Mohamed Khider University of Biskra
Faculty of Science and Technology
Department of Architecture

Master's thesis

Domain: Science and Technology
Sector: Architecture and Urban Planning
Specialty: Architecture and Environment

Submitted by:
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June 23,2024

Exploring Kinetic Architecture for Shading Efficiency and Biomimetic Inspiration

The project: Multi-Functional Tower

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2023 - 2024

DEDICATION

After praise and thanks be to God,

This work is the result of hard work, great effort, and many sacrifices over the years. Praise be to God first, who gave us the ability, health, and well-being to complete this work

I dedicate this work to everyone who has been credited with it

To the abundance of love and tenderness and the source of my strength, the pulse residing in my veins, my dear father, “Yagoub Kamel”

To the one who helped me the most , my dear mother, Chekhab Ghazala, you were the best master for me.

To my support after my father, my dear uncle Mohamed Toufik, may God protect him for us and my dear uncle Reda

To my sisters who have always been a source of help by my side: Mouna, Marwa, Keltoum, Safa, and our little ones, Nadia and Mini.

To her beloved aunt Aseel, may God grant her success in her life and make her happy

To my friends who shared all its moments with me in my university journey (Fouad Hamrit ,Hanna Keddar, Zineb Haiag)

To all my distinguished professors in the Department of Architecture, whom I had the honor to learn from

To my colleagues at work, my teacher Massaoudi, and my friends Hasna and Rayyan And Amira

To everyone who helped me and helped me accomplish this humble work

Thank you

Sincerely,

Yagoub Dounia

ACKNOWLEDGEMENT

"وَمَا تَوْفِيقِي إِلَّا بِاللَّهِ عَلَيْهِ تَوَكَّلْتُ وَإِلَيْهِ أُنِيبُ"

سورة هود، الآية 88

First and foremost, all praise and thanks are due to Allah Almighty for His blessings throughout my research work, enabling me to complete this research successfully.

I would like to express my deep and sincere gratitude to my research supervisor, **Pr.Bada Yassine**, for giving me the opportunity to conduct this research and for his invaluable guidance throughout this study. His dynamism, vision, dedication, and motivation have deeply inspired me. It has been a great privilege and honor to study and work under his guidance. I am extremely grateful for all the support he has given me, and I also wish to extend my thanks to **Dr.Hamzaoui Hafnaoui** for his efforts and assistance.

My sincere thanks also go to my esteemed professors, **Dr. Mohamed Elhadi Matallah** and **Dr. Magri El Ouadjeri Sahar**, who honored me by being part of the committee assigned to evaluate this humble work. I thank them for their approval to review and evaluate this work, for their valuable time, and for their insightful comments aimed at improving this study.

I extend my heartfelt thanks to all the faculty members of the Architecture Department at Mohamed Khider University of Biskra, especially the professors who instilled in me a love for architecture.

I am deeply grateful to my dear parents who have always been by my side.

I also thank my sisters, my brother-in-law Yazid, and Hakim. To all my dear friends, especially my companion, thank you for your unwavering support. I am grateful to everyone who helped in producing this thesis.

Thank you

Sincerely,

Yagoub Dounia

SUMMARY (English)

With the escalating emergence of numerous severe environmental challenges in recent years, predominantly attributed to the construction sector, notably excessive energy consumption and heightened environmental pollution, this thesis delves into the fusion of kinetic architectural strategies and shading mechanisms to tackle energy efficiency and user comfort. It focuses on regions with hot and arid climates such as Biskra, which exhibit a growing demand for illumination and cooling. Specifically, the study centers on a multifunctional tower housing both commercial and office spaces. The primary objective is to offer actionable insights for sustainable urban development in arid climates. Through a combination of experimental research and theoretical analysis, the research aims to showcase the potential of dynamic architectural solutions in mitigating environmental impacts and elevating the quality of life in urban settings. By presenting advanced strategies and techniques for solar protection that synergize with natural elements, the study explores how buildings physically adapt to environmental stimuli. Furthermore, it investigates the capacity of these dynamic systems to enhance thermal performance, user comfort, and energy efficiency within the desert context of Biskra Province.

Key words: Kinetic Architecture, Shading, Dynamic, Energy Efficiency, Adaptive, biomimetic, mimosa, Thermal Comfort, multifunctional tower

SUMMARY (Arabic)

مع تصاعد ظهور العديد من التحديات البيئية الشديدة في السنوات الأخيرة، والتي تعزى في الغالب إلى قطاع البناء، ولا سيما الاستهلاك المفرط للطاقة وزيادة التلوث البيئي، تتعمق هذه الأطروحة في دمج الاستراتيجيات المعمارية الحركية وآليات التظليل لمعالجة كفاءة الطاقة وراحة المستخدم. ويركز على المناطق ذات المناخ الحار والجاف مثل بسكرة، والتي تظهر طلبا متزايدا على الإضاءة والتبريد. على وجه التحديد، تركز الدراسة على برج متعدد الوظائف يضم مساحات تجارية ومكاتب. الهدف الأساسي هو تقديم رؤى قابلة للتنفيذ للتنمية الحضرية المستدامة في المناخات القاحلة. ومن خلال مزيج من البحث التجريبي والتحليل النظري، يهدف البحث إلى عرض إمكانات الحلول المعمارية الديناميكية في تخفيف الآثار البيئية ورفع نوعية الحياة في المناطق الحضرية. ومن خلال تقديم استراتيجيات وتقنيات متقدمة للحماية من أشعة الشمس التي تتآزر مع العناصر الطبيعية، تستكشف الدراسة كيفية تكيف المباني جسديًا مع المحفزات البيئية. علاوة على ذلك، فهو يبحث في قدرة هذه الأنظمة الديناميكية على تعزيز الأداء الحراري وراحة المستخدم وكفاءة الطاقة في السياق الصحراوي لولاية بسكرة.

الكلمات المفتاحية: العمارة الحركية، التظليل، الديناميكي، كفاءة الطاقة، التكيف، المحاكاة الحيوية، الميموزا، الراحة الحرارية،برج متعدد الوظائف

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GENERAL INTRODUCTION

The confluence of traditional architectural practices and modern technological innovations has led to the evolution of dynamic architectural concepts. Among these, kinetic architecture and shading mechanisms present promising avenues for energy-efficient and adaptive building designs. The city of Biskra, with its desert climate and unique urban fabric, offers an intriguing context to delve into the transformative potential of such dynamic architectural solutions.

The Physical Institute in Maldegem has found that building facades are a significant source of energy loss. They account for over 40% of heat loss during winter and contribute to overheating in the summer, leading to the increased use of air conditioning to maintain comfortable indoor temperatures. Consequently, the building sector consumes more energy than both the industrial and transportation sectors.

Biskra, known as the "Queen of the Zibans" and the "door to the desert", is characterized by its scorching temperatures and bright sunlight for a significant part of the year. Consequently, buildings in this region grapple with the challenge of maintaining thermal comfort while minimizing energy consumption. Traditional architecture in Biskra has long employed passive strategies, such as thick walls and courtyard layouts, to mitigate the harsh climatic conditions. However, as urbanization intensifies and architectural aspirations evolve, there is an increasing demand for contemporary solutions that can seamlessly integrate with the city's historic charm.

This thesis aims to explore the application of kinetic architectural strategies and shading mechanisms tailored to Biskra's unique environment. By examining how buildings can physically transform in response to environmental stimuli, we will investigate the potential of such dynamic systems to enhance thermal performance, user comfort, and energy efficiency in the desert context of Biskra.

Drawing on a blend of architectural theory, technological insights, and case studies, this research will offer a comprehensive understanding of how kinetic and adaptive architectural systems can be optimally employed in desert urbanism. By highlighting the symbiotic relationship between dynamic architectural elements and Biskra's environmental conditions, we aspire to chart a future where the city's built environment not only resonates with its past but is also resiliently poised for the challenges of the future.

Problem statement:

Arid regions, with their blazing sun and harsh climatic conditions, present a unique set of challenges for architectural design and urban planning. Many researchers and architects have explored the intricate relationship between architectural design, solar protection, and energy consumption in these challenging environments. These challenges primarily revolve around achieving energy efficiency and ensuring a comfortable environment for building occupants. To address these issues, research studies aim to incorporate principles of kinetic architecture, relying on moveable and dynamic components of the building, that can adapt sustainably to the ever-changing solar conditions, in response to external factors or user interaction. These dynamic features can serve not only as building shading (energy-efficiency) devices but also as aesthetic expression.

The central goal for shading building design is to reduce reliance on mechanical cooling systems, such as air conditioning, and create indoor spaces that are both comfortable and energy-efficient. The challenge becomes higher when it consists of a tower design in arid zones, as the case of the present work . Designing a multifunctional high-rise building, combining a shopping center, services, and office, mainly on the solar protection matter, due to its solar exposure for a long period.

Therefore, the challenge of relying on kinetic architecture is how to ensure synergy between technology and architectural creativity; the former concerns mechanical and sensors systems, and the latter concerns the features architectural design concept (aesthetics and integration). So, the questions that arise:

1. How can kinetic architecture be effectively integrated into the design of a mixed-use tower in the climatic context of Biskra to improve energy efficiency and user comfort?

2. What shading strategies can be employed to minimize solar heat gain and enhance thermal comfort within the shopping center and office portions of the building in a hot desert climate?

3. What is the most suitable biomimetic source of inspiration (top-down biomimetic approach) for kinetic elements design and operational principles which can be applied to enhance the overall sustainability and environmental performance of the mixed-use high-rise building design?

Hypotheses:

1. Incorporating kinetic architectural elements that respond to climate and sun data in the design of a mixed-use tower in Biskra will significantly improve energy efficiency and user comfort by dynamically optimizing daylighting, shading, and ventilation, thereby reducing the reliance on mechanical systems for cooling and lighting.

2. Implementing dynamic shading systems within the shopping center and office portions of the high-rise building in Biskra, based on solar exposure and climatic conditions, will effectively minimize solar heat gain and enhance thermal comfort. This requires the strategic placement of shading devices, the use of responsive materials, and the integration of smart technologies to adapt to varying sunlight angles and intensities.

3. Understanding the unique motion principles of the Mimosa pudica plant provides valuable insights for the biomimetic design of shading devices. Mimosa pudica's responses to temperature and sunlight exposure offer inspiration for creating dynamic, climate-sensitive shading solutions for architectural applications.

3. Aim of the Study :

Objectives of the study This study aims to achieve a set of goals, which we define in the following points:

- Explore the principles and applications of kinetic architecture to assess its potential in enhancing shading efficiency.
- Study adaptive mechanisms and shading strategies in organisms inhabiting arid environments for biomimetic inspiration.
- Incorporate biomimetic principles into the architectural design process to enhance the tower's responsiveness to environmental conditions.
- Presenting the design principles and standards for tall building. shopping Centre and office

4. Methodology:

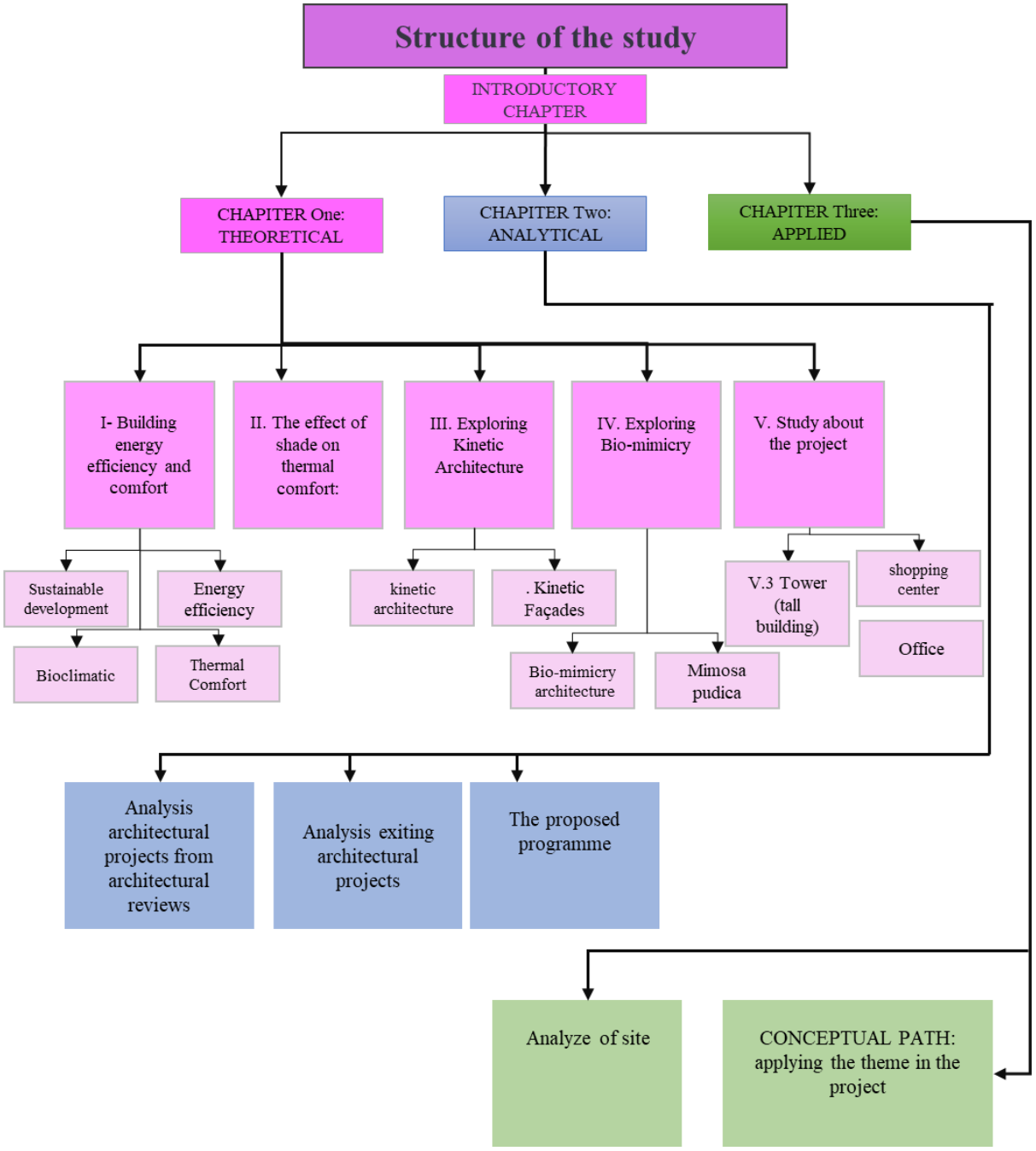
In order to understand the problem of the study and in order to achieve the objectives, we must rely on the appropriate methods for this, and therefore the descriptive analytical method was used as follows:

- The descriptive (theoretical) approach: It is divided into two parts. First, introducing the subject based on information and data taken from books, documents and scientific articles in addition to previous notes and official websites on the Internet, and everything related to the subject of kinetic architecture for shading efficiency and biomimetic inspiration

Secondly, a theoretical study of the project: focusing on high-rise buildings and studying the standards and characteristics of shopping centers and office

- Analytical approach: It is based on analyzing examples of multi-functional towers, with a focus on shopping centers and local and international offices, in addition to analyzing some examples of buildings that represent kinetic architecture.

Structure of the study



CHAPTRE 01:

THEORETICAL CHAPTER

CONCEPTS AND DEFINITION

Introduction

In the first chapter we will explore basic concepts in architectural design that aim to achieve sustainable development, energy efficiency, and thermal comfort.

Initially, sustainable development is defined as an approach that ensures that current needs are met without compromising future generations, and addresses environmental, economic and social dimensions. The study focuses on energy efficiency in buildings, defining energy and analyzing its consumption, while proposing energy saving techniques and enhancing efficiency through thermal insulation and energy saving devices.

The study investigates the impact of shading on thermal comfort and explores various shading techniques. Additionally, it delves into kinetic architecture, which features buildings that adapt and interact with their environment, incorporating kinetic structural systems and adaptive facades. The study also examines bio-inspired design and natural solutions to human challenges, showcasing examples like the mimosa plant.

Practical applications include theoretical analysis of tower projects, especially shopping malls and offices, demonstrating how these architectural concepts can be combined to enhance energy performance and thermal comfort in real-world scenarios.

I-Sustainable development and energy efficiency in buildings

I.1 Sustainable development:

Sustainable development is an increasingly widespread concept. Its main goal is to make the world sustainable; which requires the will and collaboration of all, the North and the South, the rich and the poor, governments and also populations to rebalance this world. For this vision, in this part we want to present sustainable development by defining its pillars, issues and objectives.

I.1.1 Definition:

This is, According to the definition proposed in the 1987 Brundtland Report by the World Commission on Environment and Development, sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." [1]

Sustainable development is, from a strict point of view, an expression made up of two words: Development and Sustainable. Which means the continuous and endless improvement of both qualitative and quantitative aspects of human wealth. Furthermore, from a conventional point of view, it is a socio-economic concept which combines the notion of socio-economic development, that of the sustainability of wealth and that of environmental neutrality.[2]

It can therefore be defined as a strategic and political approach based on the notion of solidarity in a space, with the objective of a triple dividend: economic efficiency, social equity and environmental quality.[3]

Sustainable development is a concept which aims to improve the living conditions of populations while remaining within the ecological carrying capacity. Sustainable development deals with both the use and preservation of natural resources, whether renewable or not. Knowledge of physical and biological sciences in the field of preservation of land and plant cover, particularly those that are arid, and the resulting techniques and methods must also be supplemented by the study of social sciences.

[1] CHERQUI, F. (2005). Methodology for evaluating a sustainable development project for a neighborhood adeque method. Thesis Doctorate, University of La Rochelle, Civil engineering discipline, Paris. Accessed April 2019, at: https://www.habiter-autrement.org/12.energies/contributions-12/These_FCherqui-quartier-durable.pdf

[2] : ZEROUALI, M.(2009). Le développement durable : l'Algérie entre rêves et impératifs. Le Quotidien d'Oran. Consulté le Avril 2019, sur https://www.djazairess.com/fr/lqo/5115058

[3] http://dspace.univ-tlemcen.dz/bitstream/112/5038/3/CAPITRE%201%20.pdf

For a number of years, both at the national and international level, the environmental aspects of the exploitation and management of resources have begun to be taken care of by the operators concerned. In terms of sustainable development, economic and social progress

favorable to the production of wealth and the creation of jobs must take place without harming the capacity for renewal of the components of biodiversity .[4] According to Brundtland's report, the notion of sustainable development consists of two inherent concepts:[5]

The first concept is "need," which is prioritized because it defines essential requirements, especially for the most deprived. The second concept is "limitations," which are determined by our current technologies and organizational capabilities regarding environmental quality. These two concepts aim to address both present and future human needs.

The idea of sustainable development has now become central to the discourse of many leaders and development policies. This concept emerged after extensive reflection on the detrimental impacts of human activities on the environment. [6]

I.1.2 The three dimensions of sustainable development:

According to the Bruntland report, sustainable development is considered the result of a harmonious evolution in the relationship between three essential interdependent dimensions:

• The economic dimension aims to generate wealth and enhance material living conditions.

• The social dimension: Covers the areas of health, education, housing, employment, intra- and intergenerational equity as well as the prevention of social exclusion.

• The ecological dimension focuses on the protection of the environment, species, and natural energy resources

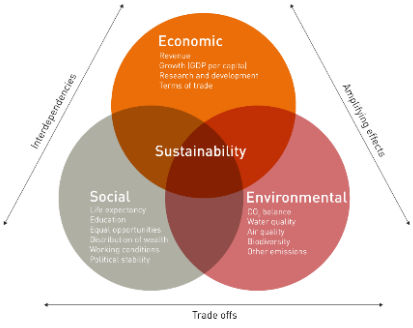


Figure 01: The three dimensions of sustainable development
source : Sustainable development includes several dimensions | economistic

I.2 Energy efficiency

I.2.1 Definition of energy

Energy is, like water and food, an essential resource for life[7]. Energy (from the Greek: force in action) is what allows action: without it, nothing happens, no movement, no light, no life[8].

[4] :KADIK, B. La biodiversité et le développement durable en Algérie. Consulté le Avril 2019, sur http://dspace.crstra.dz:8080/jspui/bitstream/123456789/308/3/la-%20biodiversite-%20et-%20le- %20developpement-%20durable%20-en-Algerie.pdf

[5] : BOUZEKRA, M. GUENAOUI, M. (2014). L'apport des nouvelles technologies sur l'économie d'énergie dans le bâtiment en Algérie, stratégie ou prestige. Mémoire de Master, Université Abderrahmane Mira – Bejaia, Faculté de Technologie Département d'Architecture

[6] : BROCHARD, L. (2011). Le développement durable : Enjeux de définition et de mesurabilité. Mémoire présenté comme exigence partielle de la maîtrise en science politique, UNIVERSITÉ DU QUÉBEC À MONTRÉAL. Consulté le Avril 2019, sur https://archipel.uqam.ca/4046/1/M12097.pdf

[7] : NGO, C. (2008). "L'énergie Ressources, technologie et environnemet". 3 éd. Paris: Dunod.

[8] Accessed Novembre 2023, at http://www.japprends-lenergie.fr/ressources/wiki-energie#ressource/sources-denergie/definition-et-principes/energie-definition-1

of energy are found on Earth, except energy that comes from the sun. It is inexhaustible and essential to life. Without the sun, no wind, no rain, no daylight and no plants [9].

In a physical sense, energy refers to the capacity to alter a state or produce work, resulting in movement, light, or heat. Any action or change of state requires an exchange of energy. Energy is obtained through the combustion of fuels or combustibles (such as oil, gasoline, diesel, fuel oil, gas, coal, wood, etc.), by using electricity, or harnessing natural forces like wind or solar energy. In the International System of Units, energy is measured in joules (J). Specialists and economists use the ton of oil equivalent (toe) to compare different energy sources. In everyday life, we commonly use the kilowatt hour (kWh). .[10]

I.2.2 Buildings Energy consumption

Building is considered most energy-consuming sectors because its consumption includes the energy used throughout the life cycle of a construction and this as follows:[11]

• Energy consumption for the manufacture of materials and their transport.

• Energy consumption during construction.

• Energy consumption during the operating phase, for heating,

ventilation, domestic hot water production, lighting and power supply of equipment.

• Energy consumption for demolition and waste disposal.

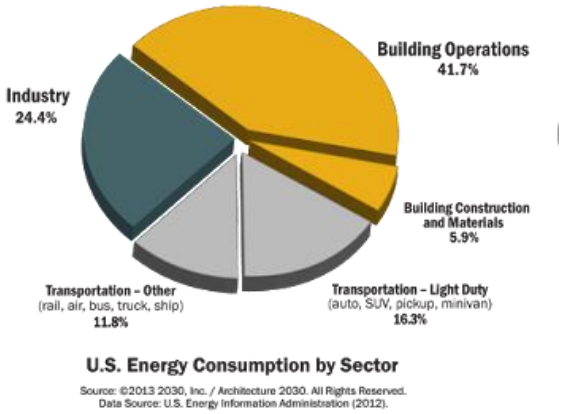


Figure 02: energy consumption by sector
source : Why The Built Environment – Architecture 2030

The building sector (residential and tertiary) is responsible for 45.7% of energy consumption in Algeria, and it represents an annual growth rate estimated at 7.1% (APRUE, 2014). [12]

In Algeria, the branch of administration in the tertiary sector is the most energy consuming by 25% (Figure 3.a), where the most consumed type of energy is electricity by 43% and natural gas by 38% (Figure 3.b). [13]

[9] Accessed April 2019, at https://docplayer.fr/340776-Tout-ce-qui-apporte-de-l-energie.html

[10] Accessed April 2019, at http://www.japprends-lenergie.fr/ressources/wiki-energie#ressource/sources-denergie/definition-et-principes/energie-definition-1

[11] Amira MEGUEHOUT Khawla DJEDDAI 2019 CONTRIBUTION OF SMART BUILDING IN ENERGY MANAGEMENT Master Thesis Mohamed Sedik Benyahia University – Jijel

[12] : BENBACHA, C. (2017). Les façades dynamiques; moyen de contrôle solaire pour accroitre l'efficacité énergétique des équipements administratifs en climat aride - Biskra. Mémoire pour l'obtention du grade de maître des sciences (M.Sc.), Département D'architecture Faculté D'architecture Et D'urbanisme Université Constantine 3. , sur https://www.researchgate.net/publication/322404246_Les_facades_dynamiques_moyen_de_controle_solaire_pour_accroitre_l'efficacite_energetique_des_equipements_administratifs_en_climat_aride_-_Biskra

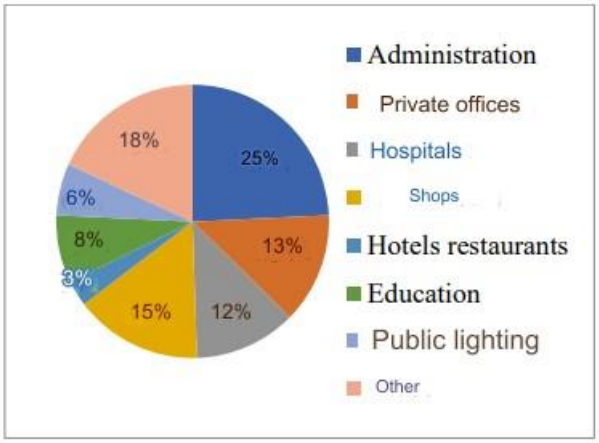


Figure 3.a: Distribution of tertiary sector consumption by branch.

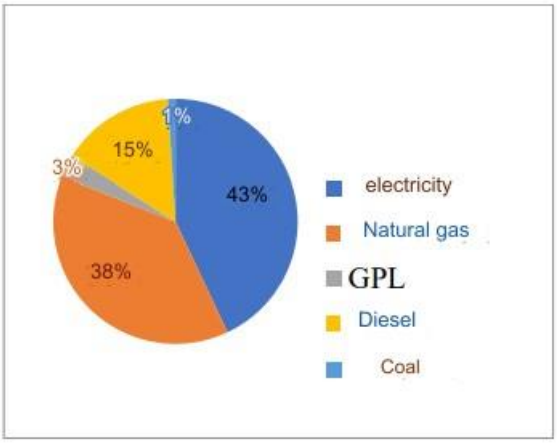


Figure 3.b: Distribution of tertiary sector consumption by energy type

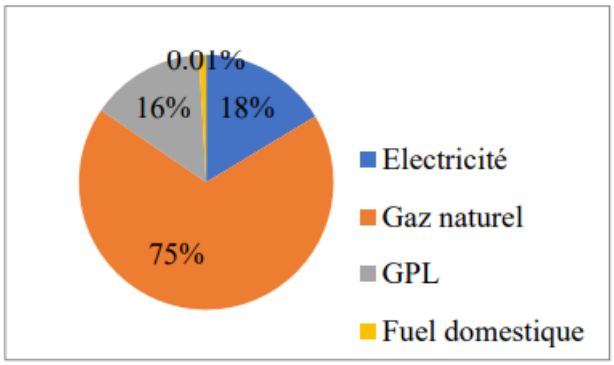


Figure 4.a: Distribution of sector consumption

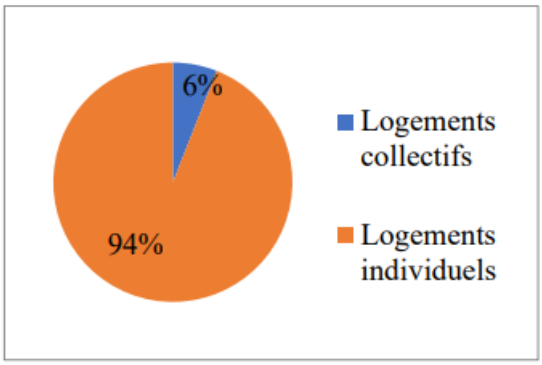


Figure 4.b: Distribution of consumption of the residential sector by type of housing

Source: Energy consumption in Algeria 15

I.2.3 Energy saving:

Energy savings refer to a decrease in energy consumption. For the world of construction, energy savings are mainly focused on building uses for heating, air conditioning, ventilation of premises, for uses of electricity such as lighting and other general uses such as household appliances, television, IT.[14]

Energy saving has been a fundamental concern since the 1970s. It aims to strengthen independence of supply and reduce "the energy bill". This issue is part of a global environmental dimension: no longer wasting traditional resources, which are not inexhaustible. This is the meaning of the Kyoto conference, held in 1977 [15]

I.2.4 Energy efficiency in buildings:

The word efficiency comes from the Latin word "efficere" is meant: "to achieve something", efficiency is therefore the relationship between profit and the efforts which make it possible to achieve this profit and can therefore be assimilated to output or effect. In scientific terms, energy efficiency represents the ratio of energy consumed to energy produced.

[13] : Consommation énergétique en Algérie (2015). Consulté le 11/2023, sur : http://www.aprue.org.dz/
[14] : AIR CONDITIONING. Energy saving. Accessed Novembre 2023, at https://www.climamaison.com/lexique/economies-d-energie.htm
[15] :BOUZEKRA,M.GUENAOUI,M. (2014). The contribution of new technologies to energy saving in building in Algeria, strategy or prestige. Master Thesis, Abderrahmane Mira University – Bejaia, Faculty of Technology Department of Architecture

In 2006, a directive from the European Parliament defined energy efficiency as "the relationship between the results, service, merchandise or energy that we obtain and the energy devoted to this effect". So it is "do better with less". Improving energy efficiency therefore consists, compared to a reference situation, of either:

• Increase the level of service provided, at constant energy consumption.
• Save energy for equal service provided.
• Do both simultaneously.

Thus, energy efficiency solutions aim to improve the performance delivered with lower energy consumption. Energy efficiency is all the better when you can do the same thing, or more, with less energy.[16]

I.2.4.1 Approach and stages of energy efficiency:

To achieve this objective within a building, two types of complementary strategies can be employed:[17]

• Passive energy efficiency involves minimizing losses by improving the thermal performance of the building, such as through enhanced insulation and the use of insulated glass windows.
• Active energy efficiency focuses on reducing energy consumption through the optimization of equipment and systems' operation.
• User behavior: training, awareness of energy efficiency.
• So in terms of energy efficiency, three levers must be used:

✓ The reduction in needs relating to buildings.

✓ Improving technical building equipment and their management.

✓ User behavior.

It is therefore a question of controlling energy consumption with a view in particular to protecting non-renewable natural resources such as oil, gas, coal or wood. Energy saving became a major issue at the end of the 20th century, when a double observation was made: fossil energy sources non-renewable energy sources, such as fossil fuels, release CO2 into the atmosphere when combusted, contributing significantly to rapid global warming on the human time scale[18].

I.3 Bioclimatic architecture

I.3.1 Definition:

Bioclimatic architecture refers to architecture that integrates climate and environmental conditions to achieve thermal comfort in spaces for human life and development.This is achieved through appropriately designed geometry, orientation, and construction of buildings tailored to the specific climatic conditions of their surroundings. Bioclimatic architecture relies primarily on design and architectural elements, minimizing reliance on mechanical systems, which are considered secondary supports. By reducing energy demands and fostering a sense of well-being through pleasant temperatures, controlled humidity, and ample natural lighting, bioclimatic architecture utilizes design techniques and high-quality materials adapted to different seasons and precise construction methods.[19]

I.3.2 Basic principle of bioclimatic architecture:

Bioclimatic architecture helps reduce energy needs, maintain pleasant temperatures, control humidity and promote natural lighting (figure 5).

1-Buffer zones, such as minimally heated spaces like garages or pantries on the north side of buildings, act as thermal insulation.

2- Compact shapes in building design minimize the surface area exposed to the exterior environment..

3-Strong thermal inertia: External insulation. High inertia materials.

[16] : : NGO, C. (2008). "Energy Resources, Technology and Environment". 3 ed. Paris: Dunod.
[17] : BENCHAMEM, M, BENHAMADA, I, ROUIDI,S. (2016). the impact of sustainable processes on quality energy of the building. ACADEMIC MASTER thesis, Mohamed Seddik Benyahia University – Jijel, Faculty of Science and Technology, Department of Architecture.
[18] Amira MEGUEHOUT Khawla DJEDDAI 2019 CONTRIBUTION OF SMART BUILDING IN ENERGY MANAGEMENT Master Thesis Mohamed Sedik Benyahia University – Jijel
[19] Nadji Mohammed Amine, creation of an eco-district, master's thesis, April 2015, p46.

4- Well-sized eaves or fixed and movable solar protection systems effectively prevent summer overheating while allowing winter sun penetration.

5- Adequate materials, such as breathable (non-waterproof) materials, help regulate humidity within homes and contribute to overall comfort.

6- Thermal and energy sensors are often placed on the roof to maximize capture efficiency, thereby covering a portion of the building's energy requirements..

7- Efficient heating: Low heating .[20]

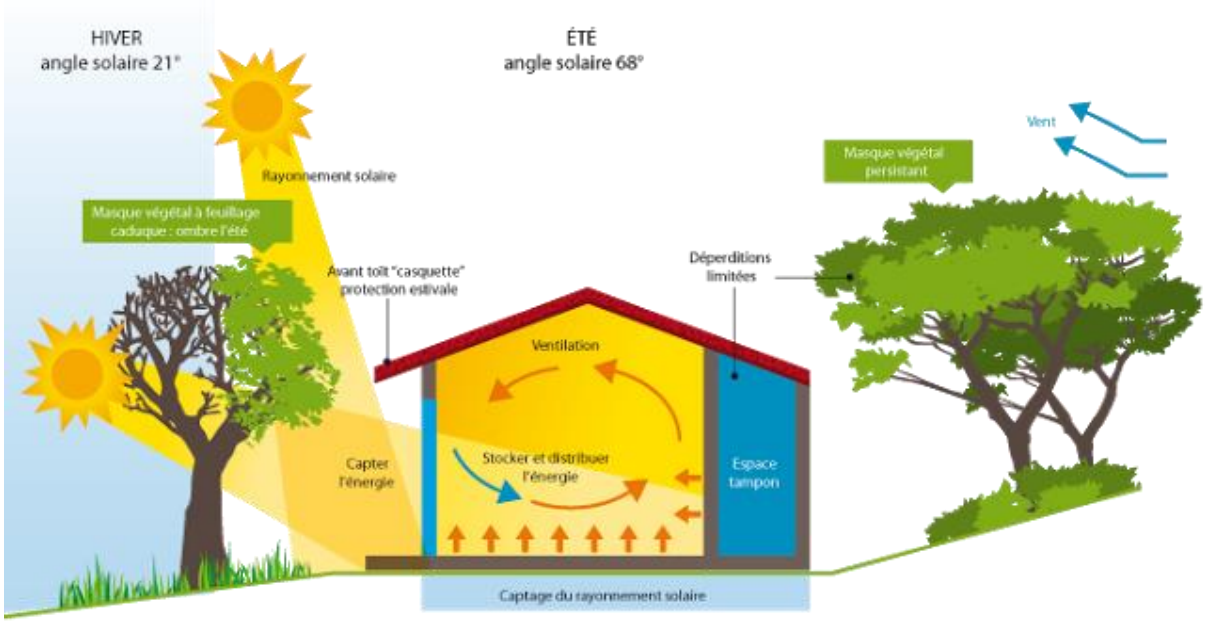


Figure 5: principles of bioclimatic design
https://www.e-rt2012.fr/explications/conception/explication-architecture-bioclimatique/

I.4 Thermal Comfort: The Interplay of Environmental Design and Shading Strategies in Architecture

I.4.1 Definition Thermal Comfort:

Thermal comfort has several definitions depending on the consideration of the human being either as a self-regulated thermal machine, a physical object or an active person affected by their sensations. (Moudjalled, B. 2007). Let us quote: -thermal comfort is Satisfaction with the thermal environment expressed by the state of mind, which is evaluated subjectively. (ANSI/ASHRAE Standard, 2017 cited by: BESBAS, y.2017) - by Jean-Yves Charbonneau: “like the satisfaction expressed with regard to the thermal environment of the surrounding environment. »(Charbonneau, J-Y, 2004). - thermal comfort is satisfaction with the thermal environment expressed by the state of mind, which is evaluated subjectively. (Givoni, B. 1978).

I.4.2 Thermal comfort aspects:

A-Physiological aspects: Man has a dynamic thermoregulation system which makes it possible to control and regulate the internal and external heat exchanges of the human body, in order to maintain body temperatures at their set values.

B-Physical aspects: human produces and exchanges heat with his environment. Its internal heat production is distributed throughout its body mass while its external heat exchanges take place on the skin surface or in the form of:

Conduction: heat propagates inside matter (the same solid body or even liquid or gaseous fluid) from particle to particle.

[20] FECIH Mebarek .2021. The effect of shade on thermal comfort Center for art and culture. Master Thesis p 13

Convection: transfer between air and solid matter resulting from the movement of particles (air) at the interface.

Radiation or radiation: transfer from one body to another by electromagnetic waves, therefore without direct contact.

Humidity: This involves exchange through evaporative caloric loss on the skin and wet surfaces (lips, eyes, respiratory tract). Humidity does not have much impact on heat exchange.

Heat balance: The metabolic heat produced in the body can be stored therein, inducing an increase in internal temperature, Heat is either dissipated into the environment through the skin surface or released through the respiratory route.[21]

C-Psychological aspect: the psychological aspect concerns the sensation and behavior of the individual in a thermal environment.

I.4.3 Parameters influencing thermal comfort:

The comfort criteria most commonly used in architectural design are based on the work of Fanger; the latter developed a theory according to which thermal comfort depends on 6 parameters:

1. Metabolism: This refers to the internal heat production in the human body, maintaining a core temperature around 36.7°C. During movement, additional metabolic heat corresponding to the specific activity level is added to the basal metabolic rate at rest. Metabolic rate is often quantified using the unit "met."

2. Clothing: Clothing provides thermal resistance against heat exchange between the skin surface and the environment. Similar to insulation in a house, clothing helps retain heat within the body.

3. Ambient air temperature (Ta): This is a primary factor in cooling the body. It refers to the temperature of the surrounding air.

4. Wall temperature (TP): Felt comfort temperature, also known as dry resultant temperature or operational temperature (Trs), takes into account both ambient air temperature (Ta) and wall temperature (TP). It is calculated as Trs = (Ta + TP) / 2.

5. Relative humidity (RH): RH is expressed as a percentage and indicates the amount of water vapor present in the air relative to the maximum amount it can hold at that temperature when saturated. 6- Air speed: This parameter influences heat exchange by convection in practice, in a building, air speeds should not exceed 0.2 m/s. in fact, the individual begins to feel the movement of the air at this speed, and the designers of mechanical ventilation systems therefore try not to exceed it; in natural hygienic ventilation of housing, it is more difficult to ensure air speeds, given the influence of wind and temperatures on air movements.

In the case of natural ventilation, correct sizing of vents and chimneys is supposed to avoid excessive drafts. Some chassis vents are also self-regulating depending on the strength of the wind, which is additional safety. [22]

[21] FECIH Mebarek .The effect of shade on thermal comfort Center for art and culture Juillet 2021 . Master Thesis p 15

[22] Alain Liébard and André De Herde. Treatise on bioclimatic architecture and town planning. The monitor.Paris: observ'ER,2005,

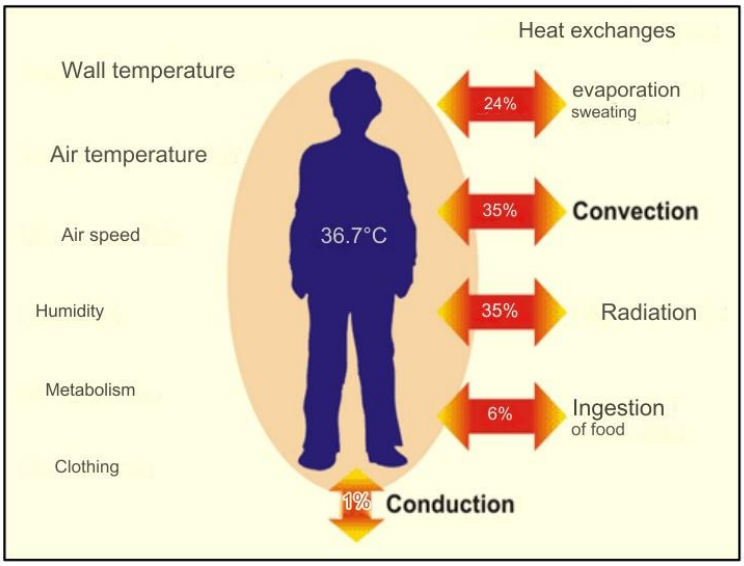


Figure 06: the heat losses of the human body depend on 6 physical parametersSource: https://www.inex.fr/ingenierie-thermique-etenvironnement/expertise-environnement/confort-etsante/confort-et-sante

I.4.4 Thermal comfort strategies in buildings:

The concept of thermal comfort is influenced by multiple factors and cannot be attributed to a single cause. It is affected by various elements such as the building's condition, environmental factors, and the physical characteristics of the occupants themselves.

To comprehensively address thermal comfort issues, several strategies must be considered. Some of these tactics include:

1- knowledge of the environment of the proposed site.
2-Orientation of the building.
3-Volume and configuration of the building.
4- Adequate ventilation to ensure proper air circulation and freshness
5-Types of construction materials and finishes used.
6-Integration of construction elements during the design of buildings 16[23]

II. The effect of shade on thermal comfort:

II.1 Notions of Shadow:

• Dark zone resulting from the interception of light or the absence of light: at setting sun, the valley is in shadow.17 [24]
• Comparative darkness and coolness caused by the shelter of the direct sunlight. 18[25]

II.2 Need for the shadow:

When ambient temperatures are within or above the comfort zone, any solar radiation entering can contribute to discomfort, so shading designs must prevent this. However, during cooler times of the year, it may be beneficial to allow solar radiation to enter directly into rooms to provide effective heating. This can be achieved through movable shading devices or by geometrically selective design.

II.3 The function of the shadow:

[23] International Journal of Scientific & Engineering Research Volume 8, Issue 12, December-2017 1023 ISSN 2229-5518

[24] https://www.larousse.fr/dictionnaires/francais/ombre/559
[25] https://www.dictionary.com/browse/shade

The functional requirements for shading vary with region and climate. Solar radiation entering a room can have three primary effects:
1) Radiation absorbed by room surfaces increases air temperature.
2) Direct solar radiation on occupants increases their average radiant temperature.
3) High-intensity radiation from the sun or diffuse sky can cause discomfort glare or disabling glare, impairing visual performance.
The function of shading is to mitigate these effects:
1) Reduce the total amount of radiation entering the room through reflection and absorption.
2) Improve the distribution of natural light within the room.

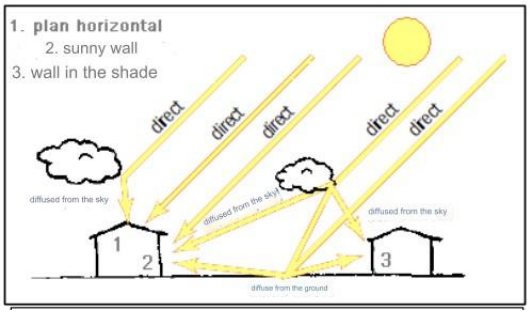


Figure 07 Sunshine on the different walls
Source: www.regionpaca.fr

II.4 The different shading techniques:

Solar control can be achieved by the following technical means:

II.4.1-Shape and orientation of the construction:

For a comfortable building, it is better to favor simple and compact shapes21. However, the shape of the building influences:

• The overall balance of energy irradiance from the sun.
• The rate of heat loss.
• The flow of flows around buildings.

Thus, according to V. Olygay, the optimal shape of a building minimizes heat loss in winter and heat gain in summer. To determine the optimal orientation of a building, three factors should be considered:

1. Solar radiation: Analyzing the intensity of solar radiation on surfaces oriented in different directions, along with diurnal and seasonal variations, helps define the orientation that minimizes heat gain from solar radiation.
2. Prevailing wind: Effective cooling through natural ventilation relies on capturing prevailing winds. This orientation may not always align with the optimal solar orientation, requiring a balance between solar heat gain and natural ventilation benefits.

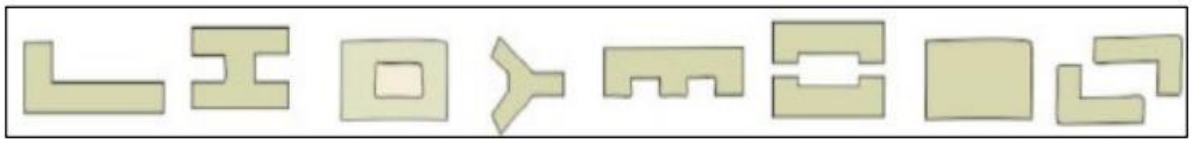


Figure 08: Orient longer facades along the north. This will provide glare-free light in northern summer without shading and penetration of the southern winter sun.
Source: http://www.nzeb.in/knowledge-centre/passive-design/form-orientation

3-Topography: The surface of the environment can store and reflect solar radiant heat towards the building, depending on the angle of the surface relative to solar radiation and the type of surface. 23[26]

[26] Kamal, M. (2012). Un aperçu des Techniques de Refroidissement Passif dans les Bâtiments : Concepts de Conception et Interventions Architecturales.

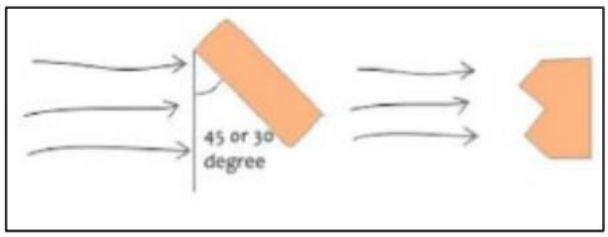


Figure :09 Place buildings at a 30 or 45 degree angle to wind direction to improve ventilation. Shape can be staggered in the wind facing direction equally to achieve the same result

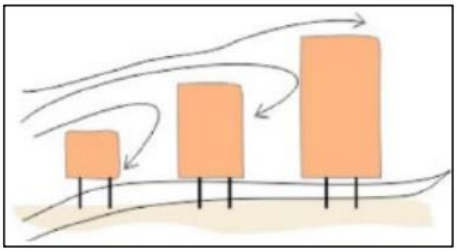


Figure: 10 If a site has several buildings, they should be arranged in ascending order of their authors and be built on stilts to allow ventilation.

Source: http://www.nzeb.in/knowledge-centre/passivedesign/form-orientation

II.4.2 Shading Devices:

The use of shading devices is a crucial element in many high-performance building design strategies. Shading devices have been shown to improve energy efficiency, mitigate glare, increase the availability of useful daylight (between 100 ~ 2000 lux), and enhance a sense of security.

Recognizing these potential advantages, a variety of shading configurations have been developed and introduced to the market, including fixed, manual, and automatic movable devices, both internal and external. Consequently, numerous simulation tools have been created to support shading design.

Operating Principle: The orientation of an opening and the incident solar radiation are pivotal in designing external shading devices. Seasonal variations in the sun's trajectory affect the impact of solar radiation. In the northern hemisphere, during winter, the sun's path is at a low angle slightly south of east and west. In summer, it is at a high angle and north of east and west. Therefore:

- South-facing openings require shading that allows low-angle sun penetration for heat gain in winter but blocks it in summer.

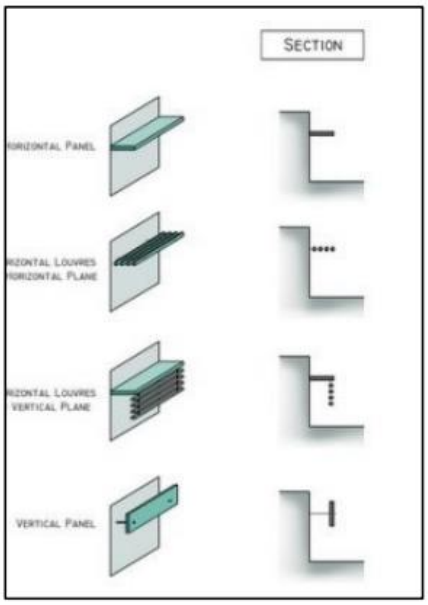
- North-facing openings primarily need shading to prevent high-angle sun penetration during summer.

- East- and west-facing openings experience less variation in solar radiation with seasonal changes in the sun's path..[27]

II.4.2.1 Fixed external shading devices:

Fixed shading devices are frequently chosen over mobile ones because of their simplicity, low cost, and minimal maintenance requirements. However, their effectiveness is somewhat limited compared to movable shading devices, which can dynamically adjust to changing sun angles and seasonal variations.
1-Overhang, horizontal panel
2-Overhang, horizontal louvers in the horizontal plane
3- Overhangs and vertical plane horizontal louvers: Optimal orientation towards south, east, and west; shorter overhang length improves effectiveness.[28]

[27]https://fairconditioning.org/knowledge/passive-design/shading/
[28] https://fairconditioning.org/knowledge/passive-design/shading



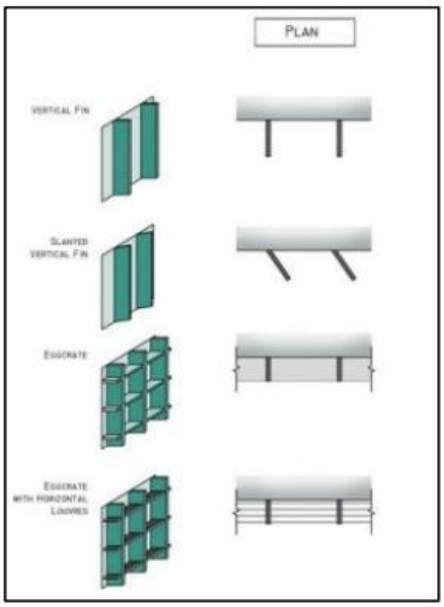


Figure 11: vertical shading devices Figure 12: shading devices horizontal
Source: tboake.com

II.4.2.2 Mobile external shading devices:

External mobile shading systems are installed on windows and glass facades of buildings to dynamically regulate solar heat entry and visual light transmission. These systems not only impact the cooling/HVAC load by controlling solar heat penetration but also offer sophisticated natural daylight management..

there are various options for external shading and solar control features for buildings:

1.Shutters
2. Sunscreens
3. Roller Blinds
4. Awning
5. Fabric Blinds
6. Horizontal Rotation Winds
7. Rotating Vertical Fins
8. Horizontal Rotating Shutters (Egg Rate)
9. Exterior Frames with Movable Awnings, Bamboo Chicks[29]

Figure 13: Rotating vertical fins: robotics and mechatronics center by Birk Heilmeyer and Frenzel Architects, Weßling, Germany Source: https://co.pinterest.com

[29] http://www.beepindia.org

II.4.3 Interior shading devices:

Interior shading systems have limited effectiveness in controlling solar gain compared to exterior systems. They are less efficient because they permit solar heat to enter the building before being intercepted, whereas exterior systems intercept solar heat before it reaches the building envelope.

II.4.4 Mutual Shading:

Building blocks should be arranged to utilize mutual shading, which helps reduce solar exposure on vertical surfaces during the summer months.

III.3.4 The use of vegetation for shading: The characteristics of plants, such as foliage density, canopy height, and distribution, should be tailored to meet specific shading requirements.

II.4.5 Roof shading:

Surface shading can be integrated as part of the building element itself or achieved through the installation of a separate roof structure.

II.4.6 Shading by textured surfaces:

Surface shading can also be provided as an integral part of the building element

II.4.7 Solar control glass:

Large area glazing has become a matter of course in modern buildings, but unwanted room heating can become a problem in summer; This is where solar control insulated glass can help, they let in daylight, but reduce the amount of incident solar energy,[30]

III. Exploring kinetic architecture

Introduction

In the realm of contemporary architecture, the paradigm is shifting from static, unyielding structures to dynamic, adaptive ones. This evolution is not merely aesthetic or novel; it is rooted in the pressing need for sustainability, efficiency, and improved occupant comfort. At the forefront of this architectural revolution is the concept of kinetic architecture, which introduces the dimension of movement into the built environment, allowing structures to adapt and change in real-time. Coupled with this is the burgeoning field of self-shading buildings, which utilize dynamic elements to modulate light and heat, ensuring optimal interior conditions with minimal energy expenditure.

Kinetic architecture challenges traditional architectural notions by embedding flexibility and movement into structures. No longer just shelter or static spaces, buildings become living entities, capable of transformations that can optimize their performance based on external conditions and internal requirements. This is not about movement for movement's sake, but rather a calculated and purposeful adaptation to enhance the structure's utility, longevity, and relationship with its surroundings.

On a parallel track, the emphasis on energy conservation and the mitigation of the urban heat island effect has propelled interest in self-shading building designs. In regions with significant solar exposure, the sun's radiant energy can substantially increase a building's cooling demands. Self-shading mechanisms offer a proactive solution, adjusting in real-time to block or allow sunlight, thus regulating thermal gain and ensuring a balance between natural illumination and shading.

III.1 Définition :

Kinetic structures harness energy; movement in one part triggers a ripple effect throughout. They are dynamic yet unstable. Introducing forces can lead to unforeseen reactions, but humanity adapts by building new environments atop previous ones. (Stan, 2006).

[30] FECIH Mebarek .The effect of shade on thermal comfort Center for art and culture Juillet 2021 . Master Thesis p25-p29

They exist both inside and outside buildings, and nature abounds with them. A keen eye can perceive them; an artist can construct them (Stan, 2006). When visible within interior spaces and in the building's surroundings, they bring a rich variety of forms inside and integrate with nature (Stan, 2006). Kinetic architecture involves creating spaces and objects that can physically reconfigure themselves to adapt to changing needs, forming an adaptable architecture. This intersection unveils a physical architecture uniquely suited to meet today's dynamic, flexible, and ever-changing demands. Kinetic design relies on motion to achieve its effects (Zadinac, 2009)..[31]

III.1.1 Interactive Forces in Kinetic Architecture:

Static movement: Forces applied during the design process via computer-aided programs, causing building design modifications (movements) solely during the drawing phase.

Dynamic movement: Integration of technologies into buildings with mechanized structures that transform based on climate, needs, or purpose.[32]

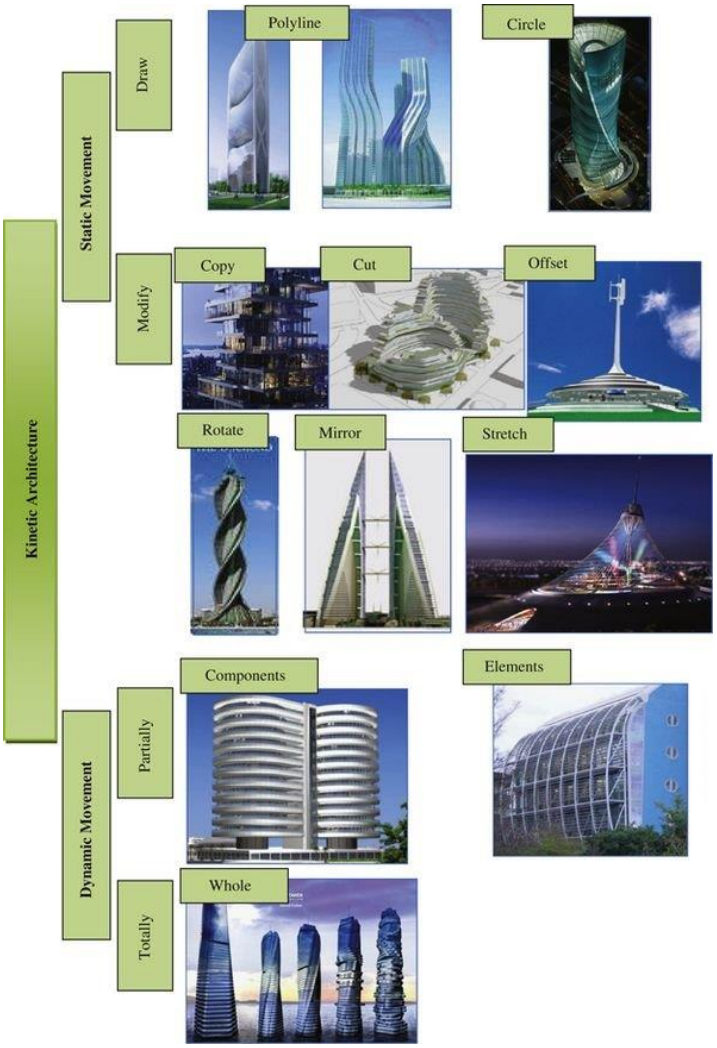


Figure 14: Forces in kinetic architecture and architectural response
Source : https://www.sutori.com/en/story/passive-design-in-architecture-dancing-facades 13/12/2023

[31] El Razaz , Z .(2010) . Sustainable vision of kinetic architecture
[32] El Razaz , Z .(2010) . Sustainable vision of kinetic architecture

III.2 Common définitions :[33]

Façade: Traditionally refers to the vertical plane of a building's construction.

Envelope: Refers to the total building enclosure.

Building Skin: Initially distinguished cladding from structure, now denotes the envelope as an intelligent environmental system exchanging energy, material, and information.

Kinematics: Studies motion independently of forces or masses, focusing on the "geometry of motion."

Kinetics: Examines laws of motion, considering forces and masses involved.

Dynamics: Studies forces affecting movement, often in relation to building systems or movable envelopes.

Retractable: Describes textile membrane roofs in architecture that fold or bunch; "movable" is a simpler term for such systems.Convertible: Refers to building structures or features designed to adjust quickly based on varying needs. It can relate to external building changes or internal space alterations.

Transformable: Pertains to objects or structures that can undergo controlled change, such as folding, retracting, or shape-shifting.

Performative: Describes a building skin's capability to regulate external factors according to specific architectural requirements, mediating between user comfort and the environment.

Adaptive: The ability of a system to autonomously adjust and adapt to changing circumstances. For building envelopes, it's about altering behavior or configurations based on external variations.

Responsive: Refers to systems that move or react. It contrasts with "manipulate," meaning systems controlled externally. In this context, a responsive system takes an active role, undergoing changes based on computations.

III.3 Kinetic Architecture Applications:

In the realm of contemporary architecture, kinetic systems have emerged as a significant paradigm, offering dynamic adaptability and aesthetic variations. Figure 02 broadly classifies the applications of these systems into three main categories:

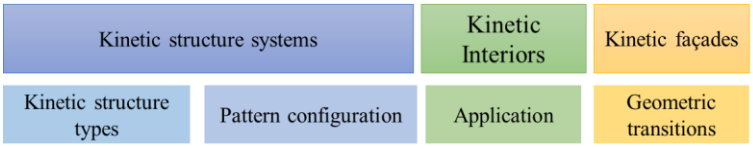


Figure 15 : three main categories of Kinetic Architecture Applications
Source : author 2023

III.3.1 Kinetic Structure Systems[34]:

These systems, as described, can alter their position, mobility, or shape through various performance methods such as pneumatic, chemical, magnetic, natural, or mechanical means. Kinetic structures can be categorized into three groups as demonstrated. in Figure16 :

[33] El Razaz , Z .(2010) . Sustainable vision of kinetic architecture
[34] Prof. Dr. Ashraf Elmokadem, Prof. Dr. Magda Ekram, Dr. Ahmed Waseef, Basma Nashaat 2016 Kinetic Architecture: Concepts, History andApplications

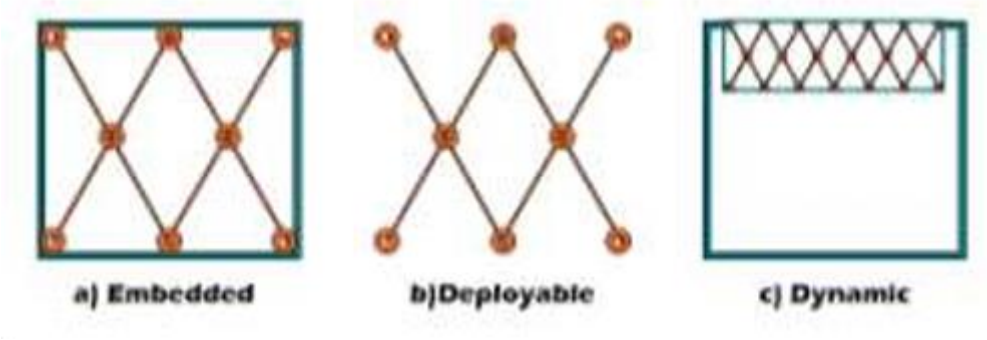


Figure 16: Kinetic structure categories

Souce : M.C. Phocas, "Initiations and Future Directions in the Development of Kinetic Structures for Earthquake Resistance," J of Archit Eng Tech, 10 (2), 2013.

1. Embedded Kinetic Structures: As the name suggests, these are firmly rooted in their location and work to control the overarching architectural system. An application might be structures that assist in damping the effects of earthquakes.

2. Deployable Kinetic Structures: These are more transient structures, designed to be transportable and usually temporary.

3. Dynamic Kinetic Structures: These structures, integrated within larger architectural systems, possess autonomy in their operations and can be categorized as follows:

1) Mobile systems:Capable of physical movement between different architectural spaces.

2) Transformable systems:Able to alter their shape to assume different three-dimensional configurations, often used to meet spatial or functional requirements.

3) Incremental kinetic systems: Can be added to or removed from a building as needed.

Additionally, kinetic devices can be arranged in patterns across two or three dimensions to create diverse kinetic structures. Among the various pattern designs, two common configurations are:

a) Centric configuration: Focuses around a central point within the space. Two typologies within this configuration include:

1) Pivotal: Organized around a central supporting element (pivot), with kinetic devices typically operating radially from the center to the perimeter. An umbrella-like structure exemplifies this configuration.

2) Peripheral configuration: Comprises supporting elements located around the perimeter of the form. For instance, the retractable roof of the Qi Zhing tennis center in China (shown in Figure 17) illustrates this configuration..[35]

[35] Prof. Dr. Ashraf Elmokadem, Prof. Dr. Magda Ekram, Dr. Ahmed Waseef, Basma Nashaat 2016 Kinetic Architecture: Concepts, History andApplications

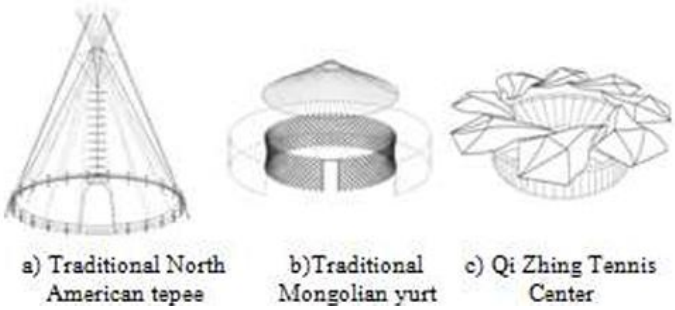


Figure 17: Kinetic architectural structures with centric configuration
Source : C. Stevenson, "Morphological principles of kinetic architectural structures," In Proceedings of The Adaptive Architecture Conference, pp. 1-12, 2011.

b) Linear configuration :

This type revolves around an axis, either straight or curved, comprising a series of modules (kinetic devices) linked by their edges or vertices to transmit movement from one to the next, as depicted in Figure 18. Table 1 provides an example of each type of kinetic structure system.

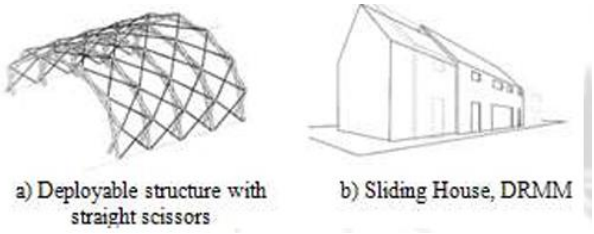


Figure 18: Kinetic architectural structures with Linear Configuration
Source: C. Stevenson, "Morphological principles of kinetic architectural structures," In Proceedings of The Adaptive Architecture Conference, pp. 1-12, 2011.

III.3.2 Kinetic Interiors

This application of kinetic design concepts spans various scales, from shop fronts to kinetic walls. The paper summarizes the main categories of this application as:

III.3.2.1 Transformable Spaces

Throughout history, architects and interior designers have endeavored to create living and workspaces that are dynamic and adaptable to meet the evolving needs of their occupants. This concept is applied across various levels, including the design of multi-functional furniture and spatially flexible areas. For example, in Figure19[36]

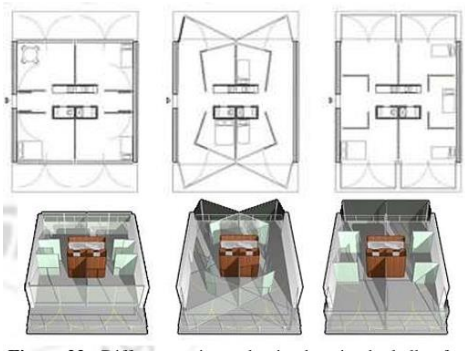


Figure 19: Different options adapting housing by kalhoefer Korschildgen
source : S. Murray, S. Whibley, D. Ramírez-Lovering, Re

[36] Prof. Dr. Ashraf Elmokadem, Prof. Dr. Magda Ekram, Dr. Ahmed Waseef, Basma Nashaat 2016 Kinetic Architecture: Concepts, History andApplications

Housing. RMIT Publishing, Melbourne, 2008.

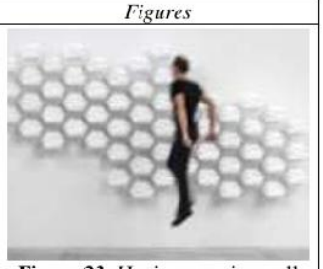
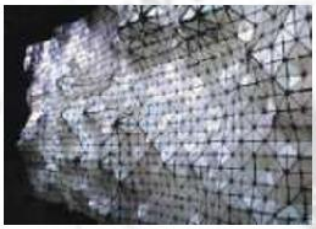
III.3.3 Kinetic Walls

Kinetic walls create the impression of responding to actions through arrays of connected elements. This response is achieved through three different strategies [34]:

1. Centralized capture: Movement is detected centrally using cameras, followed by inductive computer analysis of captured images to calculate and initiate a corresponding reaction.
2. Decentralized capture: Movement is detected by sensors distributed across the wall, followed by deductive analysis and centralized calculation to initiate a corresponding reaction.
3. Fully decentralized capture: Movement is detected entirely by decentralized means, with a direct, local reaction initiated by numerous small elements.

Table 01 illustrates examples of kinetic walls and introduces their concepts.

Source: Elmokadem, A., Ekram, M., Waseef, A., & Nashaat, B. (2018). Kinetic Architecture: Concepts, History and Applications. Journal Name, Volume(Issue), page numbers 756.

Project		*Figures*
Hexi Responsive Wall by Thibaut Sld	It consists 60 mounted panels, which use motion-tracking technology to decode actions of a person near it (walking - jumping - waving a hand) [35].	 **Figure 23:** Hexi responsive wall [35]
Tiny Fans Wall by Roosegaarde Studio	It consists of 8 m long structure with 640 small fans, It move when there is a near body in front of them [36]	 **Figure 24:** Tiny fans wall [36]
Aegis Hyposurface by dECOi Architects	It consists of a basic structure frame contains a number of pneumatic reactive actuators. They react to various motivations like light, movement and sound to move like waves [37]	 **Figure 25:** Aegis Hyposurface [37]
Kinetic Wall by Frank Barkow and Regine Leibinger	The surface consists of a translucent synthetic fabric and a pattern of motorized nodes in front of it. It looks like it is breathing in and out [38]	 **Figure 26:** Kinetic Wall [38]

III.4 Kinetic Facades

III.4.1 Definition of the adaptive facade:

Adaptability refers to a system's capacity to maintain its intended functionality while considering various criteria across different conditions. This is achieved through the design of variables that can adjust their physical values over time (Ferguson et al., 2007).

Adaptive facades are highly versatile multifunctional systems where the physical boundary between interior and exterior environments can alter its functions, characteristics, or behavior over time in response to performance demands and changing conditions. This adaptive capability aims to enhance overall building performance (Loonen et al., 2015).

Furthermore, these envelope systems can optimize energy savings by adjusting to current weather conditions and enhance occupant comfort by promptly responding to their needs and expectations (Loonen et al., 2013)

.III.4.1.1 The characteristics of adaptive facades:

Adaptive facades represent the forefront of modern architecture and technological research, driven by the aim to design dynamic envelope models. These facades utilize sensors, energy production systems, and smart materials to reduce a building's energy demand. According to Aelenei et al. (2018), this envelope typology is characterized by dynamic anisotropy, offering tailored solutions for different orientations of the building. Structural modifications adjust environmental flows based on local climatic conditions, including external environmental factors.

As part of the COST Action TU1403 collaboration, a characterization was conducted categorizing facade technologies by their purpose, as shown in Table 2.1. The purposes include enhancing thermal comfort, improving energy performance, maintaining indoor air quality (IAQ), and optimizing visual and acoustic performance, among other requirements.

III.4.1.2 Classification of adaptive facades:

The abundance of adaptive facade technologies necessitated a systematic approach to accurately understand and analyze them. The approach advocated by members of COST/GT n°1 focused on an analytical method: defining higher-level structures within the facade (facade-systems) and identifying the lower-level substructures (components and materials) comprising these higher-level structures. This approach also facilitated separate studies of the substructures.

In this context, case studies in the database were classified into three main groups, aligned with the following definitions:

• Material: Materials can exist in various states of refinement, including raw, extruded, or coated. Additionally, there are inseparably combined materials, such as bimetallics, which fall into this category. Examples include polymers, bimetals, steel, wood, and phase change materials.

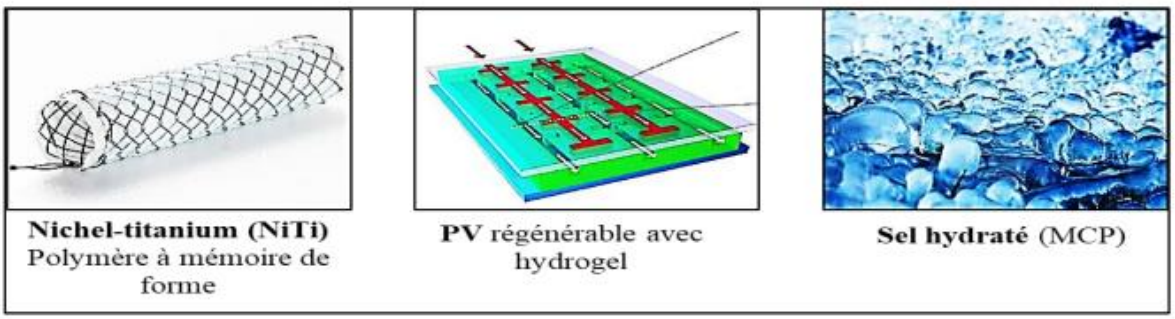


Figure20: Examples of materials used in adaptive facades.
(Source : Laura.A et al.,2018).

• A component is an assembly of various elements that together form a complete constructive or functional unit within a facade. For example, components could include systems an insulating glass unit but also a window frame including glazing or a solar protection device.

Figure 21: Examples of components of an adaptive system.
(Source: Laura.A et al., 2018).

A facade system comprises various transparent or opaque structural and technical elements that collectively provide essential functions such as insulation, water resistance, and airtightness. Examples of facade systems include:

- Prefabricated module curtain wall / Double skin façade /Ventilated façade /Kinetic facade.[37]

Figure 22: Examples of adaptive systems.
(Source: Laura.A et al., 2018)

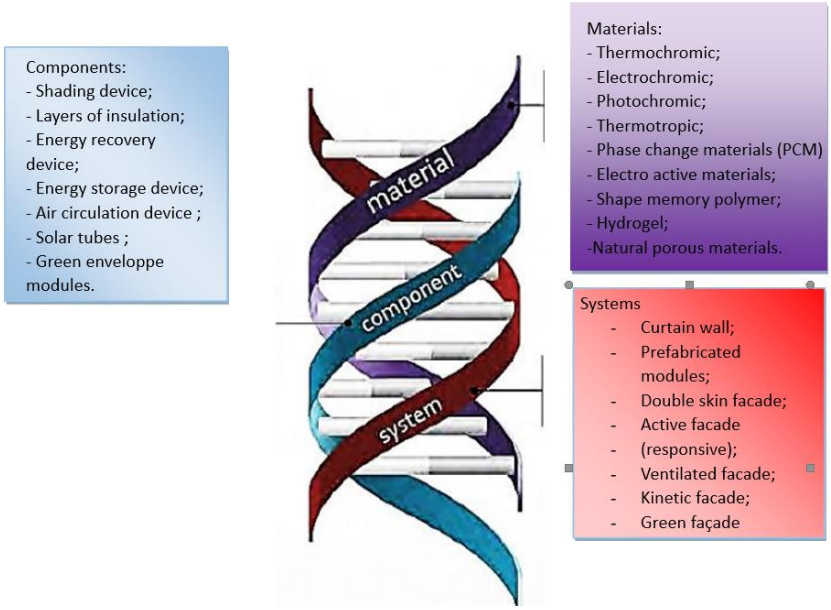


Figure 23: Conceptual diagram of the classification of adaptive facades.
(Source: Laura.A et al., 2018). - Treated by author-.

[37] Boukrouma Rayen 2020 Kinetic facades as alternatives to improve thermal performance in office buildings

III.4.2 Definition Kinetic facades:

The concept of kinetic facades involves employing geometric transformations to generate motion or movement in space. This motion or movement alters the physical structure or material properties of building facades while maintaining the integrity of the building structure. Kinetic facades are classified based on various transformations, with the most common classifications revolving around facade transformation: [38]

1) Translation: Movement occurs along a vector direction.

2) Rotation: Objects are rotated around axes.

3) Scaling: Expansion or contraction in size.

4) Motion through material deformation: Dependent on changeable material properties such as mass or elasticity.[39]

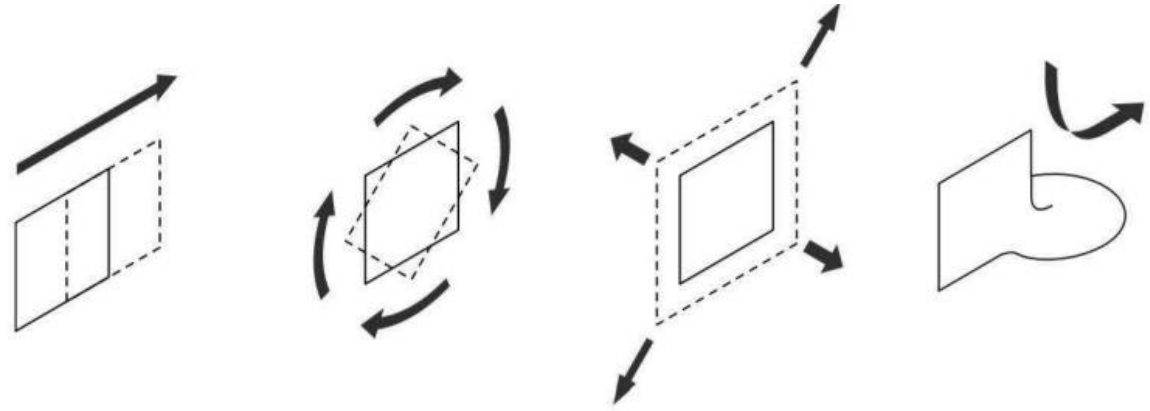


Figure 24: kinetic façade movement - (Source: MOLONEY Jules, DesigningKinetics for Architectural Façades : State Change, Routledge Editions, 3 juin 2011, p.22)

According to GREG Simmon (2017), the kinetic facade is considered a means that meets both human needs and environmental conditions. It is becoming more and more intelligent by making it possible to reduce the energy. Quite simply, it is designed to increase energy efficiency through adaptation to surrounding climatic conditions, particularly in environments with extreme climatic conditions.[40]

III.4.2.1 Spatial adaptation[41]

A. Sliding

sliding refers to the ability of panels or facade elements to move horizontally or vertically to adjust their position, sunlight or the needs of the occupant. This sliding movement can contribute to self-shading, thermal regulation, or the changing aesthetics of the facade.

here are two examples of adaptive architectural projects that integrate kinetic elements, particularly sliding, to create multi-purpose spaces and meet the changing needs of users. These two projects,

[38] R. Velasco, A.P. Brakke, D. Chavarro, (2015, July). "Dynamic façades and computation: towards an inclusive categorization of high performance kinetic façade systems," In Proceedings of The International Conference on Computer-Aided Architectural Design Futures, pp. 172-191, 2015.

[39] Prof. Dr. Ashraf Elmokadem, Prof. Dr. Magda Ekram, Dr. Ahmed Waseef, , Basma Nashaat,(2017à Kinetic Architecture: Concepts, History and Applications

[40] Boukrouma Rayen 2020 Kinetic facades as alternatives to improve thermal performance in office buildings

[41] Boukrouma Rayen 2020 Kinetic facades as alternatives to improve thermal performance in office buildings

“The Shed” , “Sliding House,” illustrate how architectural kinetics can be used to modulate space in innovative ways.

In the case of “The Shed,” it is a multi-purpose building designed to host a variety of artistic performances and events. It has a movable outer shell that unfolds along rails to create a gigantic reception area. When the hull is retracted, a large exterior space is available. The roof is made of a steel frame filled with semi-transparent cushions, which makes it a good insulator. The movement of the hull is by rails at the foot and top of the building, with large wheels to support the structure. This makes it possible to adjust the size of the space according to the needs of the shows and the number of spectators.

Figure 25 :The Shed- Diller Scofidio + Renfro
Source Shed, un centro para las artes / Diller Scofidio + Renfro | ArchDaily Colombia

The “Sliding House” is a detached house project located in the United Kingdom. It uses a sliding movement to connect three inhabited volumes. A mobile outer shell 28 meters long and weighing 50 tonnes slides along the site to create different combinations with the volumes, creating various interior and exterior spaces depending on its position. The motors necessary for movement are hidden in the hull and powered by solar panels on the roof. This house offers flexibility and the possibility of adding other modules as needed.

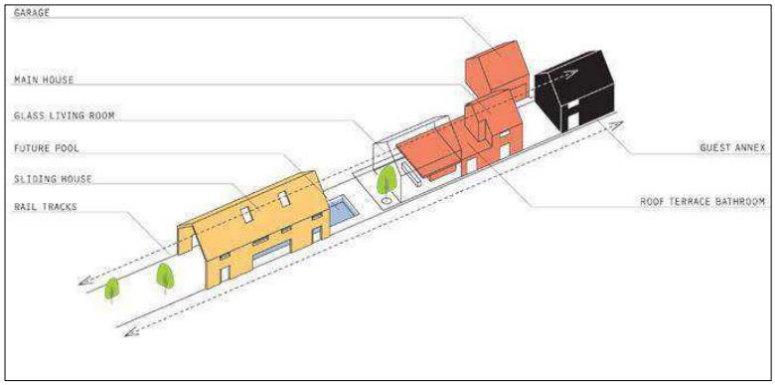


Figure 26 :The “Sliding House
Source I Should Be Laughing: Architecture Wednesday: The Sliding House

These examples highlight the importance of architectural kinetics to create adaptable and versatile spaces. They allow users to modulate their environment according to weather conditions, spatial needs and planned activities, thus offering varied and creative experiences.

B. Rotation

When we talk about "spatial adaptation" and "rotation" in the context of a kinetic facade, we generally refer to the ability of the facade or its elements to perform rotary movements to modify the configuration of the space interior or exterior of the building. Here's how this could be interpreted:

1- Rotation of Panels or Facade Elements: A kinetic facade can be designed to allow the rotation of individual panels or elements. These rotations can be used to adjust natural light entry, ventilation, visibility, or privacy in the interior space. The goal is to optimize the occupant experience and adapt the environment to changing needs.
2- Orientation Modulation: Façade rotation can also be used to change the orientation of the building relative to sun, wind or other environmental factors. This can help with thermal management, optimizing energy efficiency and creating sheltered or shaded outdoor spaces.
3- Response to Climatic Conditions: Facade rotation can indeed be utilized to adapt to varying climatic conditions. For instance, during periods of strong wind, rotating the facade can be effective in minimizing the wind's impact on the building's interior. This adjustment helps enhance comfort and maintain structural integrity by reducing wind pressure and turbulence inside the building.

The text describes an Apple store designed by Foster + Partners in collaboration with Apple's head of design. The store is located at the foot of the Burj Khalifa tower in Dubai, opposite the large fountains of the Dubai Mall, one of the busiest places in the city. The store design has several interesting architectural features:

The store is ideally located to maximize its appeal, being positioned at the heart of the action in a busy location in Dubai.

The store features a huge glass facade that opens onto the public space, reinforcing the visual connection between the interior of the store and its exterior environment. This feature creates a welcoming and attractive atmosphere for visitors.

The magazine has 18 wings (grouped in pairs) which can be folded by rotation. These woven panels serve to separate or connect the exterior terrace to the interior space of the store. During the day, these panels close to provide shade and comfort to customers, while at night, they open completely to reveal the store in the public square.

The panels are made from carbon fibers, which form a dense but light-permeable mesh. This allows natural light to be filtered in a pleasant way, creating a bright ambiance inside the store.

Figure 27: Apple StoreDubaï Mall- Foster + Partners
Source: Apple Dubai Mall / Foster + Partners | ArchDaily Perú

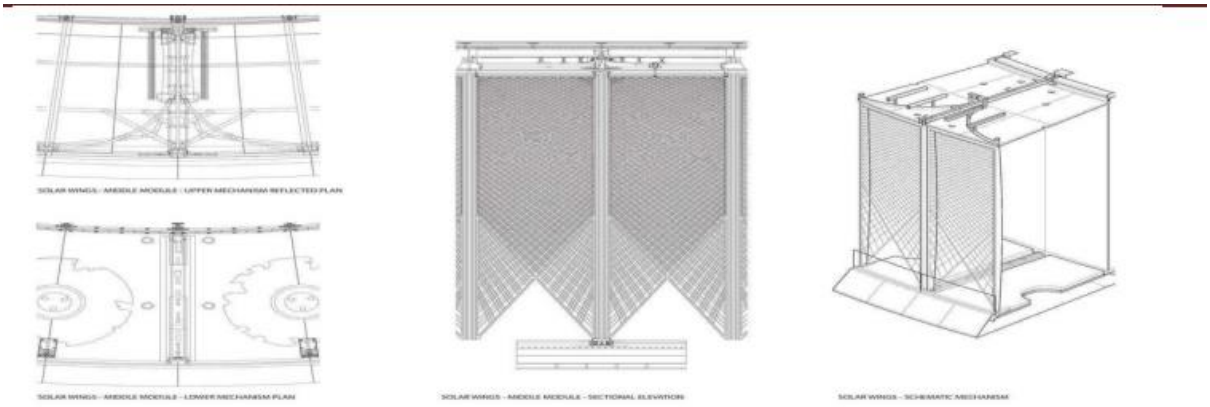


Figure 28:Apple Store Dubaï Mall– Détails techniques des ailes
Source : Apple Dubai Mall / Foster + Partners | ArchDaily Perú

This Apple store in Dubai stands out for its innovative design, notably through the use of rotating movable panels and sophisticated materials. It manages to offer a unique visual and spatial experience, in harmony with its lively environment and the needs of customers.

C. Deformation

When we speak of "deformation" in the context of a kinetic facade , we generally refer to the capacity of the facade or its elements to undergo structural or geometric transformations to modify the space interior or exterior of the building. Here's how this could be interpreted:

Deformation of Panels or Facade Elements: A kinetic facade can be designed to allow the deformation of individual panels or elements. These deformations can be used to modify the shape of the facade, creating interior or exterior spaces adapted to different activities or climatic conditions.

The Eco-29 project designed by FoxLin and Braham Architects is a multi-purpose event space that incorporates a kinetic interior double-skin facade. Unlike some other examples of architectural kinetics that use a movable exterior skin, Eco-29 opts for an approach based on a three-dimensional deformation of the interior facade material to create adaptable spaces. Here are the key points of this project:

- Spatial Versatility: Eco-29 was initially designed to accommodate weddings, but it was designed to be flexible and versatile to accommodate various types of events, such as pop-up shops or launches of products. This versatility is made possible thanks to a kinetic system which allows you to vary the configuration of the space.

Figure 29 :– Eco-29- FoxLin and Braham Architects
Eco-29 Interactive Wedding Hall - FoxLin Architects

- Tense Fabric Front:The interior facade is wrapped in a stretched fabric. Mechanical arms mounted on the walls and ceiling are used to deform this fabric surface, thereby generating

new spatial configurations. The choice of a white fabric allows significant deformations. This is an innovative approach to architectural kinetics that relies on deformation of the material itself rather than external moving elements.

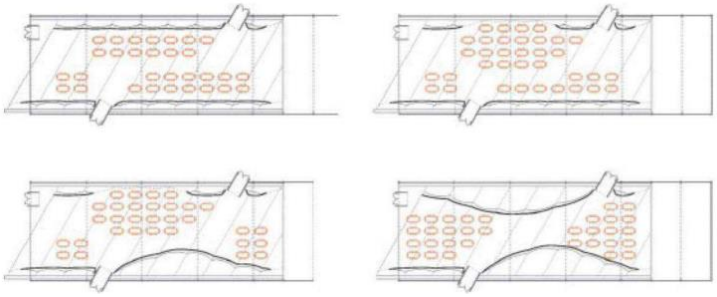


Figure 30 : - Eco-29- FoxLin and Braham Architects – Schémas de scénariid'aménagement
Eco-29 Interactive Wedding Hall - FoxLin Architects

- Custom Software Control:To achieve the deformations of the facade, the project uses two types of motors controlled by custom software. This software allows users to set the movement, speed and acceleration of each motor according to their needs. Users have the flexibility to create different shapes and spatial configurations based on their preferences.
- Three-Dimensional Flexibility: The primary objective of the project is to achieve complete three-dimensional flexibility of space. This entails architectural modifications that can adapt to evolving event needs. The kinetic facade plays a crucial role in creating a fully adaptable spatial environment, allowing for dynamic adjustments that enhance functionality and user experience as required.
- Use of Sustainable Materials: Part of the project involves the reuse of materials, such as reclaimed wood, to build the interior structure. This is part of an approach to sustainability and reduction of environmental impact

In summary, Eco-29 is a g reat example of how architectural kinetics can be used to create versatile, flexible and aesthetically interesting event spaces. The concept of three-dimensional deformation of the material allows great design freedom for users and dynamic transformation of space, thus providing a unique spatial experience for various types of events.

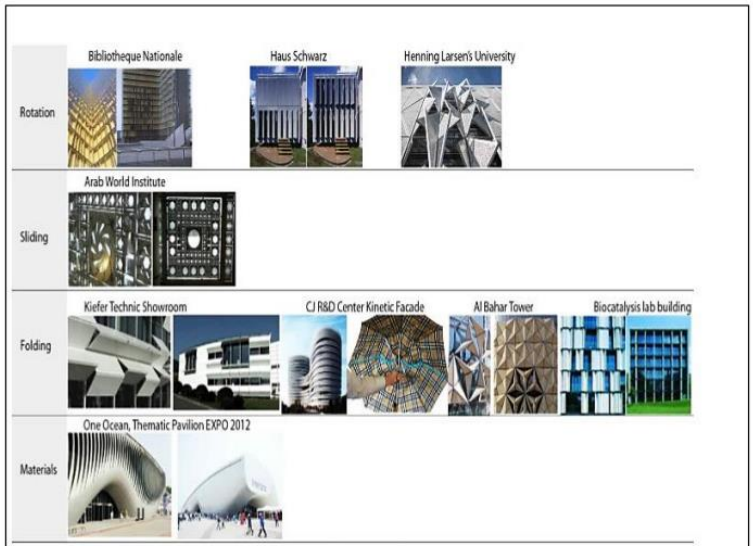


Figure 31: Examples of movements of different kinetic facades. (Source: El-Dbaa.,2016).

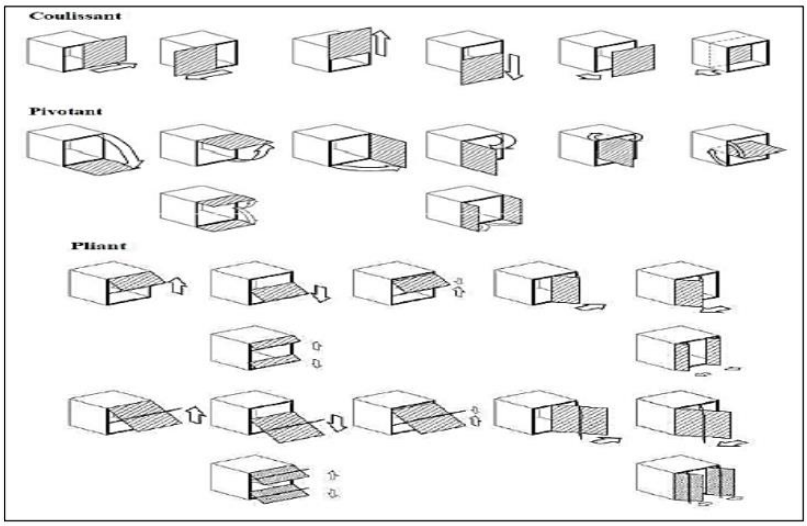


Figure 32: Typology of plane movement. (Source: Schumacher et al. 2010).

III.4.2.2 Types of movement controls:[42]

Michael FOX, the founder of the "MIT Group"[43] published a kinetic structure. FOX's major theoretical contribution is a classification of kinetic control systems; this identifies six (06) general types, classified according to the level of complexity as follows:

II.3.1 Internal control Mechanical movements, which have no direct control or mechanism. This type is based on the transformations made by the internal energy of materials.

II.3.2 Direct control involves actuating movement directly using an external energy source. Examples include electric motors, human energy, or biomechanical energy, where these sources directly initiate and regulate the movement of kinetic elements within a system.

II.3.3 Indirect control the movement is based on a feedback system from the sensors In a feedback system, the basic control setup starts with an external input detected by a sensor. The sensor then sends a signal to a control device.

II.3.4 Reactive indirect control This is the optimization of several reaction sensors; that is: The control device integrates data from multiple sensors to make informed decisions. It optimizes these inputs and sends an optimized command to the energy source to actuate the movement of a singular object

II.3.5 Pervasive indirect control This is a network of controls that uses algorithms. This system requires a "feedback" control algorithm that is predictive and self-adaptive.

II.3.6 Heuristic and reactive indirect control It is an algorithmically mediated network which has learning capacity. Movement in this level relies on people responding in singular or pervasive ways and being able to self-adjust.

III.4.2.3 Operating mechanism of a kinetic facade:

To understand how this type of dynamic interface works, several researches have been carried out in this context.

[42] Boukrouma Rayen 2020 Kinetic facades as alternatives to improve thermal performance in office buildings
[43] MIT Kinetic design Group: Group specializing in parametric design and kinetic design at the Massachusetts Institute of Technology. Cambridge. USA.

According to BRANKO and VERA., (2015), the operation of dynamic shading devices is based on the following three main phases:

- Data entry (Input);
- Treatment;
- The results (Output).

The following table shows the operating mechanism of this type of interface.[44]

Table 02: Operating mechanism of kinetic facades: (Source: Wejdane Dhia.A., 2016)

Data entry (Input):	Environmental variables	- Temperature.
		- Humidity.
		- Light.
		- Air components.
	Motion control type	- Internal
		- External
Processing of the systems used:	Systems based on mechanical means	- Use of engines;
		- Use of hydraulic systems.
	Systems based on smart materials	- Use of sensitivity sensors and — with internal movement.
Result (output): The movement of facade components	- Closing / Opening (Off/On);	
	- Pliant (folding) ;	
	- Shrinkage and stretching;	
	- Rotation ;	
	- Giration ;	
	- Scaling.	

III.4.2.4 Examples of kinetic facades:

The adoption of kinetic facades has become increasingly widespread., especially in developed countries which are interested in the subject of energy consumption. So, the examples are very numerous. In this chapter we try to analyze some of them.

A. Al-Bahr Towers:

The dynamic façade of El-Bahr Towers is designed as a contemporary interpretation of "mouchrabia". This is utilized as a shading device to maintain privacy while simultaneously reducing solar heat gain.[45]

[44] Boukrouma Rayen 2020 Kinetic facades as alternatives to improve thermal performance in office buildings

[45] Boukrouma Rayen 2020 Kinetic facades as alternatives to improve thermal performance in office buildings

Figure 33: The kinetic system of Al-Bahr Towers. (Source: https://www.researchgate.net/figure/The-Al-Bahr-Towers)

Each of the two towers features over 1000 transparent umbrella-shaped elements that open and close in response to the sun's position. These shading devices are managed by a building management system, creating a smart facade (Attia, S., 2017).

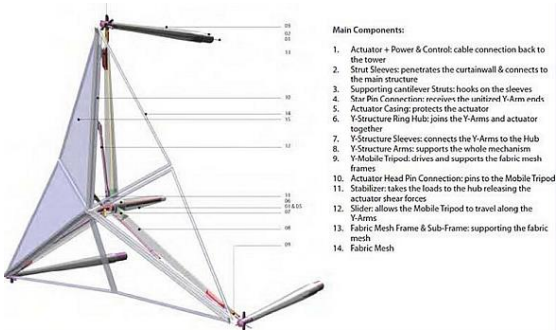


Figure 34: Conceptual detail of the kinetic component of the Al-Bah Towers facade. (Source : https://laviebohemetravel.wordpress.com).

Table 3: details of the kinetic facade of Al-Bahr Towers: (Source : Atia.S.,2017)

Descriptive details of the facade:	
Type of facade system:	▪ Reactive kinetic facade (Responsive system).
Functions/Objectives:	➡Thermal comfort; ➡ Visual and acoustic comfort; ➡Appearance (aesthetic quality).
Technological characteristics:	▪ Mobile screens to control solar radiation; ▪ Automation system for managing layouts and building envelope elements.
Type of materials:	▪ PTFE (Polytetrafluoroethylene).
Model of shading devices:	▪ Triangular unit.
Trigger type (Input):	▪ Optical. (Light level)
Actuator type (Output):	▪ Mechanics.
Type of control :	▪ Intrinsic. (Self-reactive)
System reaction time:	▪ Per minute.
Degree of system adaptability:	▪ Gradual.
Degree of spatial adaptation:	▪ Per centimeter.
Level of visibility:	▪ Visible change in size and shape of dynamic elements.
System maintenance frequency:	▪ Annual.

B. KIEFER Technic Showroom:

The office building incorporates an exhibition space situated on the southwest side of the existing production halls. Its facade is designed to showcase the creative manipulation and precise, innovative processing of stainless steel, featuring a dynamic shading system that spans the entire facade.[46]

Figure 35: The kinetic system of the KIEFER Technic Showroom facade. (The different scenarios). (Source http://www.salazarposada.com/es/blog/detalle/blog-40).

The facade comprises 112 white metal panels that are individually and continuously movable using 56 integrated motors and an intelligent control system. These panels form a dynamic three-dimensional folding surface. This design allows for shading specific parts of the facade based on weather conditions or to create various media scenarios, as outlined by Susanne Gosztonyi et al. (2018).

Table 04: details of the kinetic facade of KIEFER Technic Showroom:
(Source: Susanne Gosztonyi.,2017)

[46] Boukrouma Rayen 2020 Kinetic facades as alternatives to improve thermal performance in office buildings

Descriptive details of the facade:	
Type of facade system:	▪ Kinetic facade.
Functions/Objectives	⇨ Thermal comfort ; ⇨ Visual and acoustic comfort; ⇨ Appearance (aesthetic quality); ➡ Using personal control.
Technological characteristics	▪ Mobile screens to control solar radiation; ▪ Automation system for managing layouts and building envelope elements.
Type of materials	▪ Aluminum - Stainless steel.
Model of shading devices	▪ Blinds with slat angle control.
Trigger type (Input)	▪ Optical. (Light level)
Actuator type (Output)	▪ Mechanics.
Type of control	▪ Extrinsic. (Requires external monitoring)
System reaction time	▪ Per second.
Degree of system adaptability	▪ Gradual.
Degree of spatial adaptation	▪ Per centimeter.
Visibility level	▪ Visible change in surface.
System maintenance frequency	▪ Annual.

C. KOLDING Campus Building

The KOLDING campus is a training center, which hosts communication, design, culture and language courses

Figure 36: The kinetic system of the KOLDING Campus Building facade. (Source: https://www.sdu.dk/en/om_sdu/byerne/kolding/Studieliv.)

The building facade consists of 1600 perforated steel solar panels controlled by self-adjusting sensors that monitor light and heat levels around the building, enabling them to open and close automatically. This system optimizes user comfort by regulating lighting and heating conditions, as described by Rosa Romano et (al. 2018).[47]

[47] Boukrouma Rayen 2020 Kinetic facades as alternatives to improve thermal performance in office buildings

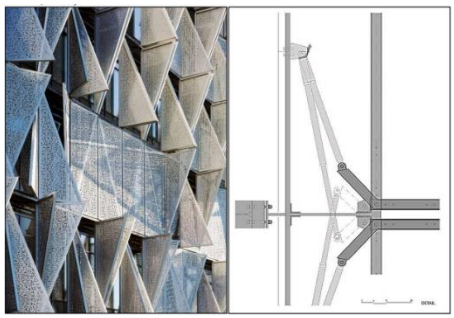


Figure 37: Conceptual detail of the kinetic component of the facade. (Source: http://arcdog.com/portfolio/)

Table 05: details of the kinetic facade of KOLDING Campus Building: (Source: RosaRomano.,2018)

Descriptive details of the facade:	
Type of facade system:	■ Reactive/Interactive kinetic facade.
Functions/Objectives	➡Thermal comfort; ➡ Visual and acoustic comfort; ➡ Appearance (aesthetic quality); ➡Personal control.
Technological characteristics	■ Mobile screens to control solar radiation; ▪ Automation system for managing layouts and building envelope elements.
Type of materials	▪ Perforated steel - Aluminum.
Model of shading devices	▪ Two-axis rotation
Trigger type (Input)	▪ Electromagnetic.
Actuator type (Output):	■ Mechanics.
Type of control :	■ Intrinsic (Self-reactive); ▪ Extrinsic.
System reaction time	▪ Second / minute / hour.
Degree of system adaptability	▪ Gradual.
Degree of spatial adaptation	■ Per centimeter.
Visibility level	▪ Visible change of dynamic elements.
System maintenance frequency	▪ Annual.

IV. Exploring Bio-mimicry

IV.1 Origins of Biomimicry:

The concept of biomimicry has deep historical roots, , the term itself gained prominence in the 1980s through the work of Janine Benyus. It's fascinating how the influence of nature on design has spanned centuries. Ancient Greek philosophers, like Aristotle, revered natural forms for their inherent wisdom, harmony, and balance—an ideal that resonated through classical aesthetics. By the nineteenth century, architects and designers began delving deeper into biology, moving beyond mere imitation of forms to explore the fundamental processes of growth and evolution. Visionaries like Le Corbusier and Frank Lloyd Wright integrated biological principles into their designs, with Le Corbusier heralding biology as pivotal in architecture and planning[48]

Early biological analogies in architecture indeed often remained superficial, focusing more on artistic representation than on a deep comprehension of biological principles. The 1920s and 1930s marked a period known as "biotechnique" or "biotechnics," where some concepts akin to biomimicry were explored, though without the rigorous engineering analysis seen today.

In recent years, biomimetics has gained significant momentum and depth. It involves a rigorous study of organisms and their behaviors to apply their principles in design and engineering. This contemporary approach builds upon earlier biological analogies in architecture, bringing scientific rigor and deeper insights into the theory and practice of design..[49]

IV.2 Definition of biomimicry:

Biomimicry is a multidisciplinary approach which consists of studying models of nature and reproducing the essential properties (shapes, materials or processes) of biological systems with a view to solving technological problems. But there is a fundamental difference between doing biomimicry and copying nature [50]

Biomimicry is a scientific approach which consists of imitating the most beautiful inventions of nature: the energy efficiency of photosynthesis, the solidity of coral, the resistance of spider silk threads, the adhesive properties of mussel filaments to adapt them to the service of man

Researchers, architects, philosophers, designers and artists define what biomimicry is today. It seeks to draw inspiration from nature to invent ecological solutions to problems that arise in various fields and to develop new interactions between man and his environment

IV.3 Design Approaches

In 2007, M. Pedersen Zari conducted a comparative literature review and analysis of existing biomimetic technologies at Victoria University in New Zealand. The study revealed distinct approaches to biomimetic design, each carrying its own set of advantages and disadvantages. These varied approaches can lead to significantly different sustainability outcomes. While some designers and scientists use biomimicry specifically to enhance sustainability in their creations, others employ it primarily for innovative novelty (Baumeister, 2007b). However, as Reap et al. (2005) demonstrate, adopting a biomimetic design approach does not guarantee that the resulting product or material will be more sustainable than its conventional counterparts when evaluated from a life cycle perspective. Generally, biomimetic design processes fall into two main categories: Problem-Based Approach and Solution-Based Approach.

[48] Salma Ashraf Saad El Ahmar 2011 BIOMIMICRY AS A TOOL FOR SUSTAINABLE ARCHITECTURAL DESIGN

[49] Salma Ashraf Saad El Ahmar 2011 BIOMIMICRY AS A TOOL FOR SUSTAINABLE ARCHITECTURAL DESIGN

[50] Définition du biomimétisme/http://tpe-biomimetisme-chimie.e-monsite.com/pages/le-biomimetisme-c-estquoi/definition-du-biomimetisme.html (consulté le 12/01/2020).

IV.3.1 The principles

The principle of biomimicry is to start from where you can, and go deeper and deeper until you can make things the way nature itself does. Biomimicry works in conjunction with chemists, designers, and Ecologists have discovered commonalities in all the ecosystems studied. From their notes we can draw a certain number of principles: (Figure38).[51]

Figure 38: Design Spiral by the Biomimicry Institute
Source : LE BIOMIMETISME OU L'ART DE S'INSPIRE DU VIVANT)

IV.3.2 Problem-Based Approach :

In the literature review, various terms have been used to describe a similar approach, such as "Design looking to biology" (Pedersen Zari, M. 2007), "Top-down Approach" (Jean Knippers, 2009), and "Problem-Driven Biologically Inspired Design" (Michael Helms, Swaroop S. Vattam, and Ashok K. Goel, 2009), all conveying the same concept.

[51] [51] Salma Ashraf Saad El Ahmar 2011 BIOMIMICRY AS A TOOL FOR SUSTAINABLE ARCHITECTURAL DESIGN

In this approach, designers seek solutions from the natural world by first identifying problems, which biologists then match to organisms that have successfully addressed similar challenges. This process is driven by designers setting initial goals and design parameters.

The methodology of problem-driven biologically inspired design follows a series of steps that are non-linear and dynamic in practice. Outputs from later stages often influence earlier stages, creating iterative feedback loops for continuous refinement (Michael Helms, Swaroop S. Vattam, and AshoK. Goel, 2009).

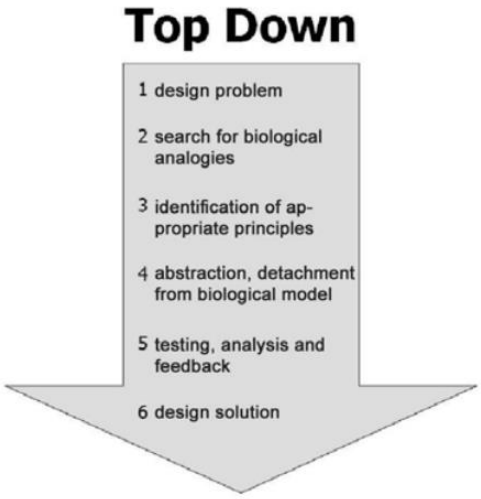


Figure 39: Top-Down Design Approach

Source :Salma Ashraf Saad El Ahmar 2011 BIOMIMICRY AS A TOOL FOR SUSTAINABLE The architectural design approach, as discussed by the Biomimicry Institute and elucidated in the Challenge to Biology Design Spiral Research at Georgia Institute of Technology by Michael Helms, Swaroop S. Vattam, and Ashok K. Goel in 2006, follows a structured process similar to that outlined by the Biomimicry Institute. This approach involves six distinct steps:

1. Problem definition
2. Reframing the problem
3. Searching for biological solutions
4. Defining the selected biological solution
5. Extracting principles from the biological solution
6. Applying these principles in design

These steps provide a systematic framework for integrating biological insights into architectural innovation (Michael Helms, Swaroop S. Vattam, and Ashok K. Goel, 2009).

IV.2.3 Example of Problem-Based Approach :

An illustrative example of this approach is seen in DaimlerChrysler's prototype, the Bionic Car (see Figure 4). To achieve a large volume with a small wheelbase, the car's design drew inspiration from the boxfish (ostracion meleagris), which despite its box-like shape, exhibits surprisingly efficient aerodynamics. Furthermore, the chassis and structure of the car were developed using a biomimetic computer modeling technique inspired by how trees grow to minimize stress concentrations. This approach resulted in a skeletal appearance where materials are strategically allocated to areas where they are most essential..[52]

[52] Salma Ashraf Saad El Ahmar 2011 BIOMIMICRY AS A TOOL FOR SUSTAINABLE ARCHITECTURAL DESIGN

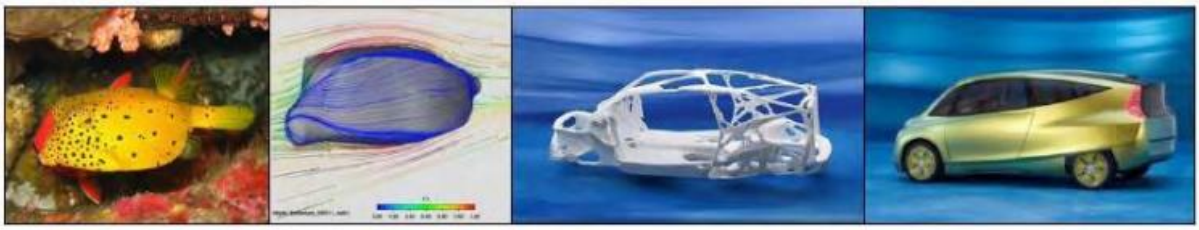
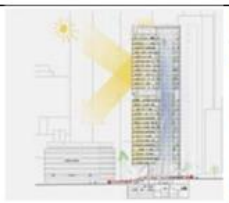


Figure 40: DaimlerChrysler bionic car inspired by the box fish and tree growth patterns. (Source: Pedersen Zari, M. 2007).

With ongoing technological advancements, modern buildings now incorporate systems for natural lighting, ventilation, water supply, and power, among others. These developments have facilitated the integration of nature-inspired features into sustainable solutions for buildings. Table 6 presents examples of biomimicry-inspired kinetic architecture and their sustainability impacts.

Table 6: Biomimicry – Kinetic Architecture – Sustainability Matrix Source: Hasan Gokberk Bayhan and Ece Karaca, 2019, "SWOT Analysis of Biomimicry for Sustainable Buildings – A Literature Review of the Importance of Kinetic Architecture Applications in Sustainable Construction Projects"

Biomi-micry examples from nature	Picture	Features	Architect. example of biomimic ry	Use in Kinetic Architecture	Picture of Kinetic Architecture Example	Sustaina-bility Impact
Termite Nest		Optimum air temperature Natural ventilation	Buildings constructed using ventilation with a chimney system.	The Blight Street structure has a natural ventilation system which represents a kinetic architecture example [14].		It provides energy conservation It provides fresh air It helps protect the heat level
White Butterfly		Sunlight reflection Energy storage	The wings of white butterflies have shaped the design of photovoltai c panels.	Peter Koch (project manager) say that the shutters open and close like butterfly wings in response to heat and light levels inside the building [15].		It takes advantage of daylight. It provides energy conservation.
Cuttlefish		Camou-flage properties Communic ation with colour change	It can be led on facades without energy.	The Galleria Centercity has a single reflective surface during the day, and the nights radiate different light waves [16].		Passive energy is obtained from sunlight absorption with the colour changes
Hippopota mus Skin		UV light absorption	UV-absorbing material has been developed for a building in Italy.	Brisbane Domestic Terminal Car Park absorb energy like water bath skin [17].		It provides energy conservation. Natural protect from the UV lights

IV.4 Levels of Biomimicry :[53]

[53] Salma Ashraf Saad El Ahmar 2011 BIOMIMICRY AS A TOOL FOR SUSTAINABLE ARCHITECTURAL DESIGN

According to the Biomimicry Guild (2007), biomimicry can be categorized into three levels—form, process, and ecosystem—each offering different aspects of organisms or ecosystems that can be emulated.

To enhance understanding and application in design, a framework has been proposed that refines these levels and clarifies biomimicry's potential to enhance the regenerative capacity of built environments. By categorizing evolved forms of biomimicry, this framework aids designers aiming to use biomimicry to advance sustainability in identifying effective approaches. It applies universally to both approaches: design inspired by biology and biology influencing design. The initial phase of this framework identifies the specific aspect of biology being mimicked, termed here as a "level" (Pedersen Zari, M. 2007).

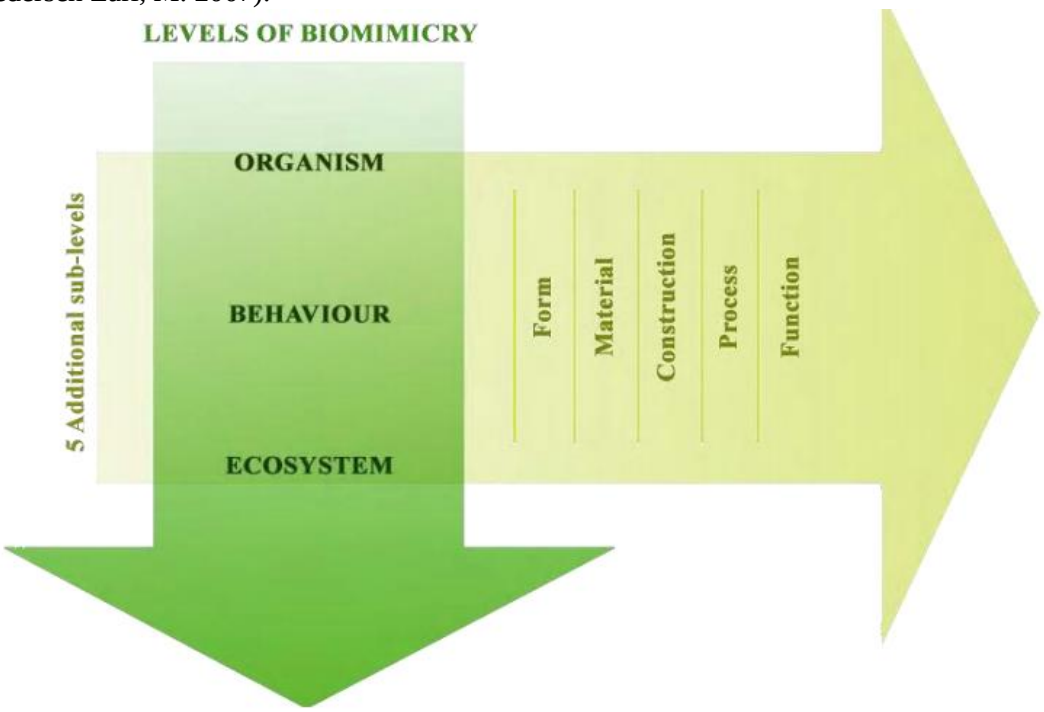


Figure 41: levels of biomimicry
Source :Salma Ashraf Saad El Ahmar 2011 BIOMIMICRY AS A TOOL FOR SUSTAINABLE ARCHITECTURAL DESIGN

Table 07: A Framework for the Application of Biomimicry (adapted from Pedersen Zari M., 2007).

Levels of Biomimicry	Example : 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 the building 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.12). 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 utilizing 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.

Within each of the biomimicry levels—form, material, construction, process, and function—there exist five dimensions through which mimicry can manifest. For instance, a design may emulate the appearance (form), composition (material), assembly (construction), operation (process), or capabilities (function) found in nature. These distinctions are outlined in Table 1, using examples from various aspects of a termite or its ecosystem to illustrate how different forms of biomimicry can be applied (Pedersen Zari, M. 2007).

It's important to note that there may be overlap between different types of biomimicry, and each type is not mutually exclusive. For example, a set of systems that interact like an ecosystem would embody biomimicry at the ecosystem level. While these systems may mimic individual organisms or behaviors, they collectively resemble the complex relationships found within biological ecosystems, where numerous organisms contribute to the overall functionality (Pedersen Zari, M. 2007).[54]

IV.5 Mimosa pudica

Plants are generally static creatures. However, some species can react in response to environmental changes. This is the case of the Mimosa pudica plant,It is a sensitive plant whose leaves bend and emit steam when exposed to external stimuli such as touch, temperature, vibration, and sunlight.

The magic of Mismosa Pudica's movement lies in how quickly the structure of the plant reacts, without muscles. This part will organize an understanding of the behavior of Mimosa and the properties of its biological system that can be applied to the material system.

IV.5.1 Definition of mimosa pudica

Mimosa pudica is a sensitive plant native to Central and South America, also found in parts of Asia. When exposed to stimuli such as touch, sunlight, temperature changes, or vibration, this plant reacts by rapidly folding its leaves. Depending on the intensity of the stimulus, it may also release steam. These responses occur swiftly, showcasing the plant's unique ability for rapid movement in response to external triggers.[55]

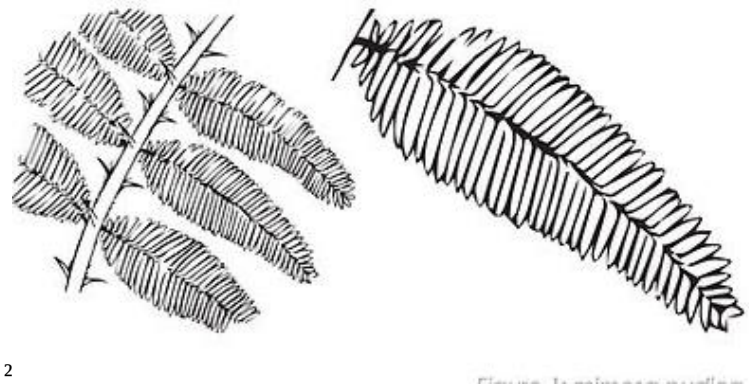


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Figure 42: the Mimosa pudica plant

source : Biomimicry : Mimosa Pudica | runda (runda-aduldejcharas.com)

[54] Salma Ashraf Saad El Ahmar 2011 BIOMIMICRY AS A TOOL FOR SUSTAINABLE ARCHITECTURAL DESIGN
[55] Biomimicry: Mimosa Pudica | runda (runda-aduldejcharas.com) 2015-2016

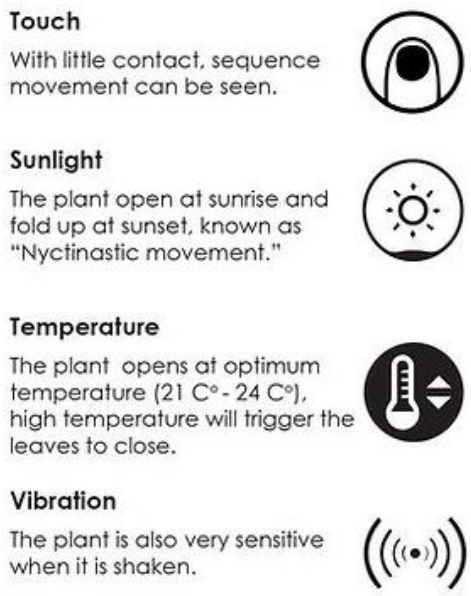


Figure 43 : Factors affecting Mimosa's reaction: touch, sunlight, temperature and vibration
source : Biomimicry : Mimosa Pudica | runda (runda-aduldejcharas.com)

IV.5.2 Motivation and hierarchy

The magic of Mimosa Pudica's movement lies in how quickly the structure of the plant reacts, without muscles. The reaction is explained by the structure and mechanics of mimosa nastic without muscles. In other words, the system is driven by the differentiation of intracellular pressure, which is called turgor pressure. This mechanism can change the stiffness of leaves and petioles and thus trigger the folding reaction. The system is activated by an external stimulus and the hierarchy of movements is one of the goals we are trying to achieve in our biomimetic project. The catalyst is transmitted cell after cell, activating the process of osmosis and exchanging calcium between their membranes. It is clearly a hierarchical process that begins on the leaves and then on the petioles. Polvini and Polvinus respectively.[56]

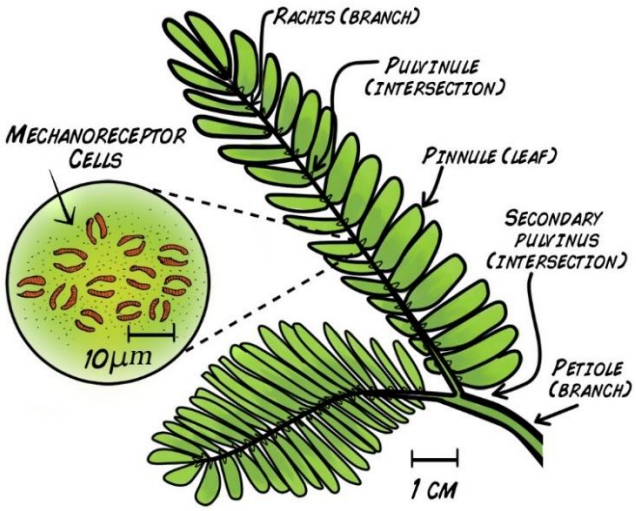


Figure 44: composition of mimosa

Sensitive Mimosa Pudica Electrophysiology (backyardbrains.com)

[56] Biomimicry: Mimosa Pudica | runda (runda-aduldejcharas.com) 2015-2016

Morphology of Bolvinus and Bolvinus Diagram (A) represents the shape of Bolvinus and how the process of osmosis works to change the stiffness of the plant and cause its bending.

The blue gradient symbolizes the volume of cells before and after stimulation. Dark blue color indicates larger cells and maximum swelling pressure in the system. Before stimulation, they are concentrated in the middle of the vulva and after osmosis they are concentrated in the upper part (diameter B). The reaction is very fast, but the recovery process is slow. The polvini morphology presents the same pressure regime and can be seen in diagram C.[57]

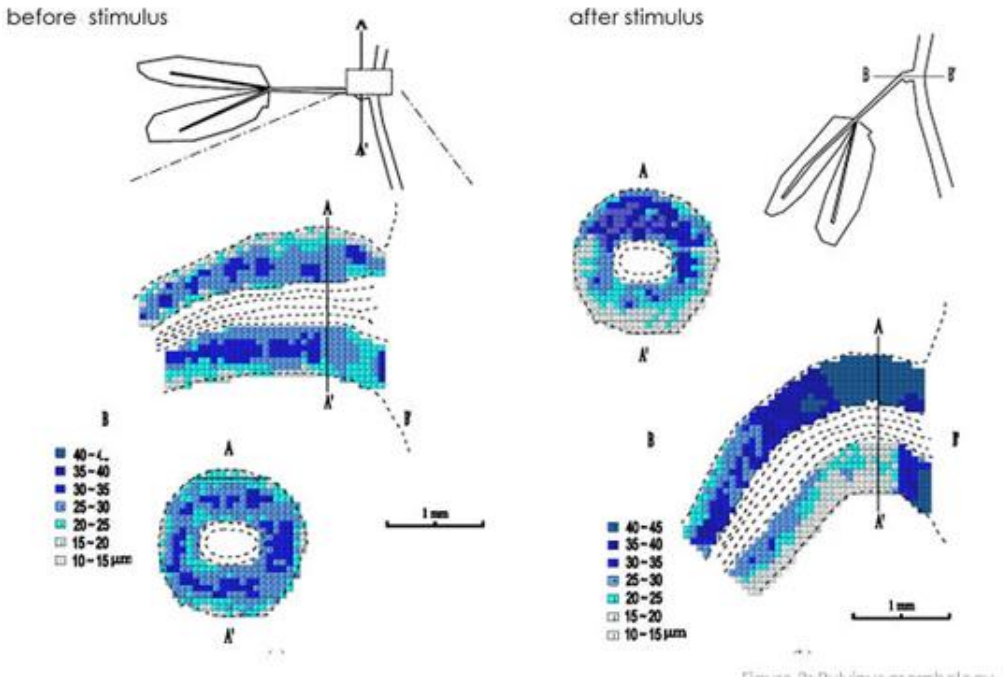


Figure 45 : pulvinus morphology
Source Biomimicry: Mimosa Pudica | runda (runda-aduldejcharas.com) 2015-2016

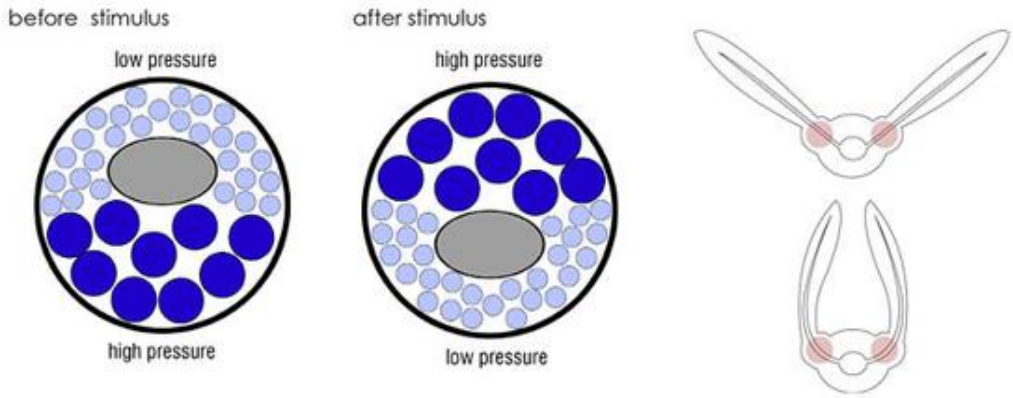


Figure 46 :pulvinus before and after stimulation
Source [Biomimicry : Mimosa Pudica | runda (runda-aduldejcharas.com)]

[57] Biomimicry: Mimosa Pudica | runda (runda-aduldejcharas.com) 2015-2016

IV.5.2.1 Temperature

Temperature is one of the main factors for leaves opening or closing. So, we experimented with a real plant to see how quickly a plant could react to heating. When they lose too much water, they begin to wilt and die.[58]

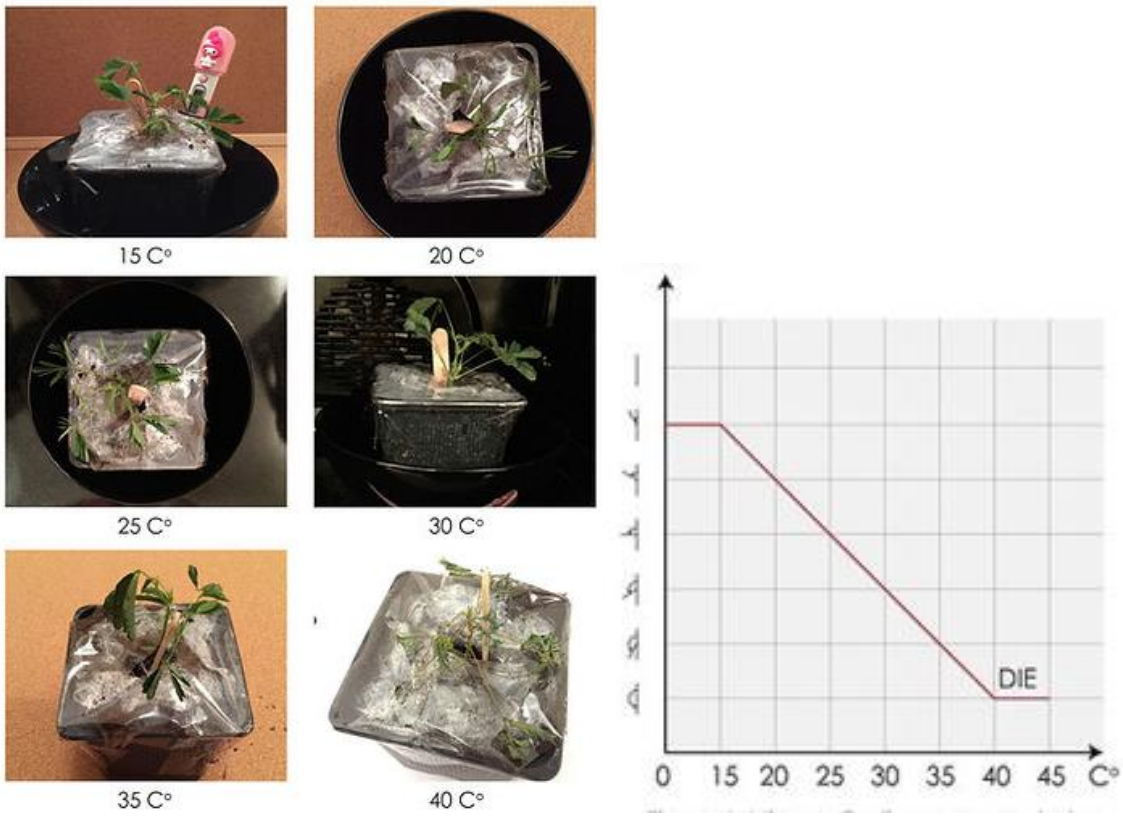


Figure 47: mimosa pudica response to temperature
Source Biomimicry : Mimosa Pudica | runda (runda-aduldejcharas.com)

IV.5.2.2 Sun light

Mimosa leaves begin to open at 9.00 in the morning and close at 18.00 in the morning. Single factor light for open or closed leaves.[59]

[58] Biomimicry: Mimosa Pudica | runda (runda-aduldejcharas.com) 2015-2016
[59] Biomimicry: Mimosa Pudica | runda (runda-aduldejcharas.com) 2015-2016

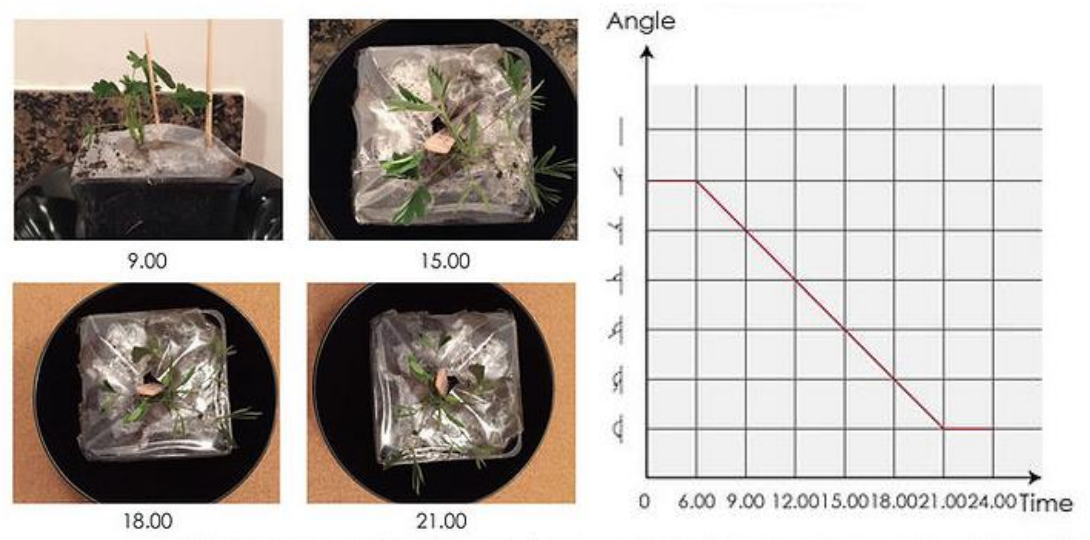


Figure 48: mimosa pudica response to sunlight
Source Biomimicry : Mimosa Pudica | runda (runda-aduldejcharas.com)

V. Study about the project :

V.1 Tower (tall building):

V.1.1 Definition of tall building :

Tall buildings are typically characterized as structures whose height exceeds the width of the adjacent street right-of-way or the wider of two streets at an intersection. In Toronto, where street right-of-way widths vary from 20 to 36 meters on average, this definition underscores the significance of site-specific context in determining whether a building qualifies as tall and when the corresponding guidelines are applicable..[60]

1-3-The evolution of tall building throughout history:

Man did not wait for the modern era to challenge heights. The idea of towers is so old that one might believe it to be unique to human nature. It was first a myth, that of the Old Testament where, after the flood, the survivors declared: “Come on! Let us build ourselves a city and a tower whose top penetrates the heavens! Let us make a name for ourselves and not be scattered throughout the earth. » So much for the Tower of Babel and its no less legendary failure. But in Mesopotamia there were indeed high ziggurats some two thousand years before our era. These colossal buildings are similar to tall three-story towers measuring several tens of meters, some even reaching 80 meters. That of Babylon, a model of the biblical tower, had eight floors. Not so different from ziggurats, the first pyramids in Egypt are called “step pyramids”. The first of these was the pyramid of Djoser, built in 2630 BC. On the same ground but much later, the lighthouse of Alexandria rose, three centuries BC, to protect sailors but also to extol the greatness of the Ptolemies. In 39 or 40 AP. BC, it is to Caligula that the lighthouse of Boulogne is due, born from the landing project in Brittany. With twelve octagonal floors, it stood more than 40 meters high, perhaps 65. The centuries pass but not the momentum towards the sky. The minarets of Islam will soon renew the genre. The oldest is perhaps that of Alwalid, raised in 705 within the walls of the great mosque of Damascus.[61]

[60] Book Tall Building Design Guidelines - Adopted by Toronto City Council May 2013
[61] Roger Cadiergues MémoCad mA18.a LES IMMEUBLES DE GRANDE HAUTEUR (IGH)

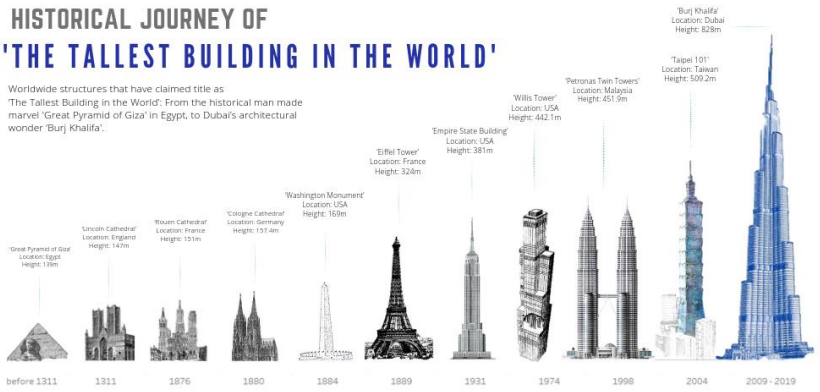


Figure 49: history of the tallest building in the world
Source: Historical Journey Of 'The Tallest Building In The World' — Information is Beautiful Awards 2024

V.1.2 Structure:

V.1.2.1 infrastructure:

- **types of foundation:**

Resist the wind and natural risks such as earthquakes...etc. Also the nature of the terrain plays an essential role, the building must have a solid anchor point. Depending on the nature of the terrain, it may be necessary to look deep into solid layers capable of supporting the building; the depth of the foundations can reach up to 100 m. So the foundations are the most important part in the construction because they play the main role in stability and they are a connection between the construction and the ground. There are three criteria to determine the size of the foundations:

• The climate provides information on the harshness of winter to then know the penetration of frost into the ground. It provides information on rains, and therefore waterlogging of land.
• The nature of the land determines at what depth you will need to look for soil capable of supporting the high-rise building
• The type of construction depends on the technical constraints to be applied to the ground, essentially the weight, the authorized differential settlement and the cohesion.

The width of the foundations depends mainly on the weight of the building. The weight is not necessarily distributed evenly on the foundations. There are three types of foundations. We note “E” for the installation height and “L” for the width.
• Surface foundations $E < 1.5.L$
• Semi-deep foundations $1.5.L < E < 5.L$
• Deep foundations $E > 5.L$

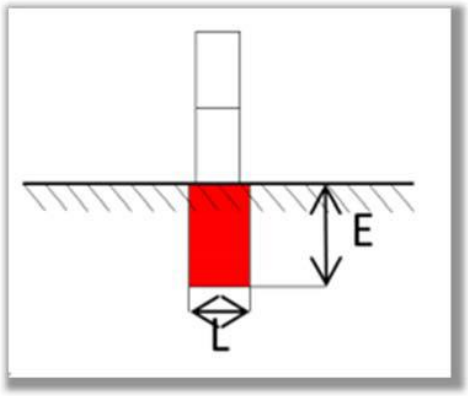


Figure 50: The relationship between the installation height (E) and the width (L)
(source: Scientific progress and technical achievement: buildings, Lycée Lafayette, Champagne sur Seine)

- **Choice type of foundation:**

For the choice of foundation type we have:

• If the ground is sufficiently load-bearing: superficial foundations will often be used, which are often more economical.

• If the soil is bad: we will rely on the better and deeper layers with deep foundations.

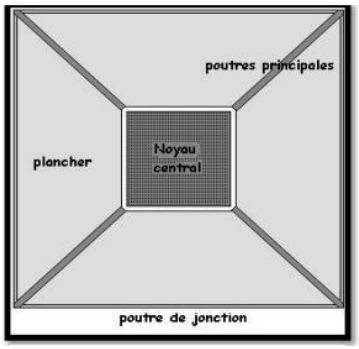
• In very flood-prone terrain: it may be advantageous to build a general foundation

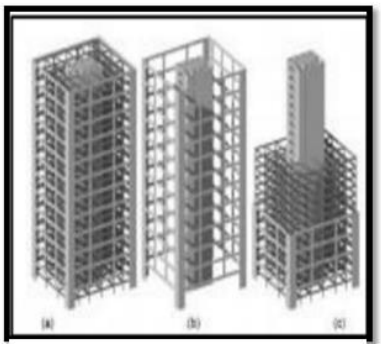
V.1.2.2 Superstructure:

- **Central core:**

The “central core” structure can be designed as an optimization of the inner single tube; a central tubular core (concrete or steel, significant in view of the twists due to the "stabilizers", which can go up to walls one meter thick) from which start rigid structural levels composed of lattice beams which are then connected at their periphery by uprights capable of taking up compression (leeward facade) and traction (windward facade), either a series of tight posts, or “mega-columns”.

The central core is the element ensuring the rigidity of the building, it runs throughout the building over its entire height and generally contains the elevators as well as the stairwells. The forces exerted by the wind are transmitted to the core via horizontal elements positioned on the different floors. Skyscrapers made up of a central core can easily reach a height equivalent to around fifty floors while reducing the footprint. The doubling, sometimes even tripling, of the central structure then made it pos sible to reach heights of around 70 floors.





Figures 51: Diagram of the central core Figure 52: Diagram of the central core
Source : www.helmo.be 0 25/12/2023)

- **External cores:**

This structural concept consists of placing the tubular cores at the periphery, then connecting them by horizontal structures together constituting a "megastructure".

The assembly behaves in a way like a "rigid mega-tube". This strategy makes it possible to free the center of the building from structures, but, depending on the typology, reveals vertical circulation on the facade, the most popular place in terms of brightness. This typological reversal with respect to the centered core carries a strong architectural potential, the platforms being free of large immobile elements, the plan is completely free between the cores, allowing the levels to be arranged according to the spatial wishes of the project as well as to create atriums and other sectional variations. [62]

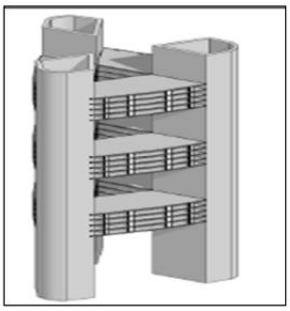


Figure 53: Three-core diagram and Source : www.helmo.be 0 25/12/2023)

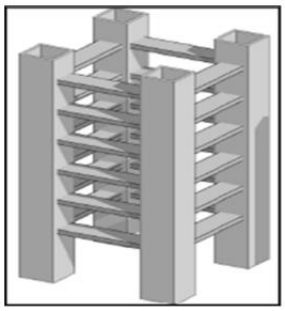


Figure 54: Four-core diagram and connecting tubes

- **Tall building structural systems :**

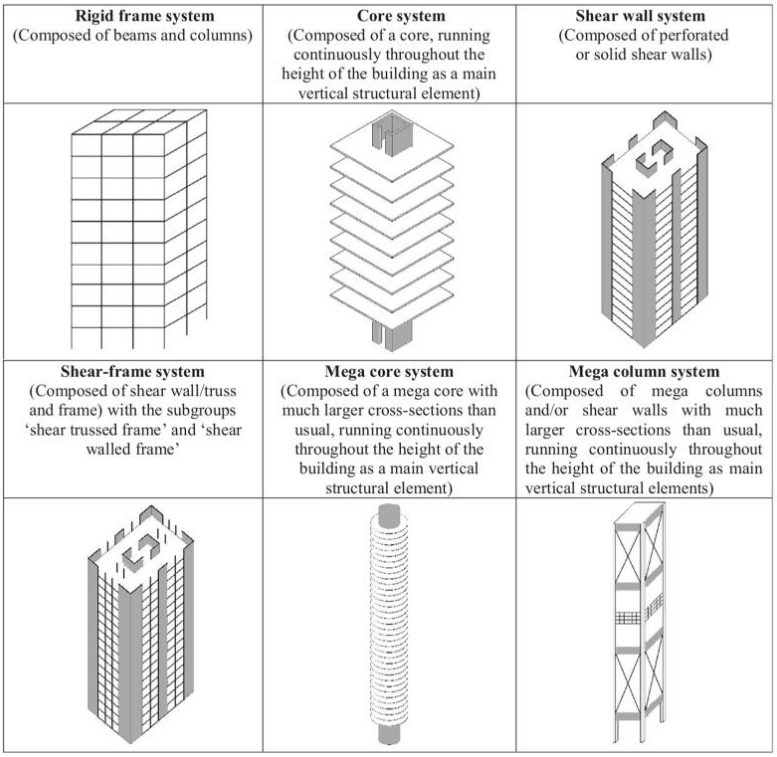


Figure 55 : Tall building structural systems
Source : Article Analysis of the Main Architectural and Structural Design Considerations in Tall Timber Buildings.

[62] YAHIA BELHADJ AMINE DERRADJI , Master Académique, Architecture, les techniques du construction et Mesures de Sécurité dans la Conception des IGH en Algérie

V.1.3 Composition of high-rise buildings:

V.1.3.1 Top tower :

The upper portions of tall buildings, encompassing upper floors, rooftop mechanical or telecommunications equipment, signage, and amenity spaces, should be designed with careful attention to tower massing and articulation. Additionally, the choice of materials should complement these design elements to achieve a cohesive and fitting culmination of the tall building form. This integrated approach ensures that the building's uppermost features contribute harmoniously to its overall aesthetic and functional integrity.

V.1.3.2 Middle of Tower :

The placement and design of a tall building's middle section (tower) significantly influence various environmental and social factors such as sky views, privacy, wind patterns, sunlight exposure, and shadow impacts on the public realm and neighboring properties. It is crucial that these aspects are carefully considered and resolved through thoughtful design practices. This ensures that tall buildings minimize their impact on surrounding streets, parks, public and private open spaces, as well as existing or future buildings on adjacent sites.

V.1.3.3 Base of Building:

The lower stories of a tall building, known as the base building, play a crucial role in urban design. Their primary functions include framing the public realm, emphasizing entrances, and contributing to a vibrant and inviting pedestrian experience. It is essential that the base building defines and enhances adjacent streets, parks, and open spaces at a suitable scale. Integration with neighboring streetwall buildings is important, as is facilitating a smooth transition to lower-scale structures. Additionally, the base building should minimize the impact of parking and servicing facilities on the public realm, ensuring that the overall urban environment remains safe, engaging, and comfortable for pedestrians.[63]

Figure 56: Composition of high-rise buildings
source: Book Tall Building Design Guidelines - Adopted by Toronto City Council May 2013

[63] Book Tall Building Design Guidelines - Adopted by Toronto City Council May 2013 p 8

V.2 Shopping center

V.2.1 Definition of shopping center

In general a collection of retail stores and service businesses gathered in the same location, often with a parking lot available to visiting consumers. It is generally designed and managed as a single company in the form of an EIG (economic interest group). Given the diversity of businesses present as well as the significant useful commercial surface area (SCU/GLA) it has, it in principle benefits from a relatively large catchment area. The name of shopping center will be retained from a surface area of 5,000 m2 with around twenty stores. We will speak of a large shopping center when the number of stores exceeds 40 units and the SCU is greater than 20,000 m2. Beyond that, the name of regional shopping center will concern establishments covering more than 40,000 m2 and comprising at least 80 distinct points of sale. With almost 500,000 m2.

B-Definition according to QUEBEC: Set of retail stores, which may include one or more large-area stores, and various services, such as a post office, a bank or a restaurant, occupying one or more buildings overlooking a park of parking in or near an urban area.

C-Definition according to the law governing commerce and crafts of December 27, 1973: Group of several retail stores located in the same place and constituting an economic unit with regard to their general design or due to the common conditions of exploitation.[64]

V.2.2 Classification of shopping centers According to CNCC

The CNCC (National Council of Shopping Centers) has classified shopping centers according to their GLA surface area and the number of stores into five types:

Table 08: typology of shopping centers source: author 2023 taken from CNCC

Super Regional Shopping Centers	Their GLA surface area is greater than 80,000 m² and/or they have at least 150 stores and services. (see fig: 02)
Regional Shopping Centers	Their GLA surface area is greater than 40,000 m² and/or they have at least 80 stores and services. (see fig: 03)
Large Shopping Centers	Their GLA surface area is greater than 20,000 m² and/or they have at least 40 stores and services. (see fig: 04)
Small Shopping Centers	Their GLA surface area is greater than 5,000 m² and/or they have at least 20 stores and services. (see fig: 05)
Theme centers	These are specialized shopping centers, for example in home furnishings or manufacturers' boutiques. (see fig: 06)
Discount store	300 to 500 m2 of sales area they are located at central points of residential areas.
Supermarkets	400 to 500 m2 of sales area.

V.2.3 Spaces in a shopping center

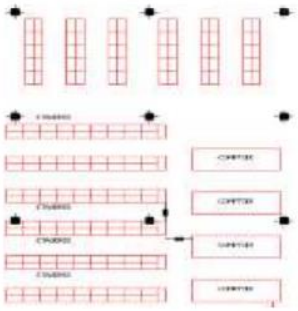
- Department store:

All regulations in force concerning construction, profession, commerce, fire prevention and labor inspection directives must be respected.
Basic dimensions:
- Height of sales premises and warehouses
- Up to 400 m² of sales area of the premises H=3.00m

[64] Chetti soundes : l'enveloppe architecturale entre l'esthétique et le confort thermique

- Beyond 400 m² of sales area of the premises 3.30 m
- Beyond 1500 m² of sales area H=3.50m
- ventilation ducts and constructions must not reduce the required headroom

Table 09: Programming a store. Source: MIHOUBI Mohammed 2010



Design of spaces	Mobilier	Mobile Surface	Mobile Surface	Surface Total M²
magasin	étager	15	3	45
	computers	13	2	26
	circulation	120%		85,2
	Comfortable ratio	60%		42,2
			total	198,4

Figure 57: Store layout model
Source: MIHOUBI Mohammed 2010

It consists of two parts, the service area and the consumption room.

- Service area: It includes a deposit, a laundry counter and a manager's area.
- Consumption room: It will be well decorated, well ventilated, have subdued lighting, a sanitary area. Particular attention will be paid to tables and chairs (clear space)

Note: by analogy we can dimension the rest of the spaces.

- Hair salon

The modern hair salon is not only the place where you get your hair done but also a space to relax. It must be suitably furnished, relaxation and waiting room, hairdressing room, beauty operations. (see fig 38)

- Fabric store

Fabrics: Women, Men, Children. (see fig 39)

- Shoe store

The facade must in principle be very clear (bay window, total transparency) (see fig 40)

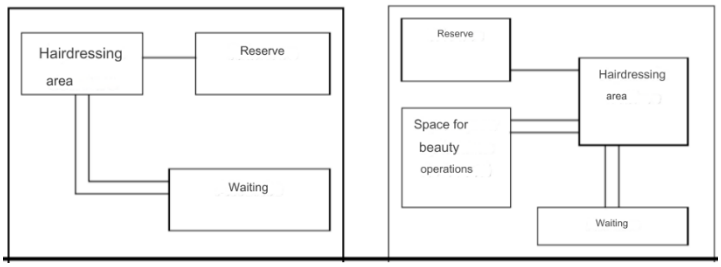


figure 58: Organization chart representing the operation of a men's and women's hair salon
Source: MIHOUBI Mohammed 2010

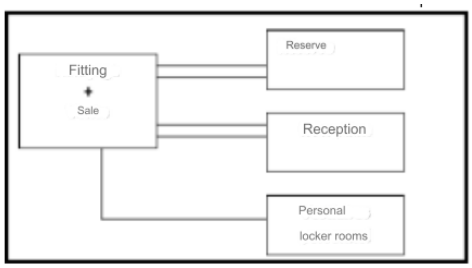


Figure 59: Organization chart shown on operation of a shoe store.

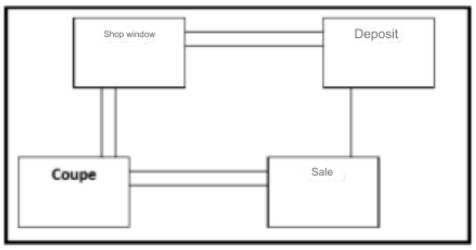


Figure 60: Organization chart shown on

Source: MIHOUBI Mohammed 2010

Table 09: represents spaces in a shopping center

Source: Chetti soundes : l'enveloppe architecturale entre l'esthétique et le confort thermique 2020

• Clothing stores	Arrange the items so that they fall under the eyes, use daylight, the display surfaces must be smooth so that the products slide well and are not scratched, limit the height of the shelves to 2.20m (possibility of reaching), Provide presentation tables 85 to 95 cm high for the standing customer and 55 to 70 m high for the seated customer (Table width 70 to 85 cm), provide fitting rooms from 1.10 to 1.15 m, avoid the formation of dust.
• other Stores	-Children's games store: Adequate special layout, attractive, the height of the object display shelves is standardized (possibility of reaching). -Camping equipment store, household appliances store, glassware store, bookstore store, musical instrument store.
• Furniture stores	In this type of store, the surface area is important. It will therefore be divided into several sub-spaces. We will ensure that each item is displayed separately and in an attractive and attractive way and the facade must in principle be very clear (bay window, total transparency)
• **Boutiques**	-Record store: Activities + Exhibition + fitting + Sale. -Flower shop, craft shop: -Exhibition in special display cases. -Artificial lighting falling from above on the exhibits.
• **Self-service**	EX: Bakery, Fruits and vegetables. -Good ventilation. -Adjustable temperature
• Butcher's shop	-Refrigerated display cases. -Operations = delivery 'slaughter' placing in refrigerated display cases 'sale.
• Fish shop	- Well ventilated store. - Delivery-maintenance-sales.
Creamery	- milk and its derivatives being perishable in the short term, it is necessary to provide additional rooms for washing cans and devices giving directly on the sales floor. - Wall covered with tiles.
• Restoration	- The restaurant is aimed much more at businessmen, civil servants and students. - The dining room must have fluid circulation thanks to an adequate (standardized) layout. - The layout of the tables changes according to the needs of the users and the performance of the restaurant. - The room must be in direct connection with the kitchen (preparation). - The kitchen must be of satisfactory capacity, have access to the service yard for the supply of consumer materials and for the disposal of waste. The kitchen being an important space, it is necessary to ensure its proper functioning, ensure sufficient ventilation, indisputable cleanliness and flawless safety.
• Relaxation and games	Electronic games rooms, ping-pong, American billiards and Bouling must be phonetically isolated. - Nightclub: loan and sale of cassettes; listening is done individually and in groups, a phonetically isolated space. - Video library: loan and sale of cassettes and screening of films in a

	projection room for 20 people on average
• Deposit	Users: personnel specialized in delivery and distribution.
• Additional premises	Premises removed from the background put in easy contact with all sectors of the equipment.

When designing a car park layout, it's essential to prioritize user-friendly features like clear signage and safe traffic flow. Compliance with local planning guidelines ensures the car park fits well with its surroundings in terms of appearance and scale. Effective design also considers the size of the car park, circulation efficiency, and geometric requirements to minimize congestion and enhance usability. These principles collectively ensure the car park meets functional needs while integrating seamlessly into its urban environment. [65]

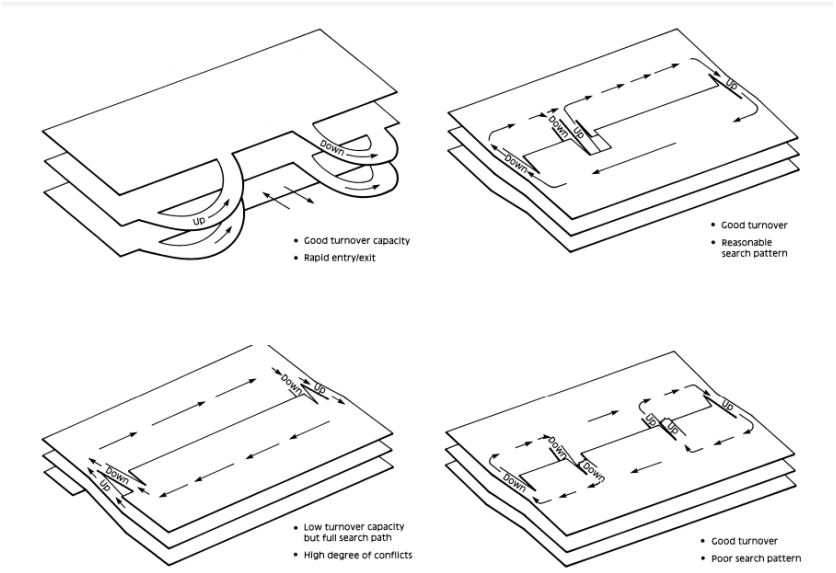


Figure 61:multi-storey and underground car parks
Source : Design recommendations for multi-storey and underground car parks THIRD EDITION June 2002

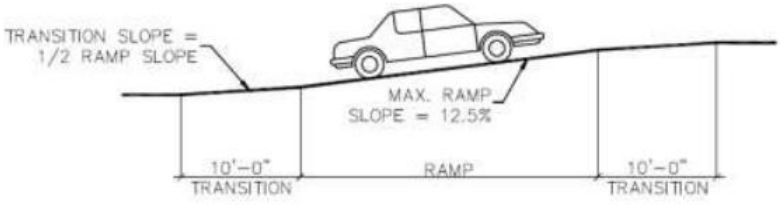


Figure 62: ramp section
Source : parking structure design 2016

V.2.4 Factors Affecting Shopping Center Selection

[65] Design recommendations for multi-storey and underground car parks THIRD EDITION June 2002

In order to increase the attractiveness of shopping centers for customers, it is first necessary to identify the factors that attract them. The factors are:
- The site of the shopping center and Accessibility (road networks) easy passage.
- relaxation and leisure.
- Provide a wide variety of products and stores.
- Sufficient number of qualified employees.
- good design and availability of adequate spaces.
- Create a suitable environment (lighting, ventilation, air conditioning, security).
-promotions and prices. (2009 فهد, س)

V.2.5 Customer tours in shopping centers

The study of circulation in the shopping center has a big role in maintaining the stability of commercial activity inside and the separation between the circulation of customers and goods. We distinguish two types of circulation:

V.2.5.1 Horizontal and peripheral circulation:

It is provided by the large halls, patios, atrium, shopping streets and exhibition galleries. Circulation varies according to the plan of the shopping center and depending on the shape and distribution of the stores:[66]

V.2.5.2 Vertical circulations

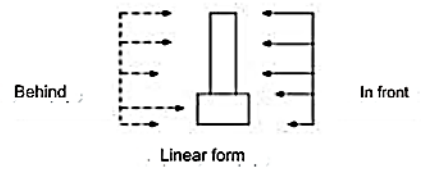
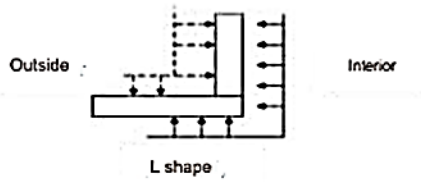
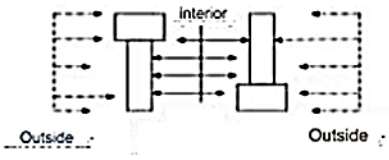
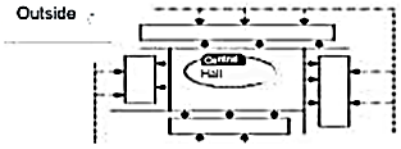
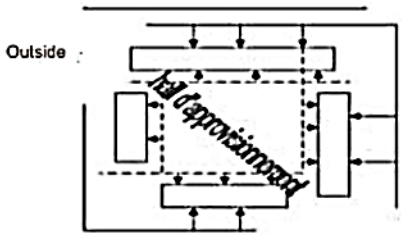
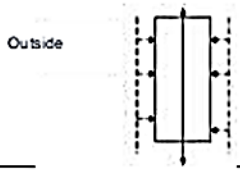
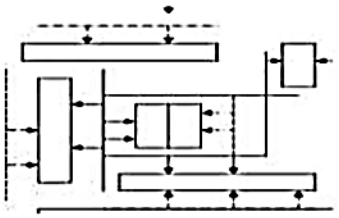
We distinguish: movement of goods by freight elevators and movement of people by stairs, escalators and elevators. In the case of multi-level shopping centers, vertical transport is decisive for good integration of the levels and good irrigation of customer flows. Elevators are necessary, but dissuasive if they are not designed to make them attractive (panoramic elevators); also, escalators and treadmills are the most used.

Good location in a strategic space, such as a square, with visual communication between levels is recommended. (Mohamed, M 2010)

- The number of freight elevators and stairs is proportional to the possible number of visitors to the center.

[66] Ali Haider 2000

Table 10: Type of horizontal and peripheral circulation, Source: Ali Haider 2000

Type 1: In this type the shopping center resembles a straight line where the movement of customers is from the front and that of supplies is from behind.	
Type 2: In this type the shopping center has letter (L) the circulation of customers is done inside and that of supplies is done from the outside.	
-Type 3: The shopping center looks like two parallel lines, the circulation of customers takes place inside between them and that of supply takes place from the outside on two sides.	 Shape of 02 parallel lines.
Type 4: The shopping center is like a set of shops grouped around a courtyard where the circulation of customers takes place inside and that of supplies takes place from the outside	 Grouped around a central hall.
Type 5: The same as type 4 except that customer circulation takes place around the exterior perimeter and supply circulation takes place from the inside.	
Type 6: The rectilinear shopping center and the magazines are aligned inside the covered linear center so the circulation of customers takes place inside and that of supplies takes place from the outside	
Type 7: the center of the courtyard is occupied by a set of shops which are open towards the interior and the magazines are scattered without order inside the shopping center, the circulation of customers and supplies intersects with that of the side stores circulation is normal, supply is from outside and customer is inside.	

V.2.6 The routes and its role in the shopping center

In a shopping center the route is the path that the customer follows to visit the stores and boutiques. It modulates the space and creates intimacy between commercial spaces and those who are customers; it must be identifiable by the visitor. Suitable for collections, it obeys related rules:
Circulation, layout, lighting and floor coverings.
So it determines the visitor's traffic plan.

V.2.6.1 Linear

In this type of journey, the goods and goods are displayed either according to a clear principle of movement; either the exhibition is organized in boutiques and stores by showcases.

V.2.6.2 Ribbon type

In the ribbon-type route, the direction of the visitor is ensured through an imposed circuit without serving any sub-space.

V.2.6.3Circular

In this type of route, boutiques and magazines come together in the same central space.
Its particularity is the superposition of the starting point with the arrival point, this type of route is integral

V.2.6.4 Labyrinthine route

In this type of route, the shopping center is made up of a large number of stores.
It's a partial route because you have the choice to take the path you want. This type of route has a disadvantage, it is a complicated route, the visitor risks passing through the same space several times or even missing a few.

From our study we come to the conclusion that the route is a very important element in the shopping center and in the design because it not only supports the visitors but it also highlights the goods and the different spaces of the shopping center , it therefore governs certain constraints to be respected. So the route allows the public an easy and pleasant visit while remaining educational. (Mohamed, M 2010)

V.2.7 For commercial activity to be satisfactory, it must meet the following goals

- Animation:

It is reinforced by large free areas cleared for circulation and spaces offered for the public (Commerce, Exhibitions, relaxation). Adequate arrangements and an aesthetic reinforcement of the interior space.

- Distribution:

We will give each activity the necessary space, and we will respect the technical requirements required by these sub-spaces: Good lighting (daylight and artificial light), ventilation, structure.

- Aesthetics:

Facing: you have to look for a very aesthetic, attractive facing and of a very high standard to appeal to a wide audience, for example: granite, marble, stone, vibrant natural colors; we choose noble and durable materials.
Floors: mosaic reflecting a good view inside, carpets for luxury retail spaces.

- Showcases:

Glass; material that expressed transparency and exposure. They must be surrounded by large frames. It is necessary to provide special equipment for maintaining window displays from the outside.

- Exterior lighting:

To guarantee constant and feverish activity immediately outside the center, dense lighting should be installed to help invite the public to visit the center. (Mohamed, M 2010)[67]

V.2.8 Method of supply (delivery) :[68]

Type 1: The warehouse consists of two levels:
- Below: the main warehouse.
- Above: The garage that serves as a transitional space.

Type: 2 The warehouse consists of three levels:
- In the center, the main storeroom plays the role of a transitional space.
- Two more for storage.

Type:3
The supply is made directly from the store to the back store. It created a barrier between the movement of customers (customers) and goods.

Type:4
The supply is done directly in the warehouse at the back.

Type:5
The supply road is located at a lower level than the built level in order to facilitate the process of transporting goods.

Type:6
The supply is made directly from the warehouse located in the basement of the store, which in turn has two entrances

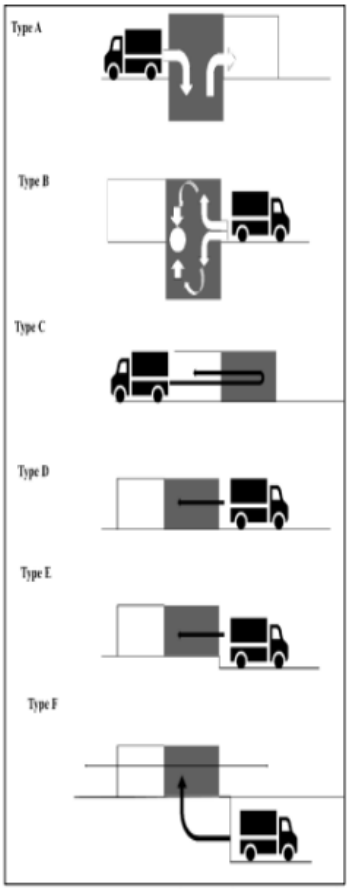


Figure 63 : Catering methods in commercial centers
Source: Ali Haider

V.3 Offices :

V.3.1 Definition:

We can define a business centre as a place composed of spaces of small, medium, or large sizes, fully equipped. These spaces are intended to accommodate businesses, entrepreneurs, and other types of users for a specified duration, whether short or long term.

From individual or shared offices to meeting or conference rooms, the various areas of a business centre are typically located in a building reserved for this purpose or spread across one or several floors of a building dedicated to tertiary activities. They have the advantage of being fully equipped, whether in terms of real estate (offices, chairs, sofas, lamps, etc.) or the technical facilities necessary for the daily operations of a business (internet connection, telephony, printers, etc.)[69].

[67] Chetti soundes : l'enveloppe architecturale entre l'esthétique et le confort thermique
[68] Bin Al-Zawi Sameh Khadjia 2023 The smart building: towards developing sustainable solar protection
[69] MGS BUSINESS.com

Figure 64 : Altrade Business Centre in Gurgaon
source: https://www.altradebusinesscentre.com/

V.3.2 Target population:

The business centre targets a specific clientele:

1. Small businesses and startups that do not consider a long-term commitment.
2. Companies in need of an office for a short stay.
3. Intermittent users - when their premises are not yet available.
4. Many personnel forced to relocate due to a lack of space in their current office.
5. Users working on a specific project (survey, film production, etc.)[70]

V.3.3 The role of business centers:

- ❖ provide an environment that is particularly conducive to economic activity, enabling companies to achieve their objectives.
- ❖ They offer companies, on demand and immediately, fully equipped and furnished offices for rent at the start of an activity, thus minimizing the cost of investment in real estate and furniture.
- ❖ A place for exchange, communication, and camaraderie.
- ❖ The variety of services in place to ensure the comfort and security of businesses and their clients provides them with the opportunity to conduct business on-site, thereby minimizing potential travel.
- ❖ A prestigious and enhancing image for the client.
- ❖ Creates a focal point of attraction for work.[71]

V.3.4 The Evolution of Office Design:

Over the past century, office design has undergone significant evolution, spurred by profound changes in work practices, technological advancements, and shifting expectations for the workplace environment. The integration of new technologies and tools, evolving employee needs and work styles, and the transition from an industrial to a knowledge-based economy have all reshaped how and where work is conducted.

- **Office Design in the 1800s**

Historically, offices have served administrative roles since ancient times, but their evolution into business centers gained prominence in the 19th century, driven by the expansive railway network in

[70] www.arenas-partners.fr/fr/guide/qu-est-ce-qu-un-centre-d-affaires
[71] Master thésis. (2021) L'AMELIORATION DE LA QUALITE DE L'AIR DANS LES ESPACES DE TRAVAIL.

the UK. This period saw offices structured to reflect hierarchical business models, with merchants and clerks on lower floors and owners often residing above. These designs mirrored the organizational and social dynamics of businesses during that era.

Figure 65: office
source: https://www.oktra.co.uk

- **1900s Office Design**

In the early 20th century, technology sparked a revolution in workplace design and functionality. Electric lighting, replacing gas lamps, expanded usable floor space. Innovations in construction materials and techniques were crucial for constructing safe multistory buildings, overcoming earlier limitations of masonry-bearing walls. The advent of the typewriter, telegraph, and telephone accelerated communication, enabling organizations to manage offices remotely.

Frederick Taylor, an American engineer and pioneer of the Efficiency Movement, is credited with designing one of the first modern office spaces. His approach, akin to factory layouts, featured linear rows of desks for typists and administrative staff, resembling assembly lines for paperwork. Managers typically occupied separate rooms, reflecting hierarchical organizational structures.

Figure 66: office
source: https://www.oktra.co.uk

- **Office from the 2000s**

The emergence of dot-coms and startups led by young, entrepreneurial minds brought significant reforms to workplace practices and cultural norms. Concepts of work-life balance began to integrate into office design, introducing more playful elements. The idea of the "office as playground" became prevalent, featuring innovative systems, open-plan layouts, and a collaborative atmosphere reminiscent of university campuses or neighborhoods. The rapid adoption of mobile technology further facilitated remote work capabilities, popularizing coworking spaces where employees could work flexibly away from traditional desks

Figure 67: relaxing space
source: https://www.oktra.co.uk

- **office in the 2020s**

The post-COVID world has accelerated ongoing transformations in the office landscape, notably in remote working, virtual collaboration, and decentralized team structures. Looking ahead, a 2021 study by Gartner predicts that by 2023, fewer than one-third of digital workers will prefer the traditional corporate office environment. By 2030, it is projected that 48% of employees will work remotely, marking a significant increase from pre-pandemic levels of 30%.

Additionally, insights from Cone Communications' Millennial Employee Study highlight shifting expectations among younger generations. Sixty-four percent of Millennials prioritize robust corporate social responsibility policies when considering job opportunities, and 83% express greater loyalty to companies actively contributing to social and environmental causes. Consequently, businesses are increasingly integrating sustainable design practices into their offices, from sustainable furniture procurement to adherence to environmental assessment standards such as BREEAM and SKA, which evaluate ecological, social, and economic impacts.

Figure 68: Highly adaptable and modular spaces
source: https://www.oktra.co.uk

V.3.5 The spaces:

offices

- ***Typology***: Two types of offices are distinguished based on their dimensions and layout: individual offices and open-plan offices. All other types are variations and present a different organization compared to these two.
- **Types of Spaces**

Individual Offices: Single and double offices are arranged on either side of a corridor, often benefiting from artificial lighting. Shared equipment occupies a valuable space in the rooms in front

of the windows because the clearance paths do not allow for furniture. Economic occupancy by two or more people can hinder concentration. Occupancy by a single person limits internal communication (Fig. 1 a).

Open-plan Offices: A form of office developed in the 1960s and 1970s. Artificial lighting and air conditioning installations have allowed for very large office spaces, symbols of communication and openness, accommodating a hundred or more people. However, the economic volumetrics of the building require significant technical distribution equipment. This form of office is not well-liked by users (Fig. b).

Collective Offices: The experience gained from very large office spaces has led to the design of collective offices with around 4 to 15 workstations, always used by the same employees or departments. This form of office is preferred, especially for creative, formatting, coordination, and development activities (Fig. c).

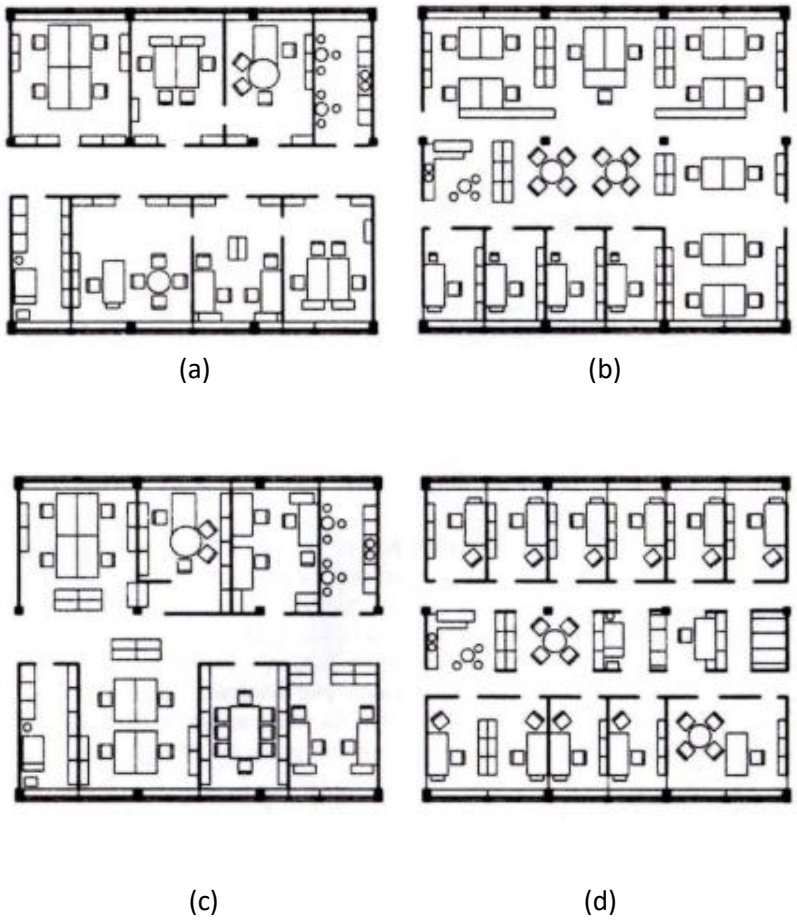


Figure 69: types of spaces of office
source: Nefeurt. (2010)

Ancillary Spaces

Ancillary and additional spaces Depending on the organizational structure and representation needs, the demand for workspace varies between 23 and 45 square meters per workstation. The 2.6 square meters of underground parking space not included in the gross area are taken into account here (**O. Gottschalk, 1994).** This trend has been on the rise since the 1970s.

Entrance Hall

Linking the public area to workstations. Essential functions include protection against wind, access control, information, visitor registration, and waiting space. Essential for the company's image (corporate identity). The first impression is crucial.

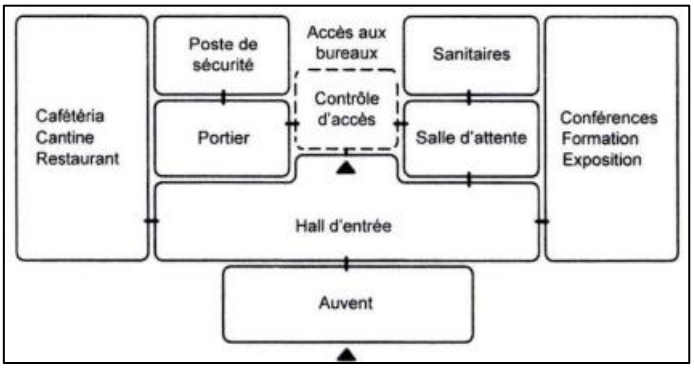


Figure 70: Spatial Layout of the Entrance and Access Control to Common Areas
source: Nefeurt. (2010)

Conferences, Training

Conference areas should be directly connected to the entrance space. Storage rooms are planned to store movable partitions used to divide large halls, tables, seats, and audiovisual equipment, as well as an office for receptions (these annex spaces occupy about a third of the conference room area). Acoustic insulation must be ensured. Approximately 2.5 square meters per seat in the conference space (excluding annex spaces). Required space: 0.3-1.0 square meters per workstation.

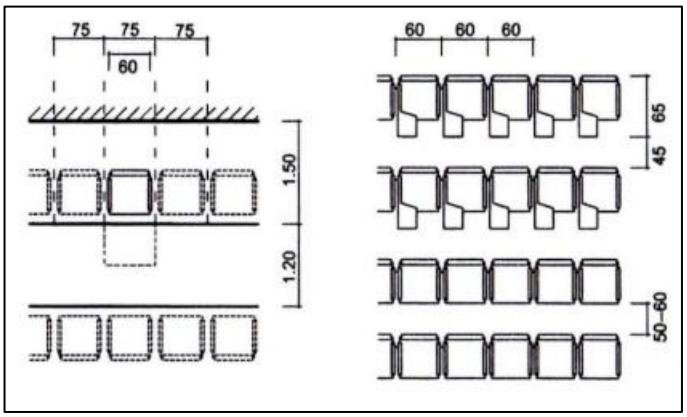


Figure 71 : Space Required in Conference and Training Rooms
source: Nefeurt. (2010)

Archives

Despite the use of new office techniques, paper consumption as the primary medium for information storage has increased. Until 1980, paper consumption doubled every four years. Computer-assisted information storage as an information medium can be more widely used within office communication systems. Non-coded information (letters, texts, magazines) will always have its place in the form of paper volumes.

L x W (filing cabinets) = filing area + 1/2 L x W + 0.5 = passage area

Total congestion = filing area + passage area.

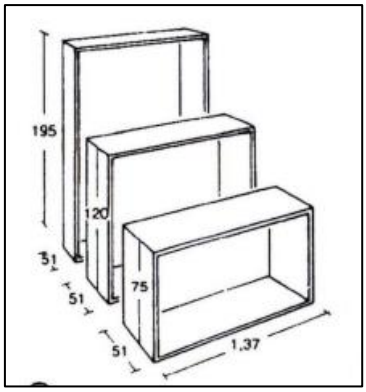


Figure 72: File cabinet system
source: Nefeurt. (2010)

Digital Data Processing

It is crucial to plan the network design in advance. This helps determine whether computer rooms require permanent workstations and whether they should be centralized or decentralized in the building. Due to their high technical level, these rooms must have a technical floor of 70 cm and be air-conditioned. Access must be particularly controlled. Backup systems should ideally be installed in fire-protected areas separated from the computer room.

Recreation Spaces

The company restaurant or cafeteria often functions as independent units. Their proximity to the reception, upstream of visitor control, allows them to be used by visitors.

Tea kitchens should be located in direct proximity to workstations, connected to communication areas. A large kitchenette of about 10 square meters is considered for 50 to 100 people.

Restrooms

Restrooms should be sized according to workplace regulations (see p. 317); spatial separation should be provided between the sink area and the restrooms themselves. A restroom group for approximately 50 to 80 people is always satisfactory. Required space: 0.6-0.8 square meters per workstation.

Maintenance Rooms

for building maintenance should be provided on each floor, as well as a room for cleaning products, ideally with a water point and a drain. Central garbage room, possibly a garbage collection room per floor with separate garbage collection container and document shredder. Also, provide a relaxation room, storage space, and a workshop for the caretaker in the centre.[72]

Conclusion :

In conclusion, this study integrates fundamental architectural concepts such as sustainable development, energy efficiency, thermal comfort, bioclimatic architecture, kinetic architecture, and biomimetic design. By defining and exploring these principles, the study provides a comprehensive understanding of how to design buildings that not only meet current needs but also ensure the well-being of future generations. The application of these concepts in real-world projects, particularly shopping centers and office towers, demonstrates the potential to significantly enhance energy performance and thermal comfort. This holistic approach to architectural design underscores the importance of innovation and sustainability in creating efficient, comfortable, and environmentally friendly buildings.

[72] Nefeurt. (2010)

CHAPITRE 02:

ANALYTICAL CHAPTER

Introduction:

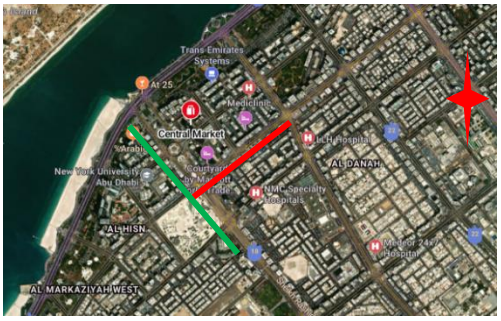
Commercial center and office projects are considered the latest developments in the world of architecture, as they are planned to meet the needs of diverse and evolving communities. The modern era is witnessing a remarkable expansion in the use of building towers as one of the most prominent architectural options, especially when incorporating the concept of mixing commercial and hotel purposes in dual structures.

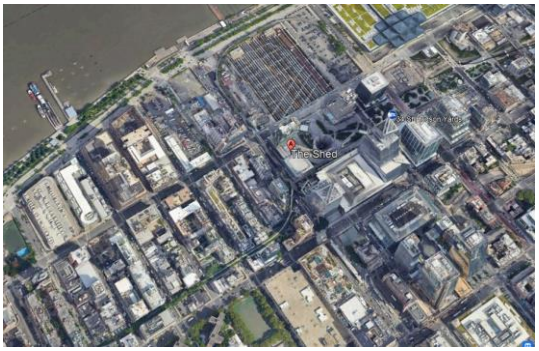
As for modern architecture projects that rely on kinetic and biomechanical concepts, they represent a qualitative leap in utilizing technology and understanding nature to enhance the design and performance of buildings. Kinetic architecture seeks to achieve a dynamic interaction between the building and the surrounding environment, while biomimicry design takes inspiration from the processes and systems of nature to create efficient and cost-effective solutions. In this context, in this chapter we will analyze specific examples of commercial center and hotel projects, some of which rely on multi-functional towers, we will also explore some innovative projects that combine the principles of kinetic and biomechanical architecture, with the aim of understanding the nature of the project and identifying the positive points of each example in order to exploit them in the design and avoid the negative points in it. In the end, we presented the proposed program for the commercial center, hotel, and services. And a comprehensive summary of it.

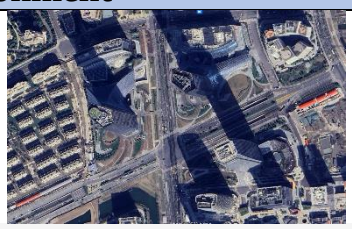
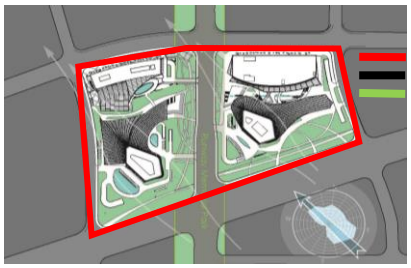
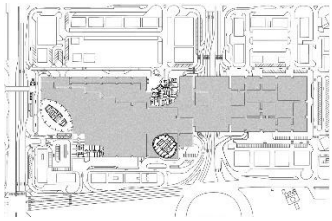
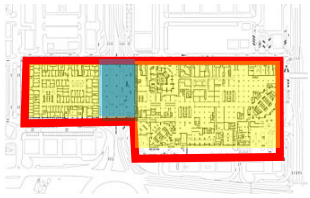
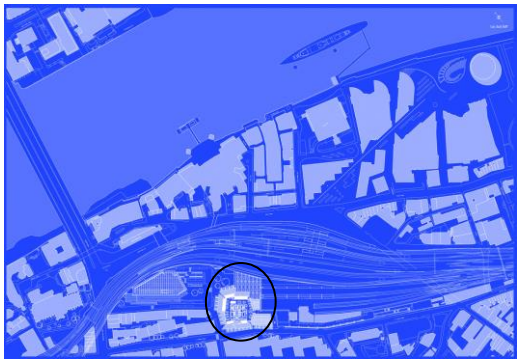
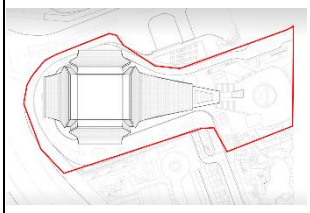
I. Existing and real projects analysis:

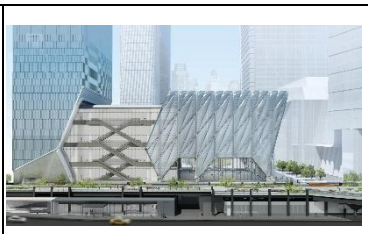
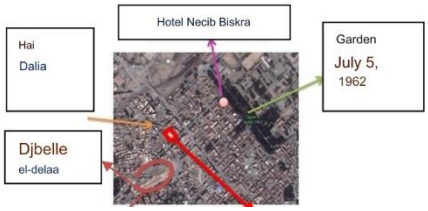
The project	Technical sheet	Situation
I.1.1 Multi-Functional Tower		
Shanghai West Bund AI Tower & Plaza 	Kind: Multi-Functional Tower Date of completion: 2021 Surface: 510000 m² Architect: Nikken Sekkei	Xuhui District . China
Abu Dhabi Central market 	Kind: Multi-Functional Tower Date of completion: 2014 Surface:39400m² Architect: Foster + Partners	Abu Dhabi, United Arab Emirates
The Shard / Renzo Piano Building Workshop 	Kind: Multi-Functional Tower Date of completion: 2012 Architect: Renzo Piano Building Workshop	London, United Kingdom
International Commerce Centre / KPF 	Kind: Multi-Functional Tower Date of completion: 2002-2010 Architect: KPF (Kohn Pedersen Fox) Associates	HONG KONG,

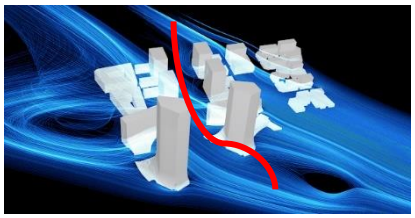
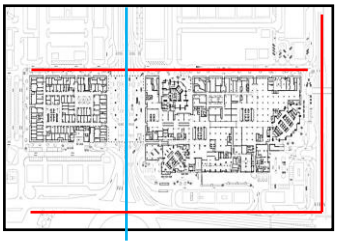
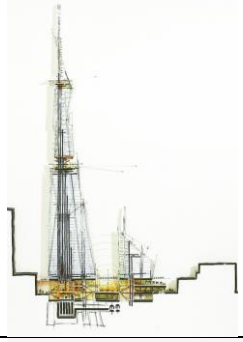
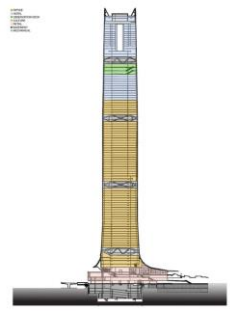
Vivo tower 	Kind: the new Vivo headquarters Date of completion: 2022-2025 Architect: NBBJ	Shenzhen's Bao'an
I.1.2 Kinetic architecture projects		
The Shed, a Center for the Arts 	Kind: EXHIBITION CENTER Date of completion: 2019 Surface:18500m² Architect: Diller Scofidio + Renfro, Rockwell Group	New York, United States
I.2 Real projects		
Park Mall Setif: 	Kind: shopping centre Marriott Hotel; administrative offices and meeting room Date of completion: 2016 Surface:140000m²	**Setif Algeria**
Al Khair shopping Centre 	Kind: shopping centre Date of completion: 2006 Surface: 22036.16 m² Architect: khatab abd allah	**Biskra Algeria**

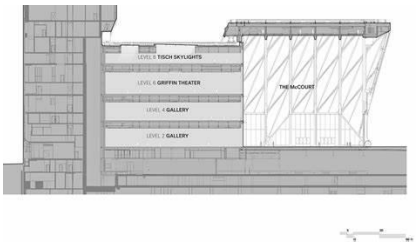
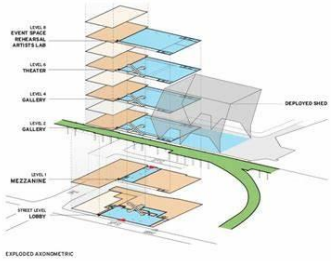
The project	The project in its distant environment
Shanghai West Bund AI Tower & Plaza	 Located on the west bank of the Huangpu River (West Bund) in Shanghai, this project consists of four buildings, among them two skyscrapers.. The project located in a compact site and well itegrated into the environment
Abu Dhabi Central market	 located in the heart of Abu Dhabi on Sheikh Rashid Bin Saeed Road. It is part of the larger World Trade Center project, featuring a well-planned mall, a modern market, offices, and residential apartments. Accessible from two main roads
The Shard / Renzo Piano Building Workshop	 Located adjacent to London Bridge Station on the south bank of the River Thames, this project was conceived in alignment with London Mayor Ken Livingstone's urban vision. It reflects his policy of promoting high-density development at strategic transport hubs in London. Such sustainable urban extensions capitalize on proximity to public transportation, aiming to reduce car dependency and alleviate traffic congestion within the city.
International Commerce Centre	 The 118-storey, 484-meter (1,588 feet) commercial skyscraper completed in 2010 in West Kowloon, Hong Kong, is part of the Union Square project situated atop Kowloon Station. At the time of its completion, it ranked as the world's 4th tallest building and the third tallest in Asia.
Vivo tower	/
Kinetic architecture projects	

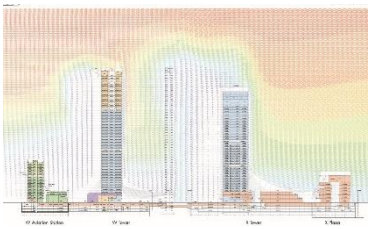
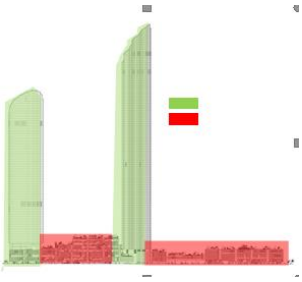
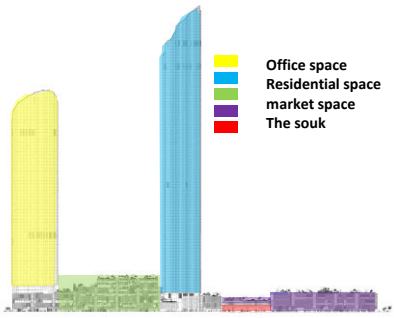
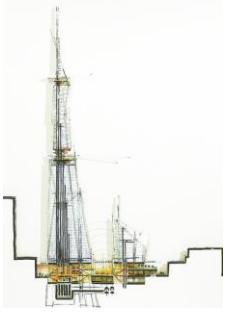
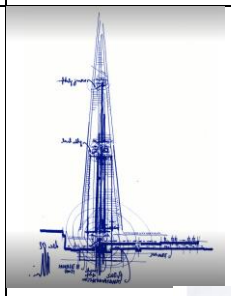
The Shed, a Center for the Arts		Located at the intersection of the High Line and the new Hudson Yards district on city-owned land, The Shed features a unique design. It includes a fixed structure with column-free galleries nested within a telescoping outer shell. This outer shell can slide onto an adjacent plaza, effectively doubling the building's footprint as needed. Inspired by industrial-scale gantry crane technology, the steel and ETFE shell can deploy within five minutes, powered by the equivalent of a single automobile's horsepower.
Real projects		
Park Mall Setif:		It is located in the center of the city of Setif, facing the governorate. It is also located near May 8, 1945 Street, which is considered one of the most important axes of the city.
Al Khair shopping Centre		This mall is located on Saouli Brothers Road, Biskra, within an urban location.

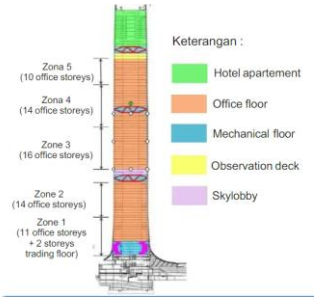
The project	The project in its immediate environment	The project plot
Shanghai West Bund AI Tower & Plaza	 The project is surrounded by cultural and commercial facilities and residents	
Abu Dhabi Central market	 The project is located in a historical location, as it reinvents the archaeological market, giving the city a new heart, and the project becomes well integrated into its location.	 site built unbuilt
The Shard / Renzo Piano Building Workshop	 The building is situated adjacent to London Bridge station on the south bank of the River Thames. This combined train, bus, and underground station is one of the busiest transportation hubs in London.	 The boundaries of the site and the tower
International Commerce Centre	 The skyline along its shores is adorned with an impressive array of skyscrapers, including the latest supertall addition by architects KPF, soaring to a height of 484 meters above Victoria Harbor in Kowloon.	 The boundaries of the site and the tower
Vivo tower	/	/
Kinetic architecture projects		

The Shed, a Center for the Arts	 The Shed, being part of the Hudson Yards development on the west side of Manhattan, is situated in a vibrant and rapidly transforming neighborhood. The immediate environment of The Shed is characterized by a mix of commercial, residential, and cultural spaces.	The project plot for The Shed, as part of the Hudson Yards development, involves creating a dynamic and versatile cultural institution that serves as a center for the arts.  
Real projects		
Park Mall Setif:	 The project enjoys good connectivity, as it is located opposite two important road networks, each of which has a large flow (Road 08 November, Road (l'ALN)), in addition to its proximity to Road 08 May 1945 (the most important axes of the city of Setif) is a monument in relation to the neighborhood and the city.	 built Absence of green fields and water bodies. In addition to the absence of outdoor rest and entertainment spaces.
Al Khair shopping Centre	 The el-kheir shopping center is a monument in relation to the neighborhood and the city.	 A complete absence of green spaces and outdoor areas, as: The percentage of the built part represents 100% of the project site.

The project	Project integration	Accessibility
Shanghai West Bund AI Tower & Plaza	 The site's "windbreak" design, a streamlined design, suppresses the most significant wind currents in low-elevation areas, and the architect took into account the main axis and direction of the prevailing winds	 The project is divided into two blocks, including a main mechanical street, and it is also surrounded by a main street
Abu Dhabi Central market	 A fluid and continuous relationship between the interior of the building and the environmental place Continuing Abu Dhabi's commitment to green spaces, the site features generous landscaping, with the roofs of the podium buildings designed as terraced gardens. Above this lush greenery rises a cluster of tall buildings, creating a contrast with the dense, interconnected landscape below.	The project has high accessibility because it is between 3 main mechanical axes 
The Shard / Renzo Piano Building Workshop	 A fluid and continuous relationship between the interior of the building and the environmental place	
International Commerce Centre	A fluid and continuous relationship between the interior of the building and the environmental place 	/ 
Vivo tower	/	/
Kinetic architecture projects		

The Shed, a Center for the Arts	 - Ensure the architectural design of The Shed seamlessly integrates with the overall aesthetics and urban design of the Hudson Yards development. - Collaborate with architects and urban planners to create a structure that complements nearby buildings and public spaces.	 - Develop and implement innovative accessibility solutions for urban roads to enhance mobility for people with disabilities.
Real projects		
Park Mall Setif:	The project was distinguished by its difference and  uniqueness from other buildings and projects in the city through its facades, whether in terms of sizes and lengths or in terms of building materials, colors and decorative elements used in it, which made it an urban landmark and a new reference for the city.	The project has good connectivity, as it is located opposite two important road networks, both of which have a large flow. 
Al Khair shopping Centre	 There is a contrast between the project and its urban environment. -The facade treatment is different in the urban environment. - the height of the project is 6 floors.	The project has good connectivity, 

The project	Volumetry	Composition
Shanghai West Bund AI Tower & Plaza	 The project's most distinctive feature is its "wind design," evident in both the overall layout and the shapes of the building volumes. The buildings' exteriors, public spaces within the commercial zone, landscaping, and interior designs all embody a streamlined aesthetic inspired by wind dynamics. This concept permeates the entirety of the project, enhancing both its visual appeal and functional coherence.	 The potential of this magnificent site has been fully realized, resulting in the creation of a new public space that seamlessly integrates landscape and architecture, harmonizing the towers with the surroundings. This unique design approach is tailored specifically to this location and could not have been achieved through the redevelopment of an existing urban area in the heart of the city.
Abu Dhabi Central market	 Above the dense, compact base, a cluster of high-rise buildings emerges, each varying in height and mass based on its function—whether office spaces, apartments, or a blend of hotels and serviced apartments. These buildings present a cohesive appearance with smooth, reflective facades designed to require minimal maintenance in the dusty desert environment..	
The Shard / Renzo Piano Building Workshop	 The tower's design optimizes its functionality with a mix of residential, office, and retail spaces, ensuring continuous activity around the clock. Its slender, pyramidal shape was specifically chosen for this mix: large floor plates at the base for offices, with restaurants, public spaces, and a hotel in the middle, and private apartments at the top. The uppermost floors feature a public viewing gallery at 240 meters above street level. This arrangement not only enhances functionality but also allows the tower to gracefully taper off into the sky, a crucial consideration for Renzo Piano Building Workshop given its prominent position in the London skyline.	 

<table>
<tr>
<td>International Commerce Centre</td>
<td> 
-Analyzed wind performance and tenant preferences.
-Circular floor plate good for wind, but not preferred by financial tenants.
-Square floor plate preferred by tenants but performs poorly in the wind.
-Chose a square floor plate with notched corners for improved wind response.</td>
<td> 
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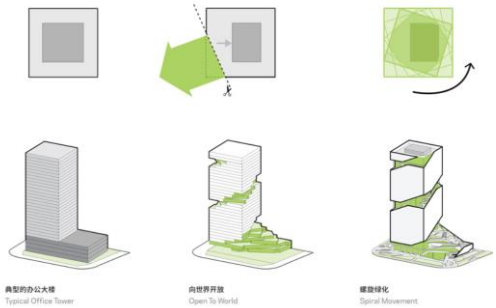
<tr>
<td>Vivo tower</td>
<td> 
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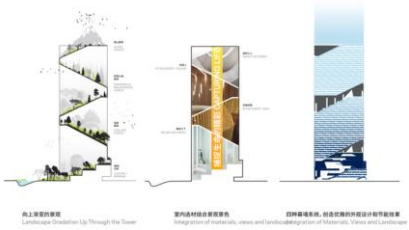
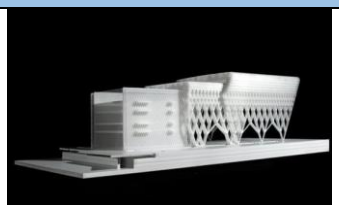
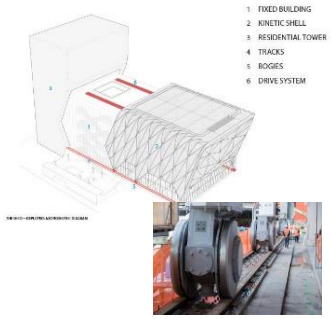
<td> 
NBBJ's impressive 150-meter, 32-story tower features a spiraling, multi-level collection of terraces and gardens that are seamlessly integrated. Beginning with a welcoming public plaza, the building descends from a sunken garden to level five, housing the flagship Vivo store, retail entrances, eateries, conference levels, and an employee cafeteria. Additionally, the penthouse offers event spaces and conference rooms, enhancing its functionality and appeal.</td>
</tr>
<tr>
<td colspan="3">Kinetic architecture projects</td>
</tr>
<tr>
<td>The Shed, a Center for the Arts</td>
<td> 
The Shed's design draws inspiration from its intended purpose as a flexible and adaptable cultural space. The movable outer shell, which can expand and retract, allows the building to transform and accommodate a variety of artistic events and exhibitions.

</td>
<td>The shell, equipped with wheels measuring six feet in diameter, takes nearly five minutes to transition from its nested position within the base building to fully deployed over the plaza. During this process, it covers a distance of approximately 115 feet..

</td>
</tr>
<tr>
<td colspan="3">Real projects</td>
</tr>
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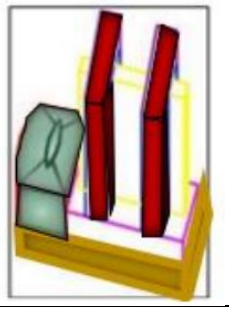
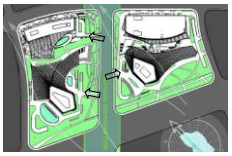
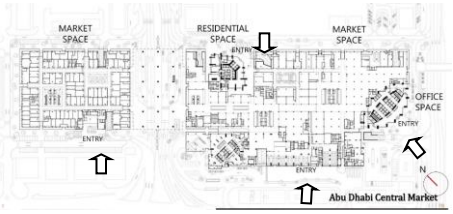
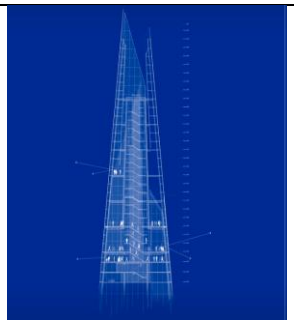
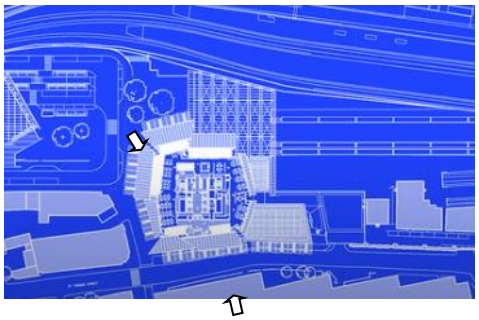
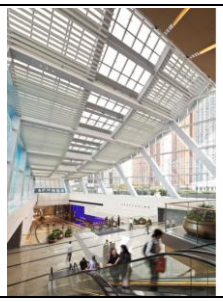
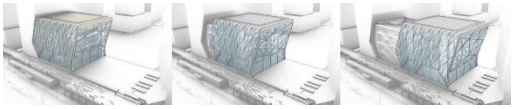
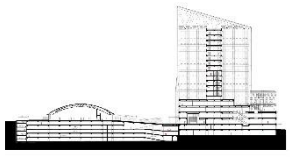
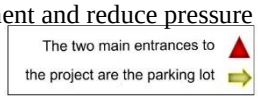
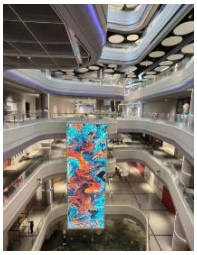
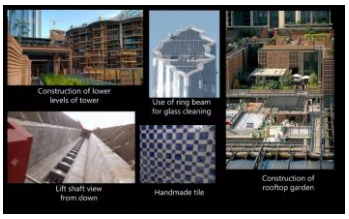
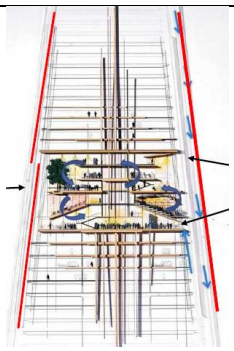
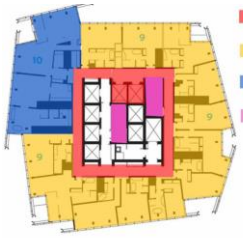
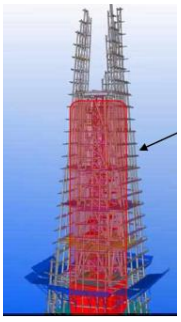
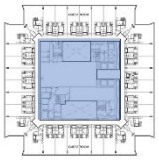
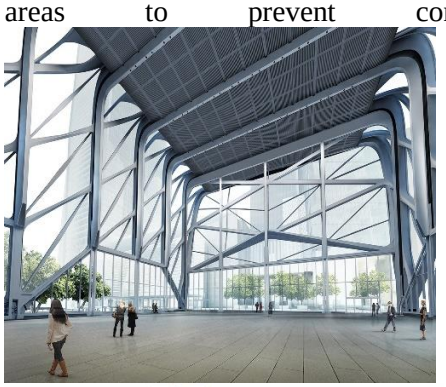
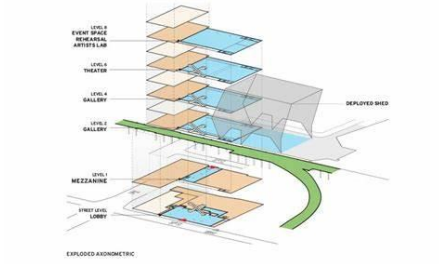
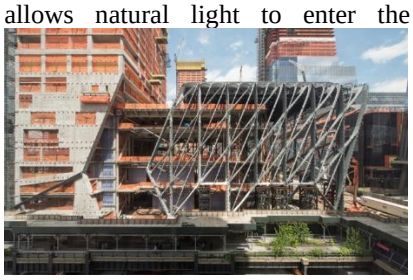
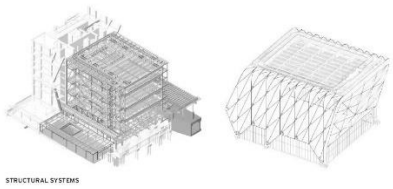
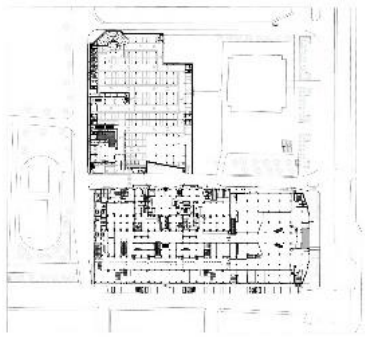
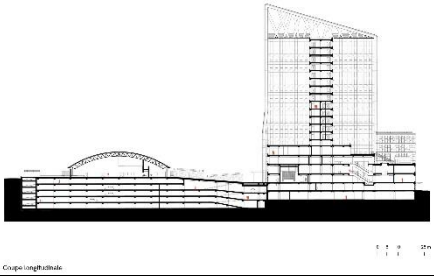
Park Mall Setif:	It consists of an interconnected group of simple shapes and sizes  		
Al Khair shopping Centre -		It is a compact volume in the form of a parallelogram	The architect chose a regular shape, with transparent facade

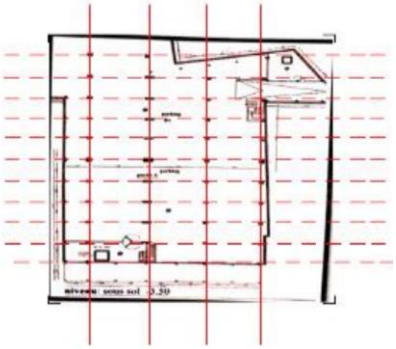
The project	Architectural envelope	Access
Shanghai West Bund AI Tower & Plaza	 inspired by the image of phoenixes, gracefully spread out at lower levels, creating ample ground space for relaxation. The design draws inspiration from the site's aviation history and prevailing winds. Early in the design process, simulation technology was employed to predict wind flows, optimizing the tower layout for a people-friendly environment. . This wind-driven design not only enhances the towers' aesthetics but also shapes the airflow in the surrounding area.	Several entrances to match the urban site, preserved by pedestrian entrances through wide ramps  
Abu Dhabi Central market	The architectural envelope of the project takes the form of the traditional Islamic Mashrabiya, in addition to preserving its characteristics, with the aim of preserving the local Islamic identity and highlighting it in it. -For the ceiling: Relying on the removable roof, or what is known as the adaptive shading system, in some parts of the building, especially in the central courtyards, with the aim of controlling the  internal environment of the project.	 Diversity and abundance of entrances in keeping with the enormity of the project and giving it architectural value, as well as with the aim of guiding visitors inside
The Shard / Renzo Piano Building Workshop	 The tower features eight sloping glass facades, known as "shards," which define its distinctive shape and visual character. These shards fragment the scale of the building and reflect light in unpredictable patterns. Opening vents positioned in the gaps or "fractures" between the shards provide natural ventilation to winter gardens. The use of extra-white glass gives the Shard a sense of lightness and makes it responsive to the changing sky, resulting in the tower's color and mood continuously evolving throughout the day.	

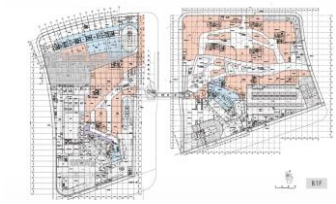
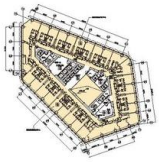
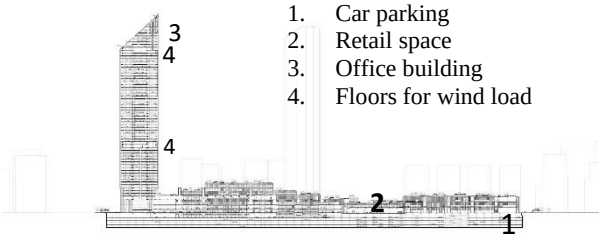
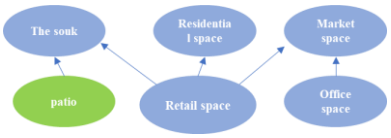
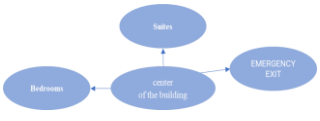
International Commerce Centre	Chiseled façades at the base give way to gently sloped curves. Curves create sheltering canopies for office and hotel entrances overlooking the harbor. Façade articulated as four planar elements rising above the roof as glass sheets to form the tower crown. 	/
Vivo tower	Reflecting the diverse native ecosystem of Shenzhen and the various biomes of Southern China, each level of the high-rise incorporates different types of trees and shrubs, creating a transition from forest floor to mountaintop environments. Additionally, the building's orientation is rotated to better engage with the cityscape, enhancing the pedestrian experience and integrating the structure more harmoniously into its urban surroundings 	/
Kinetic architecture projects		
The Shed, a Center for the Arts	The Shed's 120-foot tall (37 m) movable shell features an exposed steel diagrid frame, covered with translucent cushions made from a durable and lightweight Teflon-based polymer called ethylene tetrafluoroethylene (ETFE). This material offers thermal properties similar to insulating glass but at a much lower weight. The ETFE panels used in The Shed are among the largest ever produced, measuring nearly 70 feet (21 m) in length in certain sections. 	A wide entrance, taking into account ease of movement for handicapped  
Real projects		
Park Mall Setif:	  The mall's facades are characterized by modernity, which is embodied through: - The use of light materials represented by white and grey, in addition to the use of red in order to create contrast and highlight some elements in it. - The use of modern building materials characterized by lightness, namely: glass, aluminum, and the use of a distinctive decorative element along the façade of the mall, which is represented by a network of slanting lines intertwined with each other.	 We notice a separation between the entrances to each part of the project, which ensures privacy and functionality by regulating mechanical movement within the project floor.

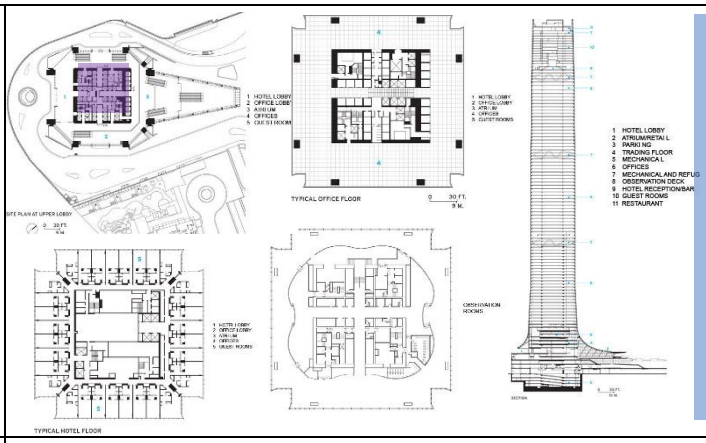
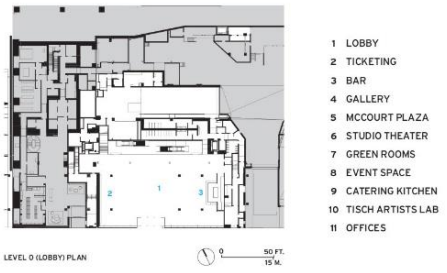
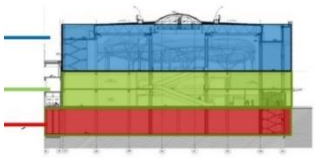
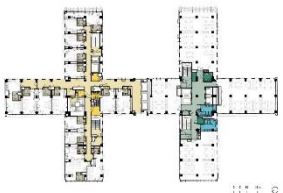
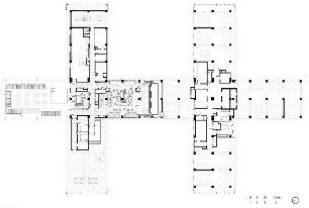
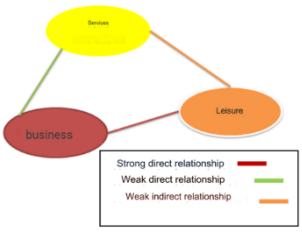
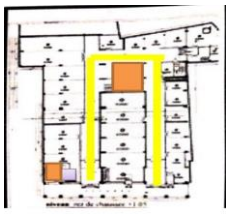
Al Khair shopping Centre	 The project has a single facade characterized by verticality. - Using glass as an aesthetic element rather than a guest, in order to give the facade a modern character - A rather modern facade, which does not express an identity in the city.	 Separating the entrances with the aim of organizing movement and separating the movement of goods from the movement of customers. - Multiple entrances in order to regulate movement and reduce pressure on the main entrance. 

The project	circulation	Structure
Shanghai West Bund AI Tower & Plaza	  The subway runs underground parallel to Amphitheater Park, with the two stations serving as hubs that connect transportation throughout the surrounding area. The planning of the adjacent lands to the north, south, east, and west is based on this infrastructure framework. This project, which is located in the middle and both sides of the Amphitheater Park, connects the eastern and western sites on both sides of the green space through underground passages, and is also connected to the underground passage of the subway to create a comfortable walking space for people.	is a building of steel and glass   
Abu Dhabi Central market	linear and vertical circulation   	The building incorporates concrete, steel, glass, and wood, particularly for its meshrabiya elements. 
The Shard / Renzo Piano Building Workshop	 The “fractures” between the pieces of glass, open to the wind, allow natural ventilation of the winter gardens. The floors are covered with hydraulic concrete slabs.   THIRTY-NINTH FLOOR/HOTEL	 The main structural element of the building is the concrete core located at its center. This core accommodates the main elevator services, elevators, and emergency staircases, and it supports all lateral loads. Additionally, this concrete column houses the building's main systems, including electrical cables, water pipes, and maintenance equipment. The foundation of the building extends 50 meters into the ground to ensure stability and support.

International Commerce Centre	 Utilizes a system of cascading escalators to divide office population between local and shuttle elevators.	is a building of steel and glass 
Vivo tower	/	/
Kinetic architecture projects		
The Shed, a Center for the Arts	- Designing spacious lobbies or foyer areas to accommodate large numbers of visitors during peak times. - Providing clear pathways within these areas to prevent congestion.  	The most distinctive feature of The Shed is its outer shell, which is designed to move along rails to expand and retract, transforming the building's footprintThe structure of The Shed primarily consists of a steel frame, which provides essential support for the building. - Cladding materials, such as ethylene tetrafluoroethylene (ETFE) panels, are used to cover the steel frame. ETFE is a lightweight and translucent material that allows natural light to enter the space.  
Real projects		
Park Mall Setif:	Linear movement within the corridors for all floors. 	The construction system used in the shopping center is reinforced concrete post-beam and metal structure with glass facade 

Al Khair shopping Centre	There are two types of circulation -Vertical circulation Elevators Stairs -Horizontal circulation and in spaces There is a traffic intersection between customers and supply 	The construction system used in the shopping center is reinforced concrete post-beam. With glass façade 

The project	Spatial and functional organization
Shanghai West Bund AI Tower & Plaza	     The project consists of two towers that share the same base as shown in the ground plan. We find two types of plans, type W and type X.
Abu Dhabi Central market	 1. Car parking 2. Retail space 3. Office building 4. Floors for wind load   A linear spatial organization for the different spaces with direct relationship and a space which divides the two parts it is received main mechanics
The Shard / Renzo Piano Building Workshop	    The Shard, designed by Renzo Piano, features a multifunctional vertical zoning system around a central core that houses elevators and essential services, ensuring efficient circulation. This design supports diverse spaces such as offices, hotels, residences, and public viewing areasjoined around a central element.

International Commerce Centre	 is a mixed-use skyscraper with a strategic spatial organization centered around a core. This central core houses elevators and essential services, optimizing space and circulation efficiency. The ICC includes offices, hotels, retail spaces, and observation decks
Vivo tower	/
Kinetic architecture projects	
The Shed, a Center for the Arts	 features a flexible and innovative spatial organization centered around a movable shell structure. This movable shell allows the transformation of indoor and outdoor spaces to accommodate diverse art forms and performances
Real projects	
Park Mall Setif:	ENTERAINMENT AND ARRUSEMENT TRADE AND SALE CAR PARKING +HYPER MARKET     At Park Mall, activities are organized into three main categories: terminal, trade, and détente. These activities are executed through staged reassembly across various levels. The southern section of the land is dedicated to terminal and trade activities, with the ground floor (RDC) and the first level primarily focused on trade, particularly luxury (LUX) trade. The upper level is designated for détente, which includes various recreational activities.
Al Khair shopping Centre	 

II. Analytical Summary of Examples:

Situation	The projects are mainly located in the heart of cities, in the compact urban site, as well as the other projects are well suited to the natural Park. far away from cities
The project in its distant environment	The projects have a strong relationship with the elements of the natural and distant urban environment.
The project in its immediate environment	The projects are well located in the urban environment, and surrounded by cultural, commercial and residential facilities
The project plot	Most projects are built on irregular plots, 50% for the project and the rest for the landscaped outdoor spaces outside.
Project integration	The integration project contains regular and irregular shapes and closed volumes to arouse people's curiosity. The unbuilt part must represent 1/4 of the area of the built part, and it must contain spaces Green and water bodies.
Accessibility	The projects are well equipped with access (stairs, ramps), Route follows the shapes of the masses.
Volumetry	
Composition	Most projects have architectural forms with space central (atrium, courtyard, forum) for an exhibition tour between key project spaces.
Architectural envelope	- interior spaces benefit from panoramic views. Using transparency in the facades to introduce the center and attract customers' attention to it. - Using advertising boards on the facade of the building. - Parameterizing and highlighting the entrance. - Adaptation and suitability of facades to the environmental climatic characteristics of the project area. - The facades preserve the elements of the region's distinctive architectural identity.
Access	Diversity of entrances (main entrance, secondary entrances, entrance mechanical and pedestrian)
circulation	Diversity of routes, a free, circular, curved route and linear to connect project spaces.
Structure	the tower generally consists of a central core for the technical space and circulation with a steel structure and glass facade
Spatial and functional organization	The main component spaces of cultural centers are: Event spaces, exhibitions, library and cafeteria. The main component spaces of hotels: lobby, bedrooms and relaxation areas

III. Program analysis

SHOPPING CENTER				
Section	The espace	the number	the area	The total area
Commercial sector	Women's / men's/children's clothing	2	200	1200
	Games for children	1	140	140
	Women's / men's / children's shoes	2	100	200
	Accessories and jewelry	2	40	80
	Bags and hats	2	50	100
	Watches and glasses	2	40	80
	Book store	1	50	50
	Women's hairdresser	1	70	70
	Men's shaving…….	1	50	50
	Sports clothing and equipment	1	80	80
	Bridal supplies	1	80	80
	Traditional industry	2	40	80
	Paintings	1	50	50
	Fabrics	1	50	50
	Sewing tools	1	50	50
	Jewelry	2	40	80
	Cosmetics	2	60	120
	Gifts	1	40	40
	Florist	1	50	50

Commercial sector	Perfumes	2	40	80
	Phones and accessories	1	70	70
	Furniture and decoration	1	100	100
	Home electricity	2	70	130
	Furnishings	1	50	50
	Supermarket	1	2000	2000
	Craft shops	1	50	50
	Tourist agency	1	60	60
Total=				
Consomption sector	Restaurants	2	200	400
	Cafes	2	100	200
	Fast food	3	80	240
	Sweets shop	2	50	100
	Traditional sweets	1	50	50
	Dates	2	50	100
	Ice cream shop	1	50	50
	Tea hall	1	200	200
Total=				
Children's toys sector	entertainment	1	800	800
	Electronic games and billiards	1	450	450
	Bowling alley	1	450	450
Total=				
Services	Pharmacy	2	50	100

section	Communications agency	1	50	50

section Services	Special care for children	1	100	100
	Prayer (men/women)	2	60	120
Total=				
section Management	Director's office	1	30	30
	Secretariat	1	25	25
	Meeting room	2	50	100
	Accounting office	1	25	50
	Registration Control Office	3	25	75
Total=				
sector Technical	Store	3	100	300
	Technical field	1	100	100
	Bathrooms			160
Total=				
Circulations area :				

Office				
Section	Spaces	the number	The area	The total area
reception	Reception area	01	16	16
	Waiting area	01	140	140
	Administration and services	04	16	64
Total=220				
Business	Partitioned offices	140 posts	1p 5m	700
	Co working	300 per	1p	1200

			4m	
	Semi-open offices	300 per	1p 5m	1500
	Meeting rooms	13	26	338
	Conference room	01	200	200
	Exhibition space	02	200	400
	Room Visio-Conference	5	16	80
	Creative rooms	6	16	96
Total=4255				
services	banking annex			
	communication agency			
	tourist and travel agency			
Total=				
commerce	shops	12	20	240
Consumption	Restaurant	01	100	100
	Cafeteria	05	28	140
Total=480				
Leisure and relaxation	Prayer (men/women)	04	12	48
	gym	02	300	300
Total=348				
Management	Director's office	01	60	60
	Secretary’s Office	01	15	15
	Meeting room	01	60	60
	Accounting office	01	15	15
	Reception office	01	15	15
	Archives	01	15	15
	Cloakrooms	01	15	15
	Control points	01	15	15
	Camera control spaces	01	15	15
Total=210				
sector Technical	Storage	04	50	50

	Technical area	01	20	20
	toilets			
	Security room	05	16	80
Total=				
Circulation				

Conclusion :

Analysis of examples of multi-functional towers that combine a shopping center and offices reveals several advantages. These projects are characterized by the integration of facilities that combine culture and work in one place, which enhances cultural exchange and creativity between different groups and communities.

We reached the conclusion of the most important characteristics that distinguish commercial centers and offices, both at the urban level in terms of general location, connectivity, and flow. . ..etc., and in terms of functional distribution of areas, movement and interface design,

In addition, the organization of the spheres plays a crucial role in the construction of these towers, especially the organization of the central part. The organization of the areas helps achieve optimal use of the spaces within the tower, ensuring an efficient and comfortable working environment for the offices, and a diverse and exciting cultural environment for the cultural and entertainment facilities. This central organization enhances the functional and cultural experience of users, making the tower an attractive business and cultural center of the city.

By studying and analyzing examples of kinetic architecture, we will be able to develop innovative and effective designs for kinetic elements that contribute to achieving your goal of displaying the building in a unique and distinctive way in the architectural

CHAPITRE 03:

PRACTICAL CHAPTER

Introduction :

This chapter delves into the practical facets of the study, offering a thorough analysis and insightful exploration of the project's various components. Initially, it presents a detailed site analysis, setting the groundwork for understanding the contextual influences on the design. Following this, the chapter elucidates the intersections between the project objectives, the developmental phases, and the overarching theme of the study, seamlessly leading into an exposition of the design concept and its progressive stages of evolution.

A significant portion of the chapter is dedicated to examining the structural intricacies involved in constructing the tower, with a lemphasis on the dynamic element inspired by the mimosa plant. This bio-inspired feature adds a unique, responsive characteristic to the design, enhancing its interaction with the environment.

Furthermore, the chapter explores practical applications of the study's theme within the project, demonstrating how theoretical concepts are translated into tangible architectural solutions. The chapter culminates in a comprehensive visual presentation of the project, encompassing detailed plans, sections, elevations, and both internal and external perspectives.

I.Site analysis:

The site is located in Biskra is a commune in the northeast of the Algerian Sahara. The city of Biskra is located between two very distinct zones. In the North the mountain range of the Saharan Atlas which constitutes a natural limit between the north and the south. Geographic coordinates Biskra -Algeria:

- Latitude: 34° 51' 1 N;
- Longitude: 5° 43' 40 E.

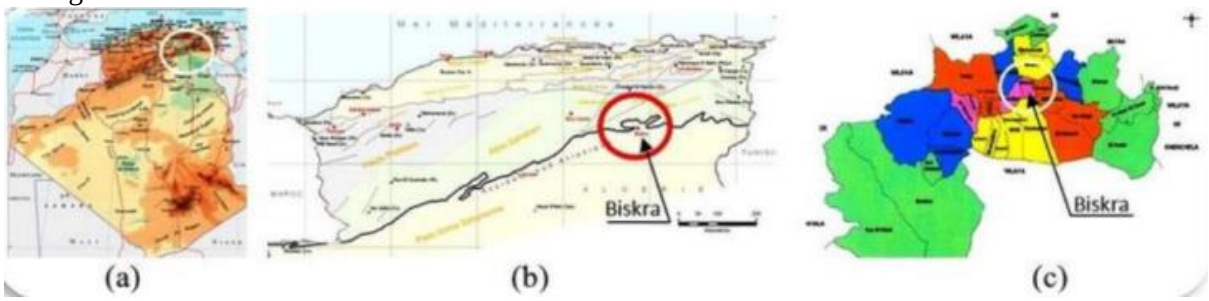


Figure 73: (a) and (b), Geographical location of the city of Biskra; (c) administrative division map, wilaya of Biskra soure: Article Jan 2017Alkama Djamel

I.1. Geographical location:

The project is located in the city of Biskra, on the edge of the Sidi Zarzour Valley, opposite Bachir Ben Nasser Park

Area = 32651,84 ²m

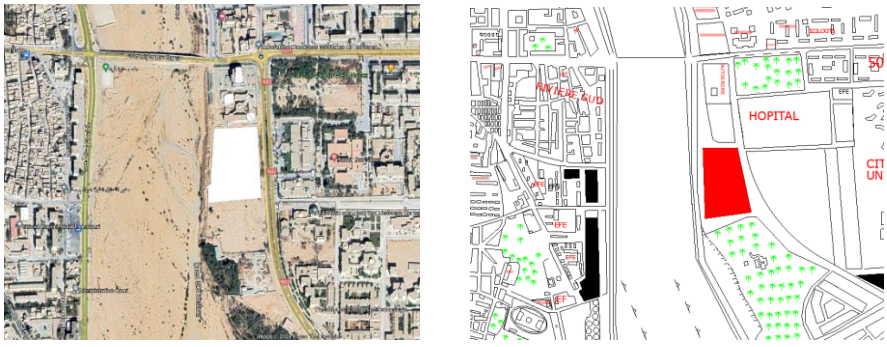
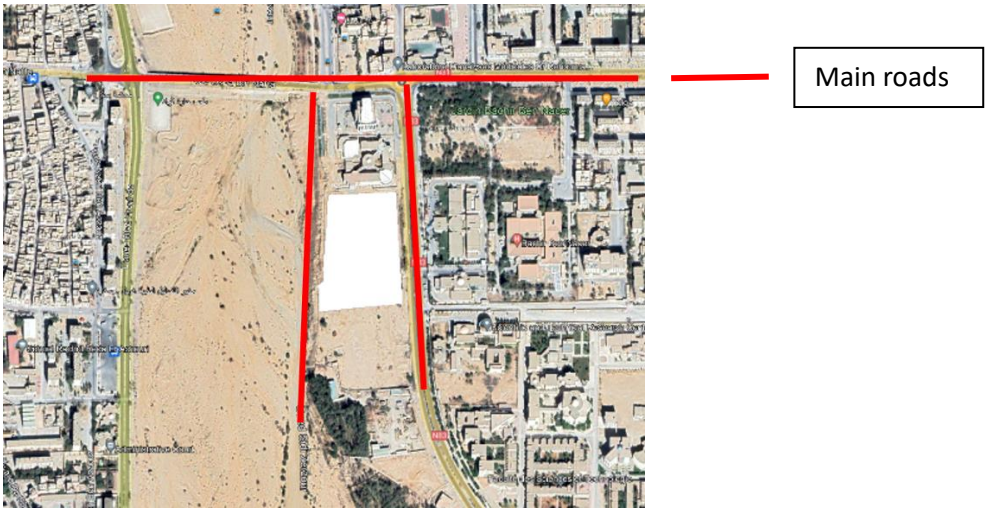


Figure 74: The site and nearby surroundings
Source: (2023EARTH GOOGLE) Adapted

I.2. Accessibility and Transportation:

The site's accessibility is a crucial factor in its development potential:

- Road Networks: Biskra is well-connected by a network of major roads that facilitate easy access to and from the city. The proximity to a main road directly connects the project site to the rest of the city
- Public Transportation: The availability of public transportation options, including buses and taxis,ensures convenient travel for residents and visitors.
- Pedestrian Access: The site is designed to be pedestrian-friendly, promoting walkability and ensuring safety and comfort for foot traffic.

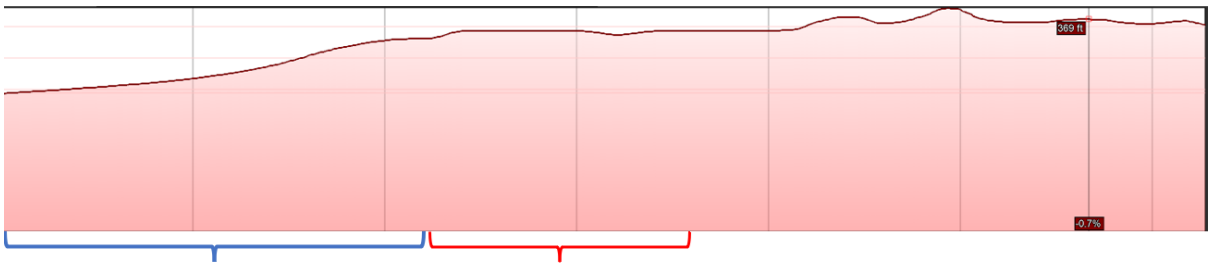


I.3. Site Topography :

I.3.1. Sections on the site:

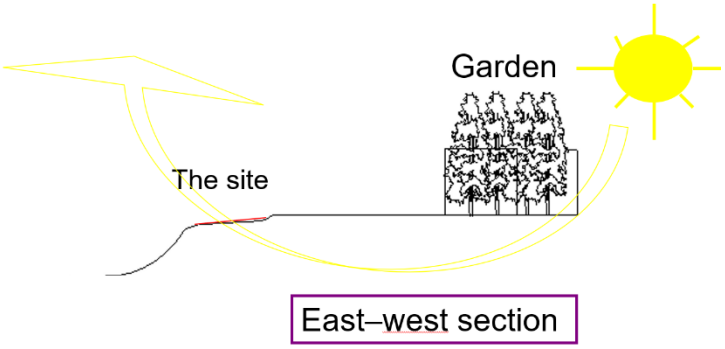
The site is irregular in shape and contains little terrain due to its location next to the valley

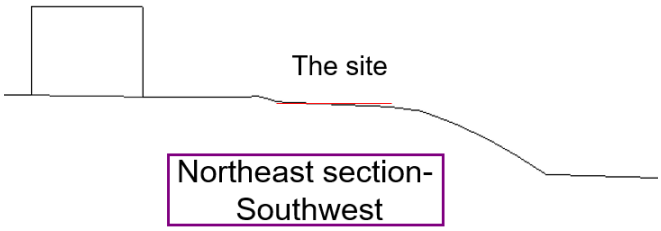
The shape of the site: has a slight slope Almost flat



valley **Terrain**

Topographic section (GOOGLE EARTH.2024)





I.4. Climate and Environmental Conditions :

Biskra's climate is characterized by its subtropical desert conditions, with key climatic indicators as follows:

- **Temperature:** Summers are extremely hot, with average temperatures reaching 43.5°C, while winters are relatively mild, with average minimum temperatures of 4°C.
- **Humidity:** Relative humidity levels vary seasonally, with low humidity during summer and higher humidity in winter.
- **Rainfall:** Rainfall is scarce, with an average of 31 days of rainfall per year, contributing to the arid nature of the region.
- **Solar Radiation:** Biskra receives intense solar radiation throughout the year, with peak intensity during July, resulting in approximately 383 hours of sunshine per month.

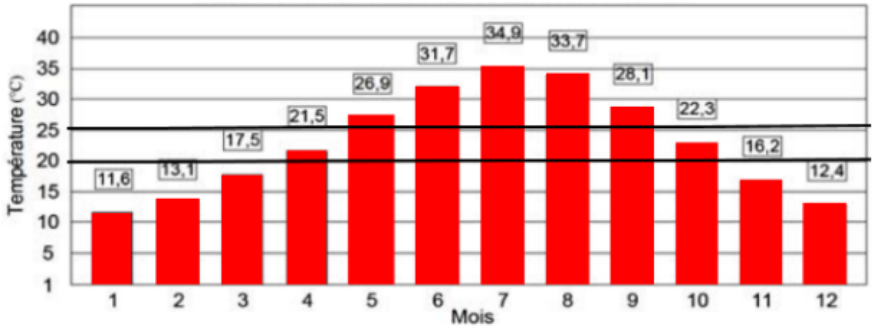


Figure 75 : Average monthly temperature under shelter of the city of Biskra (Biskra Meteorological Station, 2016)

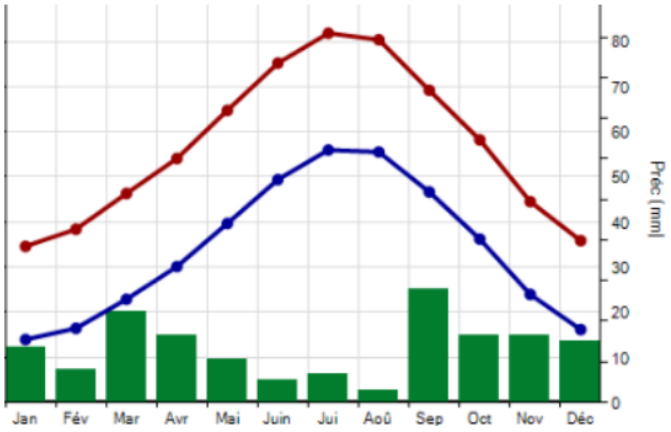


Figure 76: average monthly precipitation diagramme

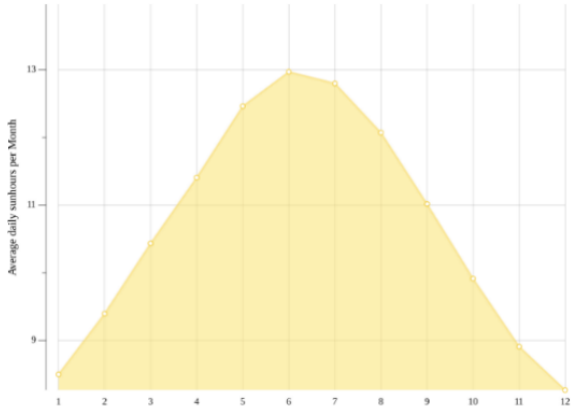
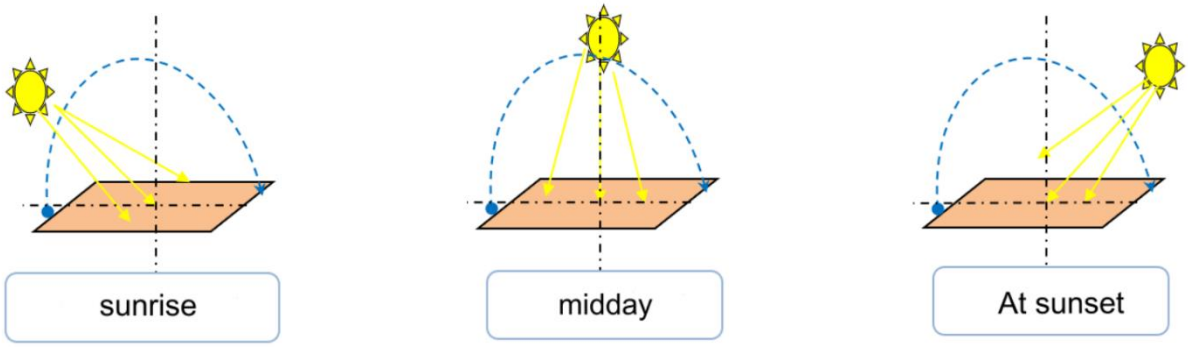


Figure 77: average daily sunhours per month

I.5. Insolation and wind:

The site is exposed almost all day to sunlight and we can see this in the pictures



In the context of Biskra's climate, winds play an important role, especially given its location in the Algerian Sahara. Here is some information about the wind in Biskra:

- Seasonal changes: Although Biskra is known for its hot and dry climate, the winds can provide some relief, especially during the summer months. Wind may help moderate extreme temperatures by providing ventilation and cooling, although it can also exacerbate heat-related discomfort.
- Wind effects: In architectural design, taking wind effects into account is crucial, especially for tall structures such as towers. Wind load analysis and structural design procedures are essential to ensure the safety and stability of buildings, especially in areas exposed to strong winds.
- Although wind can be beneficial for cooling purposes, it can also pose challenges, such as dust storms or sandstorms that are common in desert environments. Urban planning and landscaping strategies may include windbreaks or plants to mitigate the impact of strong winds on buildings and outdoor spaces.

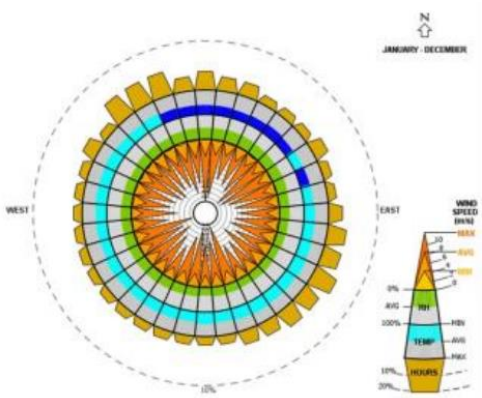
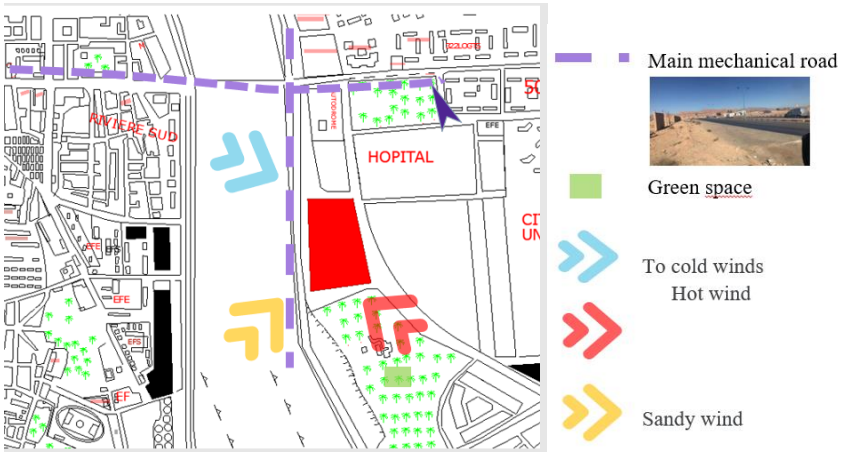


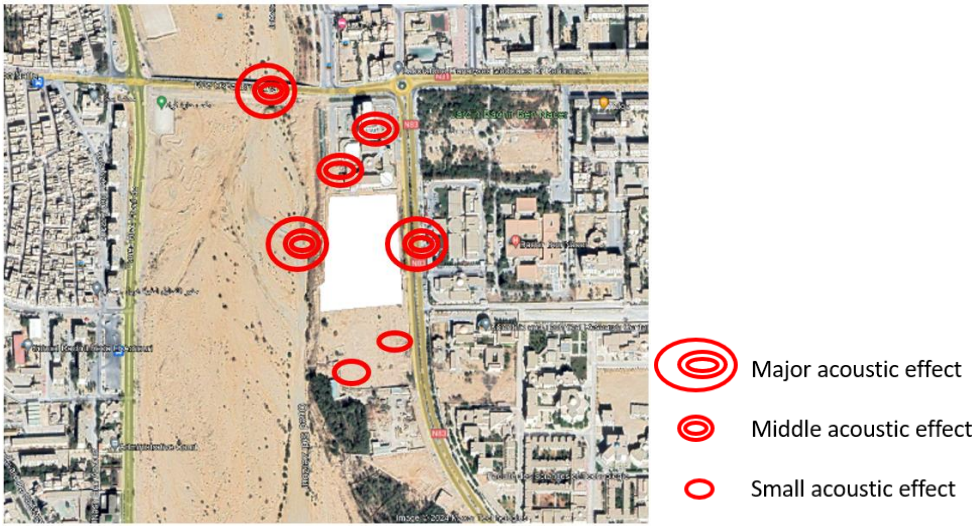
Figure 78 : wind rose of Biskra with climat consltant

I.6. summary of the important elements of the site :



I.7. Noise Sources and Levels :

The project is surrounded by a diverse array of noise sources coming from all directions, contributing to a complex acoustic environment.



I.8. Views and Vistas :

The site

The stage

Oued Sidi Zarzour

Public gardent

the university

Bashir Bin Nasser Hospital

I.9 Summary of the site analysis :

strength point:

▪ Direct connection to the ground due to its proximity to a main road.

▪ The presence of several poles through which the project can be realized.

▪ The topography of the land is good and almost flat, which facilitates the project design process.

Weaknesses:

▪ The site is completely exposed to the sun (absence of urban or natural barriers).

▪ The site is exposed to the wind.

▪ The absence of green fields and the preparation of external fields for the study area.

II. Pre-design elements

I.1 Objectives and determinations

Goals	Intentions
Goals and intentions for theme	
Implementation of design requirements for smart envelope	- Smart systems appropriate to the project function. -smart envelope Depending on the active system
Applying the characteristics of smart envelope in the project	-Through the building's response to the external environment. - Achieving the lowest energy consumption.
Show and highlight the local identity in the project	- use of traditional local elements
Goals and intentions for project	
Project Landmark	-The high of the Project (Tower) -distinctive facades - rich volumetry
optimal project orientation	-North / South.
flexibility of movement	-separation of the mechanical and pedestrian movement -use movable partitions -Clarity of movement elements!
Transparency	opening of the project to the outside
ensured spatio-functional continuity	Use distribution and assembly spaces.

III. Conceptual approach :

III.1 Opportunities and Constraints :

Opportunities	Constraints
Strategic Location: Proximity to major roads, potential for visibility and landmark status.	**Solar Exposure:** High solar exposure throughout the day, challenge in balancing natural daylighting with solar heat gain management.
Urban Context: Integration with surrounding urban fabric, opportunity to enhance cityscape.	**Wind Conditions:** Windy conditions in Sahara region, potential for dust storms.
Environmental Sustainability: Abundant sunlight for solar energy harvesting, green spaces, and sustainable technologies.	**Noise Pollution:** Surrounding noise sources, need for acoustic solutions.
Community Engagement: Creation of communal spaces, positive impact on quality of life.	Si**te Topography:** Irregular site shape, slight slope, site grading and leveling.
Economic Potential: Mixed-use development, attraction of businesses and tenants seeking modern workspace solutions.	**Regulatory and Cultural Considerations:** Compliance with local building codes, respect for local cultural context.

III.2 Concept Development :

This conceptual design seamlessly blends elements of sustainability, aesthetics, and functionality. The integration of gardens on different floors not only enhances the aesthetic appeal but also contributes to the building's environmental sustainability by improving air quality and providing natural insulation. The adoption of a circular form optimizes the use of space, allowing for more efficient circulation and creating a sense of unity and flow within the structure.

Moreover, the incorporation of a central core serves as a multifunctional space that fosters connectivity among occupants. This central hub can house communal areas, such as lounges or meeting rooms, encouraging social interaction and collaboration. The overall design aims to create a unique and harmonious environment that promotes well-being by providing access to nature and ensuring a balanced, serene atmosphere. This holistic approach ensures that the building not only meets practical needs but also enhances the quality of life for its users.

III.3 Inspiration and Vision:

The design is inspired by the mimosa plant's responsive movement to environmental stimuli, aiming to create a dynamic and adaptable architectural form that harmonizes with Biskra's desert climate. The vision is to integrate nature-inspired elements seamlessly into urban architecture, promoting sustainability and enhancing user experience.

III.4 Sustainable Strategies:

Self-Shading: Utilization of kinetic façades that adjust to sunlight angles, minimizing solar heat gain.

Energy Efficiency: Integration of smart technologies and energy-efficient systems to reduce reliance on mechanical cooling.

Natural Ventilation: Design features that maximize cross-ventilation and airflow to enhance indoor air quality.

Innovative Features:

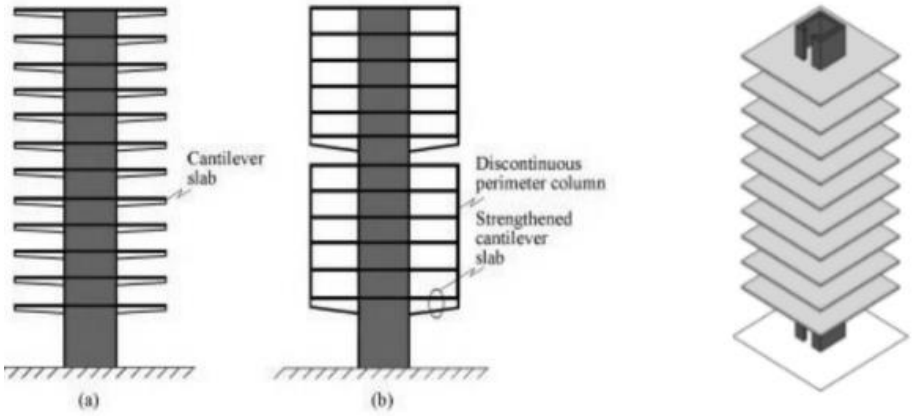
Kinetic Façade: Dynamic shading systems inspired by biomimetic principles, responding to sunlight intensity and direction.

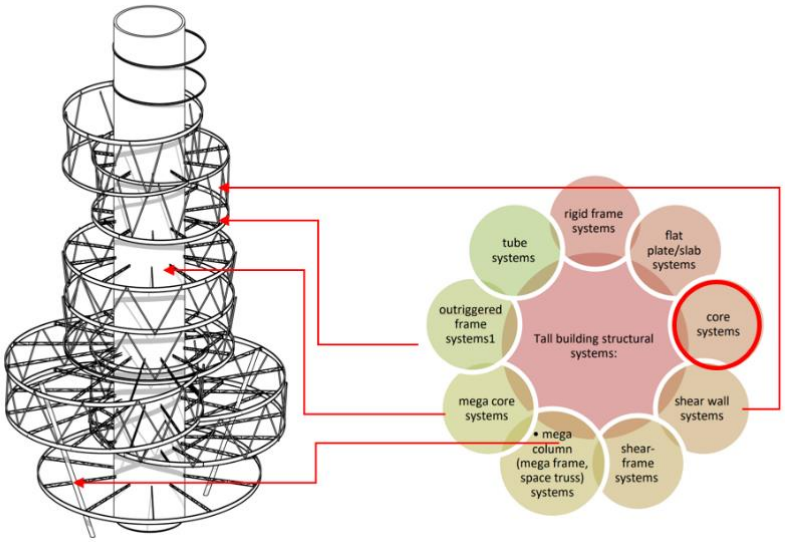
Green Spaces: The incorporation of rooftop gardens and vertical green walls serves to improve thermal insulation, mitigate the urban heat island effect, and enhance the aesthetic appeal of the building or urban environment.
Smart Sensors: Deployment of light and temperature sensors to automate façade adjustments for optimal energy use and occupant comfort.

III.5 Tall building structural systems

Core systems in reinforced concrete buildings typically involve a reinforced concrete core shear wall that bears both vertical and lateral loads. Initially an open core, it can be adapted into a partially closed core by integrating floor beams and/or slabs to bolster the building's lateral and torsional stiffness.

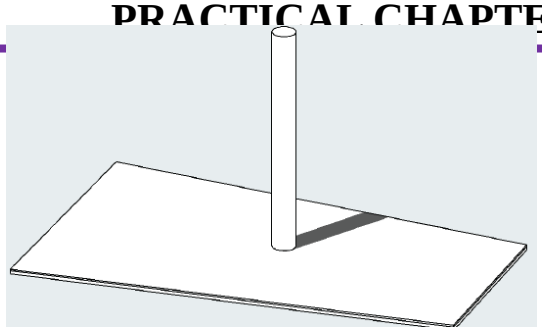
While fully closed cores are optimal for resisting torsion from lateral loads, partially closed cores are sometimes preferred for architectural reasons, approximating this behavior. This configuration is achieved by supporting the open section of the core, typically suitable for buildings up to approximately 35 stories tall.



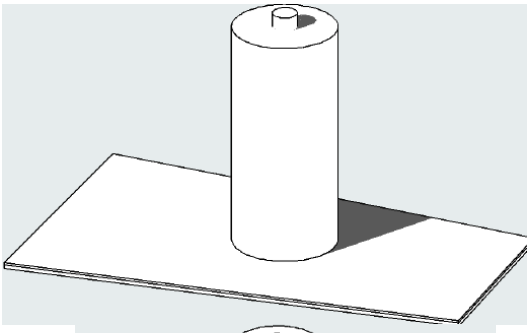


III.6 Concept design of the project :

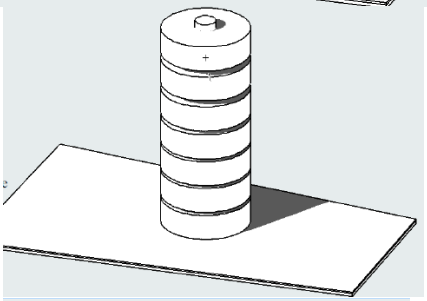
Design the main vertical circulation core of the tower, which includes elevators, staircases, ...



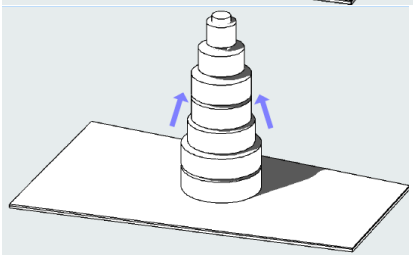
Extruding the masse of the tower



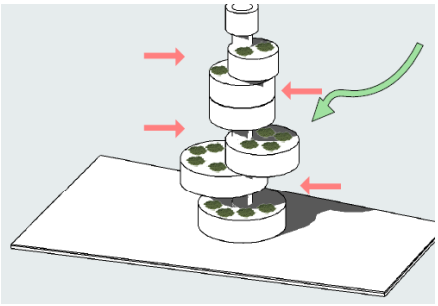
Divide the tower vertically into different zones or functional areas, such as office spaces, retail areas, etc.



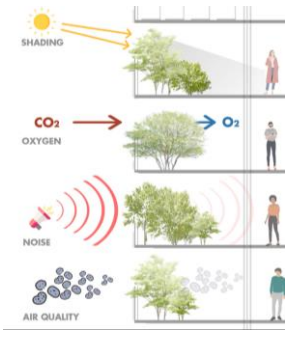
Shaping the tower +wind effect



incorporate green spaces throughout the tower. This could include rooftop gardens,



In recent decades, green magazines and green roofs have become an integral part of the architectural design of high-rise buildings. These elements provide benefits. Here is a review of some of the key benefits of using green magazines and green roofs in high rises:



III.7 Development of facade elements :

Source of inspiration :

inspiration from the Mimosa pudica movement for creating a self-shading element in a building

is a sensitive plant whose leaves bend and emit steam when exposed to external stimuli like

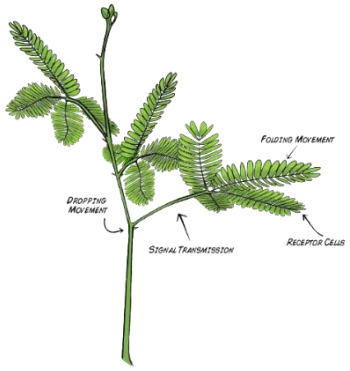
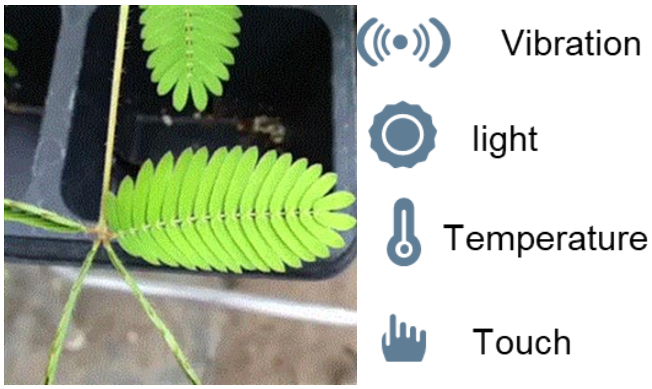


Figure 79: Sensitive Mimosa Pudica Electrophysiology

Source: https://aikyastore.life/index.php

Sensors :

Light sensing elements will be integrated to make it move dynamically and make the building thermally comfortable and adaptable to its environment.



III.8 Advantages of using light sensors to control sunshades:

Improve energy efficiency:

Reducing the use of air conditioning: By reducing the amount of sun entering the building, the need to operate air conditioning systems is reduced, which reduces energy consumption.

Increase reliance on natural lighting: Sensors can control sunshades to allow natural light in when needed, reducing the use of artificial lighting.

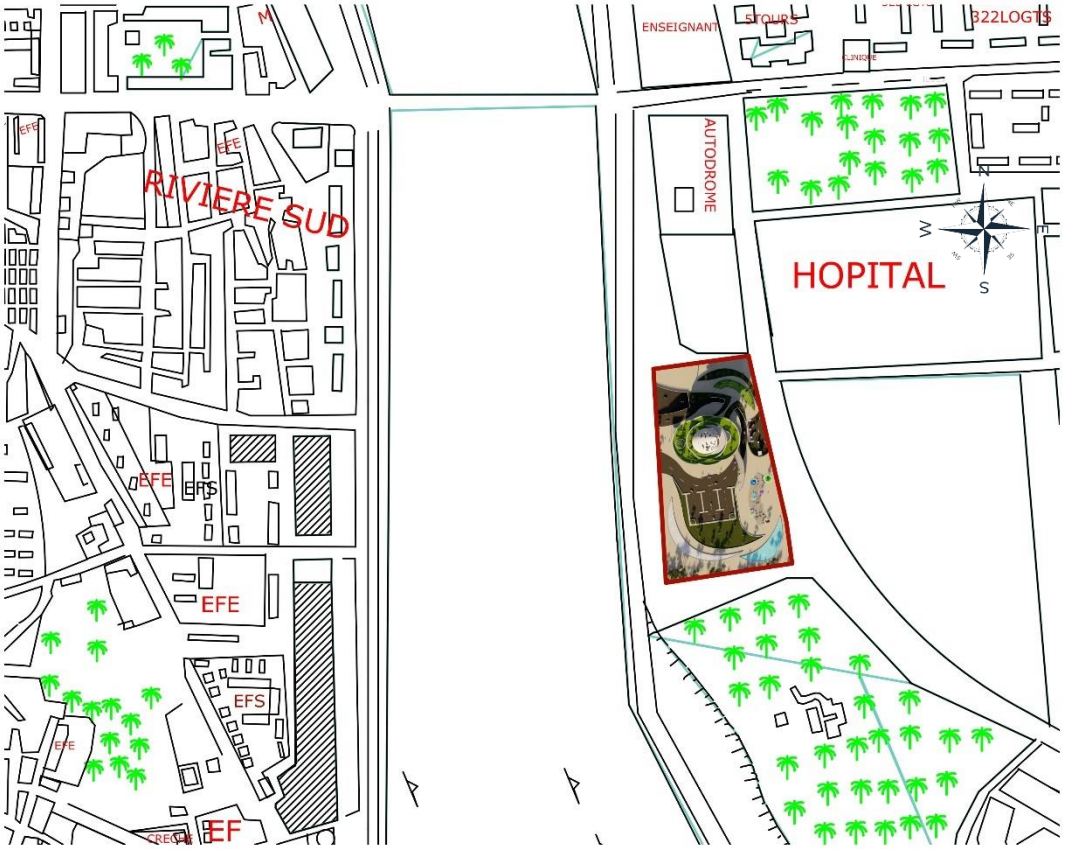
Improve thermal comfort:

Heat Control: Automatic control of the sun visors helps maintain a stable interior temperature, increasing occupant comfort.

Reduce Glare: Automatic sun visors prevent direct sunlight from entering, reducing glare and improving the working and living environment inside the build

V. Graphic presentation of the project：

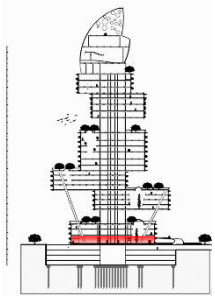
Location plan :

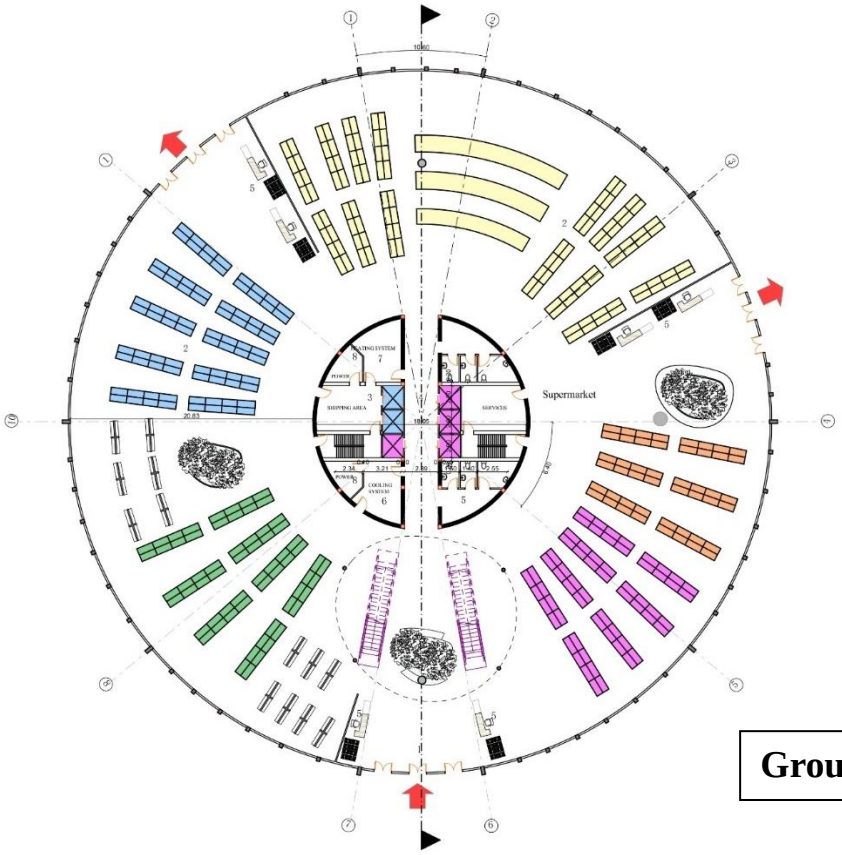


scale 1/500

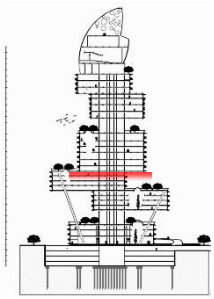
Masse plan :

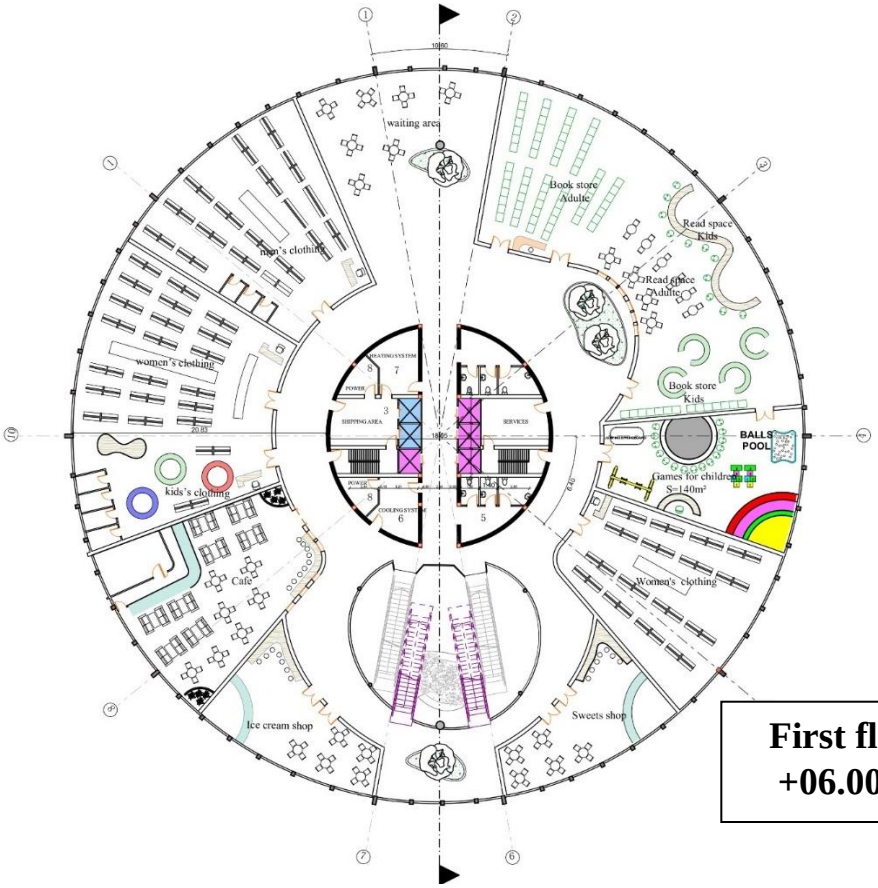
scale 1/200



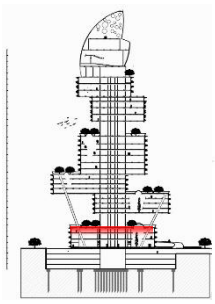


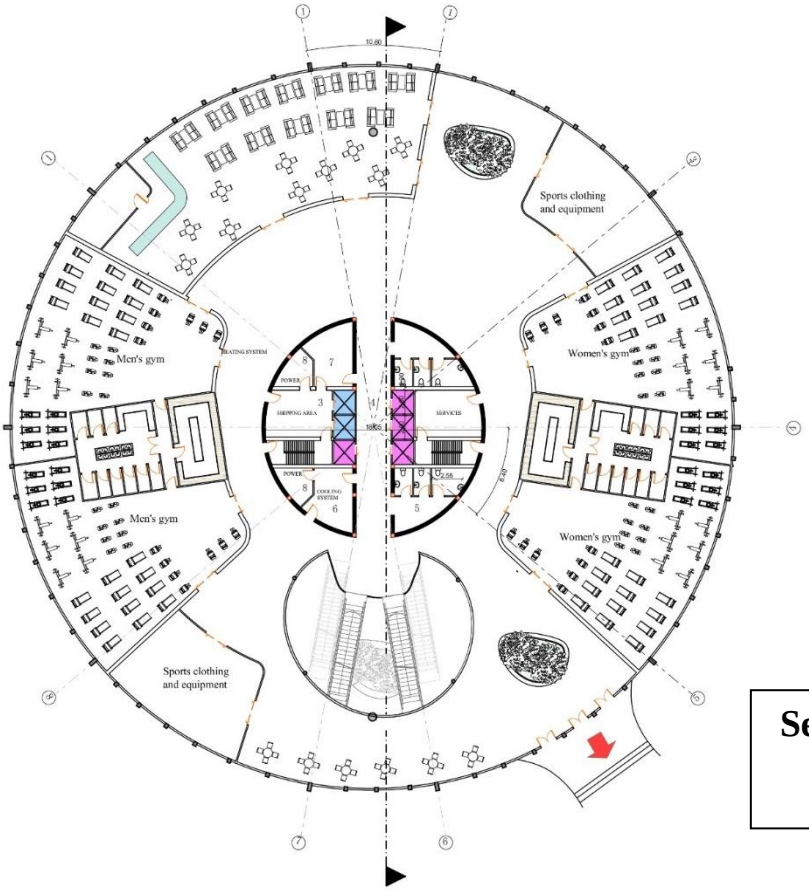
Ground floor





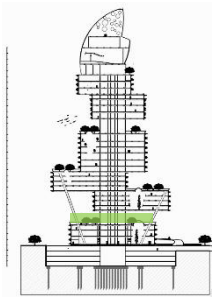
First floor
+06.00 m

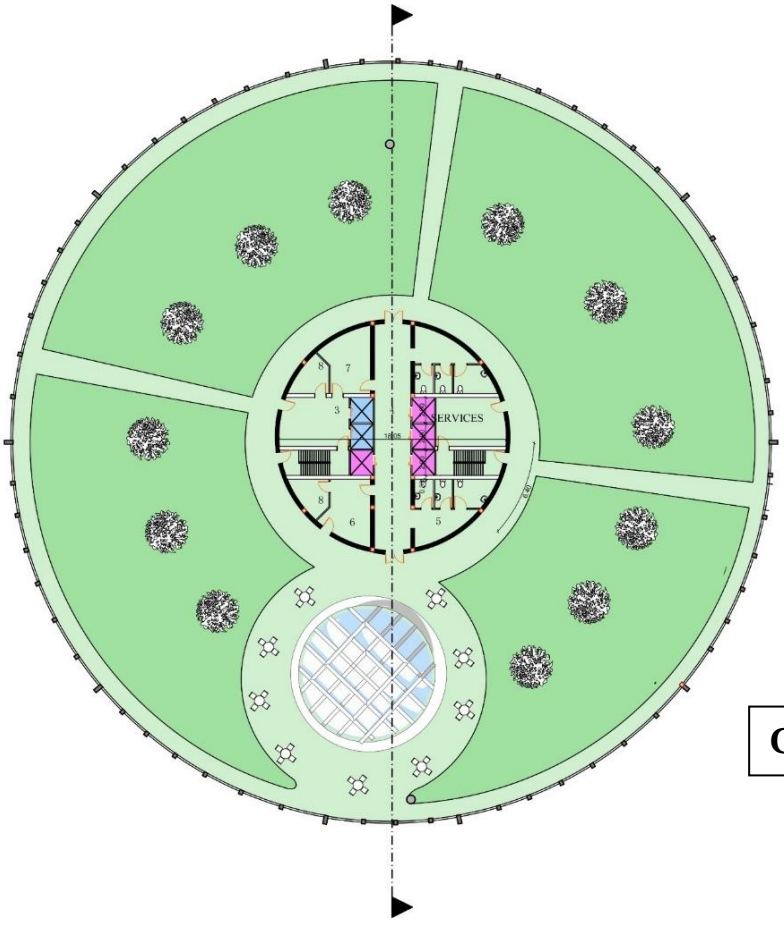




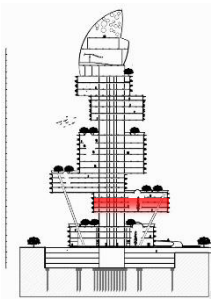
Second floor

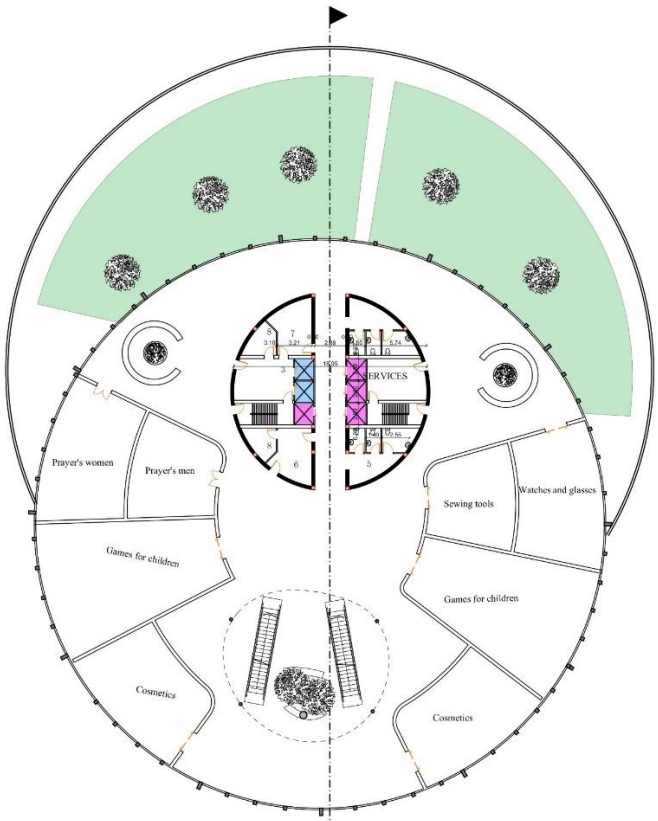
+10.00



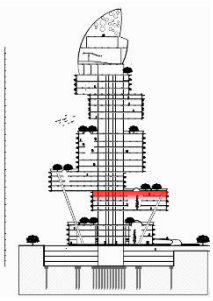


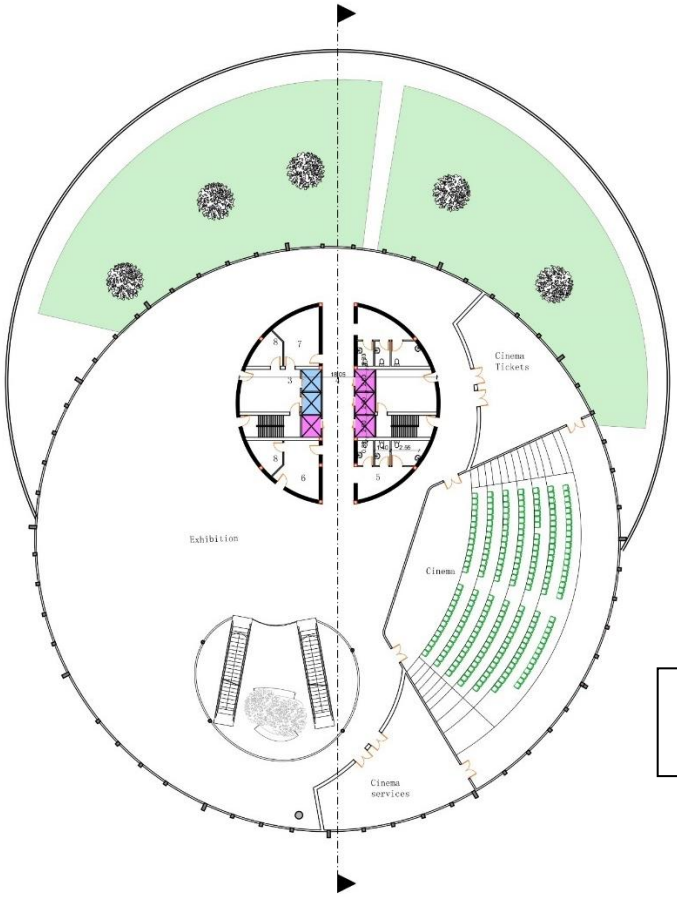
Garden floor



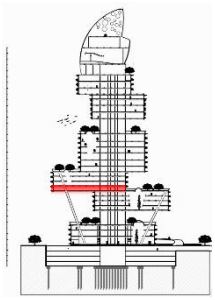


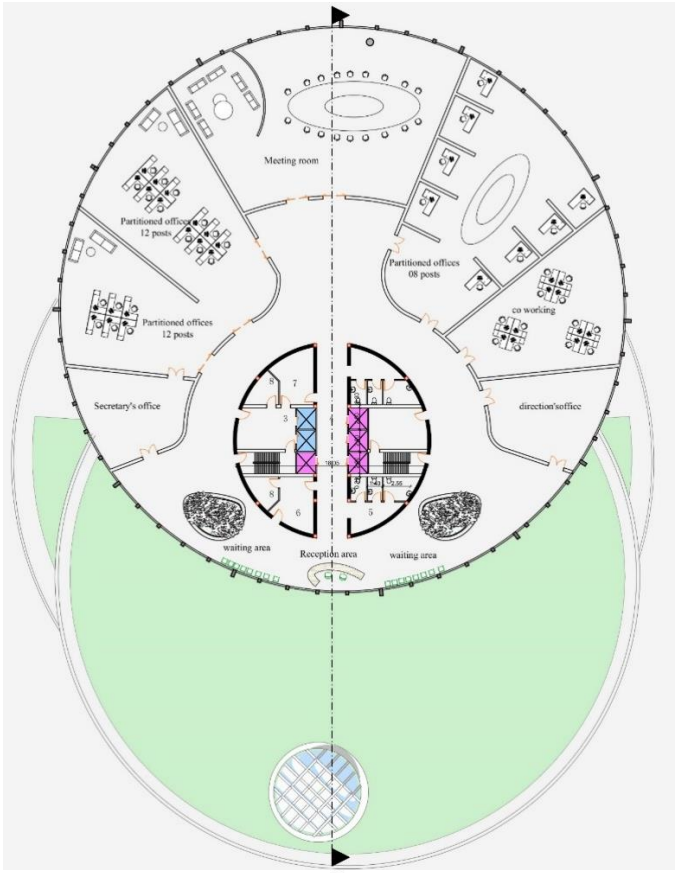
Typical floor
Third floor
+29.00 m



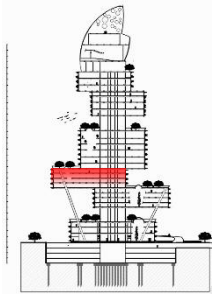


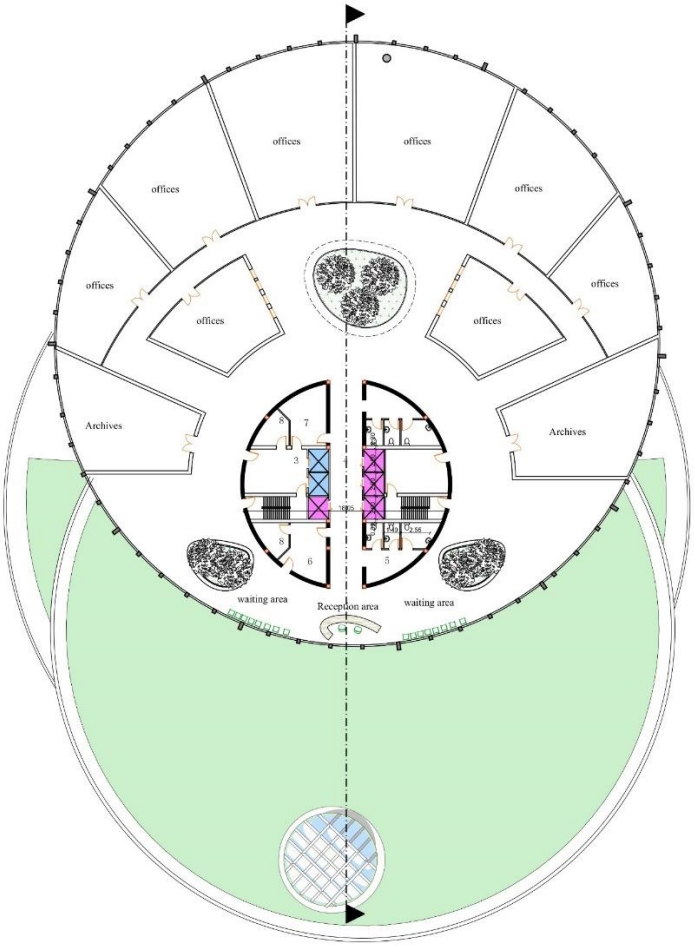
Sixth floor
+33.50 m



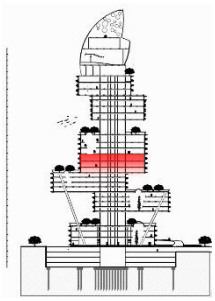


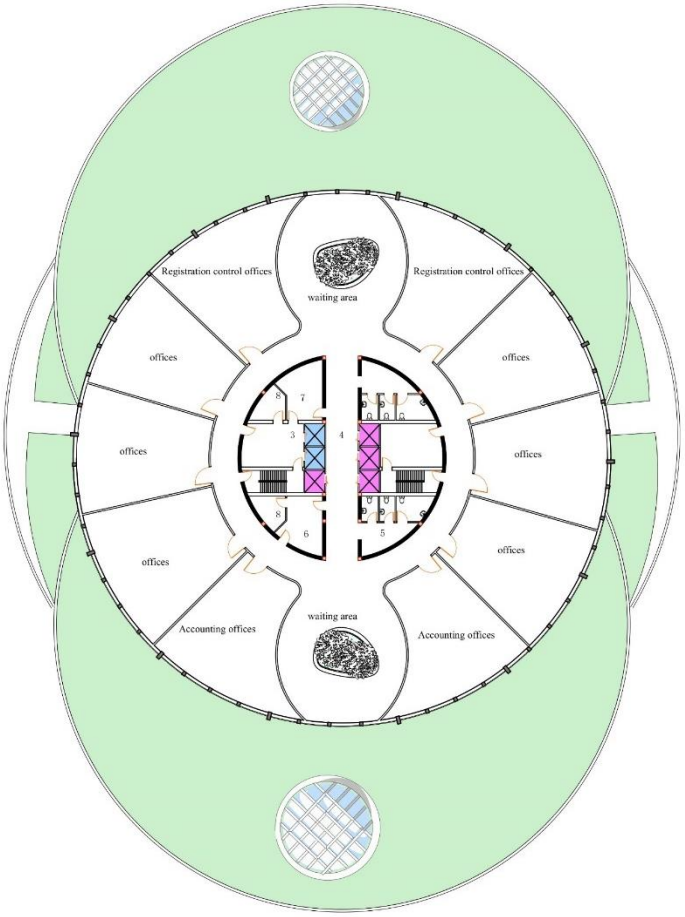
Seventh floor
+38.00 m



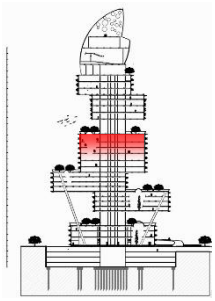


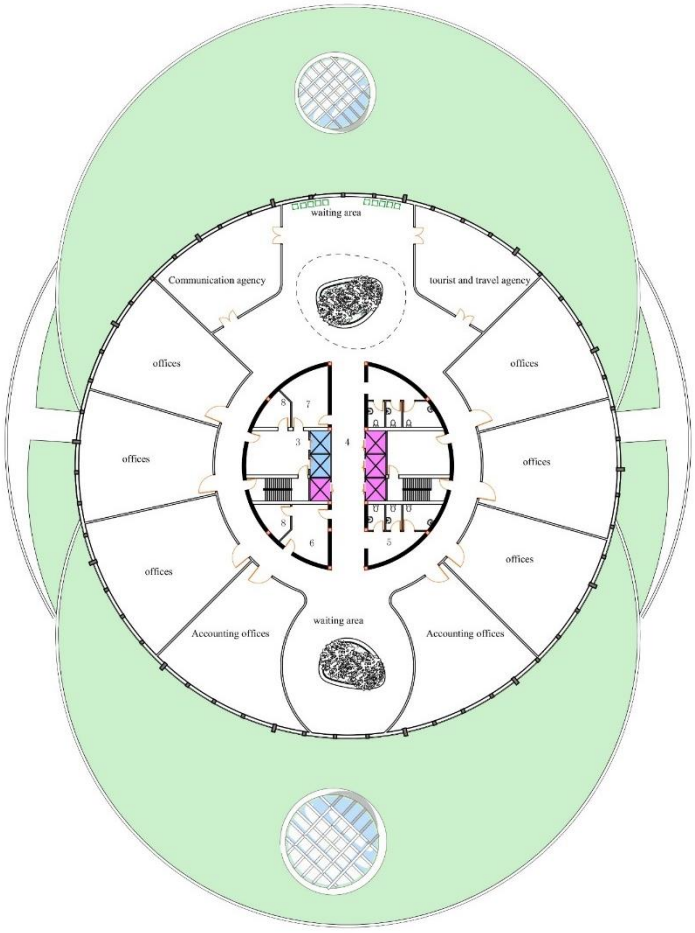
Typical floor
Eighth floor
+42.00 m



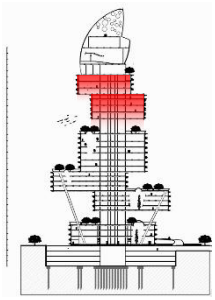


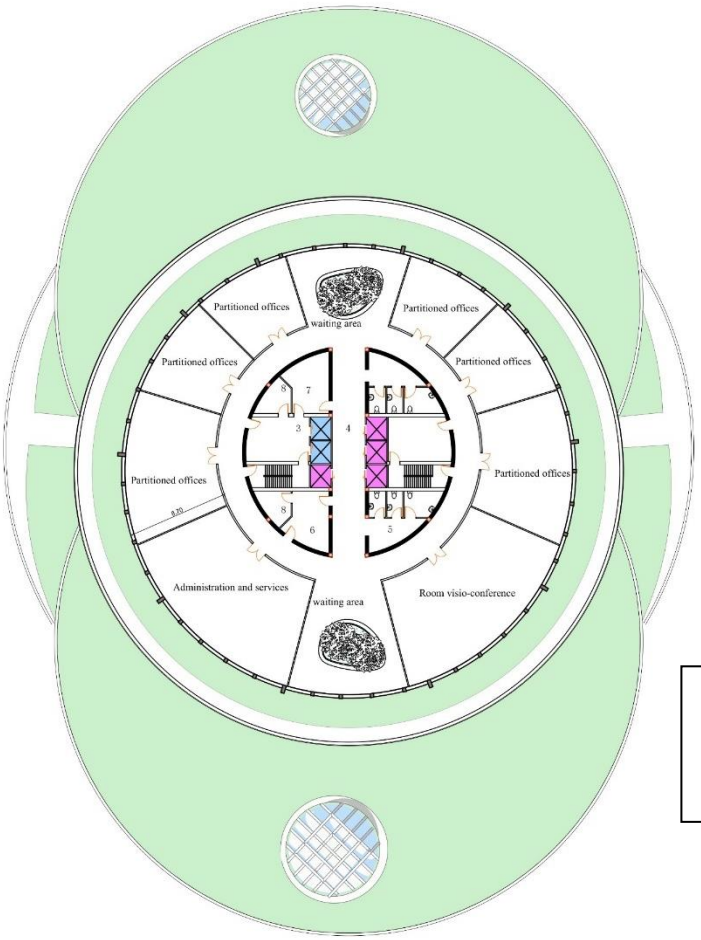
Typical floor
Twelfth floor
+46.00 m



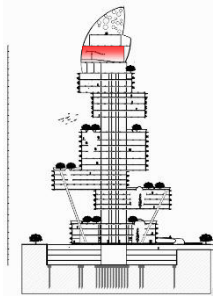


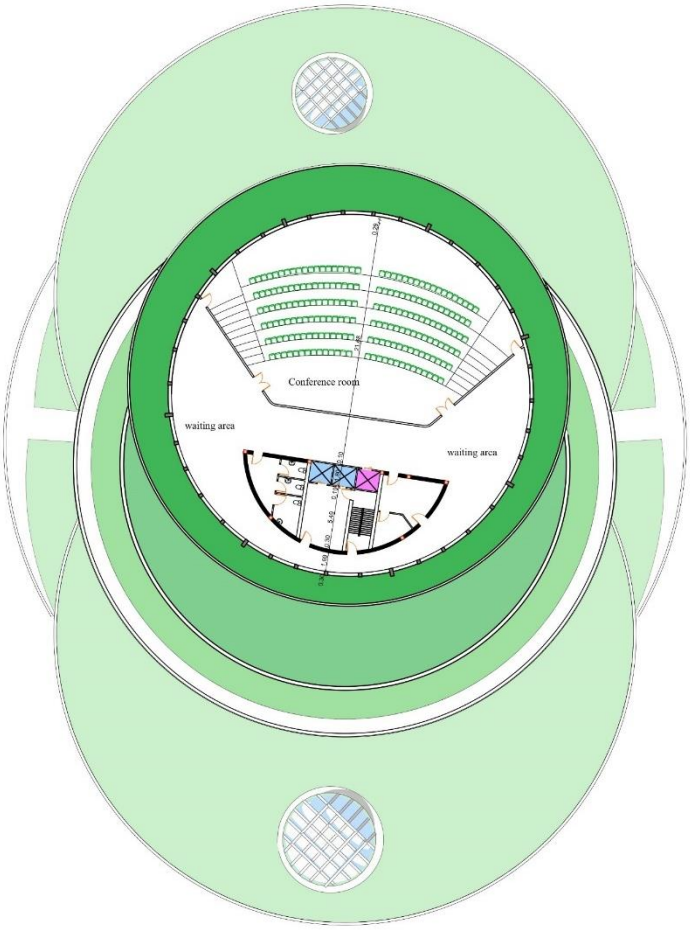
Typical floor
Fourteenth floor
+50.00 m





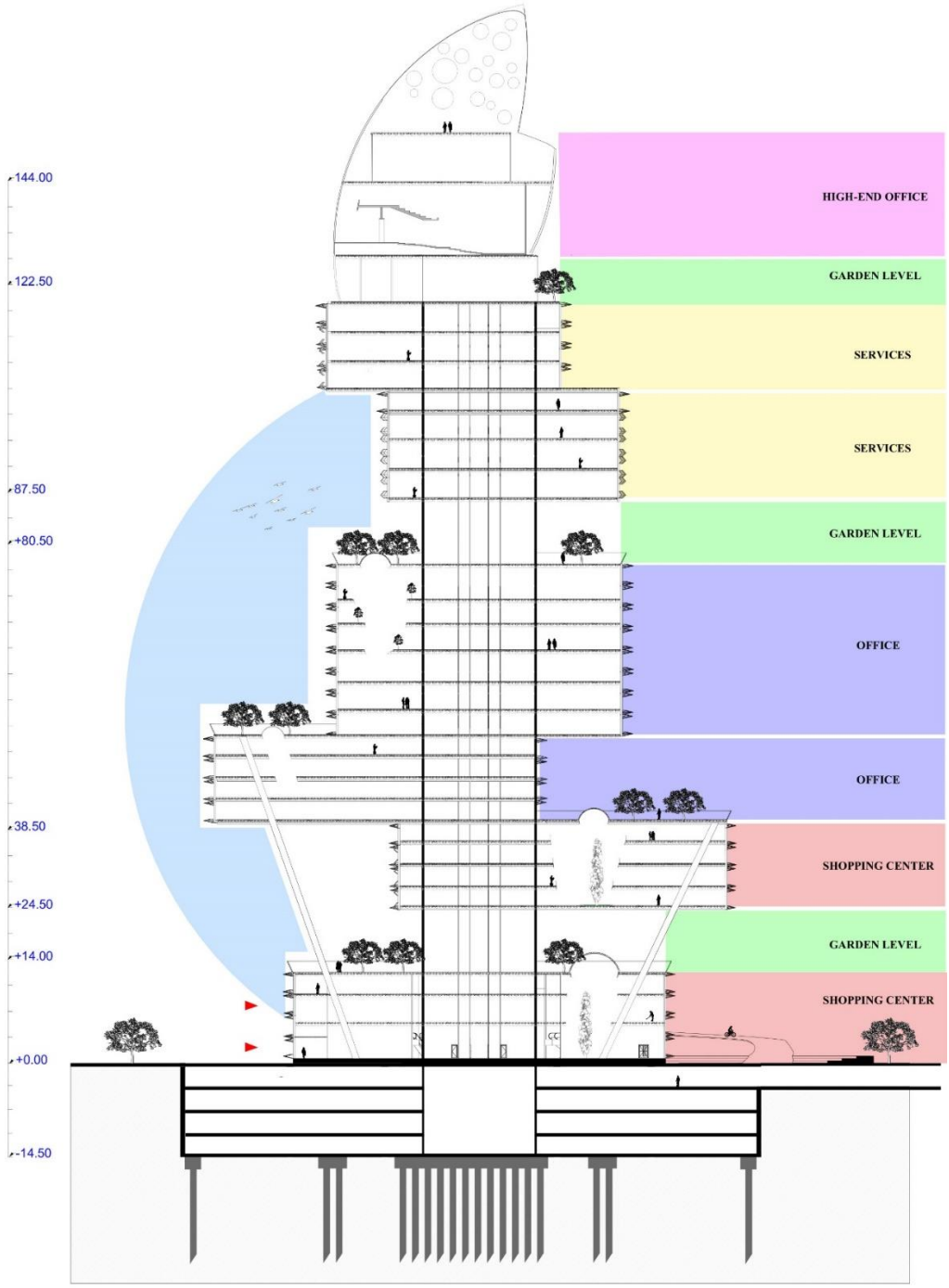
Typical floor
Nineteenth floor
+80.50 m



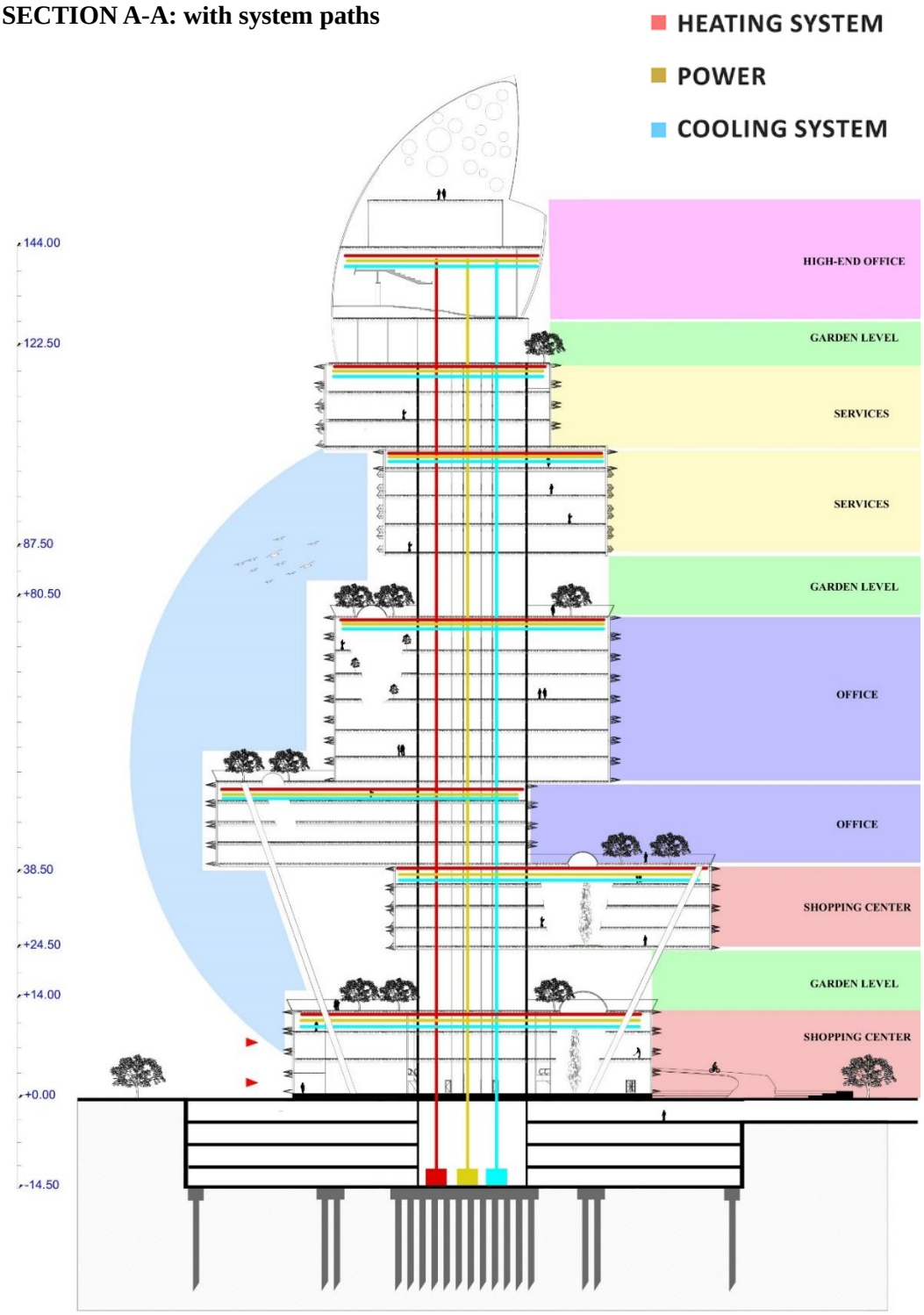


twenty-sixth floor
+127.00 m

- **SECTION A-A**

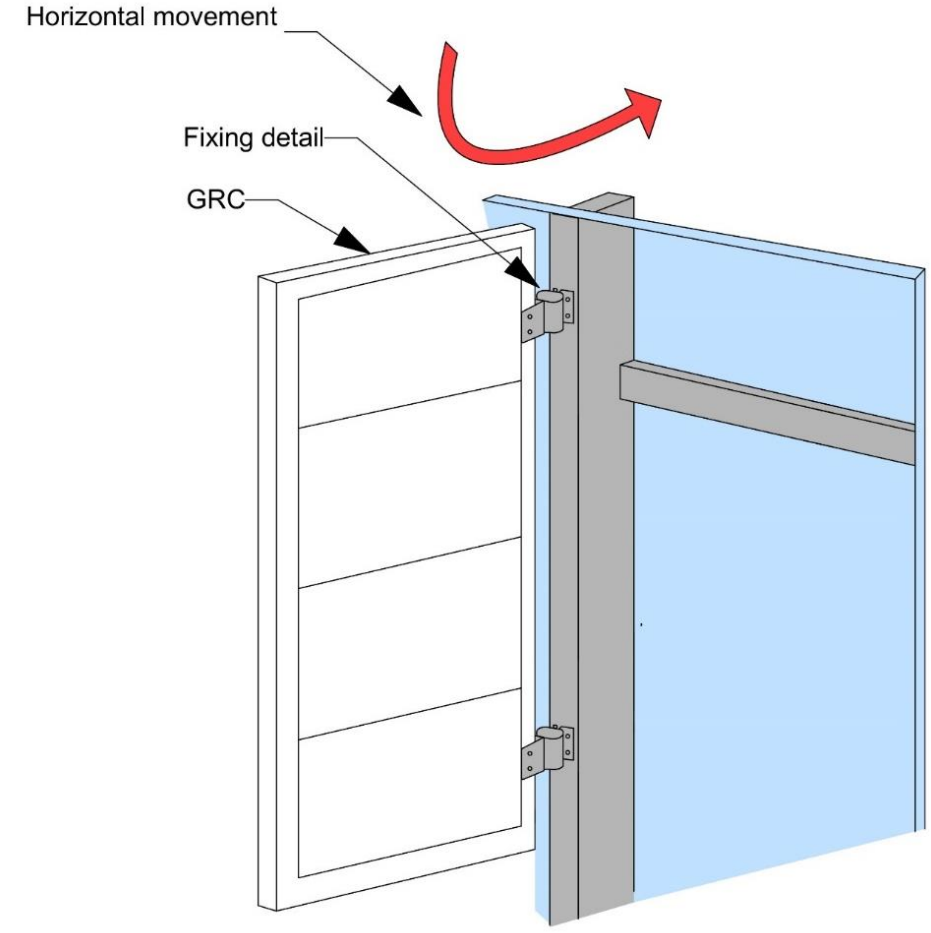

144.00
122.50
87.50
+80.50
38.50
+24.50
+14.00
+0.00
-14.50
HIGH-END OFFICE
GARDEN LEVEL
SERVICES
SERVICES
GARDEN LEVEL
OFFICE
OFFICE
SHOPPING CENTER
GARDEN LEVEL
SHOPPING CENTER

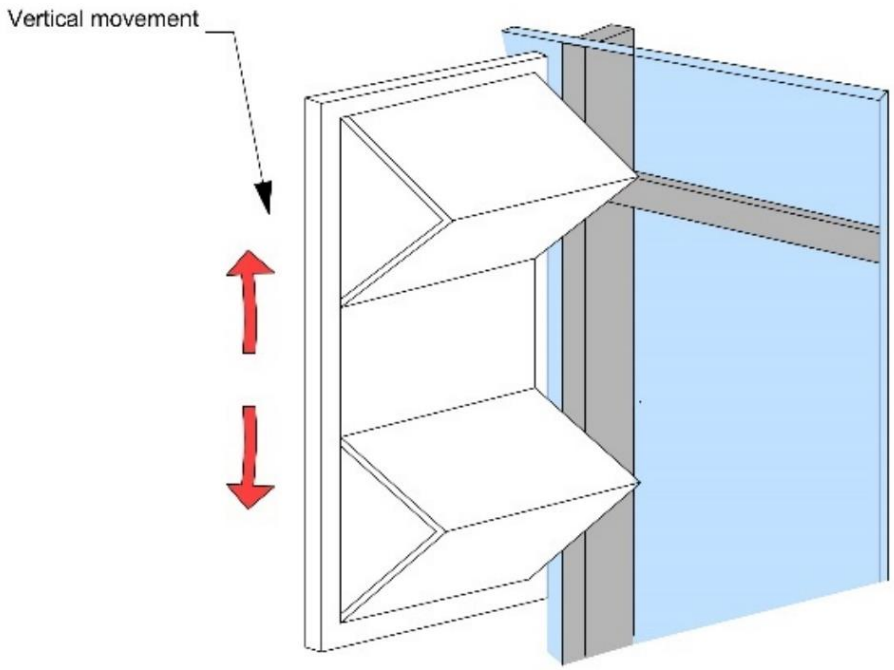
- **SECTION A-A: with system paths**



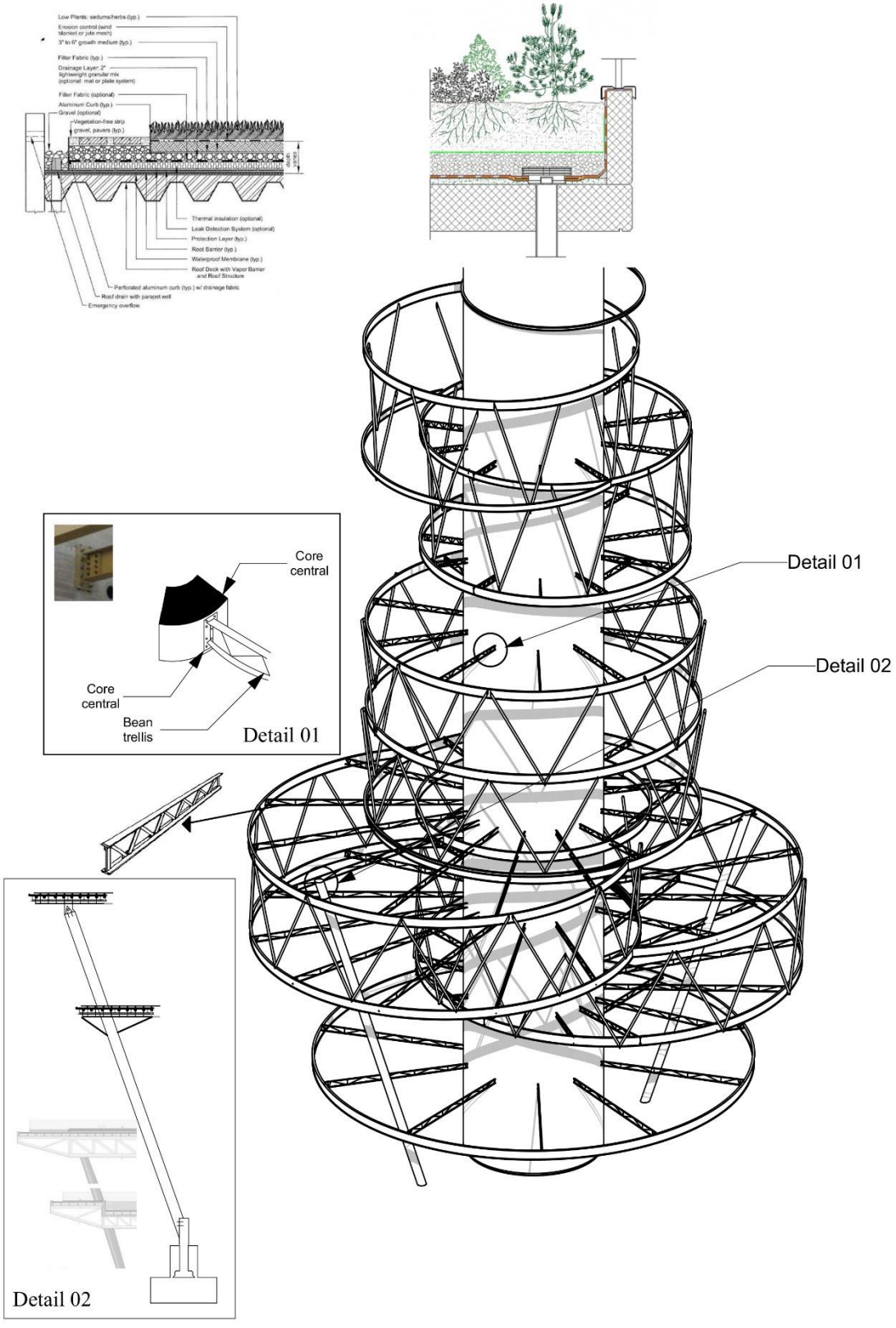
Elevator

- **DETAIL KINETIC ELEMENT**





- **DETAIL OF STRUCTURE**



Conclusion:

Based on the objectives and aspirations presented in this chapter, derived from the previous theoretical and analytical study, in addition to the design philosophy grounded in the fundamental concepts of this study, we ultimately arrived at designing a smart and sustainable mixed-use tower. This was achieved through the application of a set of design requirements and smart technologies that align with the hot and dry climate of Biskra city and respond to the functional nature of the project. The aim of this design is to achieve residential comfort within the tower, whether in terms of thermal or visual comfort, while effectively reducing energy consumption.

General Conclusion:

Throughout this thesis, we have explored the integration of kinetic architectural strategies and shading mechanisms to address the challenges of energy efficiency and user comfort in Biskra's arid climate. Key findings highlight the potential of dynamic architectural solutions in enhancing thermal performance and reducing energy consumption. The research underscores the importance of adaptive building design in mitigating environmental impacts and improving urban sustainability.

This study contributes to the field of architecture by demonstrating innovative approaches to sustainable building design in hot desert climates. By combining theoretical insights with practical applications, we have showcased how kinetic architecture and shading systems can effectively optimize solar protection and enhance occupant comfort. This research advocates for the broader adoption of dynamic architectural solutions to achieve resilient and environmentally responsive urban environments.

Acknowledging the limitations, this thesis primarily focused on theoretical analysis and case studies. Practical implementation and long-term performance evaluation of kinetic and shading systems remain essential areas for future research. Furthermore, constraints in technological integration and cost-effectiveness pose challenges that require ongoing exploration and innovation.

To advance research in this field, future studies should explore advanced materials and technologies for dynamic building facades and shading devices. Additionally, interdisciplinary collaboration between architects, engineers, and environmental scientists is crucial for developing integrated solutions that meet both aesthetic and functional requirements. Moreover, conducting post-occupancy evaluations and monitoring energy performance will provide valuable insights into the effectiveness of implemented strategies.

This is a brief list of recommendations for the design of buildings, especially towers, in Biskra, extracted after analysis:

- Integration of kinetic architectural elements.
- Optimal shading strategies.
- Use responsive materials.
- Passive cooling techniques.
- Biophilic design inspiration.
- Multidisciplinary collaboration.
- Education and awareness.

In conclusion, the journey through this thesis has underscored the transformative potential of kinetic architecture and shading mechanisms in desert urbanism. By harnessing natural elements and innovative technologies, we can create built environments that not only withstand climatic challenges but also promote sustainability and enhance quality of life for inhabitants. Moving forward**,** continuous innovation and strategic planning will be imperative to realize the vision of resilient and adaptive cities in arid regions like Biskra.

Bibliography :

- Amira MEGUEHOUT, & Khawla DJEDDAI. (2019). Contribution of smart building in energy management (Master Thesis). Mohamed Sedik Benyahia University – Jijel.
- BENBACHA, C. (2017). Les façades dynamiques; moyen de contrôle solaire pour accroitre l'efficacité énergétique des équipements administratifs en climat aride - Biskra. (Master Thesis). Département D'architecture Faculté D'architecture Et D'urbanisme Université Constantine 3.
- Boukrouma Rayen. (2020). Kinetic facades as alternatives to improve thermal performance in office buildings.
- BOUZEKRA, M., & GUENAOUI, M. (2014). L'apport des nouvelles technologies sur l'économie d'énergie dans le bâtiment en Algérie, stratégie ou prestige. Mémoire de Master, Université Abderrahmane Mira – Bejaia, Faculté de Technologie Département d'Architecture.
- BROCHARD, L. (2011). Le développement durable : Enjeux de définition et de mesurabilité. Mémoire présenté comme exigence partielle de la maîtrise en science politique, UNIVERSITÉ DU QUÉBEC À MONTRÉAL.
- Cadiergues, R. (2018). MémoCad mA18.a Les immeubles de grande hauteur (IGH).
- CHERQUI, F. (2005). Methodology for evaluating a sustainable development project for a neighborhood adequate method (Doctoral Thesis). University of La Rochelle, Civil Engineering Discipline.
- Chetti Soundes. (n.d.). L'enveloppe architecturale entre l'esthétique et le confort thermique.
- COST/GT. (n.d.). Le groupe de travail N°1 dans l'European Cooperation in Science and Technology.
- Design recommendations for multi-storey and underground car parks (3rd ed.). (2002).
- El Razaz, Z. (2010). Sustainable vision of kinetic architecture.
- FECIH, M. (2021). The effect of shade on thermal comfort: Center for art and culture (Master Thesis).
- International Journal of Scientific & Engineering Research, 8(12), 1023-1051. ISSN 2229-5518.
- KADIK, B. (n.d.). La biodiversité et le développement durable en Algérie.
- Kamal, M. (2012). Un aperçu des Techniques de Refroidissement Passif dans les Bâtiments: Concepts de Conception et Interventions Architecturales.
- Liébard, A., & De Herde, A. (2005). Treatise on bioclimatic architecture and town planning. The monitor. Paris: observ'ER.
- Master Thesis. (2021). L'amélioration de la qualité de l'air dans les espaces de travail.
- Nefeurt. (2010).
- NGO, C. (2008). L'énergie Ressources, technologie et environnement (3rd ed.). Paris: Dunod.
- OLGYAY, V. (1963). Design with climate: Bioclimatic approach to architectural regionalism. Princeton: University Press.
- Prof. Dr. Ashraf Elmokadem, Prof. Dr. Magda Ekram, Dr. Ahmed Waseef, & Basma Nashaat. (2016). Kinetic Architecture: Concepts, History and Applications.
- Roger Cadiergues. (2018). MémoCad mA18.a Les immeubles de grande hauteur (IGH).
- Salma Ashraf Saad El Ahmar. (2011). Biomimicry as a tool for sustainable architectural design.
- Tall Building Design Guidelines. (2013). Adopted by Toronto City Council.
- Velasco, R., Brakke, A. P., & Chavarro, D. (2015, July). Dynamic façades and computation: Towards an inclusive categorization of high performance kinetic façade systems. In Proceedings of The International Conference on Computer-Aided Architectural Design Futures

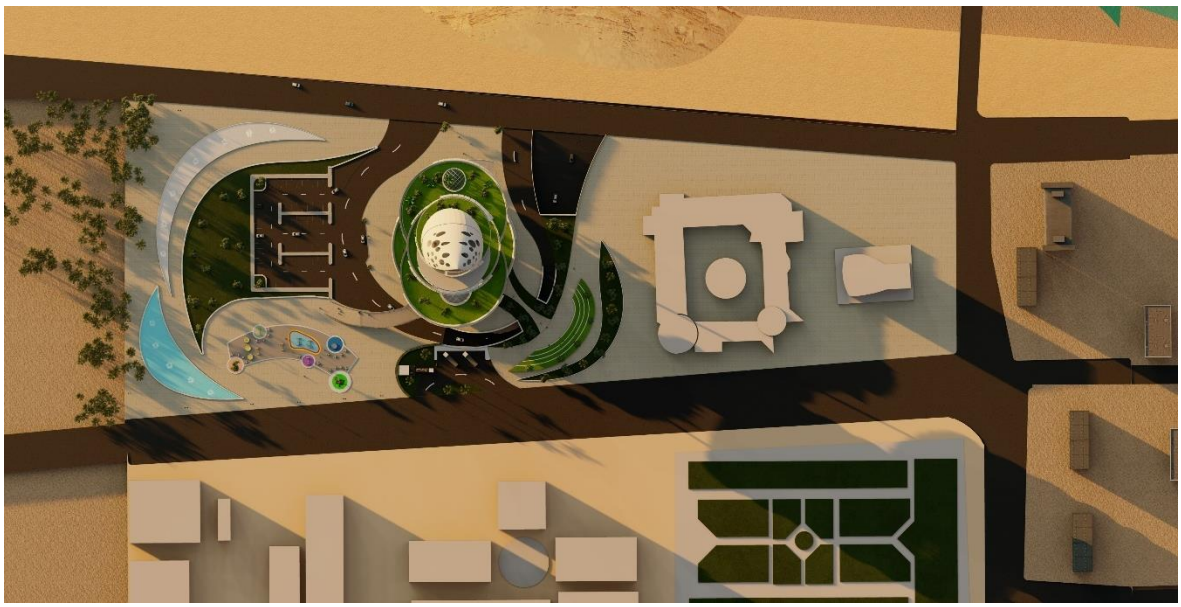
- YAHIA BELHADJ, A., & AMINE DERRADJI. (n.d.). Les techniques de construction et mesures de sécurité dans la conception des IGH en Algérie (Master Thesis).
- ZEROUALI, M. (2009). Le développement durable : l'Algérie entre rêves et impératifs. Le Quotidien d'Oran.

Web site :

- Agence pour la Promotion et la Rationalisation de l'Utilisation de l'Energie (APRUE). (n.d.). Retrieved 2024, from http://www.aprue.org.dz/
- Climamaison. (2023). Économies d'énergie. Retrieved 2024, from https://www.climamaison.com/lexique/economies-d-energie.htm
- Larousse. (n.d). Ombre. Retrieved 2024, from https://www.larousse.fr/dictionnaires/francais/ombre/559
- Dictionary.com. (n.d.). Shade. Retrieved 2024, from https://www.dictionary.com/browse/shade
- Fairconditioning. (2020). Passive design: Shading. Retrieved 2024, from https://fairconditioning.org/knowledge/passive-design/shading/
- BEEP India. (2011). Retrieved 2024, from http://www.beepindia.org
- TPE Biomimétisme Chimie. (). Définition du biomimétisme. Retrieved 2023, from http://tpe-biomimetisme-chimie.e-monsite.com/pages/le-biomimetisme-c-estquoi/definition-du-biomimetisme.html
- MGS BUSINESS.com. (2019). Retrieved 2024, from www.arenas-partners.fr/fr/guide/qu-est-ce-qu-un-centre-d-affaires

APPENDIX

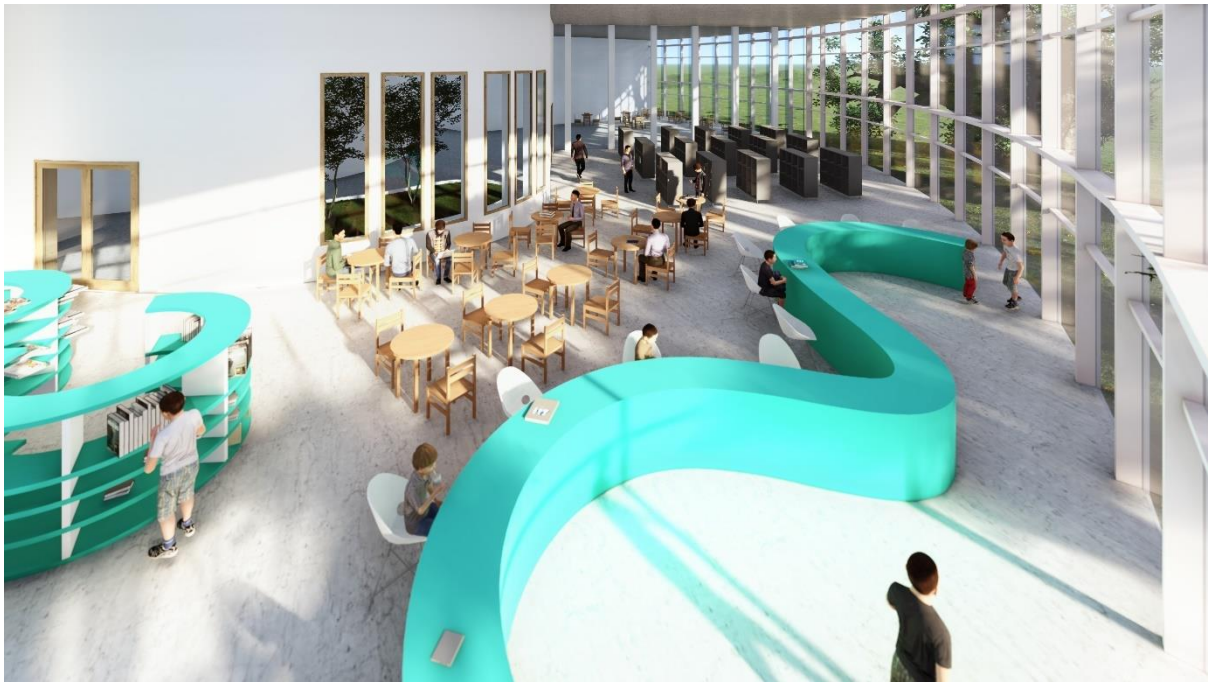
- **EXTIREIOR VIEW :**



- **INTIREIOR VIEW :**


32


YOUR
ONLY
LIMIT
IS YOU



الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي

جامعة محمد خيضر - بسكرة

حاضنة أعمال جامعة بسكرة

رقم 38/ الحاضنة /2024

شهـــادة توطيـــن /تحضيـــن "مشروع مبتكر ضمن قرار 1275"

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تاريخ تسليم العلامة: **23 نوفمبر2022**

أشهد أن الطالبة التالية أسمها:

الاسم و اللقب	الطور الدراسي	التخصص	الكلية
يعقوب دنيا	ماستر 02	هندسة معمارية	العلوم والتكنولوجيا

تحت إشراف الاساتذة التالية أسمائهم:

الاسم و اللقب	الرتبة	التخصص	الكلية
بادة ياسين	بروفيسور	هندسة معمارية	العلوم والتكنولوجيا

تم احتضانه على مستوى حاضنة *أعمال* جامعة محمد خيضر - بسكرة بمشروع تحت اسم:
استكشاف الهندسة المعمارية الحركية لكفاءة التظليل والالهام المحاكاة الحيوية في برج متعدد الوظائف
خلال السنة الجامعية 2024/2023 .

سلمت هذه الشهادة بطلب من المعني للإدلاء بها في حدود ما يسمح به القانون.

حرر في: بسكرة بتاريخ: 29/05/2024

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مسؤول حاضنة المؤسسات الناشئة
د/ محمد جلاب

الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي جامعة

محمد خيضر بسكرة

عنوان المشروع:

استكشاف الهندسة المعمارية الحركية لكفاءة التظليل والإلهام الحيوي

مشروع لنيل شهادة مؤسسة ناشئة في إطار القرار الوزاري 1275

الاسم التجاري

MIMOSA SHADE

(MIMOSHADE)

صورة العلامة التجارية

MIMOSHADE

السنة الجامعية: 2023/2024

بطاقة معلومات:

حول فريق الاشراف وفريق العمل

1- فريق الاشراف:

فريق الاشراف	
الأستاذ المشرف: بادة ياسين	التخصص: هندسة معمارية

1- فريق العمل:

فريق المشروع	التخصص	الكلية
يعقوب دنيا	هندسة معمارية	العلوم والتكنولوجيا

فهرس المحتويات

المحور الأول:

تقديم المشروع

مقدمة:

في ظل التغيرات المناخية المتسارعة وارتفاع درجات الحرارة العالمية، تبرز الحاجة إلى حلول مبتكرة ومستدامة لتحسين كفاءة الطاقة في المباني وتقليل تأثيرات الحرارة المفرطة. يتزايد الطلب على تكنولوجيا البناء الذكي والحلول البيئية، حيث تشير الدراسات إلى أن قطاع البناء يستهلك حوالي 40% من إجمالي الطاقة المستخدمة عالميًا (International Energy Agency, 2019; United Nations Environment Programme, 2017; World Green Building Council, 2019)، وهو ما يمثل فرصة كبيرة لإدخال تحسينات تؤدي إلى توفير الطاقة بشكل كبير.

مجال نشاطنا يتمثل في تصميم وتصنيع كاسرات شمس ذكية باستخدام مستشعرات ضوئية وتكنولوجيا تفاعل مع الضوء بشكل ديناميكي لتحسين كفاءة الطاقة.

1.فكرة المشروع:

يستند فكرة هذا المشروع إلى تطوير وتصنيع كاسرات شمس ذكية مستوحاة من حركة نبتة الميموزا، التي تتميز بقدرتها على التفاعل مع الضوء والانغلاق لتجنب الشمس. تهدف هذه التقنية إلى تحسين كفاءة الطاقة في المباني من خلال التحكم الذكي في التظليل، مما يقلل من الحاجة لاستخدام أنظمة التكييف بشكل مكثف. تعتبر هذه الفكرة مبتكرة لأنها تجمع بين التكنولوجيا الحيوية والحلول الهندسية الذكية، مستفيدة من خصائص نبات الميموزا لتقديم حلول تظليل تتكيف بشكل ديناميكي مع الظروف الجوية المتغيرة.

1.1 تعريف المشروع:

العنصر	الشرح
طبيعة المشروع	تصميم وتصنيع كاسرات شمس ذكية باستخدام مستشعرات ضوئية وتكنولوجيا تفاعل مع الضوء بشكل ديناميكي
اسم المشروع	MIMOSA SHADE
مجال النشاط	صناعي
موقع المشروع	ولاية بسكرة، الجزائر
النطاق	المحلي والدولي، مع التركيز على المناطق ذات المناخ الحار.
الفئة المستهدفة	- المهندسون المعماريون والمصممون - المطورون العقاريون - المقاولون وشركات البناء - مالكو المباني التجارية والسكنية - الهيئات الحكومية والمؤسسات البيئية - الشركات الصناعية والمؤسسات الكبرى - المستثمرون في قطاع البناء الأخضر
عدد العمال	19
تسمية النشاط	تطوير وتصنيع أنظمة التظليل الذكية والمستدامة

مضمون النشاط	تصميم كاسرات شمس تطوير المستشعرات ضوئية تركيبها وفقا لشكلها
الشكل القانوني للمؤسسة	شركة ذات مسؤولية محدودة (SARL)
تكلفة الكراء	/

2. القيم المقترحة:

1 .الكفاءة والفعالية في الحماية:

تقنيات التظليل الذكية تقلل من تأثير الأشعة الشمسية وتخفض درجة الحرارة داخل المباني ايضا تحسين كفاءة الطاقة وتقليل الحاجة إلى التبريد الاصطناعي، مما يساهم في تقليل تكاليف الطاقة وزيادة الراحة الداخلية.

2 .الأداء العالي:

أنظمة التظليل توفر أداءً عاليًا داخل المجال، مما يضمن راحة ورفاهية المستخدمين و تقديم تجربة مستخدم متميزة من خلال تحسين جودة الحياة اليومية في المباني.

3 .الجودة العالية:

استخدام مواد عالية الجودة ومقاومة للعوامل البيئية لضمان الحفاظ على الخصائص الأولية مثل المتانة واللون والملمس ايضا طول عمر المنتج وتقليل الحاجة إلى صيانة واستبدال، مما يعزز القيمة الاقتصادية على المدى الطويل.

4 .التصميم المبتكر والمتنوع:

تصاميم فريدة ومبتكرة مع تنوع كبير في الأشكال والألوان، مما يسمح باستخدامها في العديد من المجالات والمنشآت المختلفة حسب رغبة واحتياجات العملاءو تعزيز الجمالية والوظيفية للمباني من خلال حلول تظليل تتكامل مع التصميم المعماري.

5 .الملاءمة وسهولة الاستخدام:

تصميم المواد بطريقة تسهل استخدامها وتركيبها بواسطة العمال، مما يعزز سهولة التعامل معها وتطبيقها بشكل فعال ادا تقليل الوقت والتكاليف التركيب والصيانة، وزيادة الكفاءة التشغيلية للمشروع.

3. فريق العمل:

يتكون فريق العمل من:

الطالبة	التخصص	الدورات التكوينية
يعقوب دنيا	هندسة معمارية	• اللغة الإنجليزية مستوى B1 • تربص ميداني على مستوى مديرية الترقية والتسيير العقاري-بسكرة. • تربص ميداني على مستوى مكتب دراسات. • دورات حول برامج المحاكاة 3D

4. أهداف المشروع:

1.4 أهداف قريبة المدى:

- **تطوير المنتج:**

ابتكار كاسرات شمس ذكية ومستدامة تعتمد على مستشعرات ضوئية وتقنيات متقدمة مستوحاة من نبتة الميموزا اذا إنشاء منتج متكامل وسهل الاستخدام يحقق كفاءة عالية في التظليل.

- **اختباروتحسين الأداء:**

تقييم أداء كاسرات الشمس الذكية وضبطها لضمان الجودة والفعالية في تظليل المباني لتحقيق أداء مثالي للمنتجات وضمان رضا العملاء.

- **جذب العملاء:**

ترويج المنتجات لجذب عدد كبير من العملاء المحتملين للاستفادة من حلول التظليل الذكي و بناء قاعدة عملاء قوية وزيادة الحصة السوقية.

- **شراكات استراتيجية:**

إيجاد شراكات استراتيجية مع شركات البناء وتوزيع المواد لتعزيز قنوات التوزيع وزيادة الحصة السوقية من اجل توسيع نطاق الوصول إلى الأسواق وتحقيق نمو سريع في المبيعات.

أهداف متوسطة المدى:

- **تطوير حلول تقنية مبتكرة:**

البحث عن تقنيات جديدة للتظليل الذكي وتطوير أنظمة متقدمة لقياس الإضاءة وإدارة التظليل في الوقت الفعلي.

- **التأثير الاجتماعي والبيئي:**

تحقيق تأثير إيجابي على المجتمع والبيئة من خلال تقليل استهلاك الطاقة وتحسين جودة الحياة في المباني مما يعزز المسؤولية الاجتماعية للشركة والمساهمة في الحد من التغير المناخي.

- **الابتكار المستمر:**

الاستمرار في البحث والتطوير لتحسين المنتجات وإضافة ميزات جديدة تواكب احتياجات السوق.

للحفاظ على ريادة الابتكار وتقديم حلول متقدمة تلبي توقعات العملاء.

أهداف بعيدة المدى:

- **تحقيق الاستدامة المالية:**

ضمان استمرارية المشروع من الناحية المالية عبر زيادة الإيرادات وتقليل التكاليف من خلال توسيع قاعدة العملاء وتنويع خطط الأسعار لتحقيق الاستدامة المالية والنمو المستدام للشركة.

- **تحقيق التميز التكنولوجي:**

الوصول إلى مستوى رفيع من التميز التكنولوجي والابتكار في مجال التظليل الذكي و توفير تقنيات وحلول متقدمة تضع المشروع في مكانة متقدمة في السوق العالمية.

- **دعم التغييرات في السياسات:**

الدعوة إلى اعتماد معايير تظليل ذكي إلزامية للمباني الجديدة والتجديدات.

العمل مع الحكومات والمنظمات الدولية لتطوير سياسات تهدف إلى تحسين كفاءة الطاقة وتقليل التلوث البيئي.

تشجيع استخدام مواد بناء مستدامة وصديقة للبيئة في مشاريع البناء.

- **تعزيز التعاون الدولي**

مشاركة المعرفة والخبرات مع خبراء التصميم المستدام في جميع أنحاء العالم.

التعاون في تطوير معايير دولية لتظليل المباني.

المساهمة في الجهود العالمية لتحسين كفاءة الطاقة والاستدامة البيئية.

5. جدول زمني لتحقيق المشروع:

الشهر		1	2	3	4	5	6	7	8	9	10	11	12
الأعمال	1 الدراسة الاولية : اختيار مقر الوحدة الإنتاجية، تجهيز الوثائق المطلوبة		✓	✓									
	2 طلب التجهيزات من الخارج				✓	✓							
	3 بناء مقر الانتاج						✓	✓	✓	✓			
	4 تركيب المعدات									✓	✓		
	5 اقتناء المواد الأولية										✓	✓	
	6 بداية الإنتاج												✓

المحور الثاني:

الجوانب الابتكارية

المحور الثاني: الجوانب الابتكارية

1. طبيعة الابتكارات:

مشروعنا يركز على تطوير كاسرات شمسية متقدمة باستخدام تكنولوجيا مستشعرات ضوئية، مستوحاة من حركة نبتة الميموزا. بفضل التحكم التلقائي بتوجيه الكاسرات الشمسية، يتم تحقيق استخدام أمثل للطاقة الشمسية تحت مختلف ظروف الإضاءة والطقس. هذا يعكس طبيعة الابتكارات المتزايدة في المشروع، حيث يسعى لتحسين أداء وكفاءة جمع الطاقة الشمسية بطرق مبتكرة ومتطورة، إذا ينتمي مشروعنا الى الابتكارات المتزايدة.

2. مجالات الابتكارات:

تطوير مواد ذكية :استخدام مواد تكنولوجية متقدمة تعزز من أداء ومتانة كاسرات الشمس.
التصميم البيئي والمعماري :تكامل كاسرات الشمس المتقدمة في تصاميم مباني حديثة لتحسين كفاءة الطاقة والراحة الحرارية.
الابتكار في التكنولوجيا الحساسة للضوء :تطوير أنظمة استشعار متقدمة تتفاعل بشكل دقيق مع الظروف البيئية لتحسين أداء كاسرات الشمس.
تكنولوجيا المستشعرات الضوئية :تضمين مستشعرات ضوئية متقدمة لتحسين توجيه كاسرات الشمس وزيادة كفاءة جمع الطاقة الشمسية تلقائيًا
ابتكار وتصميم فريد ومتعدد الاستخدامات :تطوير تصميمات مميزة وذات حركة مزدوجة لكاسرات الشمس، تتيح لها التكيف مع مختلف الوجهات الجغرافية والظروف المناخية بشكل فعال، مما يزيد من مرونة استخدامها وأدائها في مختلف السيناريوهات المعمارية والبيئية.

المحور الثالث:

التحليل الاستراتيجي للسوق

1. تحليل PESTEL :

سياسة	اقتصادية	اجتماعية	قانونية	بيئية	تقنية
-التشريعات التنظيمية التي تحدد متطلبات الصناعة ومعايير الجودة والسلامة -التشريعات البيئية التي دعم الاستدامة والطاقة المتجددة - السياسة البيئية والاستدامة التي تشجع على استخدام مواد دات تأثير بيئي إيجابي -سياسات ضريبية - مصادر الدهم الحكومي	-الأجور - إمكانية الحصول على قروض عن طريق وكالات الدعم وصناديق ضمان القروض -الطلب على العناصر والمواد الخاصة بالحماية من الأشعة الشمسية في السوق. -زيادة الطلب على حلول توفير الطاقة	-الوعي البيئي زيادة الطلب على حلول الطاقة المستدامة -تحقيق الراحة والرفاهية داخل المجالات - تحسين جودة المعيشة - التعليم والتدريب ودعم الابتكار في البناء الذكي	- حماية الابتكارات والتكنولوجيا - قانون ضمان العمال -قانون الضرائب والرسوم -قوانين الصناعة والتصنيع - القوانين التنظيمية الامتثال للقوانين الخاصة بالبناء والطاقة المتجددة	-تقليل استهلاك الطاقة -غياب التأثير السلبي على الجانب البيئي. - تصميمات مبتكرة تتكيف مع الظروف المناخية	-توفير الآلات الخاصة بالتصنيع وانتاج المنتج. - تقليل معدل استهلاك الطاقة -استخدام تقنيات تصنيع حديثة يزيد من الكفاءة ويقلل التكاليف. -العمل على تطوير تركيبة ومواد الحماية من الحرارة الشمسية - تطور تكنولوجيا الاستشعار والتحكم الذكي يعزز من فعالية وكفاءة المنتج.

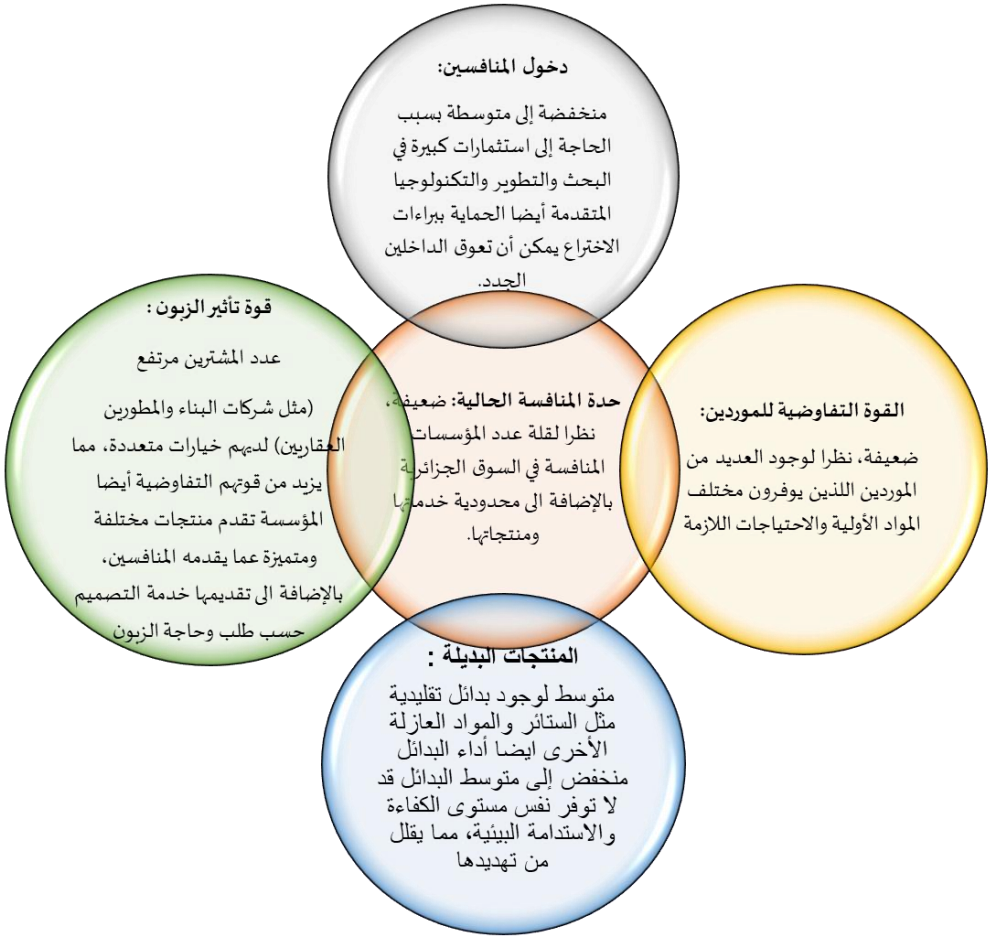
2. تحليل SWOT :

تحليل SWOT يساعد في تحديد نقاط القوة التي يمكن البناء عليها، ونقاط الضعف التي يجب معالجتها، والفرص التي يمكن استغلالها، والتهديدات التي يجب التخطيط لمواجهتها. يتيح هذا التحليل للمشروع "Mimosa Shade" وضع استراتيجيات فعالة لتحقيق النجاح المستدام والنمو في السوق.

نقاط الضعف W	نقاط القوة S	التهديدات T	الفرص O
- التكاليف الأولية :تكلفة التطوير والتصنيع قد تكون عالية بالمقارنة مع الحلول التقليدية. -الحاجة للبحث والتطوير : المشروع يتطلب استثمارًا مستمرًا في البحث والتطوير لتحسين المنتجات. -التوعية السوقية :الحاجة إلى توعية العملاء بفوائد ومزايا كاسرات الشمس الذكية.	- التكنولوجيا المتقدمة : استخدام تكنولوجيا المستشعرات الضوئية والتحكم الذكي لتحسين كفاءة الطاقة. - الابتكار :تصميم مستوحى من حركة نبتة الميموزا، مما يضفي لمسة بيولوجية فريدة على كاسرات الشمس. - الكفاءة في استهلاك الطاقة :القدرة على تقليل الحاجة لاستخدام أنظمة التكييف بشكل مكثف. - الاستدامة :تلبية الطلب المتزايد على الحلول المستدامة والصديقة للبيئة. - التكيف الديناميكي : كاسرات الشمس تتكيف مع الظروف الجوية المتغيرة، مما يحسن الراحة الداخلية في المباني	- لمنافسة :ظهور منافسين يستخدمون تكنولوجيا مشابهة أو أكثر تطورًا يمكن أن يؤثر على الحصة السوقية. - التغيرات التشريعية : تغيير القوانين والتشريعات البيئية قد يؤثر على العمليات والتكاليف. - التقلبات الاقتصادية : الأوضاع الاقتصادية غير المستقرة يمكن أن تؤثر على تمويل المشاريع وقرارات العملاء. - التحديات البيئية : التغيرات المناخية قد تؤثر على أداء كاسرات الشمس وتستدعي تعديلات مستمرة. - المخاطر التقنية : الأعطال أو المشاكل التقنية .	- زيادة الطلب على الحلول الخضراء :تزايد الوعي البيئي يدفع العملاء للبحث عن حلول مستدامة. -السياسات الحكومية الداعمة :حوافز وتمويلات لمشاريع البناء الأخضر يمكن أن تدعم نمو المشروع. -التوسع الدولي :إمكانية التوسع إلى أسواق جديدة في المناطق ذات المناخ الحار. - التعاون مع شركات البناء :شراكات استراتيجية مع شركات البناء والمطورين العقاريين لتعزيز الانتشار السوقي. - التطورات التكنولوجية : الاستفادة من الابتكارات التكنولوجية لتحسين كفاءة المنتجات وتخفيض التكاليف.

3. تحليل PORTER :

تحليل القوى الخمس لـ Michael Porter هو أداة استراتيجية تساعد على فهم مدى قوة المنافسة داخل صناعة معينة، وما هي العوامل التي يمكن أن تؤثر على ربحية المشروع. هذه القوى الخمس الخاصة بمشروعنا :



تحليل القوى الخمس لـ Porter يكشف عن أن مشروع **"Mimosa Shade"** يعمل في بيئة تنافسية متوسطة إلى عالية. التركيز على الابتكار وبناء علاقات قوية مع الموردين وتقديم قيمة مضافة للعملاء يمكن أن يعزز الميزة التنافسية للمشروع.

4. المزيج التسويقي :

4.1 المنتوج :

المنتجات / الخدمات	خصائص ومميزات منتجاتك / خدماتك	الحاجات التي يلبيها
كاسرات شمس ذكية مزودة بمستشعرات ضوئية ذات حركة مزدوجة	• حركة مستوحاة من نبتة الميموزا، حيث تنغلق الأوراق عند تعرضها للضوء المباشر، مما يوفر تظليلاً فعالاً • تتبع حركة الشمس وضبط توجيه الكاسرات تلقائيًا لتحسين التظليل • مواد متينة ومقاومة للعوامل البيئية • يمكن دمجها بسهولة في تصميمات المباني الحديثة	• تحسين كفاءة التظليل وتقليل الحرارة داخل المباني • طول عمر المنتج وقلة الحاجة للصيانة • خفض تكاليف الطاقة وزيادة الراحة الحرارية • دعم الاستدامة وتقليل الأثر البيئي • تحسين جودة الحياة داخل المباني

	• تصميم يسمح بحركة مزدوجة لتعزيز كفاءة التظليل والتكيف مع مختلف الظروف المناخية • يقلل من الحاجة لاستخدام أنظمة التكييف المكثفة • يساهم في تقليل البصمة الكربونية للمباني • يوفر بيئة داخلية مريحة عن طريق التحكم في التظليل والحد من ارتفاع درجة الحرارة	

2.4 التسعير

استراتيجية التسعير :

تعتمد استراتيجية التسعير لمشروع "Mimosa Shade" على مجموعة من العوامل التي تضمن تحقيق التوازن بين القدرة التنافسية في السوق وتقديم قيمة حقيقية للعملاء. أيضا سوف نعتمد على سياسة التسعير بالتكلفة ، بحيث: سعر المنتج = تكلفة الوحدوية للمنتج + هامش الربح

المنتوج	الحجم	الفئة	السعر المقترح (بالدينار الجزائري)
كاسرات شمس ذكية مصنوعة من مادة GRC	حجم صغير	المباني السكنية	8500
	حجم متوسط	المباني التجارية	11000
	حجم كبير	المجمعات الصناعية/الابراج	15000
كاسرات شمس ذكية مصنوعة من مادة الخشب	حجم صغير	المباني السكنية	6500
	حجم متوسط	المباني التجارية	8000
	حجم كبير	المجمعات الصناعية/الابراج	10000
كاسرات شمس ذكية مصنوعة من مادة النسيج	حجم صغير	المباني السكنية	4500
	حجم متوسط	المباني التجارية	5500
	حجم كبير	المجمعات الصناعية/الابراج	8500

3.4 الترويج:

وسيلة الترويج	التفاصيل	التكلفة
موقع ويب خاص (موقع الكتروني)	إنشاء موقع ويب محترف خاص بالمؤسسة يعرض المنتوجات ويوفر معلومات مفصلة حولها، لتسهيل عملية البيع والتواصل مع العملاء.	2000 دج
الدعاية والاعلان على مو اقع التواصل الاجتماعي	إنشاء صفحات على فيسبوك، إنستغرام، و... نشر منشورات دورية تروج للمنتج وتبرز مميزاته.	مجاني
الفعاليات والمعارض	المشاركة في المعارض والاحداث المحلية ذات الصلة، لعر ض المنتجات والتواصل المباشر مع العملاء المحتملين	5000دج (متغيرة)
المطبوعات الترويجية	تصميم وطباعة مطبوعات تعريفية عن المنتج وتوزيعها في المعارض والفعاليات الصناعية.	5000دج
اللافتات الاعلانية	انجاز المطبوعات الترويجية مثل النشرات وتوزيعها في الأماكن المناسبة.	20.000=5*4000 دج
المجموع		**32000 دج**

4.4التوزيع:

ستكون طريقة التوزيع كما يلي:

توزيع المنتج عبر هذه القنوات يساعد على تحقيق الغرض من المنتج والوصول إلى أكبر عدد ممكن من العملاء المحتملين في أسواق متنوعة ومتعددة الجغرافيات.

قناة التوزيع	الطريقة	الفوائد
مبيعات مباشرة	إنشاء موقع إلكتروني للبيع المباشر والتفاعل مع العملاء عبر الإنترنت.	وصول عالمي، تحكم في السعر والترويج مباشرة.
متاجر التجزئة	الشراكة مع متاجر التجزئة الكبرى لعرض "Mimosa Shade" كجزء من معارضهم.	وصول واسع إلى العملاء المحليين والدوليين.
شركات البناء	التعاون مع شركات البناء والمقاولين لتضمين المنتج في مشاريع البناء الجديدة والتجديدات.	تأمين عقود كبيرة وتوزيع داخلي متقدم.
موزعي الجملة	التعاون مع موزعين محليين ودوليين لتوزيع "Mimosa Shade" في الأسواق المحلية والدولية.	وصول لشبكة واسعة من الموزعين والعملاء.

4. 5 طريقة الدفع:

تكون على شكلين: - الدفع المباشر عند الاستلام

-الدفع عن طريق CCP

5.عرض القطاع السوقي :

- **السوق المحتمل:**
  - يشمل جميع مناطق الوطن التي تعاني من حرارة مرتفعة حيث يمكن تطبيق هذه التقنية في كافة المناطق التي تعاني من مشاكل الحرارة المرتفعة والإشعاع الشمسي القوي، ما يجعل هذا السوق واسعاً جداً.
- **السوق المستهدف:**
  - المؤسسات والمرافق في مختلف مناطق العالم: مثل المدارس، المستشفيات، المكاتب الحكومية، والمباني التجارية التي تتطلب حلولاً فعالة للتحكم في الحرارة والإشعاع الشمسي لتحسين راحة المستخدمين وتقليل تكاليف الطاقة.
  - الأشخاص في الولايات الجنوبية :نظراً للحاجة الكبيرة لهذه الفئات في الولايات الجنوبية للحماية من الشمس بسبب الإشعاع الشمسي القوي والحرارة المرتفعة، يعتبر التركيز على هذا السوق الجغرافي ذو أهمية كبيرة. الولايات الجنوبية مثل ورقلة، أدرار، تمنراست، وبسكرة، حيث تعاني هذه المناطق من ظروف مناخية قاسية تستدعي حلولاً فعالة ومبتكرة للحد من الحرارة والحفاظ على الراحة الحرارية.

تستهدف الكاسرات الذكية توفير حلول فعالة ومستدامة للتحكم في الإشعاع الشمسي والحرارة، مما يساهم في تحسين جودة الحياة وتقليل استهلاك الطاقة في المباني، مما يجعلها خياراً جذاباً للمؤسسات والأفراد في المناطق ذات المناخ الحار والجاف في مختلف مناطق العالم.

6.تحليل المنافسين :

المنافسين الغير المباشرين:

اسم الشركة	مكانها	الخدمات المقدمة	سنوات الخبرة
Somfy	كلوز، فرنسا	أنظمة الأتمتة للمنازل، التحكم في الإضاءة، الستائر الذكية	**+50**
Lutron	كوبرسبرغ، بنسلفانيا، الولايات المتحدة	التحكم في الإضاءة، أنظمة الستائر الذكية، حلول الأتمتة	**+60**
Hunter Douglas	روتردام، هولندا	حلول التحكم في الضوء، الستائر الذكية، الستائر والستائر الرأسية	**+80**
IKEA	ليونغبي، السويد	الأثاث المنزلي، الستائر الذكية، حلول الأتمتة المنزلية	**+80**
Luxaflex	هولندا	الستائر الذكية، حلول التحكم في الضوء والخصوصية	**+60**
Legrand	ليموج، فرنسا	الأنظمة الكهربائية، أنظمة الأتمتة المنزلية، الستائر الذكية	**+150**
Coulisse	إنتولف، هولندا	تصميم وتطوير الستائر الذكية، الأقمشة للستائر	**+30**
Crestron	روكلاند، نيوجيرسي، الولايات المتحدة	أنظمة التحكم الآلي، الأتمتة المنزلية، حلول الإضاءة	**+50**

المنافسين الغير المباشرين:

اسم الشركة	مكانها	الخدمات المقدمة	سنوات الخبرة
Somfy	فرنسا	محركات وأنظمة تحكم ذكية، تحكم تلقائي في كاسرات الشمس بناءً على شدة الإشعاع الشمسي	**+50**
SageGlass	الولايات المتحدة	زجاج ذكي يتغير تلقائيًا بناءً على مستوى الضوء الخارجي، ينظم الحرارة والإشعاع الشمسي	**+30**
Bralco	إيطاليا	أنظمة كاسرات شمسية قابلة للتعديل، تحكم ذكي في دخول الضوء والحرارة، تتفاعل مع الظروف البيئية	**+20**
Hunter Douglas	هولندا	أنظمة كاسرات شمسية خارجية مبتكرة، تصميم متكامل مع الواجهة المعمارية، تحكم ذكي لضبط مستوى الظل بناءً على الضوء والحرارة	**+80**

Schüco	ألمانيا	أنظمة واجهات متقدمة، كاسرات شمسية ذكية تعمل بالتزامن مع نظام إدارة المبنى (BMS) لتوفير تحكم دقيق في الظروف البيئية	**+70**

7.الموردون :

اسم المورد	المكان	السلعة	سبب الاختيار
شركةSolarTech	الجزائر	مستشعرات ضوئية	جودة عالية وموثوقية
Green Materials Co.	الجزائر	مواد GRC (الخرسانة المسلحة بالألياف الزجاجية)	مواد متينة ومستدامة
WoodWorld	الجزائر	خشب عالي الجودة	متانة وجودة عالية في المواد الخشبية
Textile Innovators	الجزائر	أقمشة مستدامة ومقاومة للطقس	جودة عالية وتحمل الظروف البيئية المختلفة
EcoPackaging	الجزائر	مواد تغليف صديقة للبيئة	التزام بالاستدامة وحماية البيئة
LogisticsPro	الجزائر	خدمات النقل والتوزيع	كفاءة وسرعة في التوصيل وتغطية واسعة جغرافياً

8.الاستراتيجية التسويقية

استراتيجية التميز :تعتمد المؤسسة في تسويق منتجاتها على استراتيجية التميز، وذلك من خلال:

1. الجودة العالية:
   - استخدام مواد أولية ذات جودة عالية مثلGRC ، الخشب عالي الجودة، والأقمشة المقاومة للطقس.
   - ضمان متانة المنتجات وطول عمرها، مما يقلل الحاجة إلى الصيانة والاستبدال.
2. التصاميم المبتكرة:
   - تقديم تصاميم فريدة ومستوحاة من حركة نبتة الميموزا، مما يضيف لمسة جمالية وفنية للمباني.
   - تطوير تصميمات مرنة ومتنوعة تناسب مختلف الأنماط المعمارية والوجهات الجغرافية.
3. الخدمات المقدمة:
   - توفير خدمات تركيب وصيانة متميزة تضمن الأداء الأمثل للمنتجات.
   - تقديم دعم فني واستشارات تقنية للعملاء لضمان تحقيق الفائدة القصوى من الكاسرات الشمسية.

استراتيجية التركيز :تستند المؤسسة في تسويق منتجاتها إلى استراتيجية التركيز، من خلال:

1. السوق الجهوي:

- التركيز على السوق الجهوي المتمثل في الولايات الجنوبية للوطن، حيث تكون الحاجة إلى حلول التظليل وتحسين كفاءة الطاقة أكثر إلحاحًا بسبب الظروف المناخية القاسية.

2. تلبية الاحتياجات المحلية:

- تقديم حلول تظليل ذكية تلبي الاحتياجات الخاصة للسوق الجهوي، مثل التحمل العالي للحرارة والعواصف الرملية.
- تطوير منتجات تتناسب مع المتطلبات البيئية والثقافية للسكان المحليين.

9.مكونات المزيج التسويقي:

العنصر	التفاصيل
المنتج(Product)	الكاسرات الشمسية الذكية :"Mimosa Shade" جودة عالية في المواد مثلGRC ، الخشب، والنسيج أيضا تصاميم مبتكرة ومستوحاة من نبتة الميموزا مزودة بمستشعرات ضوئية للتفاعل مع الضوء وضبط التوجيه تلقائيًا.
السعر(Price)	استراتيجية التسعير التنافسي :تسعير تنافسي يعكس الجودة العالية والتصميم المبتكر . تقديم خصومات للعقود الكبيرة والشركاء الاستراتيجيين .توفير خيارات دفع مرنة لتناسب مختلف العملاء.
المكان(Place)	التوزيع المحلي والدولي :التركيز على الولايات الجنوبية في الجزائر .التوسع في الأسواق الحارة العالمية مثل دول الخليج وأفريقيا والهند .التعاون مع موزعين محليين وشركات بناء لتعزيز الوصول إلى السوق.
الترويج (Promotion)	استراتيجيات ترويجية متنوعة :حملات إعلانية عبر الإنترنت ووسائل التواصل الاجتماعي . المشاركة في المعارض التجارية المتخصصة .العروض الترويجية والخصومات لجذب العملاء الجدد .بناء العلاقات مع الصحافة المحلية والدولية.

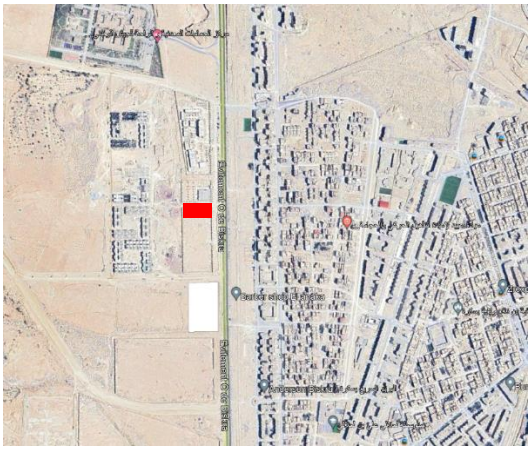
المحور الرابع:

خطة الإنتاج والتنظيم

1.المخطط الإنتاجي:

1.1الموقع:

يقع المشروع في المنطقة الصناعية لولاية بسكرة يقع موقع المشروع بالمنطقة الغربية لمدينة بسكرة بالضبط في القطب العمراني الجديد (منطقة توسع عمراني جديد) بالقرب من الطريق الوطني رقم (3) الذي يربط ولاية باتنة بمركز مدينة بسكرة. بسكرة. تبعد عن مقر الولاية 3 كم



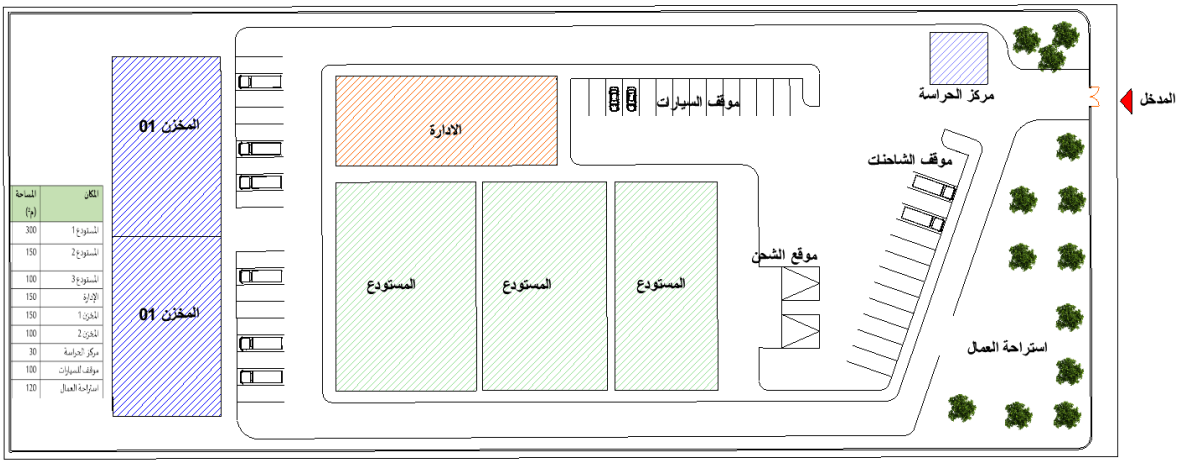
1. 2 أسباب اختيار الموقع:

- قربها من مراكز الخدمات :وجود بنية تحتية متطورة وشبكة مواصلات جيدة.
- الوصول إلى الموارد :سهولة الوصول إلى المواد الأولية ومزودي الخدمات.
- العمالة :توافر العمالة المدربة والفنية في المنطقة.
- الامتيازات الحكومية :قد تتوفر بعض الامتيازات والدعم الحكومي للمشاريع الصناعية في هذه المنطقة.

1 . 3 الجانب العمراني للمشروع: تقدر مساحة المشروع ب 1.200م² مقسمة على النحو التي:

المكان	المساحة (م²)	الاستعمال
المستودع 1	300	يخصص لتصنيع كاسرات الشمس من GRC
المستودع 2	150	يخصص لتصنيع كاسرات الشمس من المواد الأخرى مثل النسيج والخشب
المستودع 3	100	مخصص لآلات المعدات
الإدارة	150	خاص بمكاتب العمال والمدير
المخزن 1	150	مخصص للمنتوجات الجاهزة للبيع
المخزن 2	100	مخصص للمواد الأولية
مركز الحراسة	30	مخصص لعمال الحراسة
موقف للسيارات	100	خاص بسيارات عمال المؤسسة
استراحة العمال	120	تتكون من مطعم + مراحيض + مصلى

4.1 المخطط المقترح لتهيئة مكان المشروع :



5 .احتياجات المشروع:

5 . 1المعدات والآلات:

اسم الالة	العدد	السعر
الةCNC للGRC	1	6.000.000 دج
الة CNC لتقطيع الخشب	1	3.000.000 دج
الآلة المخصصة لتقطيع النسيج Fabric Cutter	1	2.200.000 دج

2.5 المعدات المكتبية:

اسم العتاد	الكمية	السعر	السعر الإجمالي
مكاتب	7	10.000	70.000
حاسوب	7	50.000	350.000
كراسي	10	4.500	45.000
خز ائن	4	9.000	36.0000
مودام انترنت	1	3.400	6.800
مكيف	4	60.000	240.000
مدفئة	3	60.000	180.000
طابعة	2	25.000	50.000
هاتف فاكس	2	2.000	4.000
المجموع	1.305.800 دج		

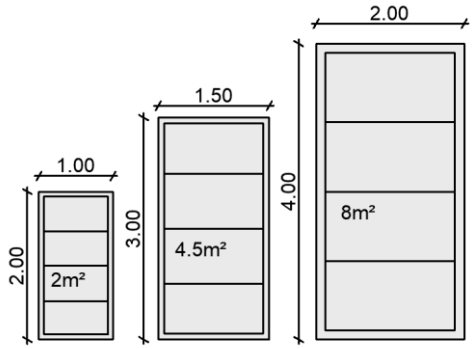
5 . 3 احتياجات الطاقة والكهرباء:

الخدمات	االحتياجات الثلاثي% الزيادة ب% 1	تكلفة السنة 1
الماء	800m3	15.600
الكهرباء	200.000 KW	5.200.000
انترنت وهاتف	غير محدود	38.400
صيانة	/	100.000
	5.354.000	

5 . 4 احتياجات المواد الأولية للحجم الصغير:

المواد	السعر	الكمية المطلوبة لسنة1	السعر الاجمالي
الحساسات	1وحدة-2000دج	2000	2.000.000
مادة GRC	1 متر² -2500دج	1000	5.000.000
مادة الخشب	1 متر² -400دج	500	200.000
مادة النسيج	1 متر² -250دج	500	125.000
عناصر التثبيت	1وحدة-100	4000	400.000

مختلف مقاساة المنتج:



5 . 5طقم البسة العمال

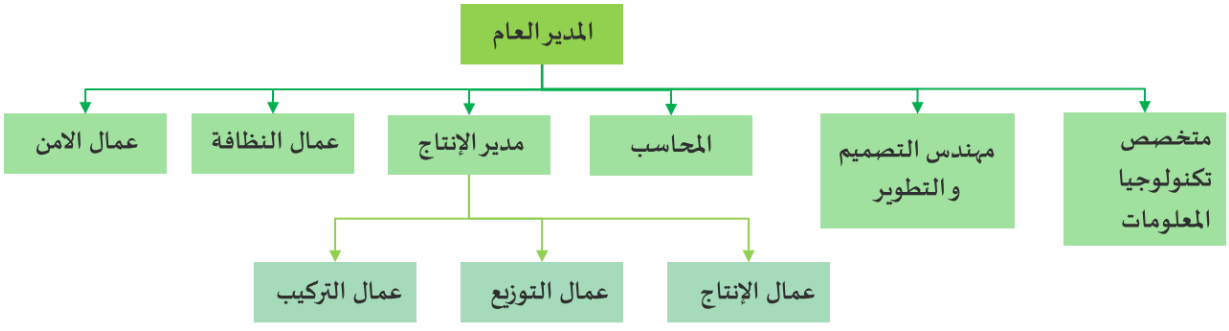
الاحتياج	الكمية	السعر	السعر الإجمالي
طقم البسة خاص بعمال الورشات	8	2500	20.000
قميص الحراس	1	1000	1000
اقمصة	4	1000	4000
احذية	13	2000	26.000
قفازات	13	500	6500
المجموع	58.500 دج		

2.النظام الإنتاجي: خطوات الإنتاج

نظام الإنتاج في مشروع تصنيع كاسرات شمسية ذكية قد يتضمن عدة خطوات رئيسية لضمان الجودة والكفاءة في عملية التصنيع.

1. **التصميم والتطوير:**
   - إعداد تصاميم الكاسرات الشمسية بناءً على متطلبات العملاء والمعايير الفنية.
   - استخدام برامج CAD/CAM لتصميم النماذج وتحليلها قبل الإنتاج.
2. **اختيار المواد والمكونات:**
   - اختيار وتأمين المواد الخام مثل GRC والخشب عالي الجودة والأقمشة المقاومة للطقس.
   - التأكد من أن المواد تتوافق مع المواصفات والمعايير المطلوبة للمنتجات.
3. **القطع والتشكيل:**
   - قطع المواد الخام إلى الأشكال والأحجام المطلوبة باستخدام معدات القطع المناسبة.
   - تشكيل المواد الخام وفقًا لتصاميم الكاسرات الشمسية.
4. **التجميع والتصنيع:**
   - تجميع المكونات المختلفة معًا لإنتاج الكاسرات الشمسية النهائية.
   - استخدام تقنيات الربط والتثبيت لضمان الاستقرار والجودة العالية للمنتج.
5. **الاختبار والمراجعة:**
   - اختبار جودة المنتجات لضمان التوافق مع المواصفات والمعايير المطلوبة.
   - مراجعة الأداء وتقييم الجودة لضمان الالتزام بالمعايير.
6. **التعبئة والتغليف:**
   - تعبئة وتغليف الكاسرات الشمسية بطريقة تضمن وصولها بأمان إلى العملاء.
   - استخدام مواد التعبئة والتغليف المناسبة لحماية المنتجات أثناء النقل والتخزين.
7. **التسليم والتوزيع والتركيب:**
   - ترتيب وتنسيق عمليات التسليم والتوزيع والتركيب وفقًا لجدول زمني محدد.
   - التأكد من وصول الكاسرات الشمسية إلى العملاء بأمان وفي الوقت المناسب.

1. 2 المخطط التنظيمي:



2.2 احتياجات اليد العاملة والأجور:

منصب	العدد	التخصص	الوظيفة	الاجور
مسؤول المبيعات والتسويق	1	ليسانس في التسويق	طوير استراتيجيات المبيعات والتسويق، إدارة العلاقات مع العملاء، تحليل السوق، تنفيذ حملات التسويق.	50.000
محاسب	1	ماستر في المحاسبة	إعداد التقارير المالية، مراقبة التكاليف، إدارة الحسابات والميزانيات، التخطيط المالي للمشروع	50.000
مدير الانتاج	1	ماستر هندسة معمارية / مدنية	تخطيط وإدارة عمليات الإنتاج، ضمان جودة المنتجات، تحسين عمليات التصنيع وتقليل التكاليف	50.000
مهندسي التصميم والتطوير	1	ماستر هندسة معمارية	تصميم وتطوير منتجات الكاسرات الشمسية، استخدام برامج التصميم المتقدمة، تحليل واختبار المنتجات	70.000
متخصص تكنولوجيا المعلومات	2	ماستر اعلام الي /ماستر الكتروميكانيك	تطوير وصيانة الأنظمة والبرمجيات اللازمة لتشغيل المشروع، دعم التكنولوجيا في العمليات اليومية.	45.000
عمال الإنتاج	4	الهندسة الميكانيكية /مهندس تقني	تصنيع الكاسرات الشمسية بناءً على التصاميم المعتمدة، مراقبة جودة التصنيع، العمل على زيادة الإنتاجية.	45.000
عمال التوزيع	2	/	تنسيق وإدارة عمليات التوزيع الداخلي للمنتجات، ضمان توصيل المنتجات بسلاسة إلى العملاء.	35.000
عمال التركيب	4	/	تركيب الكاسرات الشمسية في الأماكن المحددة، اختبار الأداء، ضمان التثبيت الصحيح والآمن.	40.000

الحراس	**1**	/	حماية مواقع الإنتاج والمكاتب، تنفيذ إجراءات الأمن والسلامة.	**25.000**
عمال النظافة	**2**	/	تنظيف وصيانة المكاتب ومناطق الإنتاج لضمان بيئة عمل نظيفة وصحية.	**25.000**
المجموع	**795.000دج**			

3.2 الشركاء:

اسم الشريك	دور الشريك
الموردين	يكمن دورهم واهميتهم في انجاح المشروع بتوفير كافة المستلزمات من الآلات وتجهيزات ومواد ألولية
حاضنة الاعمال لجامعة بسكرة	تعمل على تمويل ومرافقة المشروع والذهاب نحو تجسيده على ارض الواقع
البنوك	تعمل على تمويل ومرافقة المشروع والذهاب نحو تجسيده على ارض الواقع
الزبائن	كمن دورهم في تطوير وتحسين المنتجات عن طريق تقديم ما لحظات واقتراحات لتطلعاتهم واحتياجاتهم المستقبلية حول المنتج والخدمة المقدمة من ناحية الجودة و الأداء و التصميم.... الخ

المحور الخامس:

الخطة المالية

1.تكاليف المشروع واهتلاك الاستثمار:

1.1 تكاليف استثمارية:

الأصول	التكلفة
المبنى	/
الآلات والمعدات	11.200.000 دج
المعدات والتجهيزات	1.305.800 دج
طقم البسة العمال	58.500 دج
رأس المال	2.000.000 دج
المجموع	14,564,300 دج

2.1 التكاليف التشغيلية:

الأصول	التكلفة
المبنى	/
الآلات والمعدات	11.200.000 دج
المعدات والتجهيزات	1.305.800 دج
طقم البسة العمال	58.500 دج
رأس المال	2.000.000 دج
المجموع	14,564,300 دج

3.1 جدول تقدير المبيعات:

	جانفي	فيفري	مارس	افريل	ماي	جوان	جويلية	اوت	سبتمبر	اكتوبر	نوفمبر	ديسمبر	المجموع
2025	800	860	920	980	1040	1100	1160	1220	1280	1340	1400	1460	1460
2026	933	993	1053	1113	1173	1233	1293	1353	1413	1473	1533	1593	1593
2027	1066	1126	1186	1246	1306	1366	1426	1486	1546	1606	1666	1726	1726
2028	1199	1259	1319	1379	1439	1499	1559	1619	1679	1739	1799	1859	1859
2029	1332	1392	1452	1512	1572	1632	1692	1752	1812	1872	1932	1992	1992
المجموع	8630												
قيمة المبيعات دج	73.355.000 دج												

المحور السادس:

النموذج الاولي التجريبي

1.تطوير عنصر الكاسرة الشمسية:

مصدر الإلهام:

الإلهام مستمد من حركة نبات الميموزا بوديكا لإنشاء عنصر تظليل ذاتي في المبنى. هذا النبات الحساس تنحني أوراقه وتبعث بخارًا عند تعرضه لمؤثرات خارجية مثل:

المستشعرات:

سيتم دمج عناصر استشعار الضوء لجعلها تتحرك ديناميكيًا وتوفر راحة حرارية للمبنى وتجعلها قابلة للتكيف مع بيئتها.

2.فوائد استخدام مستشعرات الضوء للتحكم في الظلال الشمسية:

تحسين كفاءة الطاقة:

تقليل استخدام التكييف: من خلال تقليل كمية الشمس التي تدخل المبنى، يتم تقليل الحاجة إلى تشغيل أنظمة التكييف، مما يقلل من استهلاك الطاقة.

زيادة الاعتماد على الإضاءة الطبيعية: يمكن للمستشعرات التحكم في الظلال الشمسية للسماح بدخول الضوء الطبيعي عند الحاجة، مما يقلل من استخدام الإضاءة الصناعية.

تحسين الراحة الحرارية:

التحكم في الحرارة: يساعد التحكم التلقائي في الكاسرات الشمسية في الحفاظ على درجة حرارة داخلية مستقرة، مما يزيد من راحة السكان.

تقليل الوهج: تمنع الكاسرات الشمسية التلقائية و الذكية دخول أشعة الشمس المباشرة، مما يقلل الوهج ويحسن بيئة العمل والمعيشة داخل المبنى.

3. شرح النظام:

حركة أفقية وعمودية:

أفقياً: يمكن للنظام التحرك أفقيًا لتغطية مناطق مختلفة من الواجهة استنادًا إلى موقع الشمس. هذا يساعد في تقليل كمية الشمس المباشرة التي تدخل المبنى خلال ساعات النهار المختلفة.

عمودياً: يمكن للنظام التحرك عموديًا لتظليل حسب الحاجة، مما يوفر تظليلًا ديناميكيًا يتكيف مع تغيرات الشمس على مدار اليوم والفصول.

آلية الطي:

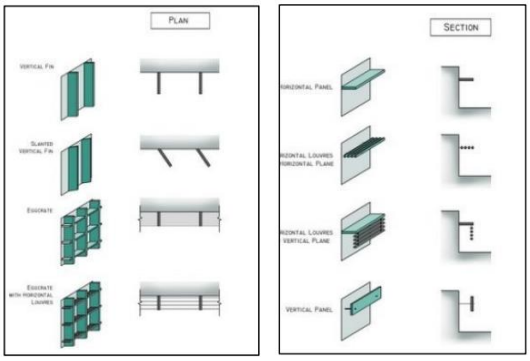
تعتمد الآلية على طي العناصر بشكل يشبه أوراق نبات الميموزا التي تنثني عند التعرض لمؤثرات خارجية. يمكن أن تكون هذه العناصر مصنوعة من مواد خفيفة ومتينة مثل الألمنيوم أو مواد مركبة أخرى.

يتم تشغيل الطي بواسطة مستشعرات ضوئية تكتشف مستوى الإشعاع الشمسي وتعدل وضعية العناصر لتحقيق الظل الأمثل.

تعتمد الآلية على طي العناصر بشكل يشبه أوراق نبات الميموزا التي تنثني عند التعرض لمؤثرات خارجية. يمكن أن تكون هذه العناصر مصنوعة من مواد خفيفة ومتينة مثل الألمنيوم أو مواد مركبة أخرى.

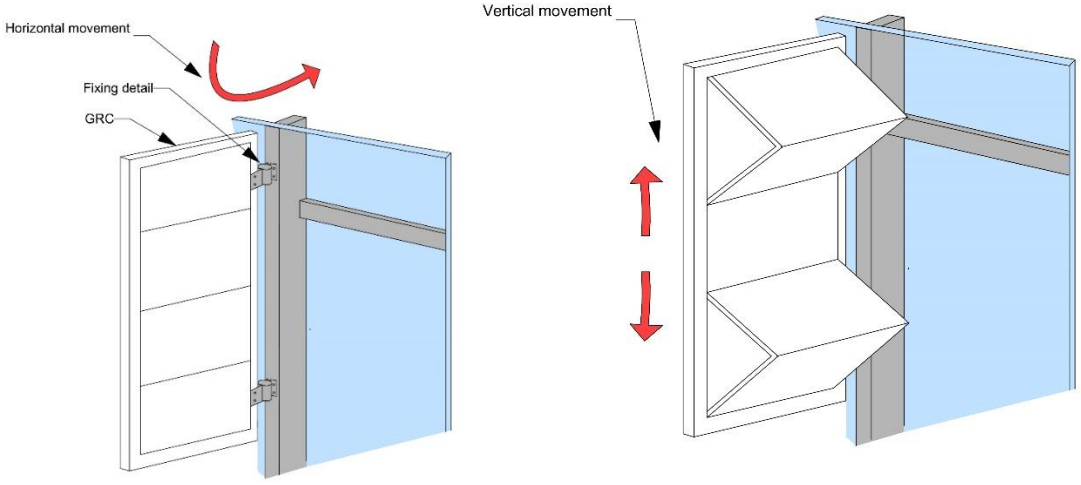
يتم تشغيل الطي بواسطة مستشعرات ضوئية تكتشف مستوى الإشعاع الشمسي وتعدل وضعية العناصر لتحقيق الظل الأمثل.

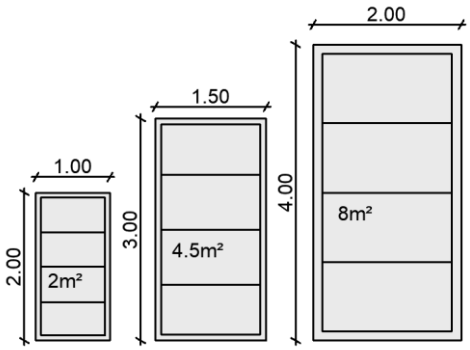
جمع بين وضعين للكاسرات الشمسية التقليدية مع اضافت مستشعرات لجعلها متحركة أيضا تتأقلم مع محيطها



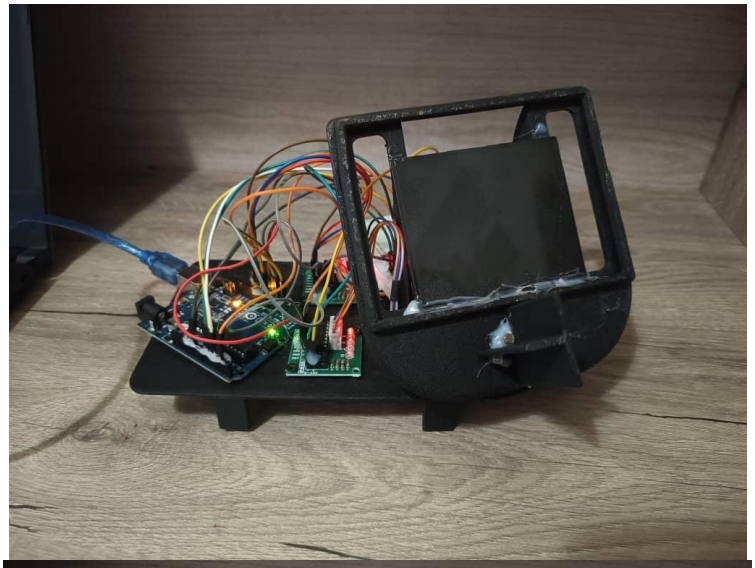
أجهزة التظليل الرأسي أجهزة التظليل الأفقي

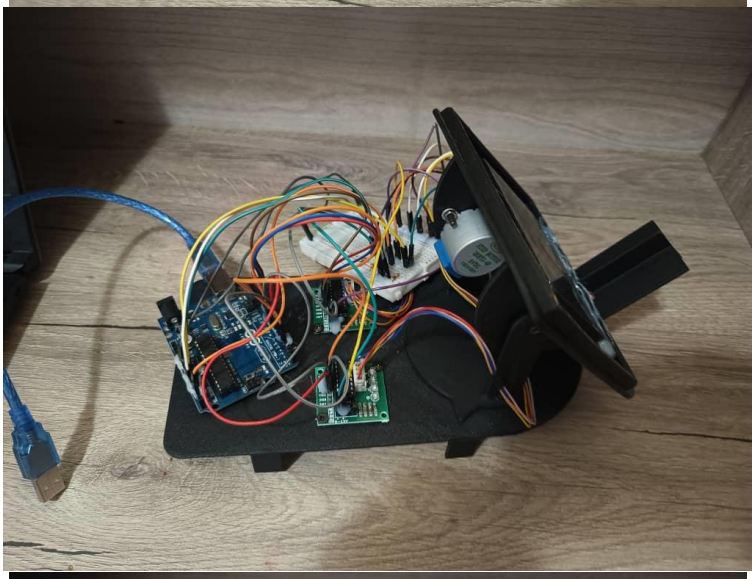
4.النموذج الاولي لتصميم :

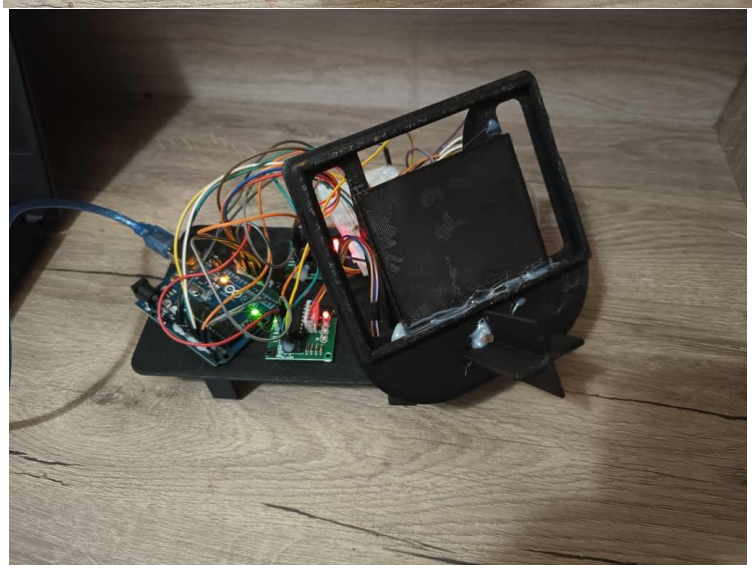




مستشعر الضوء :







شرائح العملاء:	العلاقات مع العملاء:	القيم المقترحة:	الأنشطة الرئيسية:	الشركات الرئيسية
-المهندسون المعماريون والمصممون - المطورون العقاريون - المقاولون وشركات البناء - مالكو المباني التجارية والسكنية - الهيئات الحكومية والمؤسسات البيئية - الشركات الصناعية والمؤسسات الكبرى - المستثمرون في قطاع البناء الأخضر	-دعم فني واستشارات تقنية - خدمة العملاء ما بعد البيع - توفير معلومات وتعليمات واضحة للتركيب والصيانة - برامج ولاء وعروض حصرية	- الكفاءة والفعالية في الحماية من الشمس - تحسين كفاءة الطاقة وتقليل التبريد الاصطناعي - تصاميم مبتكرة ومرنة تتكيف مع مختلف الأنماط المعمارية - استخدام مواد عالية الجودة ومستدامة - خدمات تركيب وصيانة متميزة	-تصميم وتصنيع كاسرات الشمس الذكية - تطوير تقنيات المستشعرات الضوئية - تركيب وصيانة الأنظمة - البحث والتطوير لتحسين المنتجات	- شركة SolarTech -شركة Green Materials Co -شركة WoodWorld -شركة Textile Innovators -شركة EcoPackaging -شركة LogisticsPro - شركة التوصيل LogisticsPro -البنك
	القنوات:		موارد الرئيسية:	
	- الفعاليات والمعارض -وسائل التواصل الاجتماعي -نقاط البيع -شركات التوصيل -خدمة ما بعد البيع(التركيب والصيانة)		-مقر العمل المصنع -المواد الأولية (نسيج،) -الآلات والمعدات -عمال ذو كفاءة وفريق انتاج محترف	

المصادر والارادات:	هيكل التكاليف:
بيع المنتج تركيب المنتج عائدات دورات تعليم التركيب للمنتج	-تكاليف ثابتة : تكاليف شراء الآلات و المعدات، تكاليف تهيئة المقر، اجا ر العمال -تكاليف متغيرة: تكاليف المواد الأولية، تكاليف املاء والكهرباء والغاز

الملحق رقم 04: نموذج العمل التجاري