.6	-0.3	1.0

V.3.2. Winter season analysis

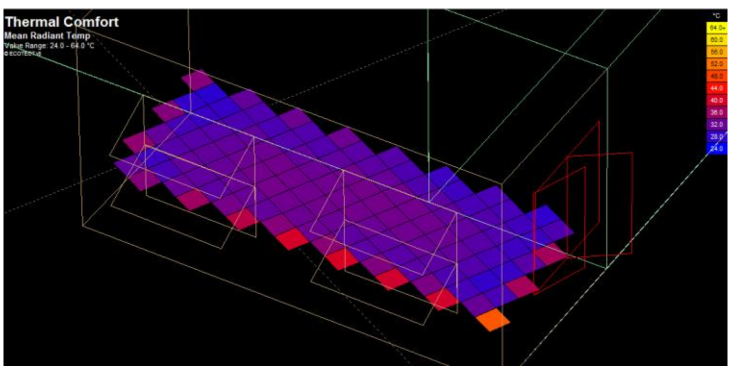


Figure 90 thermal comfort in the winter ECOTECT_V5.5

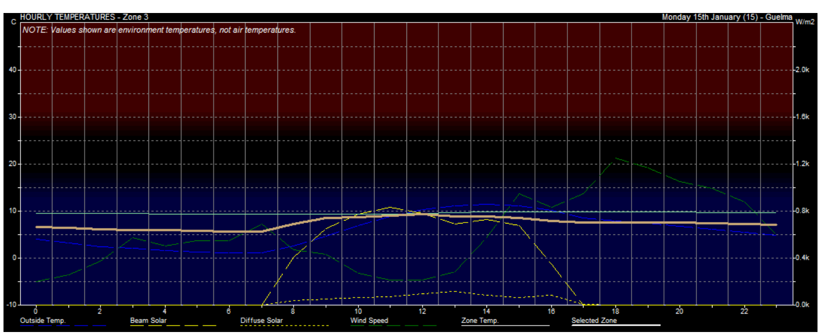


Figure 91 hourly temperature in the coldest day in Guelma ECOTECT_V5.5

Hourly temperatures - Monday 15th January

Average Temperature: 6.5 C

Table 15 hourly temperature in the coldest day in Guelma

Hours	00	01	02	03	04	05	06	07	08	09	10	11
Inside temp.(C°)	6.6	6.4	6.2	6.1	5.9	5.8	5.7	5.7	7.3	8.6	8.7	9.1
Outside temp.(C°)	4.0	3.3	2.5	2.1	1.7	1.4	1.1	1.1	2.6	4.7	6.9	8.9
Temp-diff.(C°)	2.6	3.3	3.7	4.0	4.2	4.4	4.6	4.6	4.7	3.9	1.8	0.2

Hours	12	13	14	15	16	17	18	19	20	21	22	23
Inside temp.(C°)	9.3	8.9	8.9	8.5	7.9	7.5	7.6	7.6	7.5	7.4	7.3	7.1
Outside temp.(C°)	10.3	11.1	11.4	11.2	10.2	8.6	8.0	7.4	6.8	6.1	5.5	4.9
Temp-diff.(C°)	-1.0	-2.2	-2.5	-2.7	-2.3	8.6	-0.4	0.2	0.7	1.3	1.8	2.2

VI. SYNTHESIS

The façade panels open and close according to the climatic conditions they open to let the day light enter to the workspace and close to protect the interior space from being overheated; they work as sun blockers (the first model; the temperature is reduced with 12.2C°in the summer season)

But in the winter the interior space still warmer than the outside with +5.4C° (the double skin works as a buffer space isolating the interior space from the cold outside).

So this façade gathers up the two typical solutions for thermal comfort in climatic conditions of Guelma and fundamental workspace conditions (daylight and acceptable temperature).

CONCLUSION

The ecological architectural project is born from its environment like a tree born from the earth which received its seed, this is why this chapter is done: the climatic and environmental study of the project context that affected the choice of the strategies of design where the biodynamic facade is essential to have the thermal comfort in the workspaces because it plays dual role as a sun blocker; as in the first model; the temperature is reduced with 12.2C°in the summer season ensuring in the same time the entrance of day light, and as a buffer space; the double skin isolates the interior space from the cold outside as a result the interior space still warmer than the outside with +5.4C° in the winter season.

In an innovative and ecological way the biodynamic façade system had reduced energy consumption for heating, coolling or artificial lighting in workspace.

INTRODUCTION

In the words of office design consultant and author Francis Duffy, "*The office building is one of the great icons of the twentieth century…they have come to symbolize much of what this century has been about.*"(Duffy,1997)

In Guelma we don't have this type of buildings in their formal way, for example the liberal officials; doctors, architects, companies and lawyers rent apartments or even garage to do their work meanwhile they deserve more comfortable locals also they are scattered all over the city as a result it takes more time, energy and effort to access to them this is why I chose this project to gather them up in one building, optimize space consumption and to get a functional mix.

I. OFFICE BUILDING ATTRIBUTES

An office building must have flexible and technologically-advanced working environments that are safe, healthy, comfortable, durable, aesthetically-pleasing, and accessible. It must be able to accommodate the specific space and equipment needs of the tenant. Special attention should be made to the selection of interior finishes and art installations, particularly in entry spaces, conference rooms and other areas with public access. (Conway;2017)

I.1. TYPES OF SPACES

An office building incorporates a number of space types to meet the needs of staff and visitors. These may include:

-Offices

- •Offices: May be private or semi-private acoustically and/or visually.
- •Conference Rooms

-Employee/visitor support spaces

- •Convenience Store, Kiosk, or Vending Machines
- •Lobby: Central location for building directory, schedules, and general information
- •Atria or Common Space: Informal, multi-purpose recreation and social gathering space
- •Cafeteria or Dining Hall
- •Private Toilets or Restrooms
- •Child Care Centers
- •Physical Fitness Area
- •Interior or Surface Parking Areas

-Administrative support spaces

•Administrative Offices: May be private or semi-private acoustically and/or visually.

Operation and maintenance spaces

•General Storage: For items such as stationery, equipment, and instructional materials.

•Food Preparation Area or Kitchen

•Computer/Information Technology (IT) Closets. See WBDG Automated Data Processing: PC System related information.

•Maintenance Closets

I.2. IMPORTANT DESIGN CONSIDERATIONS

I.3. COST-EFFECTIVE

The high-performance office should be evaluated using life-cycle economic and material evaluation models. In some cases, owners need to appreciate that optimizing building performance will require a willingness to invest more initially to save on long-term operations and maintenance.

I.4. FUNCTIONAL/OPERATIONAL

Tenant Requirements-The building design must consider the integrated requirements of the intended tenants. This includes their desired image, degree of public access, operating hours, growth demands, security issues and vulnerability assessment results, organization and group sizes, growth potential, long-term consistency of need, group assembly requirements, electronic equipment and technology requirements, acoustical requirements, special floor loading and filing/storage requirements, special utility services, any material handling or operational process flows, special health hazards, use of vehicles and types of vehicles used, and economic objectives.

I.5. FLEXIBILITY

The high-performance office must easily and economically accommodate frequent renovation and alteration, sometimes referred to as "churn." These modifications may be due to management reorganization, personnel shift, changes in business models, or the advent of technological innovation, but the office infrastructure, interior systems, and furnishings must be up to the challenge.

•Consider raised floors to allow for easy access to cabling and power distribution, as well as advanced air distribution capabilities to address individual occupant comfort.

•Incorporate features such as plug-and-play floor boxes for power, data, voice and fiber, modular and harnessed wiring and buses, and conferencing hubs to allow for daily flexibility at work as well as future reorganization of office workstations.

I.6. URBAN PLANNING

The concentration of a large number of workers within one building can have a significant impact on neighborhoods. Office structures can vitalize neighborhoods with the retail, food service, and interrelated business links the office brings to the neighborhood. Consideration of transportation issues must also be given when developing office structures. Office buildings are often impacted by urban planning and municipal zoning, which attempt to promote compatible land use and vibrant neighborhoods.

I.7. PRODUCTIVE

Worker Satisfaction, Health, and Comfort—In office environments, by far the single greatest cost to employers is the salaries of the employees occupying the space. It generally exceeds the lease and energy costs of a facility by a factor of ten on a square foot basis. For this reason, the health, safety, and comfort of employees in a high-performance office are of paramount concern.

- Utilize strategies such as increased natural ventilation rates, the specification of non-toxic and low-polluting materials and systems, and indoor air quality monitoring.
- Provide individualized climate control that permits users to set their own, localized temperature, ventilation rate, and air movement preferences.
- While difficult to quantify, it is widely accepted that worker satisfaction and performance is increased when office workers are provided stimulating, dynamic working environments. Access to windows and view, opportunities for interaction, and control of one's immediate environment are some of the factors that contribute to improved workplace satisfaction. See also the Psychosocial Value of Space.
- Natural light is important to the health and psychological well-being of office workers. The design of office environments must place emphasis on providing each occupant with access to natural light and views to the outside. A minimum of 30 foot candles per square foot of diffused indirect natural light is desirable.
- The acoustical environment of the office must be designed and integrated with the other architectural systems and furnishings of the office. Special consideration must be given to noise control in open office settings, with absorptive finish materials, masking white noise, and sufficient separation of individual occupants.

I.8. SUSTAINABLE

Energy Efficiency-Depending on the office's size, local climate, use profile, and utility rates, strategies for minimizing energy consumption involve:

- reducing the load (by integrating the building with the site, optimizing the building envelope [decreasing infiltration, increasing insulation], etc.);
- correctly sizing the heating, ventilating, and air-conditioning systems.
- installing high-efficiency equipment, lighting, and appliances.

Consideration should be given to the application of renewable energy systems such as building-integrated photovoltaic systems that generate building electricity, solar thermal systems that produce hot water for domestic hot water (DHW) or space conditioning, or geothermal heat pump systems that draw on the thermal capacitance of the earth.

Additional consideration should be given to the applications of other distributed energy sources, including micro turbines, fuel cells, etc… that provide reliability (emergency and mission critical power) and grid-independence, and reduce reliance on fossil fuel grid power.

I.9.WHAT TEMPERATURE SHOULD AN OFFICE BE?

Recommendations provided by CSA Z412-17 Office Ergonomics – An application standard for workplace ergonomics include:

- Summer conditions: optimum temperature of 24.5°C with an acceptable range of 23-26°C
- Winter conditions: optimum temperature of 22°C with an acceptable range of 20-23.5°C (Woodward;2013)

I.10. WHAT HUMIDITY LEVEL SHOULD AN OFFICE BE?

Relative humidity levels below 20% can cause discomfort through drying of the eyes and mucous membranes and skin. Low relative humidity levels may also cause static electricity build-up and negatively affect the operations of some office equipment such as printers and computers. Relative humidity levels above 70% may lead to the development of condensation on surfaces and within the interior of equipment and building structures. Left alone, these areas may develop mold and fungi. Higher humidity also makes the area feel stuffy.

The Health and Safety Executive (UK) states that a relative humidity between 40% and 70% does not have a major impact on thermal comfort. (Woodward;2013)

II. SOME DESIGN TRENDS TO CREATE A PRODUCTIVE WORKSPACE

-Office rooms and open workspace

Employees hated to be isolated in their office rooms they are happier when they work together in an opened space especially for less experienced members.

For some jobs; employee need privacy and calm (example: lawyers) so it’s not a good idea to put them in open workspace.

-Cubicles

Three walled design that could be reshaped offering flexibility autonomy and independence.

-Hexagonal space

A hexagonal room levels the playing field. As an added benefit, you'll be able to see everyone instead of only those sitting across from you. And materials placed on the walls will be more visible to everyone.

-Psychology of colors

Colors and textures have a big impact on visual comfort and productivity; using the green makes people more creative with broader thinking (fits offices, and desks).

Red boosts energy, speeds up reaction and stimulate appetite (fits kitchen and dining rooms).

Blue increases productivity for its calm affectation.

Pink has a calming effect (fits boardroom and meeting room where conversations may get heated).

White refers to modernity with a clean sleek look fits all spaces but it should be combined with other colors or textures like wood to break up monocracy to avoid reflecting people's own thoughts.

-Letting employees have their fun at home

The idea is to unwind, get away from the stresses of the job long enough that the brain resets, and when the batteries are fully recharged, the employee emerges ready to tackle even the toughest projects with renewed energy. (Pochepan;2018)

The most recent trends in office design is to incorporate meditation, sports, fun and greenery.

But the most effective one is to create an electronic-free lounge with a library; books help regenerating ideas and reset minds.

III. EXAMPLE ANALYSIS

III.1.THE BLOOMBERG NEW OFFICE OF LONDON

III.1.1. Identification of the work: presentation of the project and motivation of choice

In December 2010, Bloomberg embarked on the construction of a new building in the heart of the City of London that would meet the needs of the growing employee population and represent the company's culture, values and ambitions, from the ground up.

Conceived by founder Mike Bloomberg in collaboration with leading architect Lord Norman Foster of Foster + Partners, the new building's design is sympathetic to its surrounding context, an exemplar of sustainable design and uniquely of its place and time, a natural extension of the City that will endure and improve the surrounding public realm. (Bloomberg;2018)

I choose this building to be my guide office building because It is a true exemplar of sustainable development, with a BREEAM Outstanding rating – the highest design stage score ever achieved by any major office development.

III.1.2. Situation and analysis of the immediate environment

Located between the Bank of England and St Paul’s Cathedral,

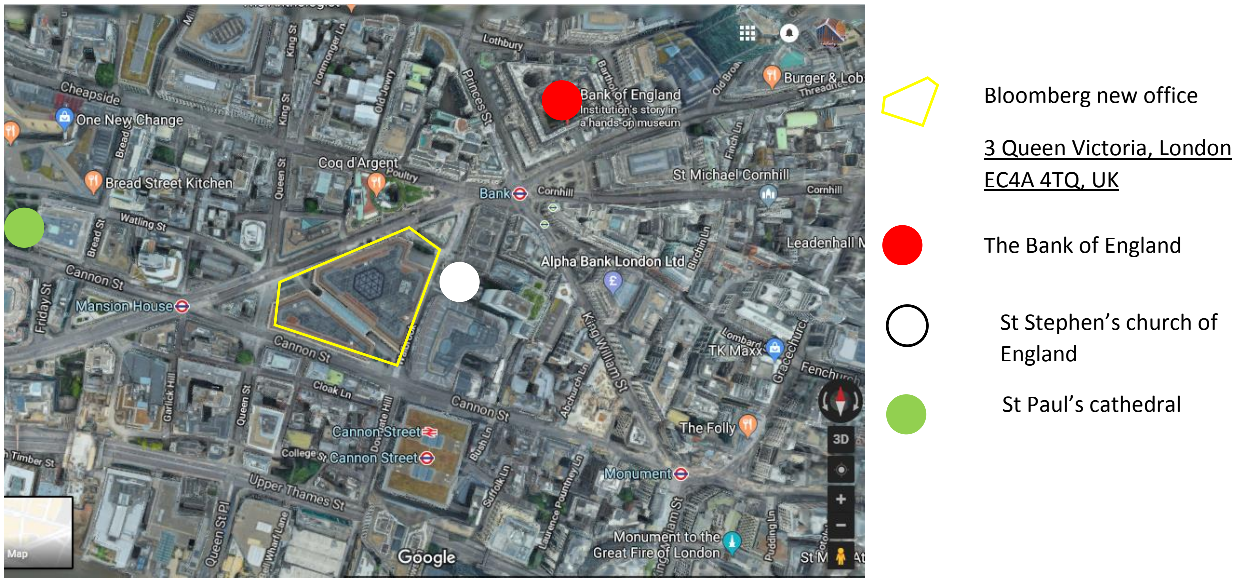


Figure 92 situation of the building, (google earth 2018)

The new site occupies 3.2 acres and will provide approximately 1.1 million square feet of sustainable office space, three new public spaces – two featuring a specially commissioned artwork – a retail area, Bloomberg Arcade that will reinstate an ancient Roman travel route, and an anticipated cultural hub that will restore the Temple of Mithras to its original site. (Foster&Partners;2018)

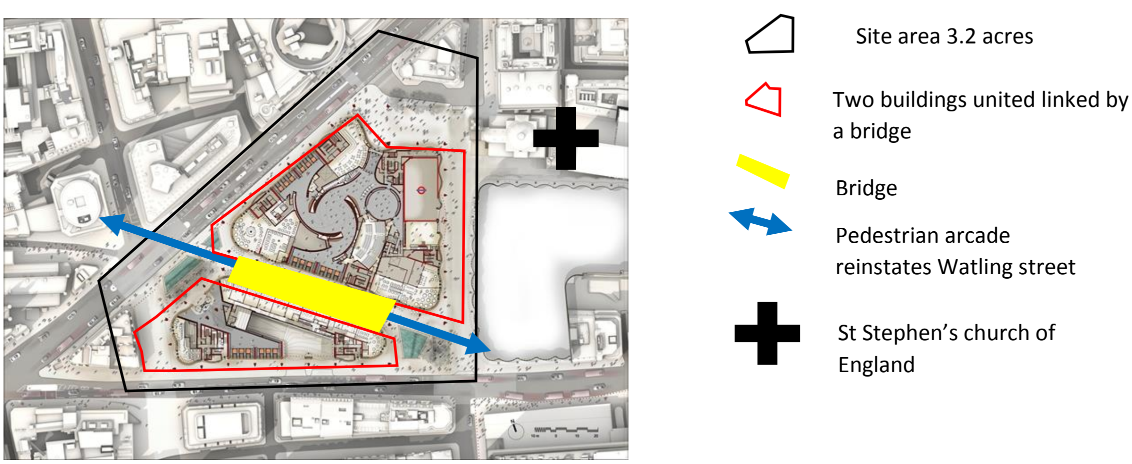


Figure 93 site plan (https://www.architecture.com)

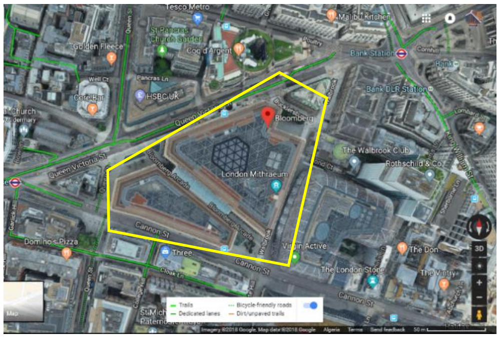


Figure 94 ancient site – (google earth 2018)

Ancient site

Figure 95 Bucklers bury house stood on the Bloomberg site before its demolition 2010

-Accessibility to the site

The site is accessible from north by "Queen Victoria street" and from the south by "Cannon street", the inside is totally pedestrian except for a bicycle-friendly road at the West side.

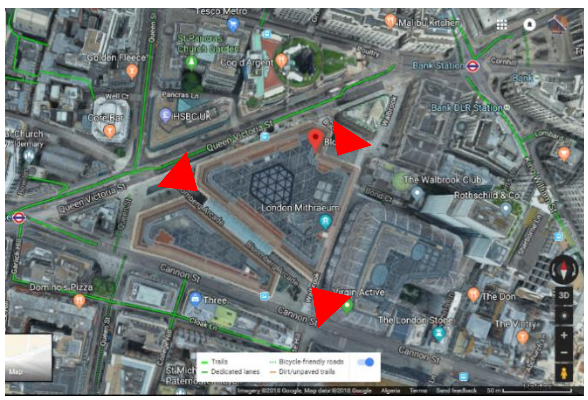


Figure 96 accessibility to the site, (google earth 2018)

-Climatology

Southern England is the part of the UK closest to continental Europe and as such can be subject to continental weather influences that bring cold spells in winter and hot, humid weather in summer.

Figure 97 representative drawing of climatic zones in England (https://www.lordgrey.org.uk)

It is also furthest from the paths of most Atlantic depressions, with their associated cloud, wind and rain, so the climate is relatively quiescent. (Lordgrey;2018)

-Topography

The hills in the City of London, from west to east, Ludgate Hill, Corn Hill and Tower Hill, are presumed to have influenced the precise siting of the early city, but they are very minor, and most of central London is almost flat. These hills are developed in various gravel terrace deposits of the river hames.

III.1.3. Components of the ground plan

Bloomberg Arcade is now a key route for people moving around the City, with restaurants and cafes at ground level, three public plazas, located at each end of the arcade and in front of the building's entrance, provide new civic spaces in the heart of the Square Mile. (Bloomberg;2018)

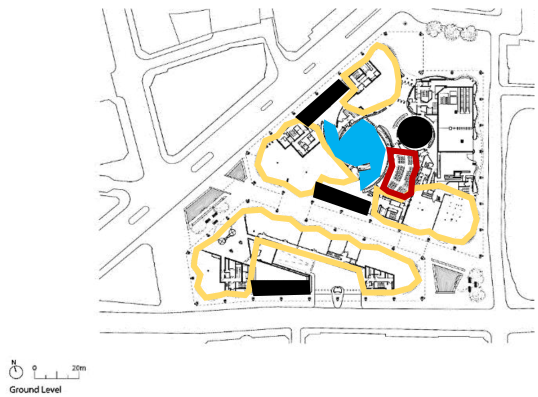
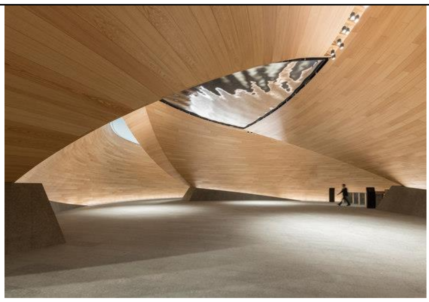


Figure 98 ground level plan (www.detail-online.com)

Table 19 components of the ground level (source; author)

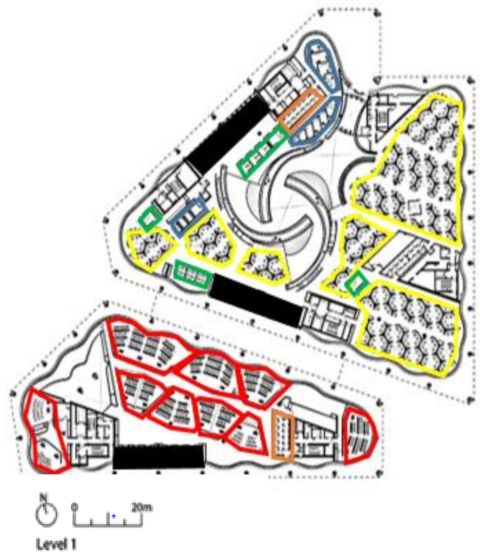
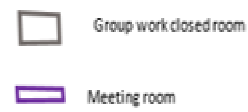
Component	Photo	About
Water sculptures		Cristina Iglesias' water sculpture in three parts, 'Forgotten Streams' – an homage to the ancient Walbrook River that once flowed through the site

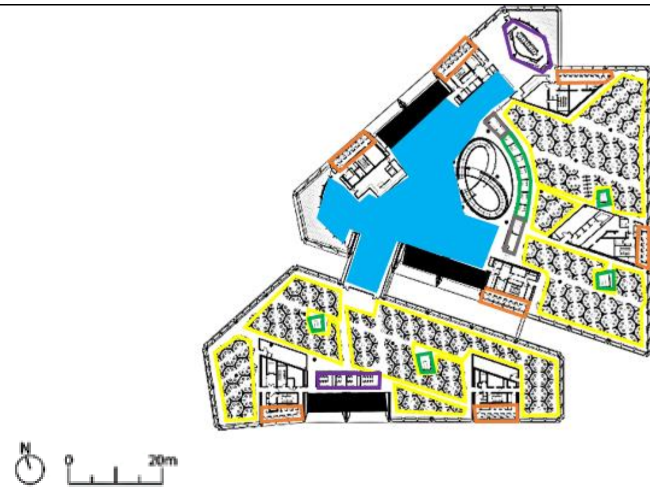
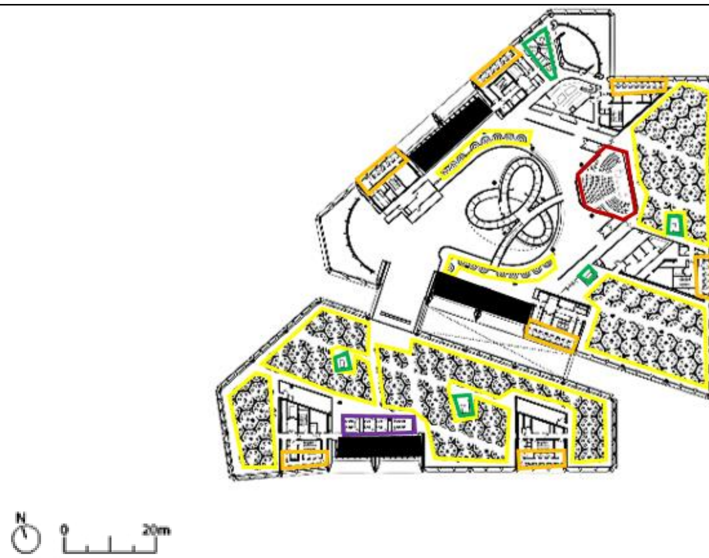
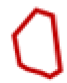
the Roman Temple of Mithras		Reconstructed Roman Temple of Mithras with a new interpretation center and cultural hub designed to give visitors an immersive experience of the temple and bring the history of the site to life.
The main entrance		defined by a substantial porte-cochère, where the building forms two sides of a new formal city square
the reception lobby		the Vortex – a dramatic double-height space created by three inclined, curving timber shells, whose unique form echoes the dynamism and energy of Bloomberg. These shells twist to form an oculus at their apex, which contains an artwork titled 'No Future Is Possible Without a Past' by Olafur Eliasson
hypotrochoïd stepped ramp		Clad in bronze, the ramp is designed and proportioned as a place of meeting and connection, allowing people to hold brief impromptu conversations with colleagues, whilst not impeding the flow of people.
Restaurants and cafes		restaurants and cafes at ground level

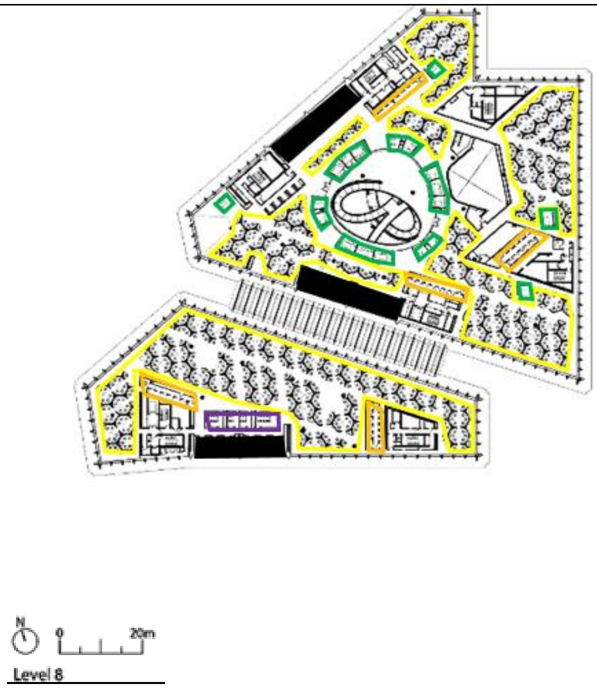
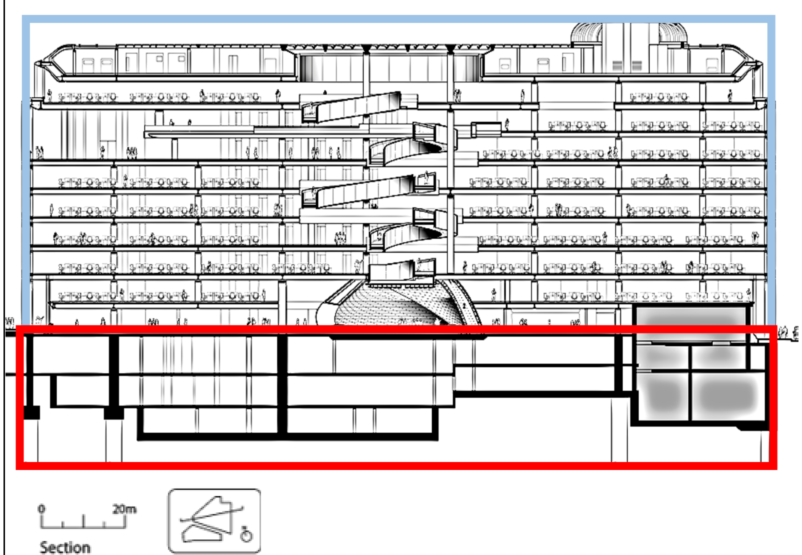
-Components of deferent levels

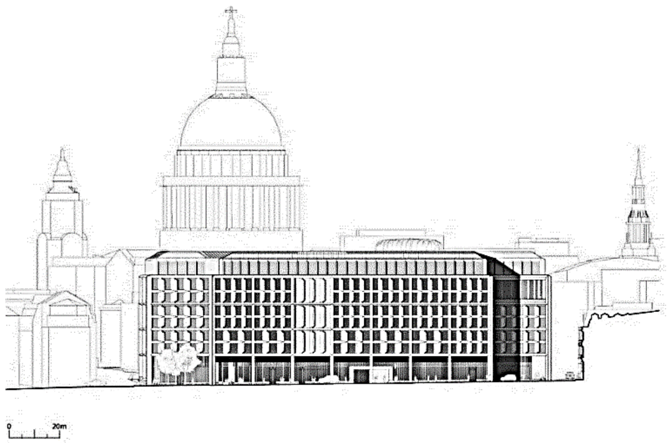
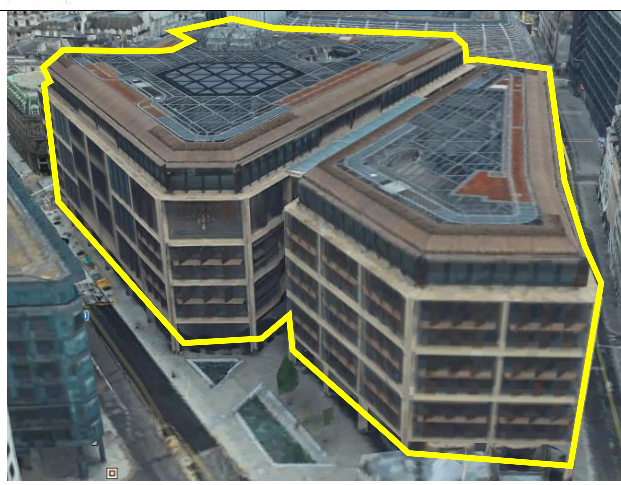
Table 16 components of different levels (source; author)

Levels	Illustrations	Key

1	N 0 20m Level 1	Open work space Closed work space Cubicles Media W.C Elevators
2	N 0 20m Level 2	Group work closed room Meeting room
3	N 0 20m Level 3	

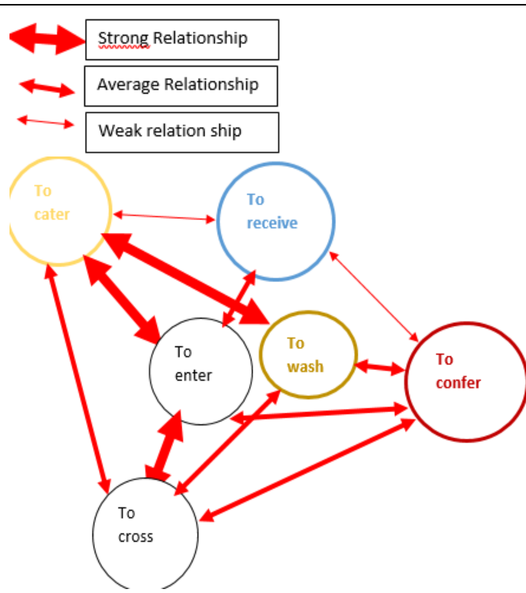
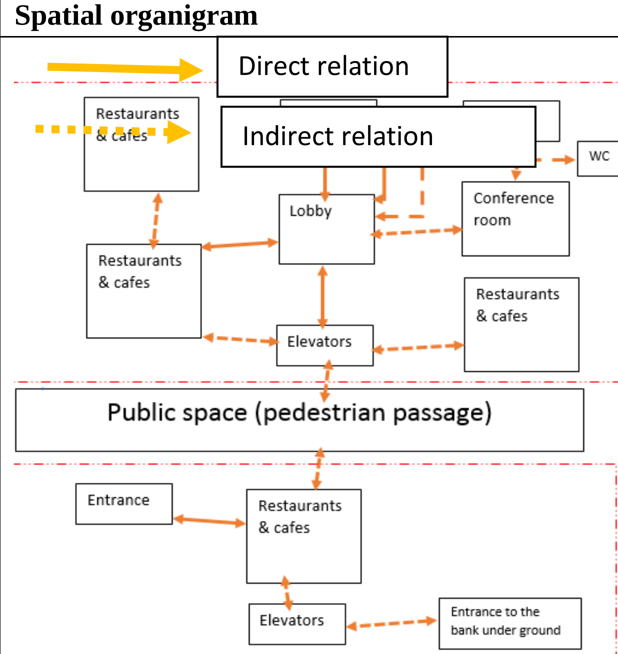
6	 Level 6	 Leisure area
7	 Level 7	 Conference room

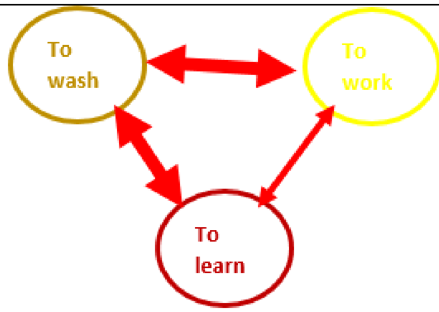
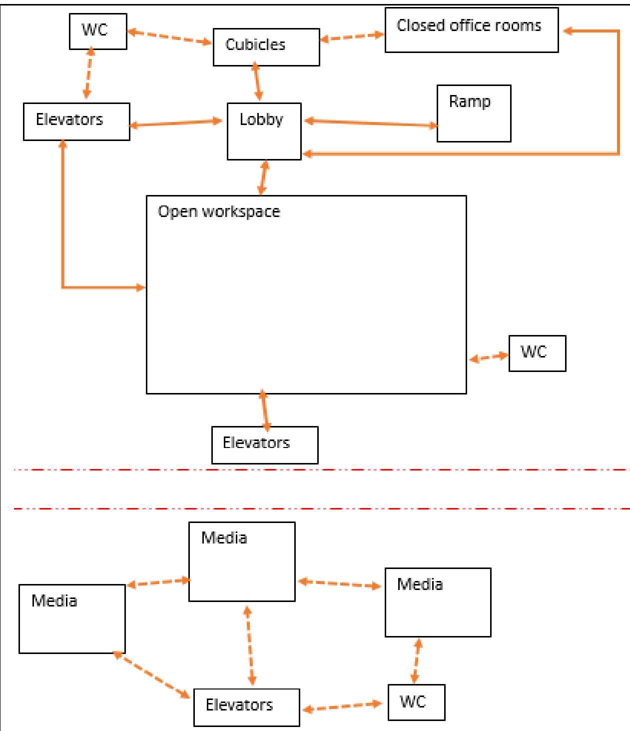
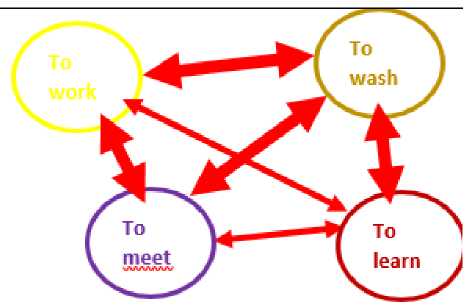
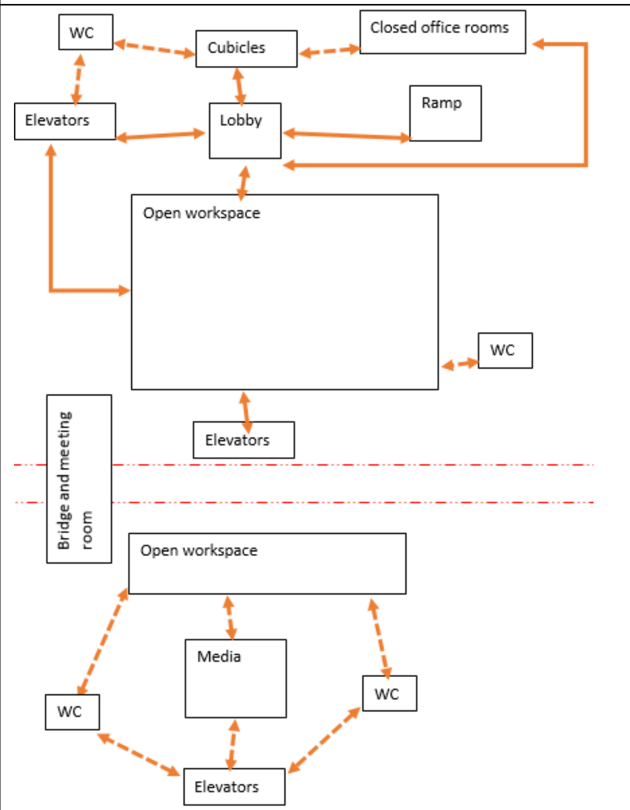
8		
Section		the banck underground station the bloomberg office The building height protects key views of St Paul's Cathedral whilst respecting neighboring historic buildings. the Bloomberg office consists in 8 storeys linked by a herochoide bronze ramp.

Elevation		The fins give the building a visual hierarchy and rhythm as they vary in scale, pitch and density across each façade according to orientation and solar exposure.
Volume		The building is a very simple two trapezoidal volumes linked by a parallelepiped volume.

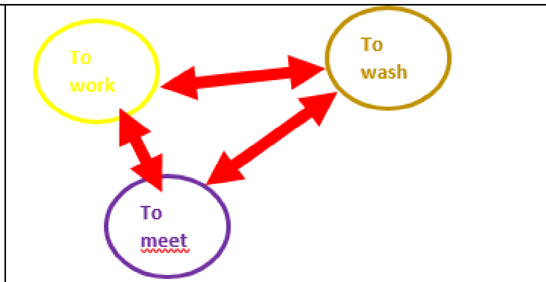
-functional and special organization

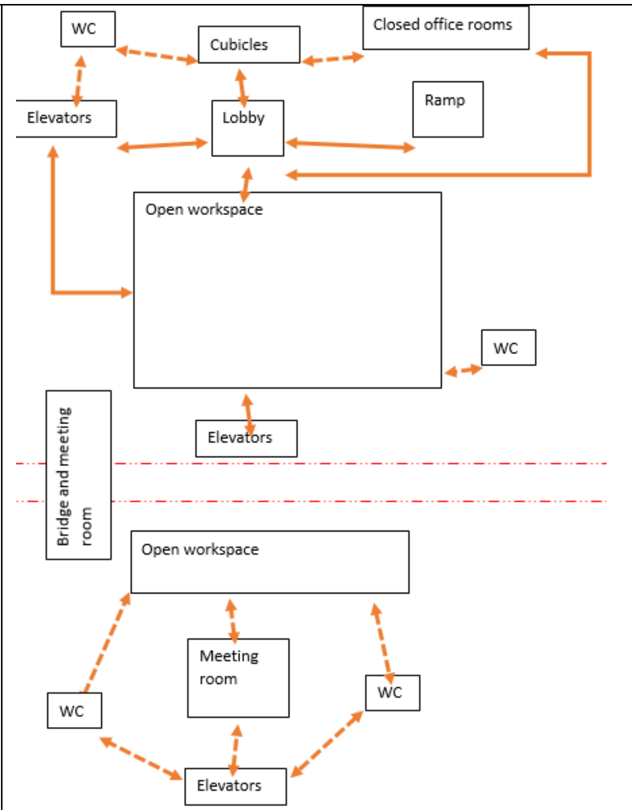
Table 21 organigrams of the Bloomberg building (source; author)

Level	Functional organigram	Spatial organigram
Ground level		

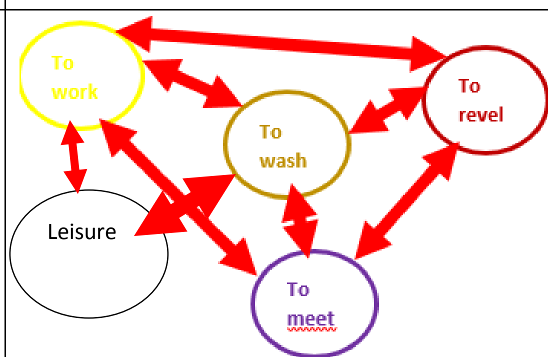
<table>
<tr>
<td>1st ,2nd ,4th ,5th floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd ,8th floor</td>
<td></td>
<td></td>
</tr>
</table>

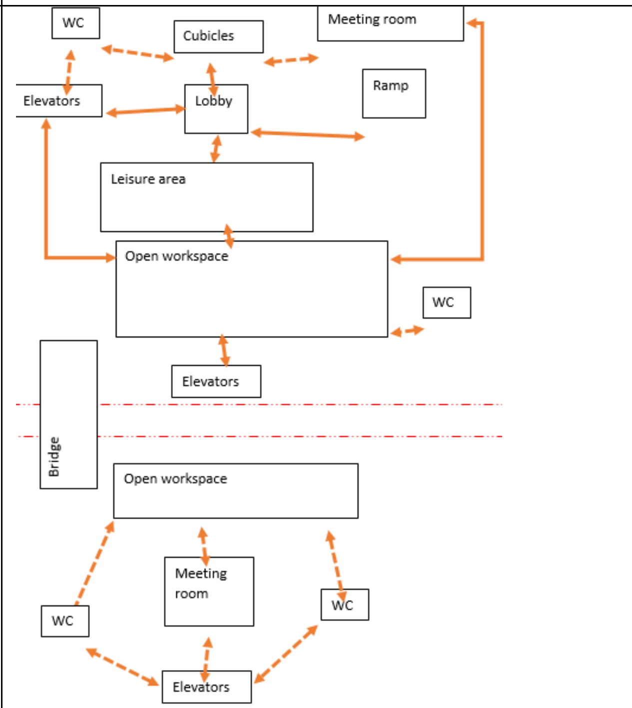
7th floor





6th floor

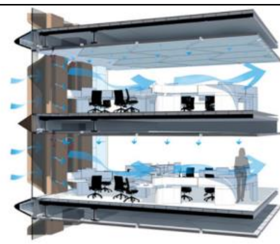




III.1.4. Techniques and systems

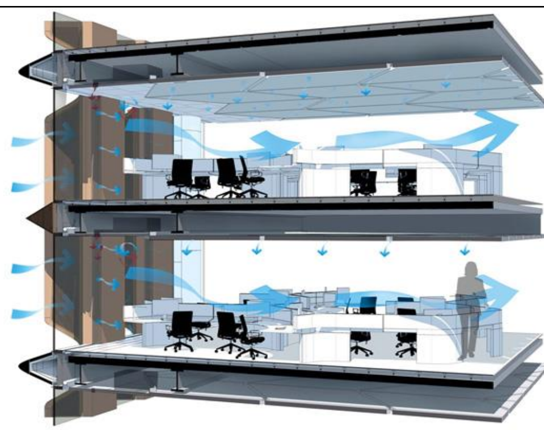
-Innovation Highlights

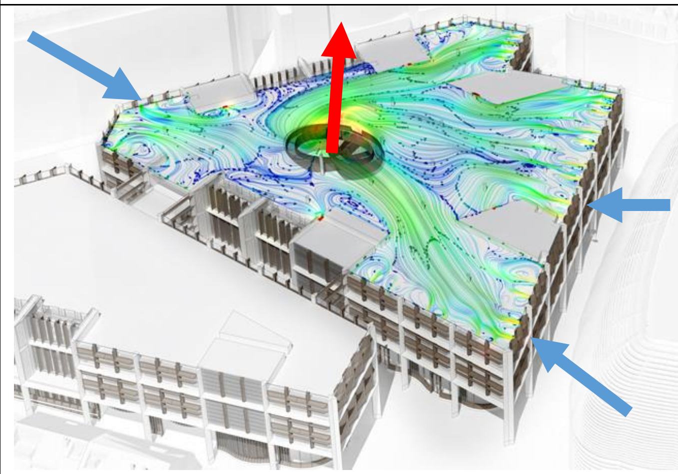
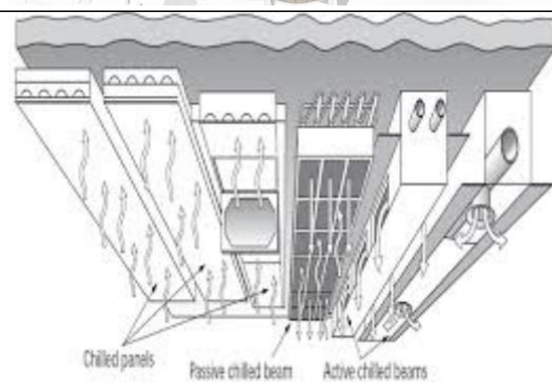
Table 22 innovations in the Bloomberg new office building (source; author)

Innovation high lights	**Illustration**
Integrated Ceiling Panels	
Water Conservation	
Breathing Building and smart air flows	

-Innovative façade

Table 23 the innovative facade of the Bloomberg (source; author)

Problem	**Solution**	**Illustration**
Temperate weather conditions multi-storey and deep plan building	get natural ventilation to work for large floor plates bronze blades can open and close, allowing the building to operate in a "breathable" natural ventilation mode. Reducing dependency on mechanical ventilation and cooling equipment. (Foster+Parteners;2018)	

the buoyancy-stack effect available on the higher floor is less than on floor two.	The openings on floor seven need to be open wider than on floor two.	
30-metre floor plate is the heat gain the air will experience as it moves across the floor. Natural ventilation might remove much of the heat from the space	you will need to ensure that cooling is available from the chilled ceiling to limit the heat gain. As the roof is the 5^{th} façade	
cannot know how the building will function on day one. It will take at least a year to hone and refine the control algorithms.	Natural ventilation for this building is most definitely a hybrid. We exploit the benefits of natural ventilation when possible, but have the option of sealing the building and running it under a fully mechanical solution. (Foster+Parteners;2018)	

III.1.5. Pillars extracted from this building

1-site renovation & glamorizing the Mithras (the past)

2- sustainable design & creating centrality

3- using landmarks & respect neighboring

4- bee nest's like

5- flexibility & simplicity

6- using articulation (bridge like workspace)

7-no parking no vehicles

III.2. THE ENERGY COMMISSION DIAMOND BUILDING

III.2.1. Identification of the work: presentation of the project and motivation of choice

The dark green opacity on the cover represents a fresh and flourishing environment. It depicts the Diamond Building design concept that encapsulates the essence of eco-friendliness and energy efficiency. It is also a novelty color that portrays integrity and excellence in all aspects.

The outline of the Diamond Building symbolizes the Energy Commission's key position as the gate keeper for the energy sector in Malaysia and highly resilient in the enforcement of energy efficiency practices to ensure sustainability. (*DIAMOND BUILDING*;2012)

Figure 99 Energy Commission Diamond Building

(Https://www.st.gov.my/)

III.2.2. Situation and analysis of the immediate environment

The site is on Lot 2C15 Precinct 2, Putrajaya. Precinct 2, is the Commercial and Business District of Core Island, Putrajaya. The plot area is 4,928.11sq.m

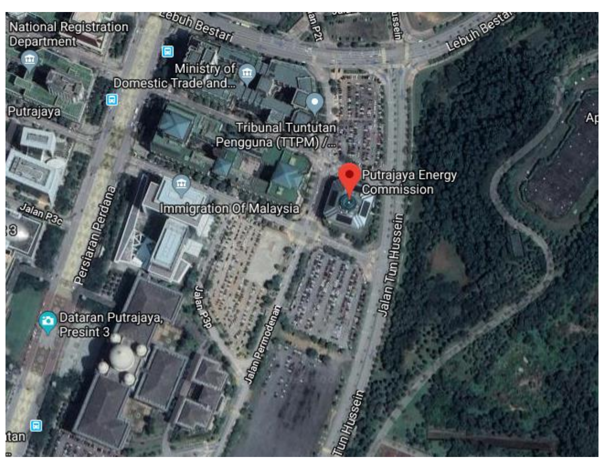


Figure 100 Situation of the EC.Building PURTAJAYA (googlemaps.com-2018)

-Accessibility

The site is accessible from three main roads surrounding the building.

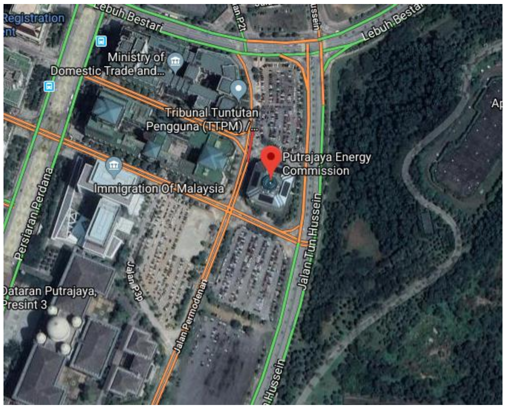


Figure 101 the road frame arround the ECB(googlemaps.com-2018)

-Climatology

The climate here is tropical. The is a great deal of rainfall in Putrajaya, even in the driest month. According to Köppen and Geiger. In a year, the average rainfall is 2307 mm.

The driest month is June, with 118 mm of rain. The greatest amount of precipitation occurs in November, with an average of 268 mm.

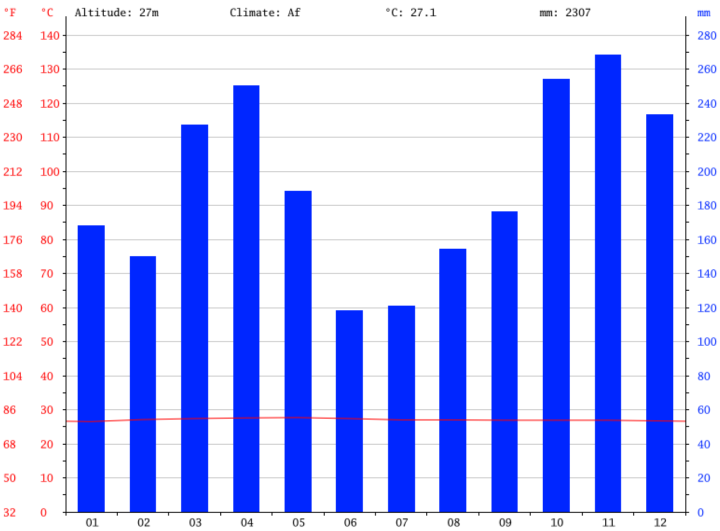


Figure 102 Climate graph weather by month PUTRAJAYA (https://en.climate-data.org)

The average temperature in Putrajaya is 27.1 °C.

May is the warmest month of the year. The temperature in May averages 27.7 °C. The lowest average temperatures in the year occur in January, when it is around 26.5 °C. (climate-data;2018)

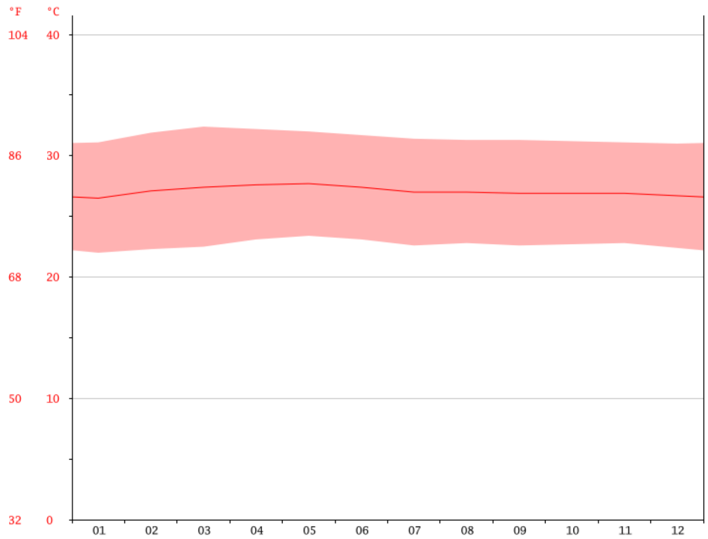


Figure 103 Average temperature PUTRAJAYA (https://en.climate-data.org)

-Landmarks

The site in which the building was planted is very interesting with administrative building like the immigration department and the palace of justice.

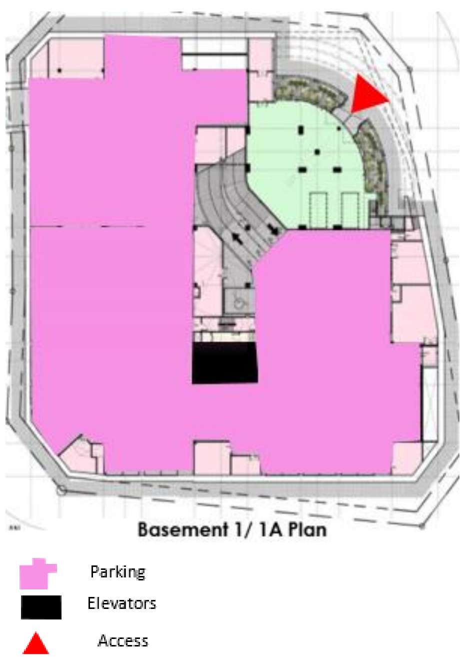
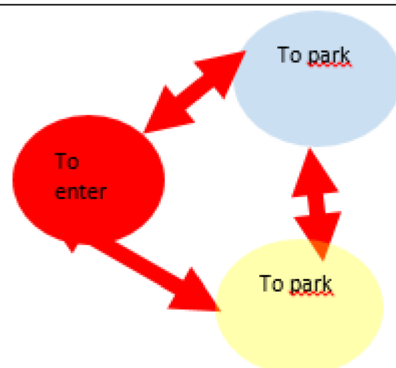
Figure 104 location of the EC Building (DIAMOND BUILDING;2012)

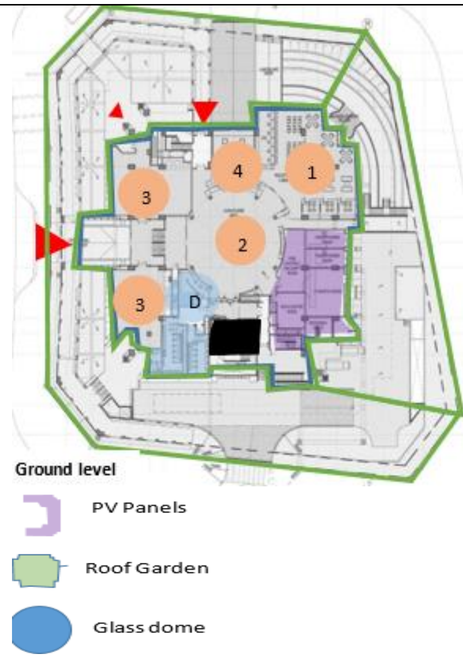
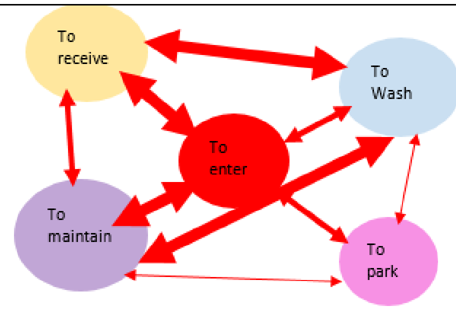
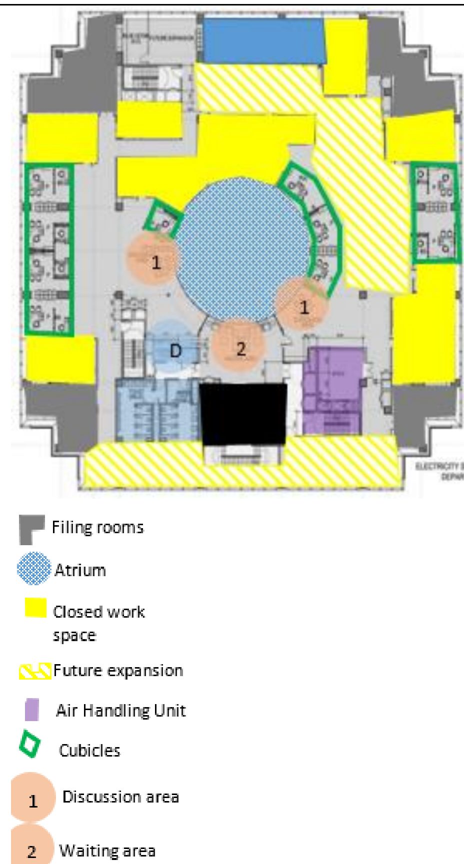
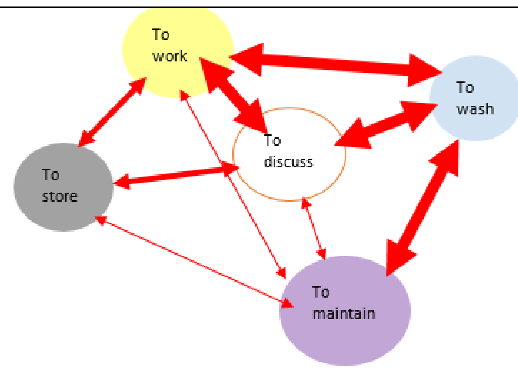
-Topography the site is almost flat at 12 m of altitude.

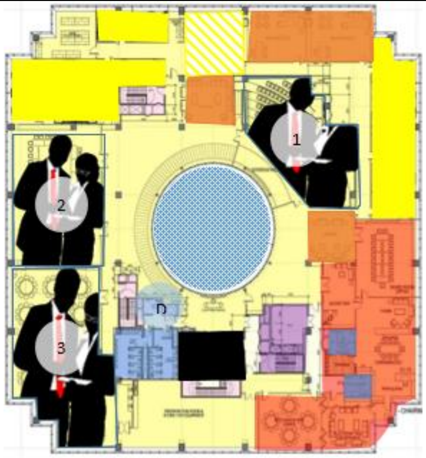
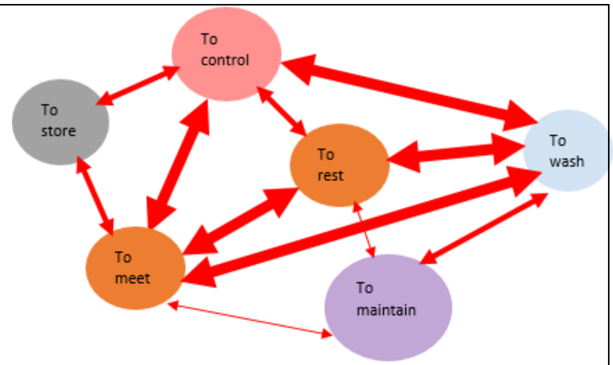
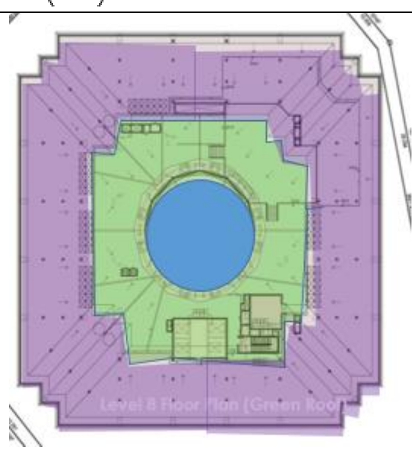
Figure 105 topographic card of the site of PORTAJAYA (https://en-gb.topographic-map.com/)

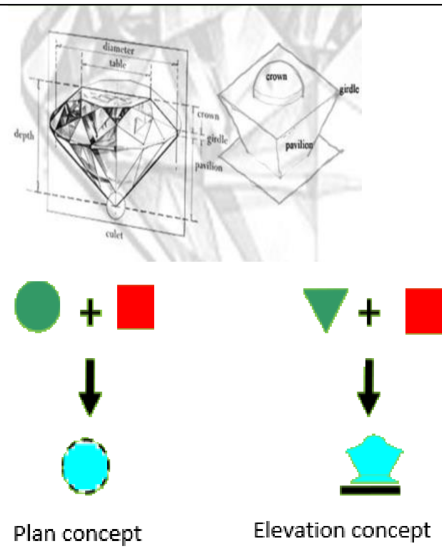
III.2.3. Components of the different levels (Green Landscape Area: 3,600m²)

Table 24 components of the different levels (source; author)

Level	Plan	Illustration
Basement	 	

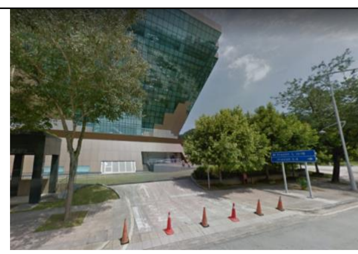
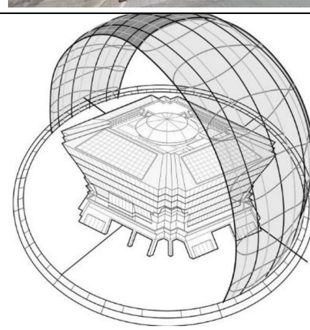
<table>
<tr>
<td>Ground floor</td>
<td>
</td>
<td>
</td>
</tr>
<tr>
<td>Typical floor plan</td>
<td>
</td>
<td>
</td>
</tr>
</table>

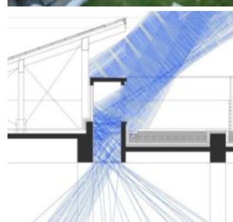
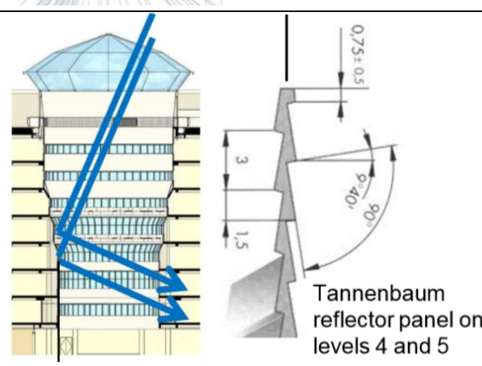
Chairman's level	 Chairman's suite Lounges Group spaces 1 Conference room 2 Meeting room 3 Council room	
The roof	 PV Panels Roof Garden Glass dome	

Volumetric & Design concept	A distinctive diamond form: - is prominent and unique -symbolizes value, quality, transparency & durability, - characterize EC's role as a regulatory body is an optimum passive design approach to achieve energy efficiency. (*DIAMOND BUILDING*;2012)	

III.2.4. Techniques and systems

Table 25 technics and systems in the EC building (SURUHANJAYA TENAGA-energy commission;2018)

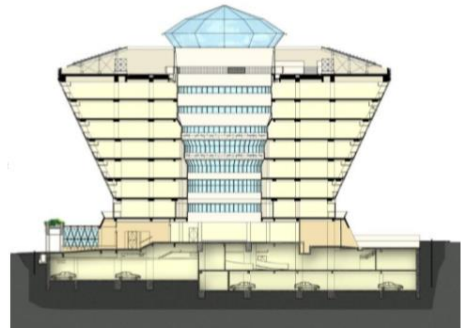
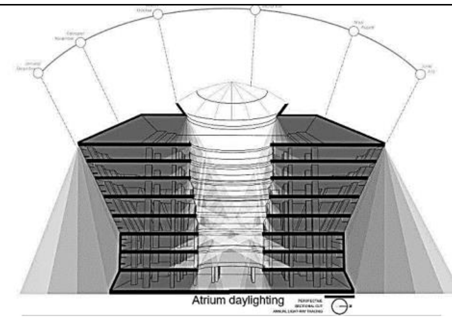
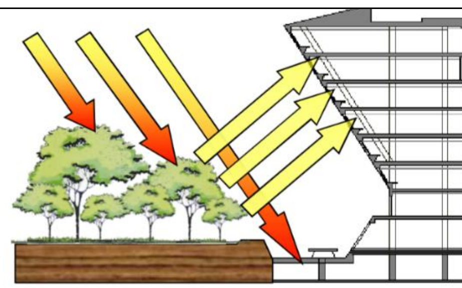
Techniques	Application	Illustration
Sunken Garden Area	the sunken garden located at the basement serves as a void space which provides natural ventilation to the parking area at the basement level	
Building Orientation	the construction of the building has also taken into account on the rising and setting of the sun, to minimize the areas impacted by direct sunlight.	
Photovoltaics	This total capacity produced is estimated to cover approximately 10% of the building's energy needs.	

Daylighting – Natural and Artificial	the Diamond Building is designed to obtain 50% of its daylight needs from natural lighting. Integration with daylight sensors enable the artificial lighting to be switched off when daylight is adequate, resulting in energy savings.	
Roof Light Trough	A roof light trough is incorporated to bring in sufficient daylight to illuminate the lounge area at the seventh floor.	 
Atrium	Atrium Daylight Design The atrium has been carefully designed optimize daylight utilization for each floor	
Water Efficiency	1. Rainwater Harvesting 2. Efficient Water Fittings 3. Greywater Recycling for Wetland	 

-The Façade

Table 26 tilted innovative facade of the ECB (Chad Merchant;2013)

Element	Application	Illustration

Tilting Façade	the tilting facade allows self-shading for the lower floors, protection from direct sun rays into the building and a smaller building footprint, resulting in a larger area for landscaping.	
Solar Geometry	The solar path was used to sculpt the building geometry. The 25° tilt angle of the facades ensures that North and South facades are fully self-shaded during the hottest mid-day hours. For the East and the West facades, the tilting façade helps to reduce the solar impact by 41%.	
Light	The tilted glazing admits more of the desirable diffuse light reflected off the landscape for glare free daylighting use in the building.	

-The main spaces in the building

Table 27 the main spaces in the ECB

Storey	Spaces
Underground level	Parking Vertical circulation
Ground level	Sunken garden Reception: lobby, Concourse area,Commercial, Gallery atrium Wc,Technical services
Typical floor plan	Atrium,Filing room,closed work space,cubicles,discussion area ,waiting area,air handling area ,future expansion
Chairman's level	Chairman's suit,lounge ,conference room,meeting room,council room
Level 8	Photovoltaic panels,roof garden

III.2.5. Pillars extracted from this building

1-important site

2-taking in consideration the disable people

3-basement parking & outside garden

4-future expansion space

5- using different types of offices (open, closed rooms)

6- self shading façade

7- atrium daylight with reflectors

8- reflected daylight from the roof & using PV panels for energy generation.

III.3. EXEMPLE OF OFFICE BUILDING IN ALGERIA

THE NEW RECTORSHIP OF GUELMA UNIVERSITY OF MAY 8TH 1945

III.3.1. Identification of the work: presentation of the project and motivation of choice

The project is an administrative building the new rector ship in order of 5500 teaching places, I chose this building because it represents the type of the majority of work spaces in Algeria.

III.3.2. Situation and analysis of the immediate environment

-Accessibility to the site

The building is accessible because it’s located in the university of Guelma

Figure 106 accessibility to rector ship(googlemaps.com-2018)

-Climatology

The building is in Guelma which has a cold humid winter and dry hot summer as previously mentioned

-Topography

Figure 107 cross section with slope=5.42%

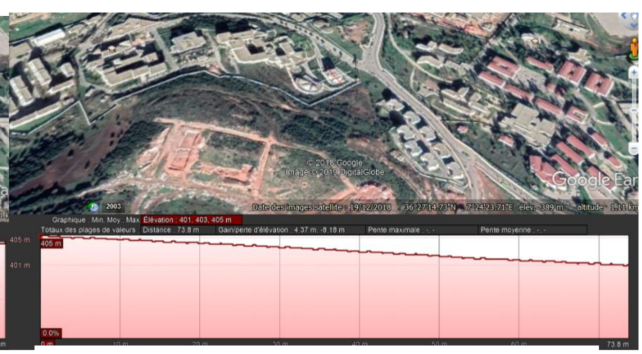


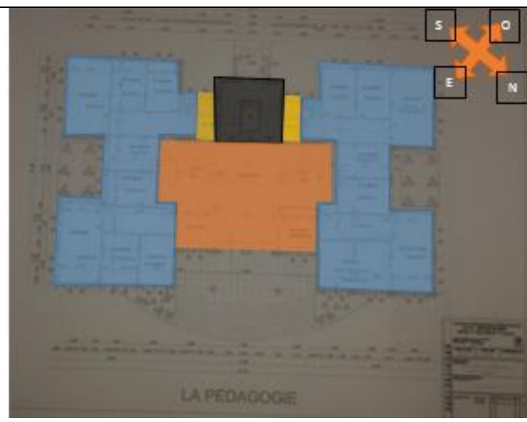
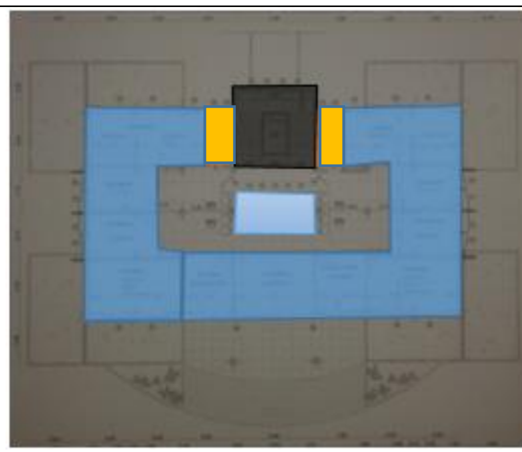
Figure 108 longitudinal section with slope=18.727%

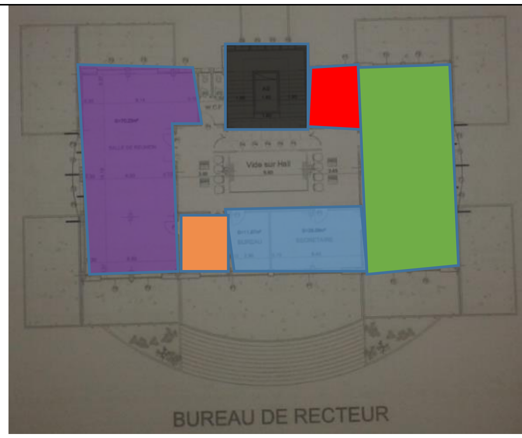
As we can see that the slope is very important the engineers had to climb the entire slope to locate the building instead of taking advantage of it; the result of this design was that the stairs to access the building are very long and tiring.

Figure 109 the way the rector ship (photo by the author)

III.3.3. Components of the ground plan: plans sections facades 3d

Table 28 components of the building (source; author)

Level	Plan	Key
Ground floor plan		Office spaces WC Reception
Typical floor plan		atrium vertical circulation

5th floor plan		meeting space control space kitchen space

-The program of the building

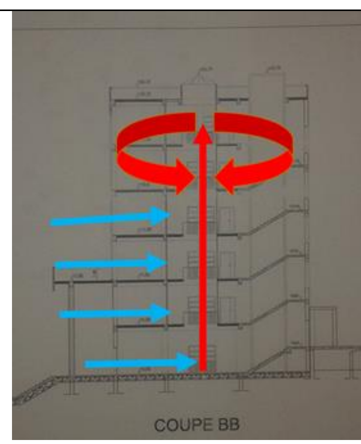
Table 29.a different levels of the building (ZERAIRIA MAAMA)

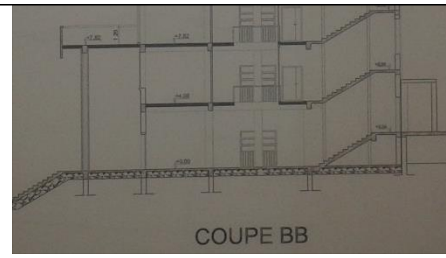
Storey	Spaces	Area
Ground floor (the teaching)	Lobby Reception Standards 2 waiting areas 10 office rooms 3 main offices 1 suit for vice rector of teaching WC(M/W) separated	202.52m² 12.32m² 12.32m² 3.65/2.90m²*2 14.36~14.86m²*10 27.59m²*3 10.70/6.90m² 4.10m²*2
First floor (general secretary)	6 single office rooms 3 group office rooms 2 main offices WC(M/W) separated	14.08~14.86m²*6 23.31~29.87m²*3 23.95m² 4.10m²*2
Second floor (general secretary)	5 single office rooms 2 group office rooms 2 suits for service chef: secretary, chef office WC(M/W) separated	11.97~14.86m²*5 29.87~30.13m²*2 14.08~11.97m²,23.95~38.03m² 4.10m²*2
Third floor (vice rector of searching)	6 single office rooms 2 group office rooms vice rector of searching office: secretary, office filing WC(M/W) separated	11.97~14.86m²*6 29.87~30.13m²*2 11.97m²,38.03m² 23.95m² 4.10m²*2
Fourth floor (vice rector of prospective)	6 single office rooms 2 group office rooms vice rector of searching office: secretary, office filing	11.97~14.86m²*6 29.87~30.13m²*2 11.97m²,38.03m² 23.95m²

	WC(M/W) separated	4.10m²*2
Fifth floor (rector's suit)	1 single office room Rector office Bathroom Secretary Kitchen Secretary Meeting room WC(W)	11.97m² 60.03m² 3.70m² 26.06m² 4.19m² 13.73m² 70.23m² 4.10m²
Outside parking	Estimated=32places Existent=15places	2.5/5m²

-Problems found in the building

Table 29.b schedule illustrate some problems extracted from asking employees in the rector ship

Space or construction element	Aimed to be	The existent state	Illustration
Parking	1 place for each 30m² of work space	15 places	
Atrium	Source of light and ventilation for the inside spaces	Artificial light in the corridor can explain that it doesn't its function as estimated because skylights are not enough due to the use of concrete in the construction of the roof also there is the problem of stagnancy of the hot air in the last storey because there are no openings in the top of the atrium that take out the hot air.	
Space conception and appropriation	The architect mast perform a full study	In this building the separation of interior spaces followed the first design form as a result we can find a	

	before he does his design to get fa functional building	luck in spaces like restauration ,toilet ,11m² offices and 3 employees in 23m²	
Flexibility	The office building must be flexible and expandable	The rector ship is constructed in concrete beam-column system So the space is limited by the distance between the beam and the column.	
The façade	Light, ventilation, insolation and aesthetic role	The green effect of the glass minimizes the light also it’s not double glazed as a result it’s a source of cold in winter and heat in summer also there is no vertical sunscreen in the east west facades and horizontal ones in south facades.	

IV. SITE ANALYSIS

IV.1. MOTIVATION OF THE CHOICE OF THE SITE

In order to the recent trend of city densification, I chose the site of an ancient swimming pool situated in Guelma; to implant my project to renovate it.

IV.2. PRESENTATION OF THE SITE

The site is an ancient swimming pool in ruined state next to the ancient military barracks.

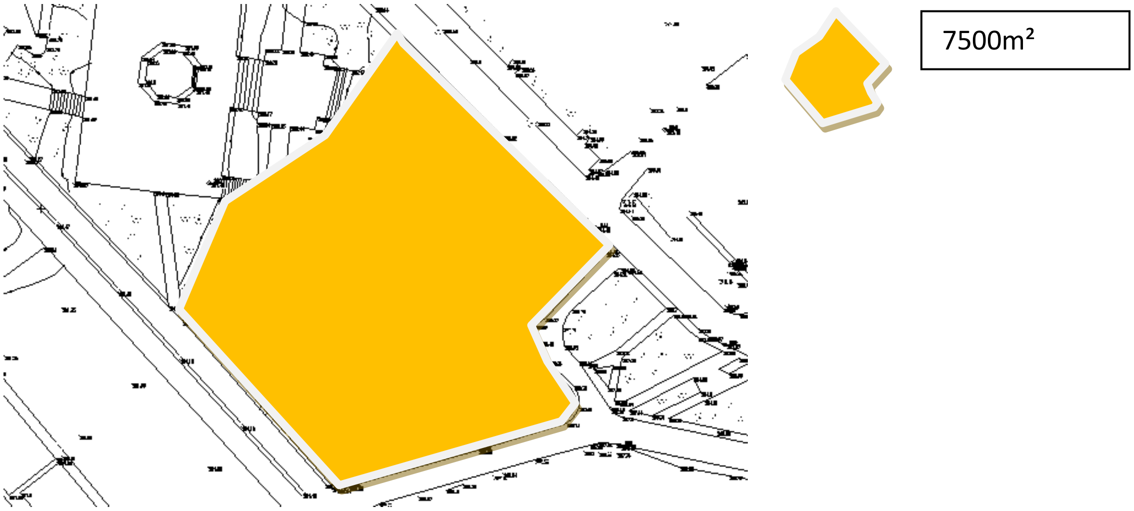


Figure 110 the site study case (pos ua7-3.DWG)

IV.2.1. Geographical situation (Plan of mass, plan of situation):

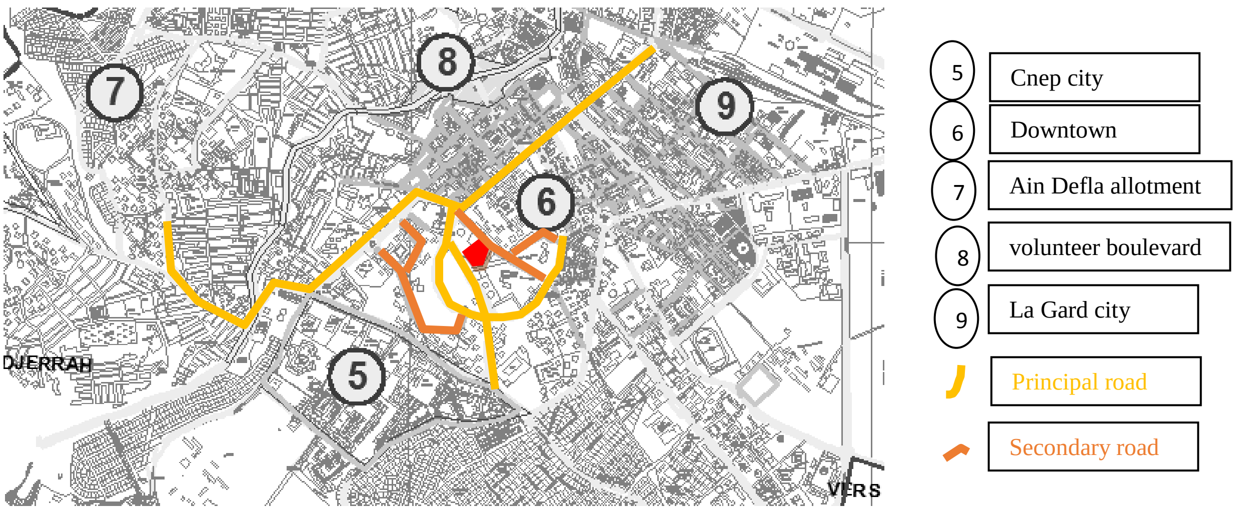


Figure 111 plan of situation (localization of POSs.DWG)

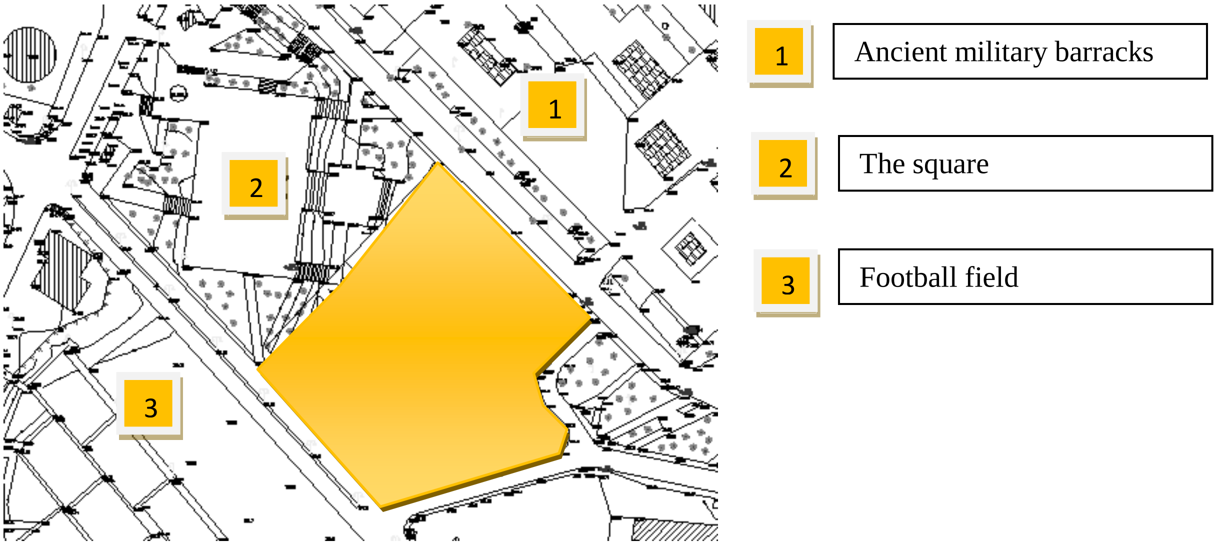


Figure 112 masse plan (pos ua7-3.DWG)

IV.2.2. the urban fabric: - Analyze the functional plan

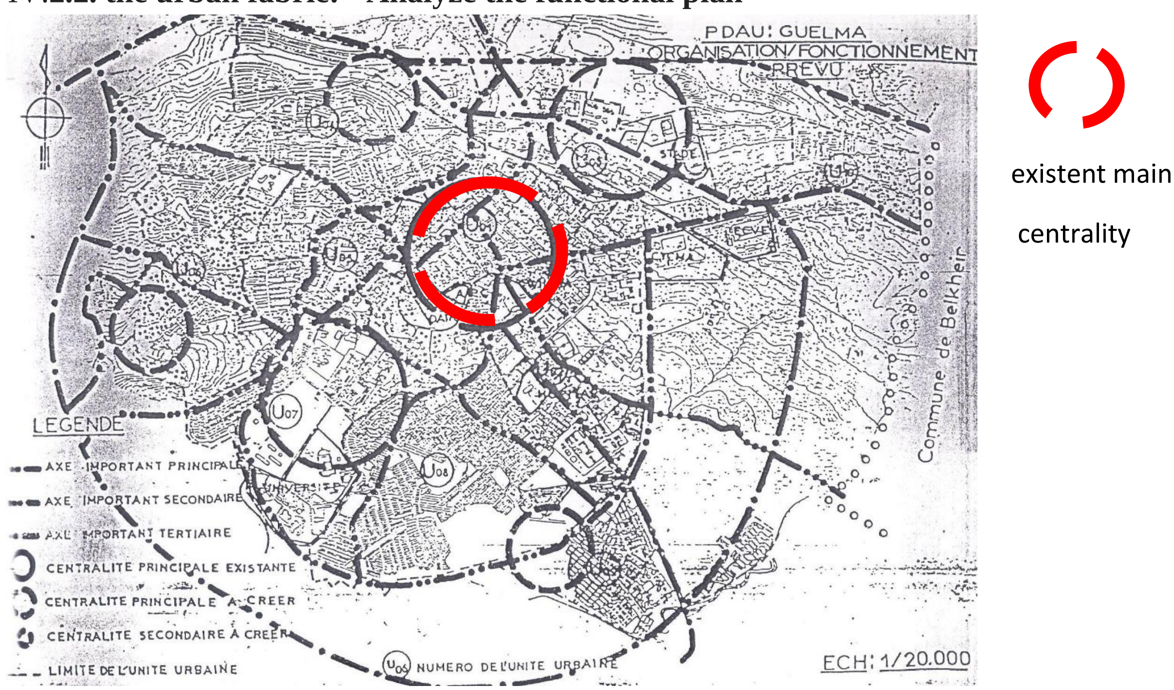


Figure 113 Master plan of planning and urban planning (pos ua7-3 repport)

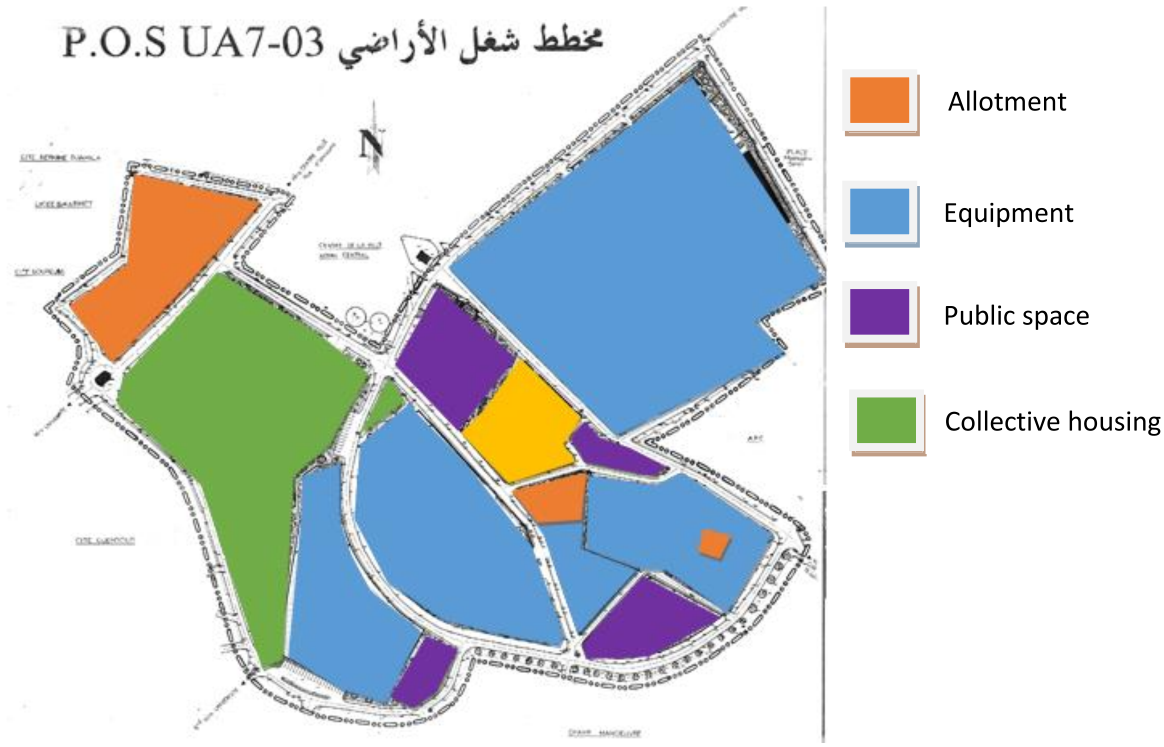


Figure 114 the ground occupation plan (pos ua7-3 repport)

Table 30 functions existing near to the site (source; author)

Function	Equipment
Administrative	business center bank trade and service tribunal customs organization of the martyrs' sons Medical work tax direction
Educative	A school High school Nursery
Religious	A mosque al Quds
Sportive	Stadium Swimming pool
Public spaces	A play ground Public square

IV.3. SITE ANALYSIS

IV.3.1. Physical Analysis

- Morphology

shape of the ground is irregular, the plot is delimited by a square from the north west and the road from the south west and the military barrack from the north east.

Figure 115 delimitation and form of the site (pos ua7-3 repport)

-The slope

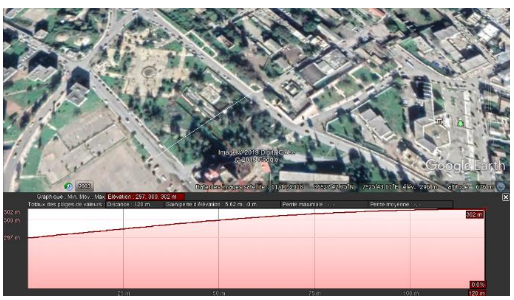


Figure 116 longitudinal section slope :4.17% (Google.earth-2018)

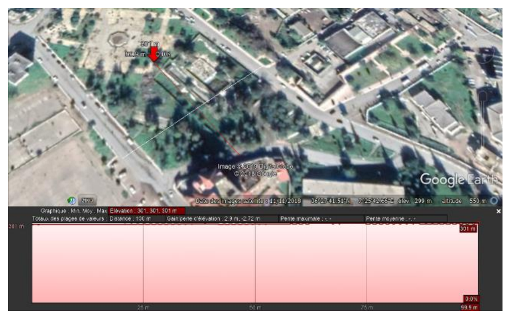


Figure 117 transversal section slope:0% (Google.earth-2018)

Figure 118 pine trees in the south side of the side (photo by the author)

- Artificial

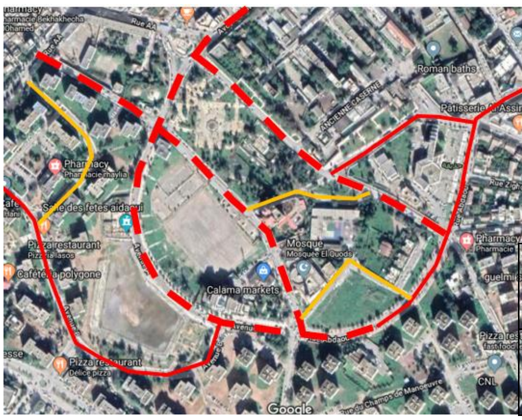
Figure 119 the swimming pool in the site

Figure 120 Boudjehems villa (photo by the author)

Figure 121 ancient military barracks (photo by the author)

IV.3.3. Technical analysis

-Circulation



Major axes	Secondary roads

Primer road	Important flow	A tow way road 8m
Secondary road	Average flow	One way road 4m

Figure 122 road axes of the site (google.maps.com-2018)

-Accessibility The site is accessible from the national road N20 N80 and the wilayale road W123 from the east side and N20 W123 for the northern side

Figure 123 Guelma from (google maps-2018)

IV.3. 4. site exposure

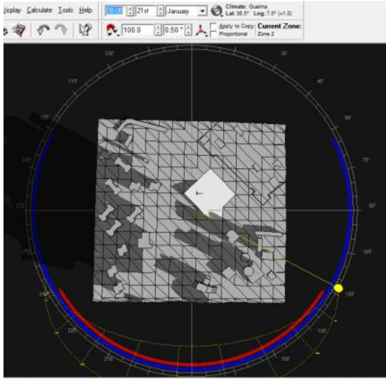


Figure 124 the site in winter at 8 am

(ECOTECT V-5.5)

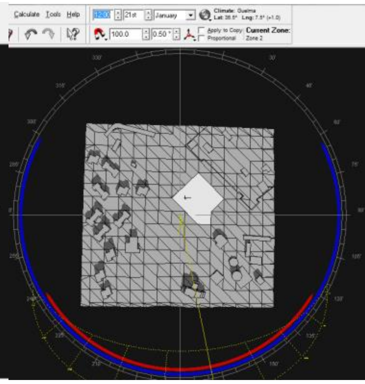


Figure 125 the site in winter at 12am (ECOTECT V-5.5)

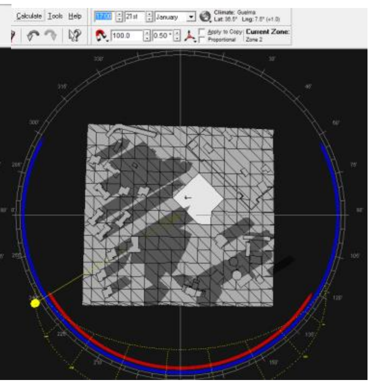


Figure 126 the site in winter at 17 pm (ECOTECT V-5.5)

The site has a burst urban fabric so the conception should be protected from northern cold wind

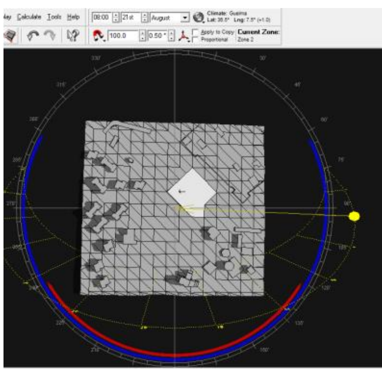


Figure 127 the site in winter at 8 am

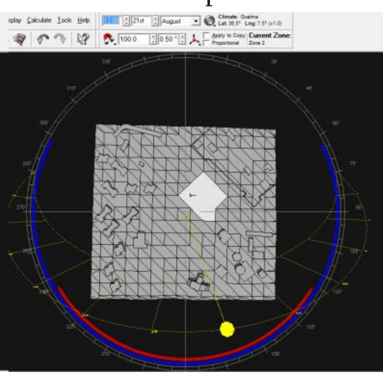


Figure 128 the site in winter at 12 am (ECOTECT V-5.5)

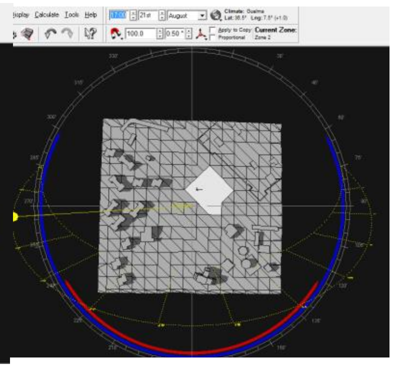


Figure 129 the site in winter at 17 pm (ECOTECT V-5.5)

The site is exposed to the sunshine all the daytime; so it should be protected from being over heated; but the strength is the big potential of solar radiation and high level of daylighting.

IV.3.5. The views

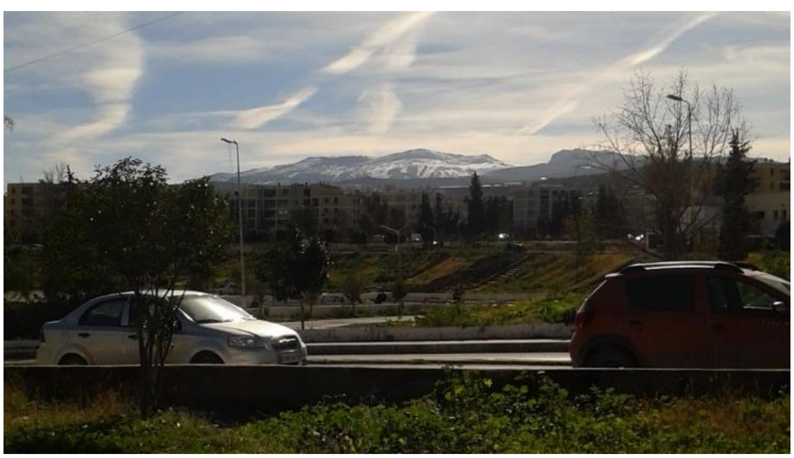


Figure 127 the view from the south side of the site (photo by the author)

Figure 128 view from the west side (photo by the author)

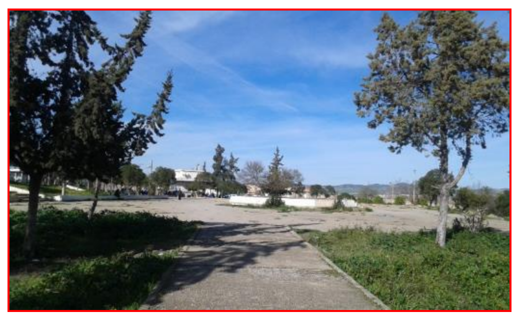
Figure 129 views from the south side (photo by the author)

Table 31 intentions extracted from all the previous researches

INTENTIONS AND RECOMMENDATIONS EXTRACTED
Site renovation. 
Glamorizing the historic barrack (the past) The main façade will face it.

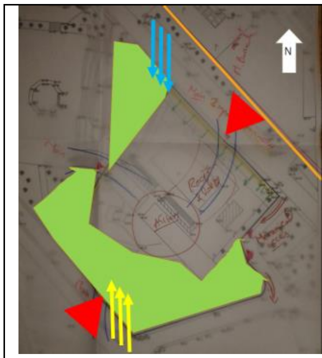
Benefit from the views in southern and northern side.

Respect neighboring create relationship with the existent (the square).



Preserving the existent in site pine trees.

Use the trees as a mask to be protected from the southern hot wind and northern cold wind.


The biodynamic facade design must perform light and ventilation requirements needed in workspace according to the specificity of climate of Guelma no glare nor overheating.
Creating centrality « atrium ».
Flexibility and simplicity of the design.
Consideration of disable people.
Consideration for future expansion.
Sustainable design.
The use of different workspace types according to the province and specialty.

SPACE PROGRAM OF THE OFFICE BUILDING

Table 32 program extracted for the office building (source; author)

MAIN FEATURES	**DESCRIPTION TENANT OCCUPIABLE AREAS**	**QUANTITY**	**SF EACH M²**	**Sum**	**Parking places**
			CONFERENCE		
Entrance	Lobby	1	139.00	139.00	
	Entrance Vestibules	1	9.00	9.00	
	Coat Check	1	14.00	14.00	
	Retail Area	1	18.50	18.50	
	Media Library	1	14.00	14.00	
				=194,50	
Main Auditorium	Seating (300 seats)	1	334.00	334.00	1place for each 3 fixed seats.
	Stage	1	112.00	112.00	
				=446.00	
Support Spaces	Projection/Control Room	1	28.00	28.00	

	Equipment Storage	1	28.00	28.00	
	Rear Projection Room	1	37.00	37.00	
	Public Toilets (Male)	1	11.00	11.00	
	Public Toilets (Female)	1	17.00	17.00	
				=121.00	
				=733,50	100places
RESTAURATION					
Customer Areas	Dining Area (200 seats)	1	193.00	193.00	1place for each 14m² from the gross floor area.
	Cafeteria 50% from the dining area.	1	96.00	96.00	
	Condiment Areas	4	5.00	20.00	
	Service Line	1	111.00	111.00	
	Public Toilets (Male)	1	11.00	11.00	
	Public Toilets (Female)	1	11.00	11.00	
				=442.00	
Kitchen	Meat Preparation	1	18.50	18.50	
	Bakeshop	1	18.50	18.50	
	Cold Foods	1	10.00	10.00	
	Vegetable Preparation	1	11.00	11.00	
	Range/Grill	1	37.00	37.00	
				=95.00	
Storage Area	Receiving	1	5.00	5.00	
	Common-Dry	1	22.00	22.00	
	Refrigerated	1	15.00	15.00	
				=42.00	
Cleaning Areas	Dish and Truck Wash	1	21.00	21.00	
	Pot Washing	1	6.00	6.00	
	Trash	1	10.00	10.00	
				=37.00	
Employee Areas	Manager	1	11.00	11.00	
	Lockers	2	4.00	8.00	
	Toilets	2	6.00	12.00	
	Employee Dining	1	12.00	12.00	
				=43.00	
Office	Office	1	11.00	11.00	
				=11.00	
				=670.00	54 places
MEDICAL OFFICES					
Entry Lobby	Waiting	1	30.00	30.00	

	Reception/Registration	1	12.00	12.00	1 place for each 13m²
	Payee Window	1	6.00	6.00	
				=48.00	
General Patient Care	Physician Office/Consult	13	17.00	221.00	
	Dentist office	1	20.00	20.00	
	Nurse Work Area	1	16.00	16.00	
	Patient Toilets(male)	1	12.00	12.00	
	Patient toilets (female)	1	12.00	12.00	
	Clean/Supply Room	1	6.00	6.00	
	Medications Storage	1	20.00	20.00	
	Soiled Utility Room	1	6.00	6.00	
	Pharmacy	1	60.00	60.00	
				=373.00	
Medical Records	Medical Records Files	1	6.00	6.00	
				=6.00	
Staff Support Spaces	Staff Toilet (Male)	1	6.00	6.00	
	Staff Toilet (Female)	1	6.00	6.00	
	Staff Break Room	1	60.00	60.00	
				=72.00	
				=499.00	39 places
LAWYERS FIRM					
Work space	Main offices	2	30.00	60.00	1place for each 23m² from the gross floor area.
	Offices	13	15.00	195.00	
	Secretary	2	12.00	24.00	
	Waiting area	2	12.00	24.00	
				=303.00	
Support spaces	Library and lounge area	1	60.00	60.00	
	Sanitary for men	1	17.00	17.00	
	Sanitary for women	1	17.00	17.00	
	Filling room	1	23.00	23.00	
				=117.00	
				=420.00	13places
ARCHITECTS AND ENGINEERS FIRM					
Work spaces	Main offices	2	30.00	60.00	1place for each 23m² from the gross floor area.
	Open work space	1	100.00	100.00	
	Secretary	2	12.00	24.00	
	Waiting area	2	12.00	24.00	
				=208.00	
Support spaces	Library and lounge area	1	60.00	60.00	

	Sanitary for men	1	17.00	17.00	
	Sanitary for women	1	17.00	17.00	
	Filling room	2	23.00	46.00	
				=140.00	
				=348.00	15 places
HEADQUARTERS					
Different scales	Big	2	410.00	820.00	1place for each 23m² from the gross floor area.
	Intermediate	3	260.00	780.00	
	Small	6	145.00	870.00	
				=2470.00	107 places
WORSHIP					
Prayer areas	Prayer room for men	1	100.00	100.00	//
	Prayer room for women	1	100.00	100.00	
				=200.00	
Support spaces	Sanitary and ablution for men	1	20.00	20.00	
	Sanitary and ablution for women	1	20.00	20.00	
				=40.00	
				=240.00	
Technical services				=45m²	//
				= 5380.00	**328 places**

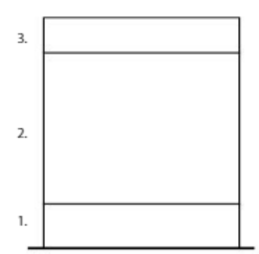
FUNCTIONING OF THE BUILDING

Function: clearly separate / hierarchical

3.top: noble floor

-communicate the prestige of the company at the scale of the city

-finish the volume of the building by giving it a unique character



2.floor: office service

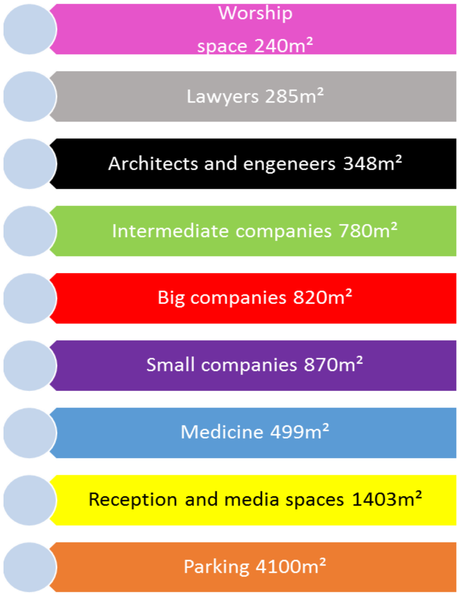
-express the seriousness, the efficiency of the company

-put forward the idea of equality in the work

1.base: commercial RDC

- attract the eye / brand image

- invite the passer-by to enter / create the event (Baptiste Charles Yves Bride lance;2013)



Parts of the building	1.Base	2.Floor	3.Top
The office building	Common spaces	Each floor is sacrificed for a function	For calmer areas like religious spaces

Figure 130 functionality of my new office building

CONCEPTUEL IDEA

Philosophical concept

The context

T site is full of pine trees, a tree means the calm, coherence, symbiosis, the bidirectional conversation. the ecological building is born of its environment like a tree born of the earth which received its seed

"*To make the landscape more beautiful than before the building was built*" (WRIGHT;1901)

"*I think the universe is pure geometry-basically, a beautiful shape turning around and dancing over space-time*" (Antonny GARRET).

Square as the basic form

Today the square represents above all that which is constructed by man and not by nature. This form is now more positive since it conveys notions of enterprise, of human fabrication. The square will tend to reflect actions or things structured and organized, not natural or creative.

I want to say that even though man can't be perfect he can be workman and serious.

The combination of the square and the spiral motion Everything in this universe turns over from the wright to the left for example the earth; with obliquity =23,4.

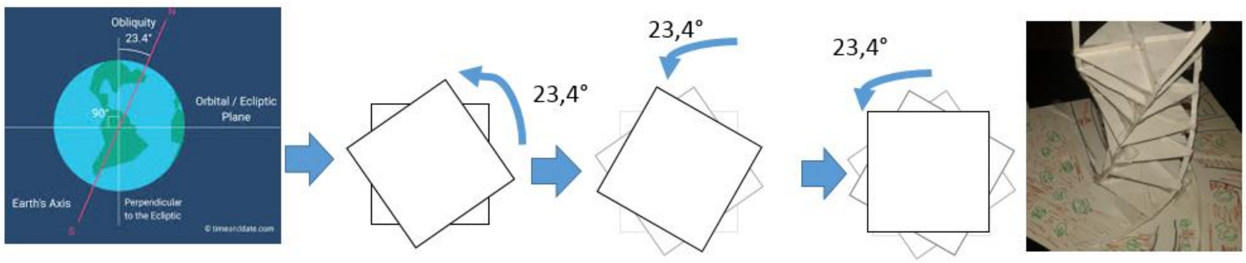


Figure 131 geneses of the project

CONCLUSION

Every employer wants the best productivity by ensuring an acceptable condition to make the workspace more comfortable this is why the design of an office building need specific spatial thermal and psychological attributes.

GENERAL CONCLUSION

The energy performance in the office building means the energy consumed for different needs The most energy-consuming thing in these buildings is lighting and air conditioning where this last primordial to offer an acceptable thermal condition for employees, in this context this study was raised to incorporate a biodynamic façade as a solution and show how would be its impact on the thermal comfort of workspaces.

The first step in this study was the architectural façade; the main constitute of the building impacts the environmental conditions of indoor spaces so the design and selection of facades during the design process of building should be considered as one of the major tasks in order to support the quality of thermal sensations in indoor environments.

In essence, biodynamic facade can be developed as an intersection of biomimicry, and responsive architecture to achieve these performance-oriented goals in architecture.

They are not designed just for aesthetic reasons but they are mainly designed to solve serious architectural and comfort issues; the most important characteristics in the analyzed biodynamic facades is the design inspiration which was born from cultural natural and climatic context.

The ecological architectural project is born from its environment like a tree born from the earth which received its seed, the study of the project context affected the choice of the strategies of design where the biodynamic facade is essential to have the thermal comfort in the workspaces because it plays dual role as a sun blocker; as in the first model; the temperature is reduced with 12.2C°in the summer season ensuring in the same time the entrance of day light, and as a buffer space; the double skin isolates the interior space from the cold outside as a result the interior space still warmer than the outside with +5.4C° in the winter season.

In an innovative and ecological way the biodynamic façade system had reduced energy consumption for heating, coolling or artificial lighting in workspace.

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