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Faculty of Science and Technology
Department of Architecture

MASTER DISSERTATION

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The theme:
Thermal comfort through shading system in school of architecture.

The project:
School of architecture - Biskra

Jury

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Abstract:

Thermal comfort in an indoor environment is largely dependent on several parameters and indicators.in this study we mentioned how can we provide an optimal thermal comfort for users in architecture school using different type of shading system. However, a research has been done on the thermal comfort and its different factors and parameters that have a significant influence on the thermal comfort perception of a person, also we studied the strategy of shading system in buildings that should be able to moderate or control direct, diffuse and reflected solar radiation, and glare, whilst ensuring that daylighting and natural ventilation are not excessively reduced. This study aims to provide a comfortable space for working by maintain and improve optimal thermal comfort in architecture school for users. Using the methods of shading system and maintain the thermal environment with suitable orientation and positioning while performing a site analysis and using a simulation model relaying on PVM and PPD indicators to help achieving optimal results. A very strong positive correlation was founded between thermal comfort and shading system depends on the designing and controlling of shading devises.

Keywords: Thermal comfort; Thermal discomfort; Predicted Mean Vote (PMV); Shading system;

School of architecture; Dynamism;

Résumé:

Le confort thermique dans un environnement intérieur dépend en grande partie de plusieurs paramètres et indicateurs. Dans cette étude, nous avons mentionné comment fournir un confort thermique optimal aux utilisateurs des écoles d'architecture utilisant différents types de systèmes d'ombrage. Cependant, une recherche a été faite sur le confort thermique et ses différents facteurs et paramètres qui ont une influence significative sur la perception du confort thermique d'une personne, nous avons également étudié la stratégie de système d'ombrage dans les bâtiments qui devraient pouvoir modérer ou contrôler directement , le rayonnement solaire diffus et réfléchi et l'éblouissement, tout en garantissant que la lumière du jour et la ventilation naturelle ne sont pas excessivement réduites. Cette étude vise à fournir un espace de travail confortable en maintenant et en améliorant le confort thermique optimal en école d'architecture pour les utilisateurs. Utiliser les méthodes de système d'ombrage et maintenir l'environnement thermique avec une orientation et un positionnement approprié tout en effectuant une analyse du site et en utilisant un modèle de simulation reposant sur des indicateurs PVM et PPD pour aider à obtenir des résultats optimaux. Une corrélation positive très forte a été établie entre le confort thermique et le système d'ombrage dépend de la conception et du contrôle des dispositifs d’ombrage.

Mots-clés: confort thermique; Inconfort thermique; Vote moyen prévisible (PMV); Système d'ombrage; Ecole d'architecture; Dynamisme;

DEDICATION

I am dedicating this thesis to beloved people who have meant and continue to mean so much to me, my family and many friends.

A special feeling of gratitude to my loving parents, whose words of encouragement and push for tenacity ring in my ears.

My beloved brothers and sister who have never left my side, and I always find them when I need them.

I also dedicate this thesis to my many friends who have supported me throughout the process. I will always appreciate all they have done.

I dedicate this work and give special thanks to architecture family, all people teachers, classmates, workers, that I learnt and enjoyed time with during my studies journey.

ACKNOWLEGMENTS

First and foremost, I must acknowledge my limitless thanks to Allah, the Ever-Magnificent; the Ever-Thankful, for His help and bless. I am totally sure that this work would have never become truth, without His guidance.

I am grateful to some people, who worked hard with me from the beginning till the completion of the present research particularly my supervisors Dr. Boukhabla Moufida, and Mrs.Sebti Moufida who have been always generous during all phases of the research, I am forever indebted for their unwavering support, encouragements and patience through this process.

I would like to take this opportunity to say warm thanks to all my beloved friends, who have been so supportive along the way of doing my thesis.

I also would like to express my wholehearted thanks to my family for their generous support they provided me throughout my entire life and particularly through the process of pursuing the master degree. Because of their unconditional love and prayers, I have the chance to complete this thesis.

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GENERAL INTORDUCTION

Introduction:

The main purpose for heating and air conditioning of work spaces is to provide an environment that is acceptable and does not impair the health and performance of the occupants. Light, noise, air quality and the thermal environment are all factors which will influence the acceptability and performance of the occupants Understanding thermal comfort is important to architecture, since it not only lays the foundation for architecture school design, but also affects the field of sustainable design,

The thermal environment is affected by the air temperature and surrounding surface temperatures humidity and flow rate. Good indoor air is characterized by the right room temperature, proper humidity, cleanliness and freshness. Thermal comfort refers to a condition where a person is satisfied with the ambient temperature and Central to any cooling strategy is protection of the architecture school from unwanted solar gain and this is most readily achieved by blocking the sun's rays before they reach the school. Protection of the architecture school apertures is the first and most fundamental consideration in the design of shading systems. When designed well they may also protect the opaque surfaces, including the roof. In designing efficient cooling strategies for buildings, the sun is the most important concern. Correctly designed shading systems can effectively control the sun's direct radiation, and partially block diffuse and reflected radiation

Problematic:

There are many different reasons to want to control the amount of sunlight that is admitted into a architecture schools, Well-designed sun control and shading devices can dramatically reduce building peak heat gain and cooling requirements and improve the natural lighting quality of building interiors, Shading against solar heat gain is the most readily applicable and flexible method of cooling and can be applied in all climate types in which the sun's influence is significant, the traditional roles of shading systems are to improve thermal and visual comfort by reducing overheating and glare, and to provide privacy. Shading devices may perform one or all three roles

So how can we provide the optimal thermal comfort for users in indoor environment of architecture school using different type of shading system (occultation)?

Hypotheses:

To provide an optimal thermal comfort for users in indoor environment using different type of shading system it requires a good knowledge of the properties of materials characteristics and a good control to architecture school position orientation and indoor spaces function which are affected with outdoor environment

Objectives:

the main goal of building design is to provide a comfortable space for working by maintain or improve optimal thermal comfort in architecture school for users.

- ✓ Moderating or blocking direct solar radiation at required periods
- ✓ Controlling diffuse and reflected and direct radiation
- ✓ Preventing glare from external and internal sources

methodology de memoir:

This research is based on two parts for each variant (project and theme): a theoretical part and another analytical part.

- **Theoretical part:**

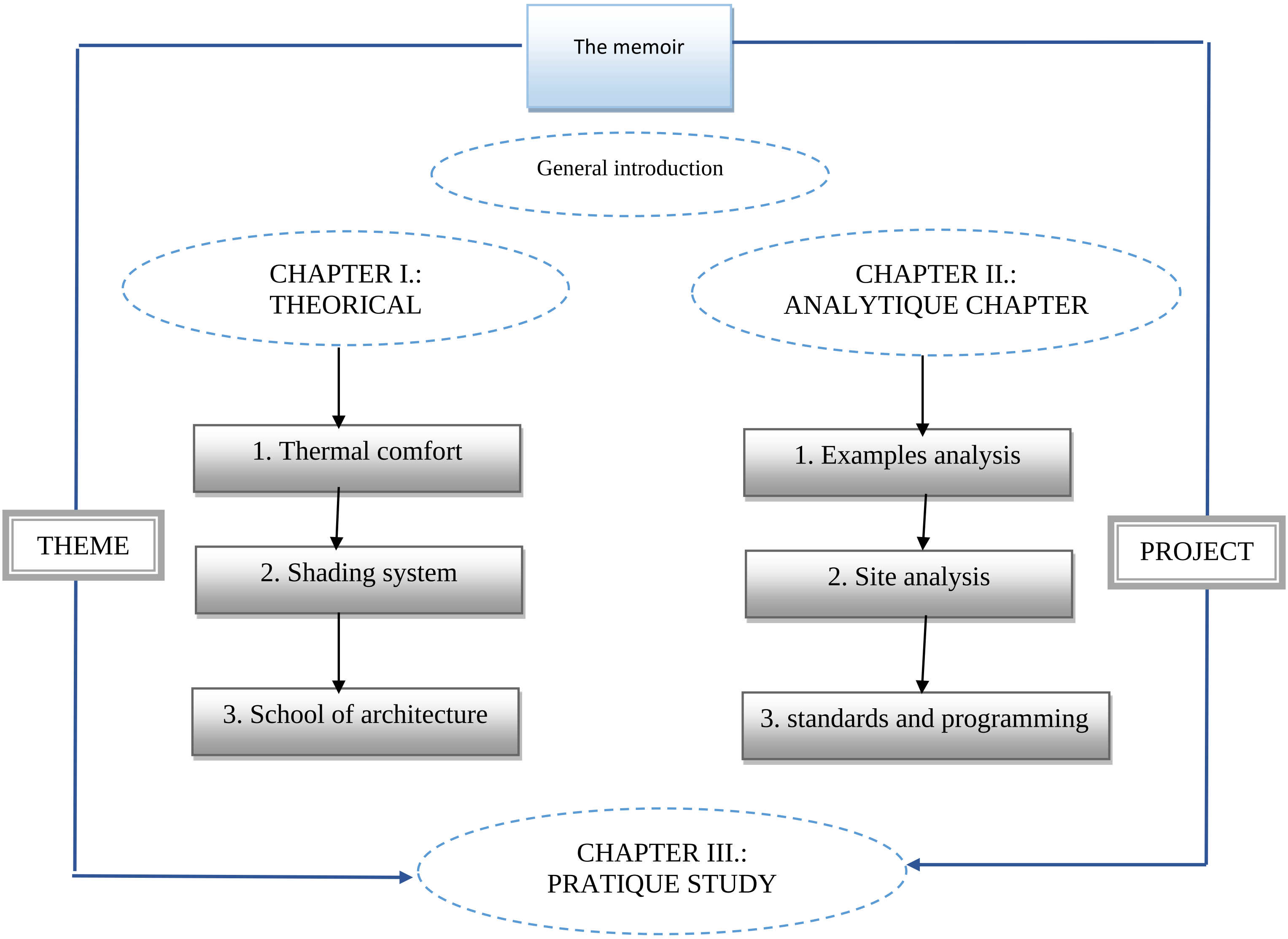
For theme: in this part we have treated all the theoretical study such as the concepts of thermal comfort, and all that relates to it such as heating and factors and indicators, besides that, we mentioned shading system and the typology and strategy.

For the project (School of Architecture): definitions concerning education and the school of architecture and the relation between them.

- **Analytical part:**

For the project: we present analyses for an existing example and other bookish, which they explain the theme-project relationship and we mention some standards and norms about the school of architecture including programming for the spaces

Structure of the thesis:



CHAPTER I: THEORICAL STUDY

Introduction

One of the most important considerations when designing a building is the extent to which it provides an environment that is comfortable for its occupants. Comfort in the built environment is affected by a great number of different factors which can, if not addressed properly, can lead to poor levels of comfort, discomfort, or can even cause harm and ill health to occupants.

Aspects of comfort include; personal factors, health and wellbeing, thermal comfort, indoor air quality, visual comfort, noise nuisance, ergonomics, and so on.

1 Thermal comfort

Introduction

feeling comfortable in an interior space directly impacts people's mood. In office buildings, working in optimal conditions enables us to think and work better, and thermal comfort contributes not only to well-being but even to productivity.

The human thermal environment is not straight forward and cannot be expressed in degrees. Nor can it be satisfactorily defined by acceptable temperature ranges. It is a personal experience dependent on a great number of criteria and can be different from one person to another within the same space.

Understanding thermal comfort is important to architecture, since it not only lays the foundation for building design, but also affects the field of sustainable design

1.1 Historical Perspective

1.1.1 The ancient Babylonians as far back as 2,000 BC:

evaporative cooling to condition their dwellings. Individuals would spray water onto exposed surfaces at night; the combined evaporation and drop in night time temperatures provided a simple and effective method to get relief from the heat

1.1.2 Ancient Indians:

would hang wet grass mats on the windward side of their homes to achieve a cooler indoor temperature

1.1.3 in the early 1900s. In 1902:

the first mechanical cooling system was built. Four years later, the first office building was designed for air conditioning

1.1.4 In 1929- 1931:

Marked the first time that year-round central air systems became available for homes

1.2 Definition of thermal comfort:

Comfort has been defined as 'the condition of mind which expresses satisfaction with the... environment'. The indoor environment should be designed and controlled so that occupants' comfort and health are assured. Most of the time of people now is spent in buildings or urban spaces. Although comfort models mostly talk about indoor climate but both indoor and outdoor climate should be taken into consideration not only in urban design but also in buildings. So, both indoor and outdoor comfort is a matter of attention for architects and urbanists.

1.3 Thermal comfort variables:

•Ambient temperature (air temperature)
• Radiant temperature (the temperature of the surfaces around us)
• Relative humidity (measurement of the water vapor in an air -water mixture)
• Air motion (the rate at which air moves around and touches skin)
• Metabolic rate (amount of energy expended)
• Clothing insulation (materials used to retain or remove body heat)

Understanding these six variables, is essential to making informed decisions when planning and

designing a building air conditioning system

1.4 Baruch Giovani bioclimatic chart:

Giovani's bioclimatic chart, figure aimed at predicting the indoor conditions of the building according to the outdoor prevailing conditions. He based his study on the linear relationship between the temperature amplitude and vapor pressure of the outdoor air in various regions.

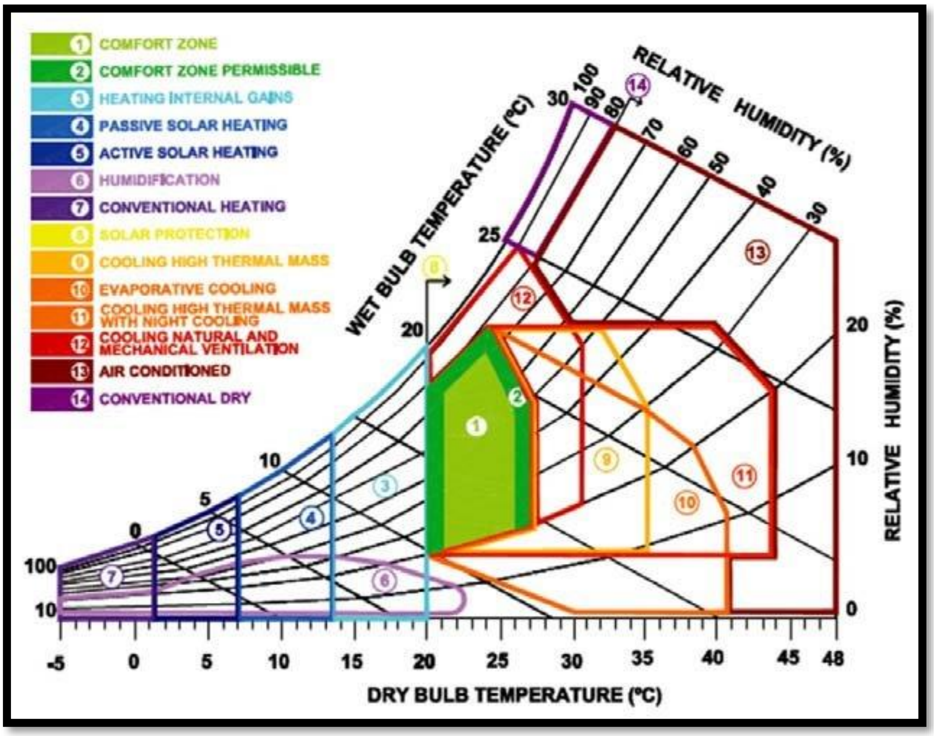


Figure 1:Giovani Bioclimatic Diagram (Source: www.eoi.es)

June and July are the most hot, humid months in the year where mechanical dehumidification and cooling is a must for maintaining thermal comfort.

Month	$\overline{T}_{db,max}$	$\overline{T}_{db,min}$	$\overline{w}_{max}$	$\overline{w}_{min}$	$T_{db,mean}$	w_{mean}	$T_{neutrality}$
Jan	25.4	16.7	0.0110	0.0071	21.4	0.0089	23.3
Feb	25.9	17.8	0.0121	0.0074	22.0	0.0100	23.7
Mar	28.7	20.2	0.0148	0.0084	24.4	0.0115	24.9
Apr	35.3	26.9	0.0156	0.0079	30.9	0.0114	28.4
May	38.4	29.7	0.0199	0.0092	33.9	0.0145	30.0
Jun	40.0	30.9	0.0224	0.0100	35.2	0.0163	30.7
Jul	39.0	30.5	0.0233	0.0118	34.6	0.0177	30.4
Aug	33.5	27.1	0.0217	0.0162	29.9	0.0195	27.9
Sep	35.6	26.7	0.0213	0.0127	30.9	0.0174	28.4
Oct	35.0	25.8	0.0186	0.0096	29.9	0.0143	27.8
Nov	30.4	22.6	0.0157	0.0094	26.4	0.0124	26.0
Dec	25.2	17.7	0.0115	0.0081	21.5	0.0098	23.4

Table 1:Giovani Bioclimatic table (Source: www.semanticscholar.org)

1.5 The Indicator of thermal comfort

1.5.1 The predicted mean vote (PMV):

was developed by Povl Ole Fanger at Kansas State University and the Technical University of Denmark as an empirical fit to the human sensation of thermal comfort. It was later adopted as an ISO standard. It predicts the average vote of a large group of people on the a seven-point thermal sensation scale where:

$$PMV = f(\dot{M}, \dot{W}, f_{cl}, p_a, T_{db}, T_{cl}, h_c)$$

- +3 = hot **PMV calculation**
- +2 = warm
- +1 = slightly warm
- 0 = neutral
- -1 = slightly cool
- -2 = cool
- -3 = cold
- **hc** is the convective heat transfer coefficient in [W m−2 °C−1]
- ***W*** is the rate of mechanical work
- **Tcl** is the mean temperature of clothing [C°]
- ***f*cl** is ratio of clothed surface area to the nude surface area.
- **Tdb** Air temperature [C°]
- ***p*a** water vapour pressure in an air mass [Pa]

1.5.1.1 Adaptive Predicted Mean Vote (aPMV):

The term Adaptive Predicted Mean Vote (aPMV) describes the thermal comfort in a warm environment and predicts “the same optimum operative temperature as the analytic PMV approach, but uses mean outdoor effective temperature as the only input instead of the usual four inputs (clothing insulation, metabolic rate, relative humidity, and air velocity) required by the analytic PMV method”

1.5.1.2 Extended Predicted Mean Vote (ePMV):

The ePMV model introduced by Fanger and Tofum highlights expectations of people based on local climate and popularity of mechanical conditioning. The PMV model works well inside the airconditioned buildings, while the ePMV model is only suitable for warm and humid climates in non-air conditioned building where the indoor air temperature rises significantly .The ePMV model includes a correction factor called expectancy factor ep, which is multiplied by PMV to obtain the corrected value of PMV representing the mean TSV of the persons: ePMV = ep . PMV

1.5.1.3 New Predicted Mean Vote (nPMV):

The New Predicted Mean Vote (nPMV) is recommended by Humphreys and Nicol for air-conditioned buildings. This method based on adaptive comfort theory, equilibrating the difference between the PMV predictions and thermal sensation of occupants in buildings. The equation of nPMV is written in under the following form

1.5.2 Predicted Percentage Dissatisfied (PPD):

Developed by Fanger (1967), the predicted percent dissatisfied (PPD) is an index that predicts the percentage of thermally dissatisfied people who feel too cool or too warm, and is calculated from the predicted mean vote (PMV). The PMV and PPD form are therefore closely related, and both indices take the form of a U-shaped relationship, where percentage dissatisfied increases for PMV values above and below zero (thermally neutral). At the neutral temperature as defined by the PMV index, PPD indicates that 5 % of occupants will still be dissatisfied with the thermal environment.

1.5.3 Physiological Equivalent Temperature (PET)

The PET comfort index, derived from the human heat balance model, combines weather and thermo-physiological, parameters (clothing and human activities). It is used to measure the thermal comfort of an individual in a given situation by comparing her physiological responses to those she would have in the reference environment, for example an office in which she feels generally comfortable.

“Strictly speaking, the PET index is a temperature. It is the operative temperature of a reference environment that would cause the same physiological response in the subject as the environment under study, i.e., the same skin temperature and core temperature.”

For the study of indoor spaces, the PET index is often used as its reference environment is comparable to an office and it is easier to apply and less theoretical than the Universal Thermal Climate Index (UTCI), a more complex variant (with about 340 calculation nodes instead of two).

1.6 The effects of thermal indoor environment:

1.6.1 Air temperature:

a common component of thermal comfort; it can easily be influenced with passive and mechanical heating and cooling

1.6.2 Mean radiant temperature:

the weighted average temperature of all exposed surfaces in a room. Combined with the air temperature, it allows defining the operative temperature which is the most essential component of thermal comfort.

1.6.3 Air velocity:

(or air flow) quantifies the speed and direction of the air movements in the room. Rapid air velocity fluctuations might result in draught complaints.

1.6.4 Humidity

(or relative humidity) is the moisture content of the air. Too high or too low humidity levels may induce discomfort

1.6.5 Clothing level:

the amount of insulation added to the human body. Higher clothing levels will reduce the heat lost through the skin and lower the environment´s temperature perceived as comfortable

1.6.6 Metabolic heat or level of activity

The heat we produce through physical activity. A stationary person will tend to feel cooler than a person who is exercising.

1.7 Heat Transfer Methods:

1.7.1 Radiation

- Radiation is a method of heat transfer that does not rely upon any contact between the heat source and the heated object as is the case with conduction and convection. Heat can be transmitted through empty space by thermal radiation often called infrared radiation. This is a type electromagnetic radiation . No mass is exchanged and no medium is required in the process of radiation. Examples of radiation is the heat from the sun, or heat released from the filament of a light bulb.

1.7.2 Convection:

- Thermal energy is transferred from hot places to cold places by convection. Convection occurs when warmer areas of a liquid or gas rise to cooler areas in the liquid or gas. Cooler liquid or gas then takes the place of the warmer areas which have risen higher. This results in a continuous circulation pattern. Water boiling in a pan is a good example of these convection currents. Another good example of convection is in the atmosphere. The earth's surface is warmed by the sun, the warm air rises and cool air moves in.

1.7.3 Conduction:

Conduction is the transfer of heat between substances that are in direct contact with each other. The better the conductor, the more rapidly heat will be transferred. Metal is a good conduction of heat. Conduction occurs when a substance is heated, particles will gain more energy, and vibrate more. These molecules then bump into nearby particles and transfer some of their energy to them. This then continues and passes the energy from the hot end down to the colder end of the substance.

Thermal indoor environment is affected by both internal and external sources.

Common heat sources:

- electrical equipment (such as lighting and computers)
- Sun radiation
- Human presence
- Windows surfaces
- Poorly insulated walls
- thermal bridges in the constructions

All these sources will influence the human perception of the environment

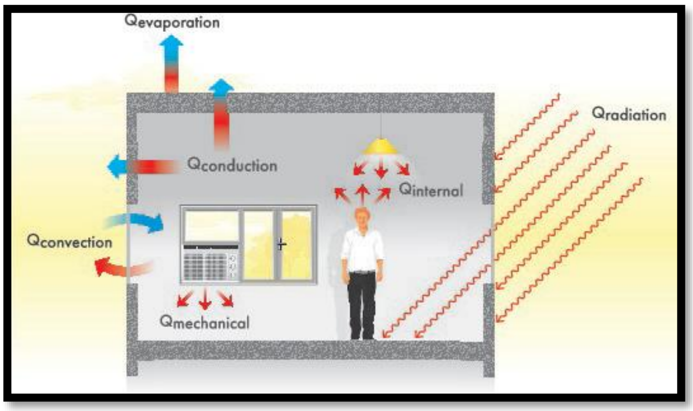


Figure 2:thermal indoor environment affects (Source: www.ecophon.com)

1.8 Thermal comfort and the work performance:

Thermal conditions can affect the building occupants 'productivity and work performance through several mechanisms. Thermal discomfort can:

- cause attention distraction
- disturb well-being
- reduce the ability to concentrate properly

1.9 Thermal comfort and acoustics:

- If a high-quality indoor environment is strongly dependent on thermal comfort, it is crucial to think of it in combination with other indoor parameters, such as:
- Acoustics: a science that deals with the production, control, transmission, reception, and effects of sound.
- Lighting: s the deliberate use of light to achieve practical or aesthetic effects.

1.10 Factors of comfort zones Factors:

Factors influencing the thermal comfort near a window are:

1. Window geometry
2. Room geometry
3. Location of the occupant
4. Glazing system
5. Outside conditions
6. Inside Conditions

1.10.1 Windows:

The windows impact on the thermal comfort zone is dependent on the time of the year. In the summer energy passes through the window more as thermal radiation from the sun, the thermal radiation is not restricted by the U-value of the window. A single pane window's inside surface temperature is not affected from the heat flux due to radiation during the warmer nor colder periods. During the winter the comfort is dependent on the inside surface temperature of the window, this can be rated directly on basis of the U-value (thermal conductivity) of the window.

1.10.2 Ventilation:

Ventilation is used to control the purity, temperature, humidity and movement of air at work by regulating the incoming, outgoing or circulated air. The air space of a workroom intended for permanent use should be at least ten cubic metres per employee.

According to the Occupational Safety and Health Act, a workplace should have enough good air to breathe, and the ventilation should be sufficiently effective and appropriate. If the workplace has mechanical ventilation, it must be kept in working order. Impurities in the ventilation systems may cause health problems.

1.11 Materials and Methods of Construction

In recent years, there has been a dramatic increase in the variety of shading devices and glazing available for use in buildings. A wide range of adjustable shading products is commercially available from canvas awnings to solar screens, roll-down blinds, shutters, and vertical louvers. While they often perform well, their practicality is limited by the need for manual or mechanical manipulation. Durability and maintenance issues are also a concern.

- Landscape features such as mature trees or hedge rows;
- Exterior elements such as overhangs or vertical fins;
- Horizontal reflecting surfaces called light shelves;
- Low shading coefficient (SC) glass; and,
- Interior glare control devices such as Venetian blinds or adjustable louvers

When designing shading devices, carefully evaluate all operations and maintenance and safety implications. In some locations, hazards such as nesting birds or earthquakes may reduce the viability of incorporating exterior shading devices in the design. The need to maintain and clean shading devices, particularly operable ones, must be factored into any life-cycle cost analysis of their

2 Shading system:

Introduction

Shading systems are designed to deal with solar radiation. Protection of the building's apertures is the first consideration in the design of shading systems. When designed well they may also protect the opaque surfaces, including the roof. Shading systems can help save energy by reducing:

• cooling loads in summer/heat loads in winter

• needed artificial lightning (redistribute daylight)

Shading systems can also improve user visual comfort by controlling glare and reducing contrast ratios. While the cooling load may be reduced by shading, any associated reduction of lighting in the space may lead to a higher artificial lighting load. Therefore, the design of shading systems should consider concurrently heat rejection in summer/heat capture in winter, daylighting and ventilation needs

2.1 definition of shading system:

Solar shading, is a form of solar control that can be used to optimise the amount of solar heat gain and visible light that is admitted into a building

Shading systems perform a number of roles, the most apparent of which is protection from direct solar radiation and the resultant unwanted build-up of heat inside the building. This protection is best achieved by shading the building's windows and other apertures. Shading the building facades and roof can also significantly reduce unwanted heat build-up, particularly when these elements are uninsulated. Shading the building envelope and apertures directly reduces the need for cooling: the potential of shading systems to reduce building cooling loads should not be under-estimated

2.2 Typology of shading Systems:

2.2.1 External Devices:

External devices are the most effective introducing heat gains because they intercept and dissipate (largely by convection) most of the heat in solar radiation before it reaches the building surface. However, they tend to be more expensive to install and maintain, and have a greater impact on the aesthetic character of the building

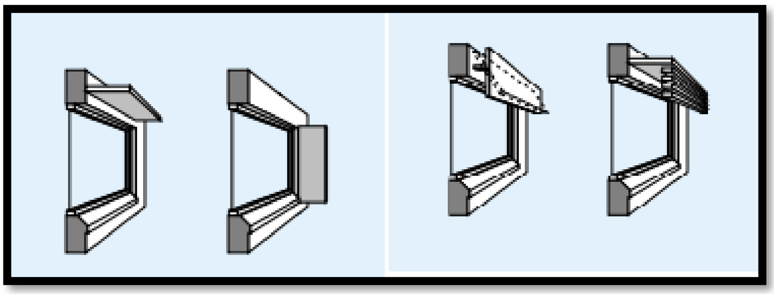


Figure 3:External shading devices (Solar shading for the European climates.ENERGIE.P.7)

2.2.2 Internal Devices:

Internal shading is almost always adjustable or retractable, and is typically in the form of roller or venetian blinds or curtains. It is easily adjusted and maintained, and can provide night-time blackout. It is also generally cheaper and is particularly effective at controlling diffuse and reflected light

2.2.3 Fixed Devices:

Fixed shading devices are usually external and highly visible and can provide important architectural opportunities. Typically, they are in the form of horizontal overhangs, vertical fins or egg-crate (combined horizontal and vertical) devices

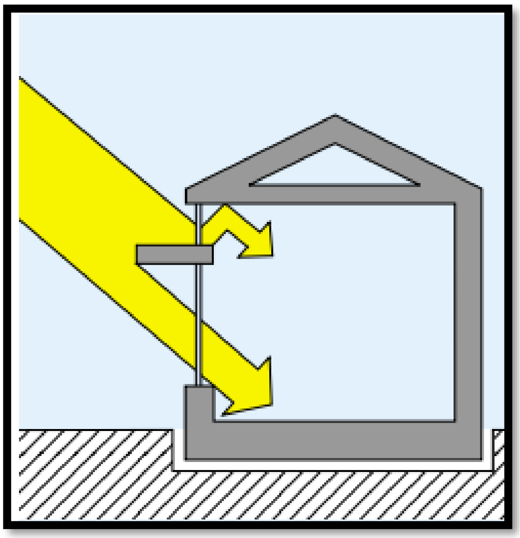


Figure 4:Fixed devices (Solar shading for the European climates.ENERGIE.P.8)

2.2.4 Adjustable Devices:

Adjustable and moveable shading devices can be located externally, internally or between the panes of a double or triple glazed window. Adjustability is most often found in internal shading systems, where manipulation is readily achievable and relatively inexpensive

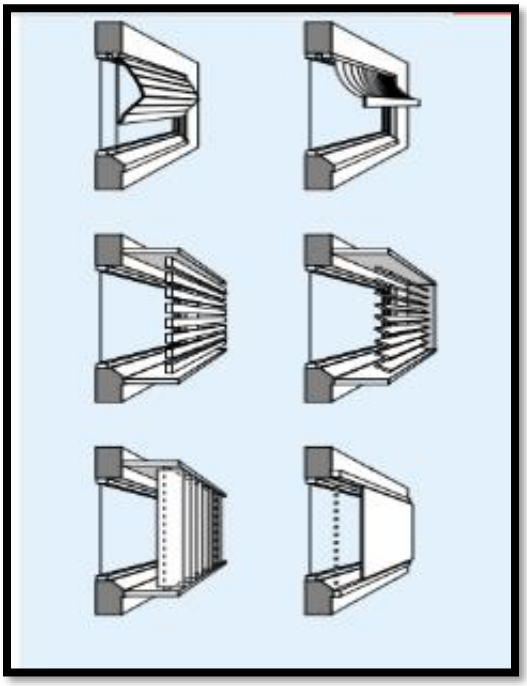


Figure 5:Adjustable external louvers (Solar shading for the European climates.ENERGIE.P.7)

2.2.5 Retractable Devices:

Retractable shading devices may be retracted to the upper or side portion of the window, or totally removed. Internal blinds and curtains fall under this category, as do external devices such as fabric awnings, louvres and shutters. These devices avoid the compromise between adequate shading in summer and adequate sun access in winter.

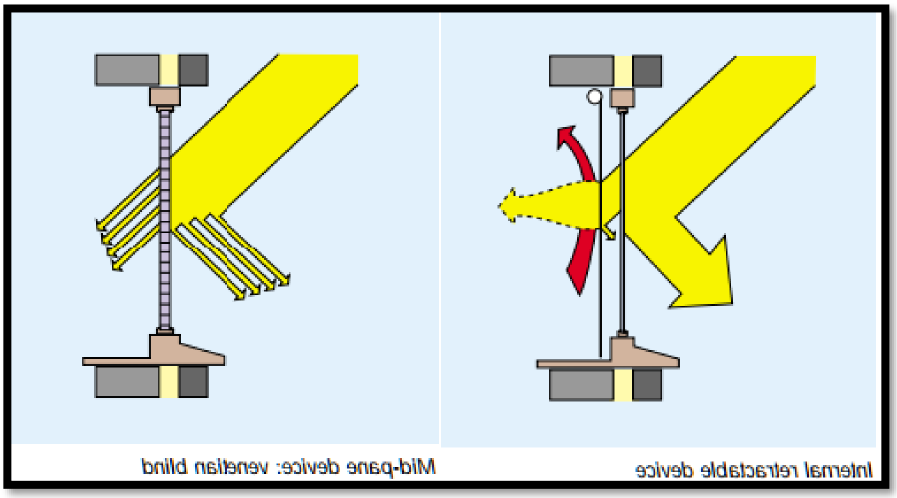


Figure 6: retractable device (Solar shading for the European climates.ENERGIE.P.9)

2.2.6 Mid-Pane Devices:

Mid-pane shading devices may be located between the panes of a double-glazed unitor, in some commercial buildings, within a curtain wall. Such devices, when accompanied by effective ventilation to the outside.

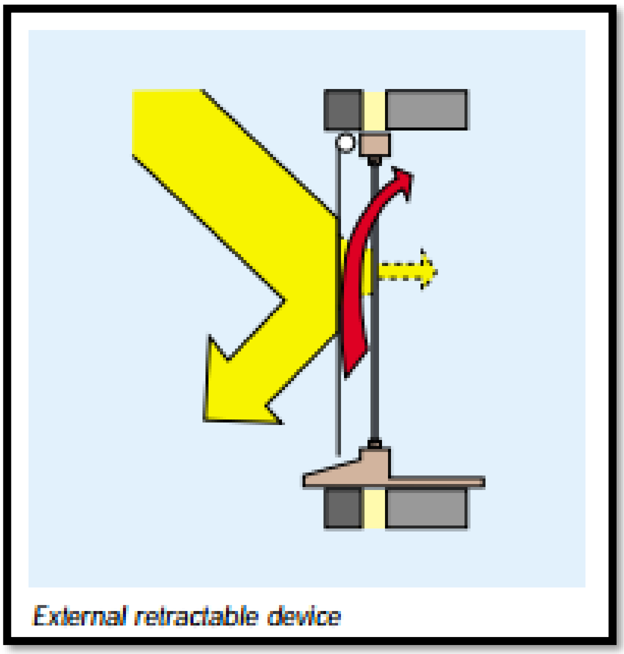


Figure 7:mid-pane device: venetian blind (Solar shading for the European climates.ENERGIE.P.9)

2.2.7 Vegetation:

Strategic planting of trees, shrubs and vines about a building and on structures such as pergolas and beam overhangs can, along with urban form, help to modify the microclimate. When correctly applied, the need for internal and external shading devices can be greatly reduced. Selective planting can shade not only windows another aperture but also whole facades and roofs, reducing conductive as well as radiative heat gains

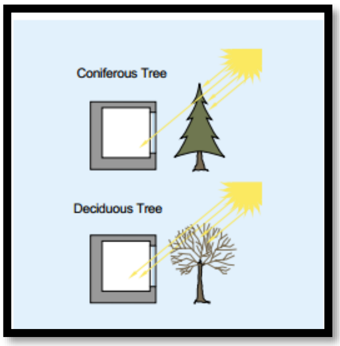


Figure 8: Vegetation (Solar shading for the European climates.ENERGIE.P.9)

2.2.8 Urban Morphology:

In regions experiencing hot summers, the built urban environment is often compact in layout. Streets are narrow and sometimes covered, partially or wholly, by fabric awnings and overhangs during the peak summer season, and shaded by neighbouring buildings at critical times.

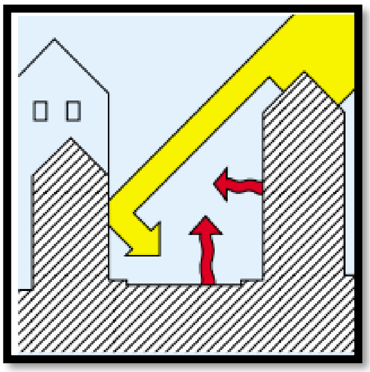


Figure 9:: Shading by neighboring buildings (Solar shading for the European climates.ENERGIE.P.10)

2.2.9 Advanced Glazing Systems:

All advanced glazing systems influence the passage of light and heat through glass in some way. Their performance is measured in terms of reflectance, absorptance, transmittance and emittance. Absorptance refers to the ability of an element to absorb solar radiation

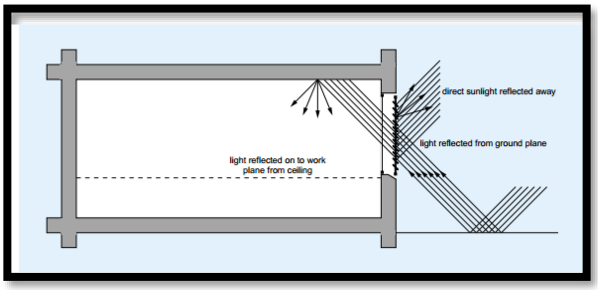


Figure 10: Reflecting glass:6mm (Solar shading for the European climates. ENERGIE.P11)

2.2.10 Combined Daylight & Shading Systems:

Light shelves, prismatic glazing and holographic louvres are advanced shading systems insofar as they redirect and redistribute light, thus serving a daylighting as well as a shading function. They are able to redirect sunlight deeper into a space, improving light uniformity.

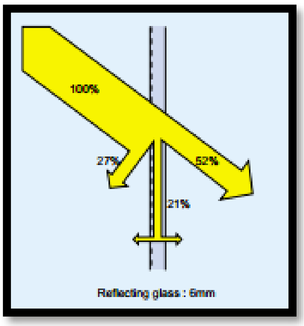


Figure 11: light redirection light self: prismatic glass (Solar shading for the European climates.ENERGIE.P.9)

2.3 Design consideration:

The design specifications of the shading device are a necessary part of the design's long-term performance:

- The application must be realistic and practical.
- All details must be improved, especially the design process and generation.
- The design may be extensively used
- It must also possess the function of home security
- It must include all facts relevant to product maintenance.
- The concepts may be improved in the future.

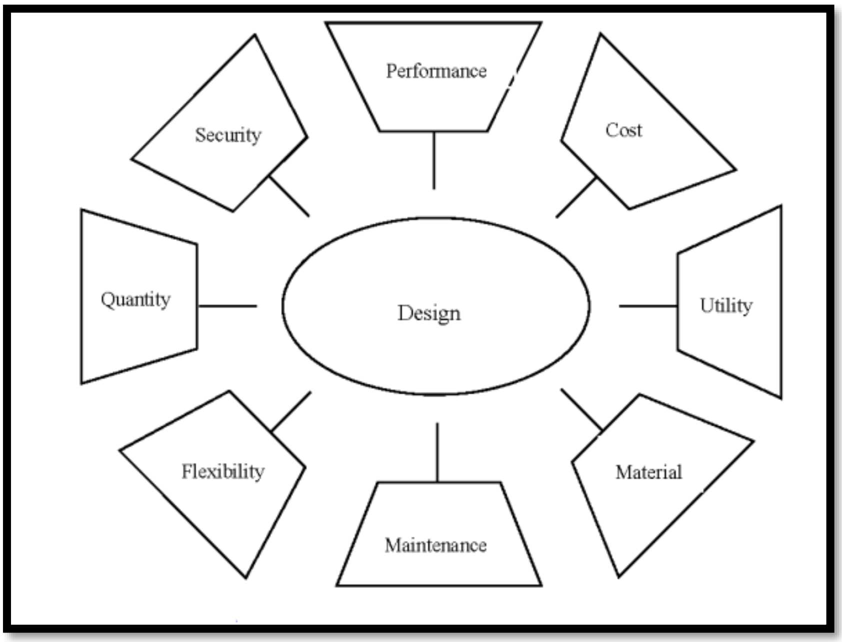


Figure 12: Design considerations of the shading device (Source: www.researchgate.net)

2.4 Techniques:

building form, layout and site design, solar control, microclimate design, thermal insulation, internal gain control, occupancy pattern, Control of solar radiation can be achieved through, shading devices, orientation and aperture geometry, control of solar-optical properties of opaque and transparent surfaces, urban design – shading by neighbouring buildings, vegetation – planting of trees, vines, shrubs.

2.5 Designing Shading Systems:

2.5.1 Solar Geometry:

Regarding solar geometry, all that is required of the designer is to understand the sun's apparent movement

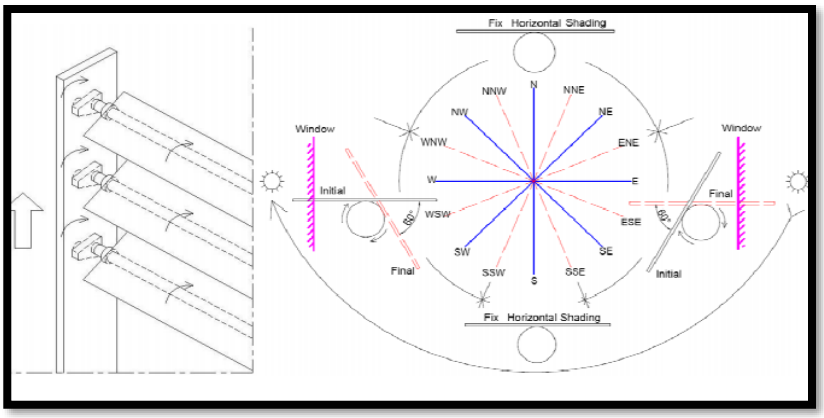


Figure 13: The driving and rotating mechanisms of blinds (Source: www.researchgate.net)

2.5.2 Solar Time:

Because of the human constructions of latitude, longitude and reference time zones, solar time does not equate directly with the local clock time of each time zone, and horizontal and Vertical Shadow Angles

2.5.3 Overshadowing:

The shadowing impact of neighbouring buildings can be assessed using sun-path diagram

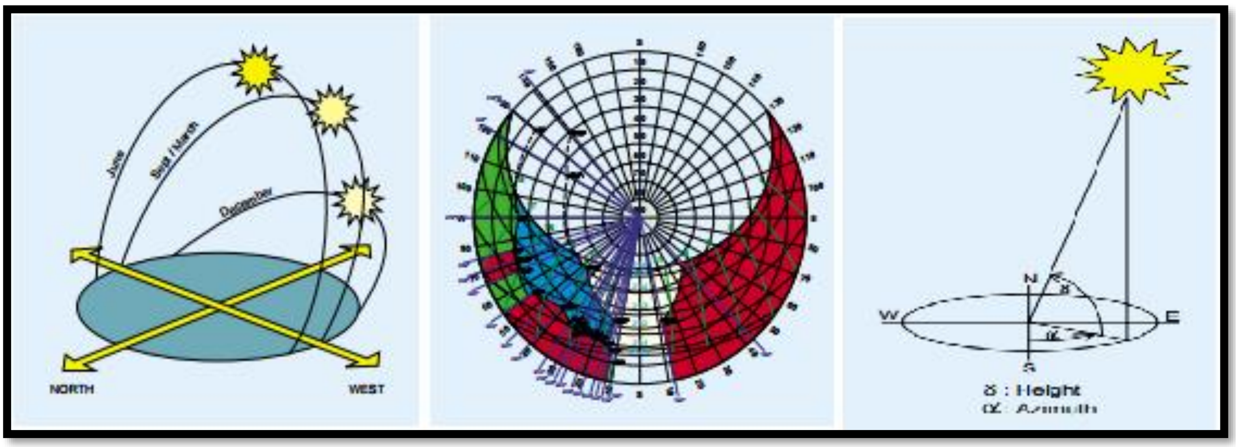


Figure 14: Example completed sun-path chart for over-shadowing use (Solar shading for the European climates.ENERGIE.P.14)

3 Architecture school:

Introduction:

Architecture schools and the students they house have a particularly unique and interesting building-user relationship. Architecture students value the buildings of their school not only for providing the valuable work space necessary for constructing studio projects but also as an example and model of a building in use. As the buildings are the places where students first learn how to read and understand architecture, design schools become full-scale teaching tools that help new designers grasp structure, details, how materials perform and interact, and so many of the other core concepts of architecture. While the scrutiny of students and faculty can be exhaustive, architects have embraced the challenge of creating engaging works of architecture that both suit the specific needs of a school and take on the pedagogical challenge of educating students by example

3.1 Definition of Education:

Education is a term that has several definitions:

Art of training a person, especially a child or adolescent, by developing their physical, intellectual and moral qualities, so as to enable him to face his life, personal and social with a sufficiently fulfilled personality, Initiation of a person to a field of knowledge, an activity or a discipline particular. Act of forming and enriching the mind of a person. A set of public services responsible for training young people and more. Particularly his intellectual training such as: primary, CEM, high schools, and higher education establishments, institutes….

3.2 Definition of hight education

Higher education includes all post-baccalaureate training. Two systems coexist:

An open system within universities: This is the system that welcomes the most of students. All high school graduates have the right to enter without prior selection. The training is very diversified;

A selective system with controlled reception capacity: Entry is by competitive examination, tests or file, possibly supplemented by an interview. This is the strength of the system especially in large schools (such as the National School of Administration, the National Superior School, engineering schools and of architecture), university institutes and university institutes professionalized. They mainly train senior and middle managers government and business.

3.3 Definition of architecture school:

Buildings for teaching and learning architecture are often part of a larger college or university campus, which requires them to comply with a school’s campus master plan and fit within a sometimes-homogeneous architectural context. Architecture schools are not typical academic buildings though—the demand for open studio space, critique spaces that accommodate large gatherings (but may not always be in use), and space for resources like a workshop or digital workrooms make flexibility an important factor for a successful architecture school.

3.4 Education and Architecture:

Among all other branches of education, Architecture has been such discipline that enables true manifestation of civilization. It is the art or practice of designing and constructing building. Landscape Architecture is the practice of designing the outdoor environment, especially designing parks or gardens together with buildings and roads. Urban, City, and town Planning integrates land use planning and transportation planning to improve the built, economic and social environments of communities. Regional planning deals with a still larger environment, at a less detailed level

3.5 History of school of architecture in Algeria

In 1881, an architectural studio was founded at the National School of Fine Arts in Algiers. Until 1940, programs, competitions, as well as judgments and awards depended on local patrons and juries. From 1940, the workshop became regional and became part of the École des beaux-arts de Paris. It is the only structure belonging to the French colonial empire to have been granted this status. While the evolution of architectural and urban thinking in Algiers during the French period has been the subject of much research, the history of the training of architects in this city has remained unexplored. This thesis therefore unveils the existing veil around the educational model developed in Algeria. It examines in particular the period between 1909 and 1962. These chronological boundaries correspond both to a better documented period and to two important moments for the architectural institution. In fact, the year 1909 marked the appointment of the first French architect born in Algeria to head the architectural workshop. This advent is the starting point for a more structured and better organized teaching of architecture. As for the year 1962, it marks the end of the French presence in Algeria and the birth of the Algerian school.

3.6 Activities in architecture school:

- drawing and painting: graphic design
- art and sculpture
- media studies: video and film
- furniture and interior design
- photography
- Schedule of accommodation including:
- design studio and display areas
- technical workshop(s)
- admin office
- storage

Conclusion

In this chapter, we have studied the theoretical approach which presents thermal comfort parameters affecting human thermal comfort and shading devices that perform the double role of protection against solar radiation and redistribution of available daylight. Furthermore, we look at the different types of shading systems, such as external, internal, seasonal, fixed or moveable. Finally, we studied the literary part of the project (school of architecture / education).

CHAPTER II : ANALYTICAL STUDY

Introduction

In Algeria, more than 8 million young people, representing more than a quarter of the global population, are in the benches of schools, colleges, high schools and universities. These young people study for at least 9 years,5 days a week and 8 hours a day in a classrooms and workshops, to understand and comprehend school of architecture, analysing different examples with variety of ideas and reflections throw several aspects is needed for our conception, however ,the require of site analysis and climate characteristic is necessary for a good project adaptation on its environment, and also passing to the programming throw the examples by elaborating the needed spaces and its surface .finally, we choose Ecotect for the simulation calculation to test the thermal comfort in spaces.

1 Examples analysis

Technical sheet for the examples analysed:

Melbourne School of Design University of Melbourne / NADAAA + John Wardle Architects	
location	Parkville, Victoria
Architect	Team JWA and NADAAA in collaboration
Opening year	2014
Floor area	15,772 sqm

Table 2: Technical sheet of example 01

McEwen School of Architecture LGA Architectural Partners	
location	SUDBURY, CANADA
Architect	LGA Architectural Partners
Opening year	2018
Floor area	6767.8 ft2

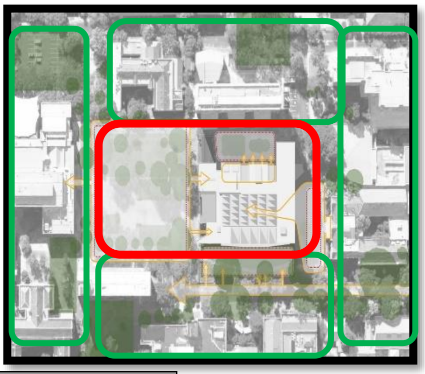
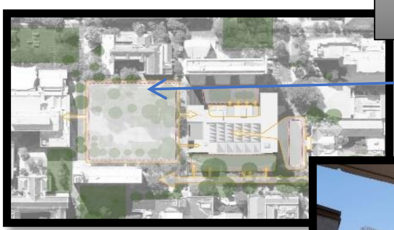
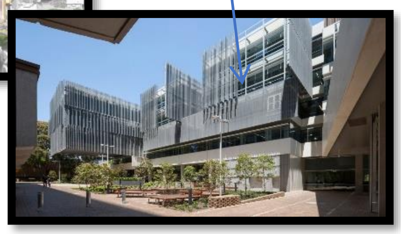
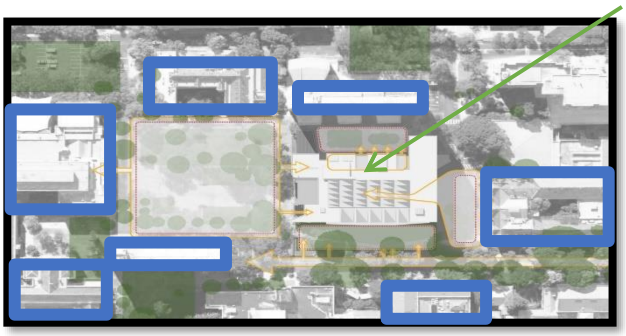
Table 5: Technical sheet of example 02

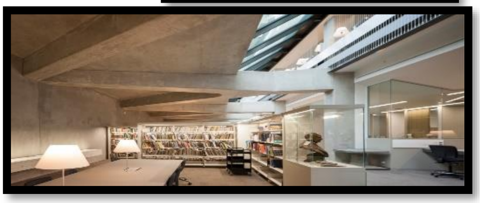
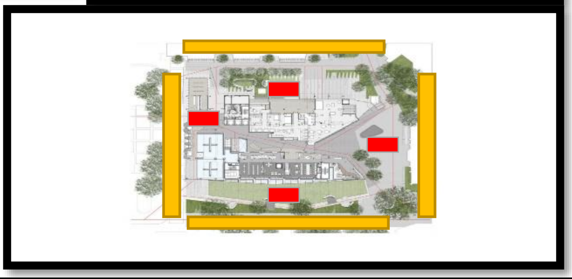
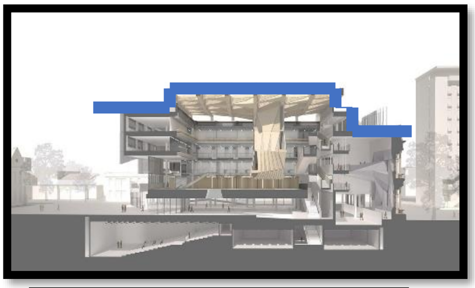
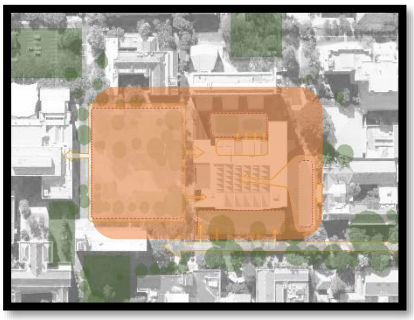
Porto School of Architecture	
location	Via Panorâmica, Porto, Portugal
Architect	Alvaro Siza
Opening year	1996
Floor area	12,074 sqm

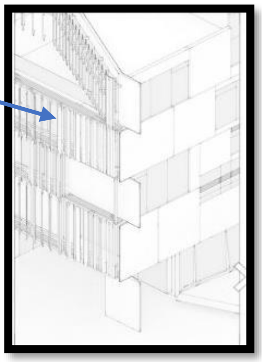
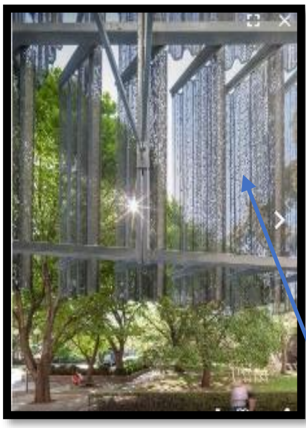
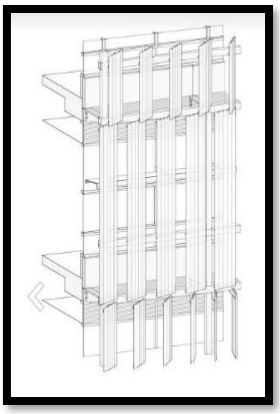
Table 4: Technical sheet of example 03

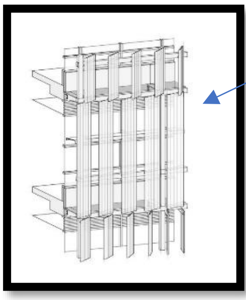
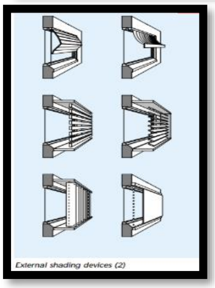
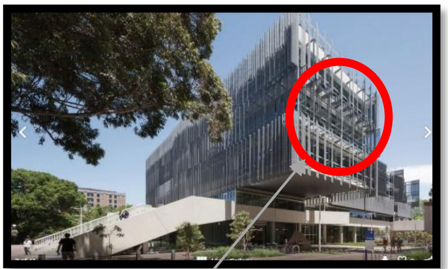
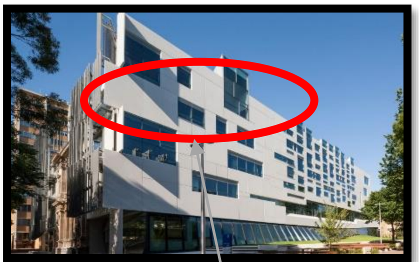
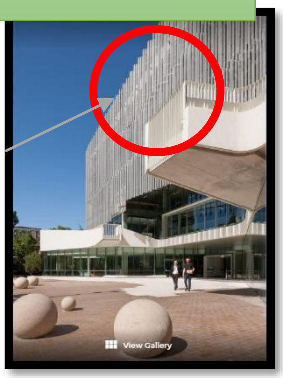
Polytechnic School of Architecture and urbanism	
location	Oued Smar.Alger
Architect	Oscar Niemeyer
Opening year	1970
Floor area	15.234 sqm

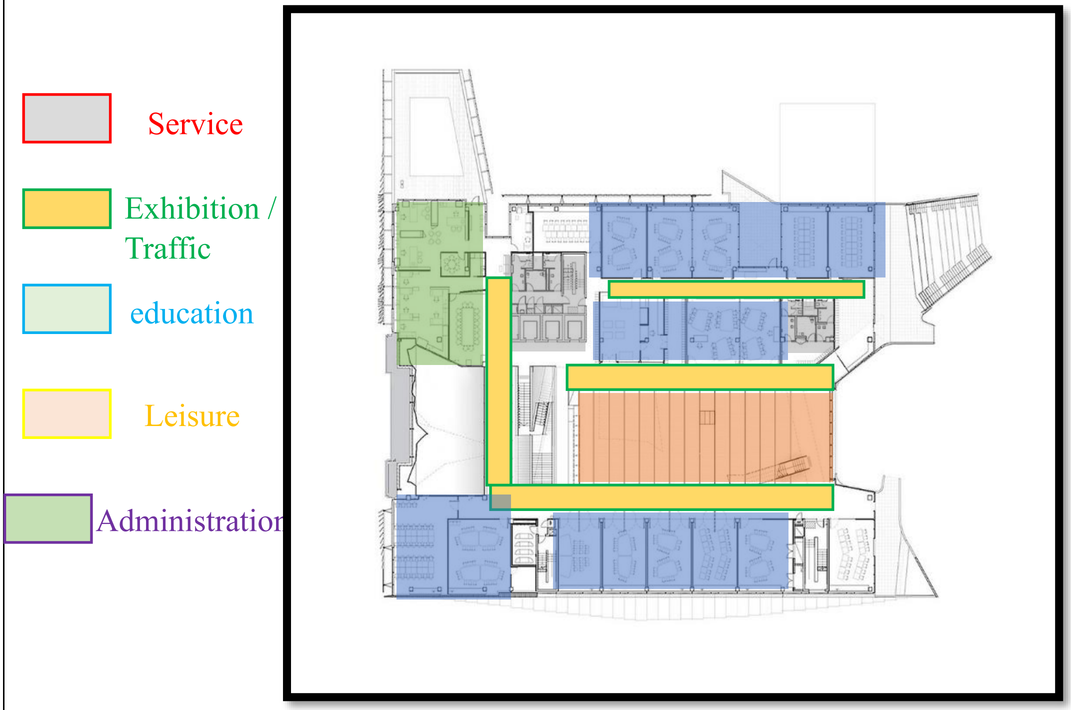
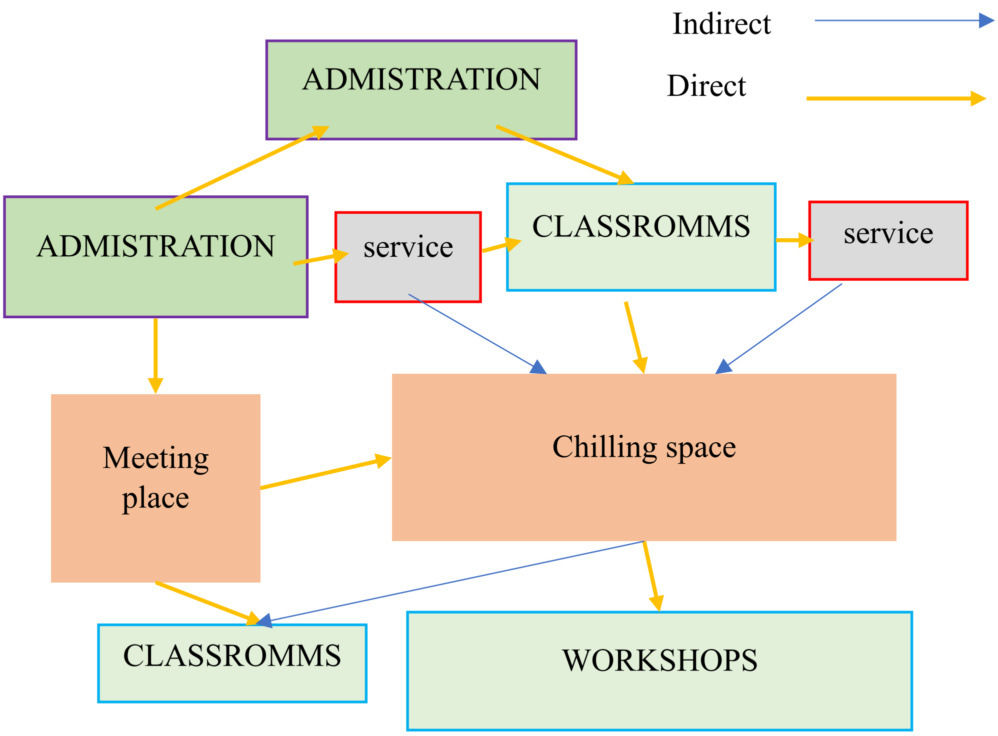
Table 3: Technical sheet of example 04

	Project: Melbourne School of Design University of Melbourne / NADAAA + John Wardle Architects (source: www.archdaily.com)
Far-away environment / city level	**Urban and Natural:**  The idea of what architecture can give back to the community also works at the scale of the
Integration / contrast	The building design meets its briefed **Integration**   The volumetric shape fits the urban area
Structuring or structured role:	the school. Connecting back into the network of buildings and courtyards **Structured**  ➢ Follows the peripheral shapes

Report, inside / outside	 PUBLIC  *SEMI PUBLIC* PRIVA 
Accessibility	  Mechanical access Pedestrian access 
Order and hierarchy	 the project is not in the same level it is hierarchy  Compact project

Order of facades	Prefabricated panels  Trancparency  **Use of metal + glass**
Shading system	Parametric modelling was adopted to assist in the design of the folded perforated zinc solar screens to the east, north and west facades.     Key parameters such as achieving the optimum Visual Light Transmittance and sun shading while responding to sightlines to a variety of surrounding vistas influenced the design outcome of the external

	 Eternal Devices  reducing heat gains   have a greater impact on the aesthetic character of the building intercept and dissipate) most of the heat in solar radiation
	 North façade the devices are more open they provide more lightning and heating  south façade there is no shading system but their periphery buildings with high elevation  Eastern and western façade the devices are closer they provide less lightning and heating 

Zoning	
Space relationship	

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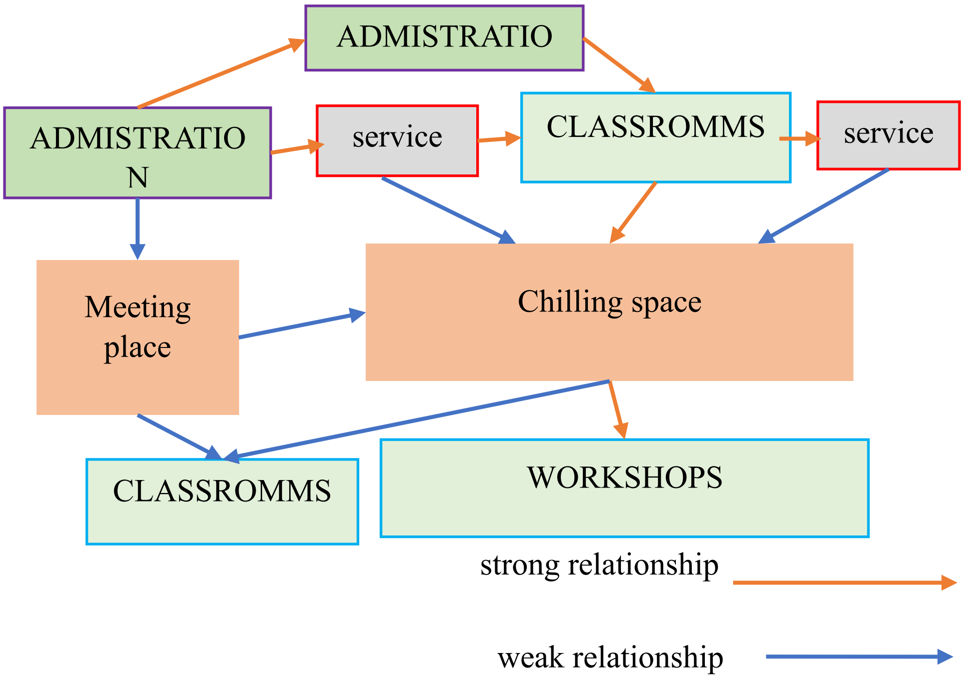

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<td>Ambience</td>
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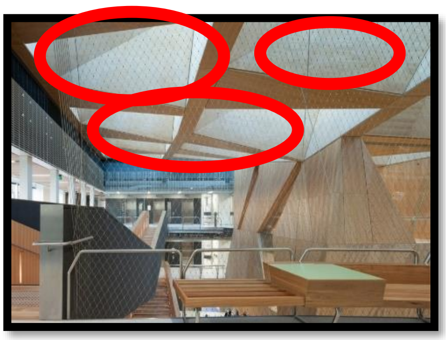
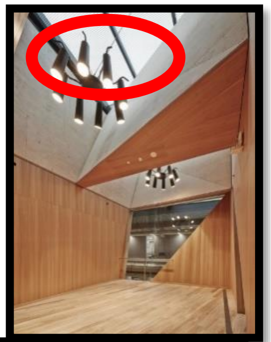
Natural Lighting

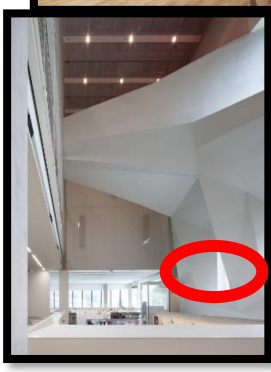
The Studio Hall is enclosed by a coffered timber roof that mediates natural daylight and assists natural ventilation

Zenith Lighting





the builder turned to three dimensional and creative Ultra Frame lightweight solution.



Light colors

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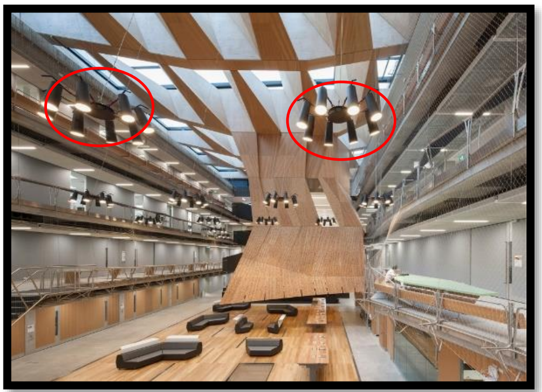
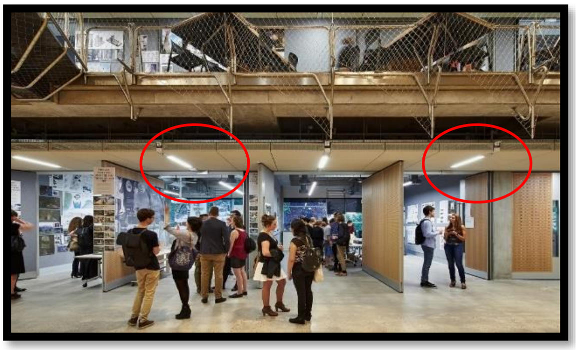
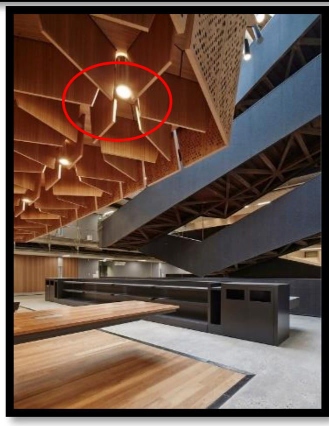
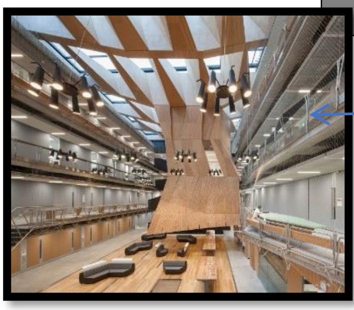
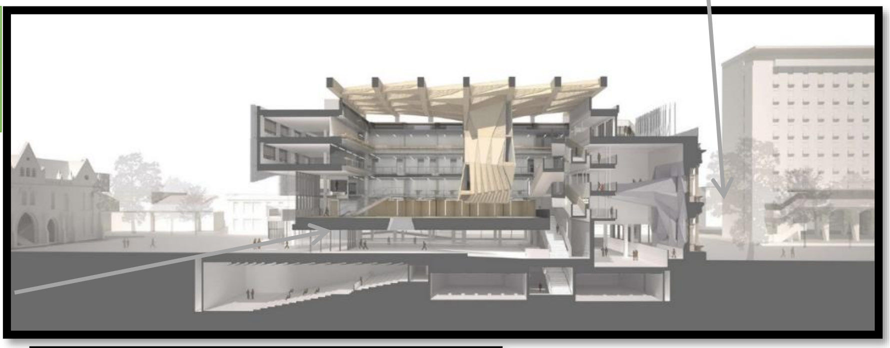
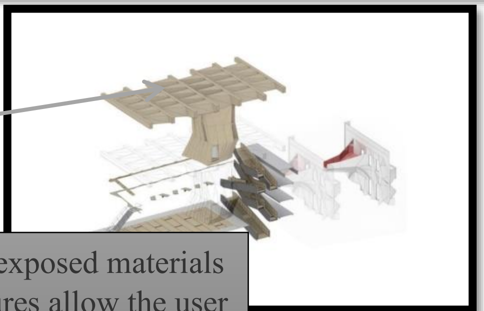
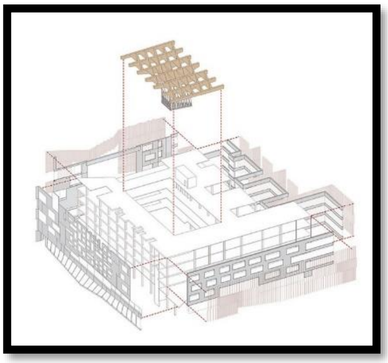
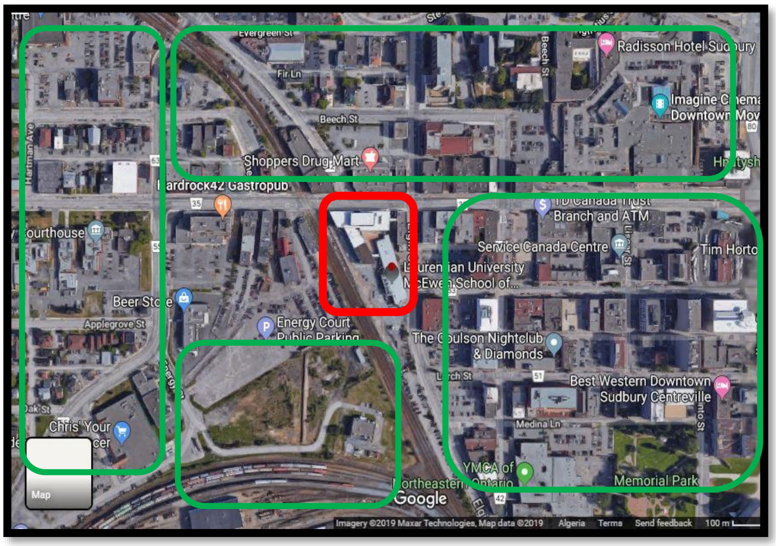
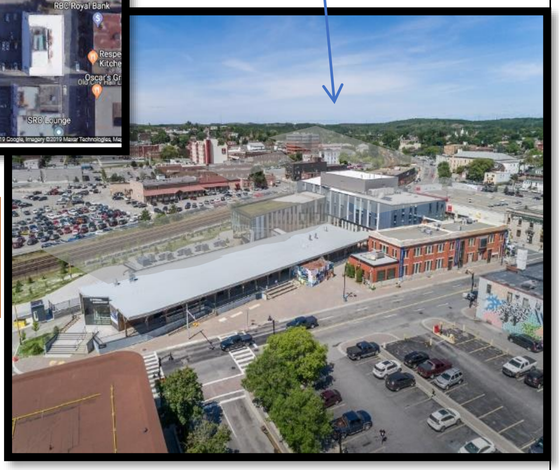
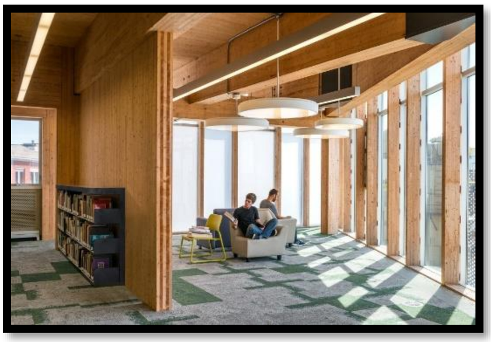
	Artificial Lighting    
Envelope and material	The inner envelope unique sense of visibility in the building with features such as the mesh balustrade and open-top gallery, allowing for further transparency between floors  Paint, wood, metal,    The transparency of the building supports the vision of a living/learning building. Carefully exposed materials and structures

	The outer envelope Printed glass, reinforced concrete, metal, wood  
The structure	Mixed structure Sailing wall Concrete slab  Wood frame   Carefully exposed materials and structures allow the user insight into the minds of the designers and the

	McEwen School of Architecture LGA Architectural Partners (source: www.archdaily.com)
Far-away environment / city level	Far-away environment / **Project** **Urban**  The school functions as a catalyst for urban regeneration and as an educational hub for the region in addition to serving as a teaching laboratory for the advancement of sustainable, community-based design in northern climates.
Integration / contrast	 **Integration**  The volumetric shape fits the urban area

Structuring or structured role:	Construction was phased over several years and began with the renovation of the two heritage buildings so that the school could open while the second phase of construction proceeded on the two new wings **structured**  **The project** ➢ **Follows the peripheral shapes**
Report, inside / outside	  ***SEMI PUBLIC*** **PUBLIC** **PRIVATE** 

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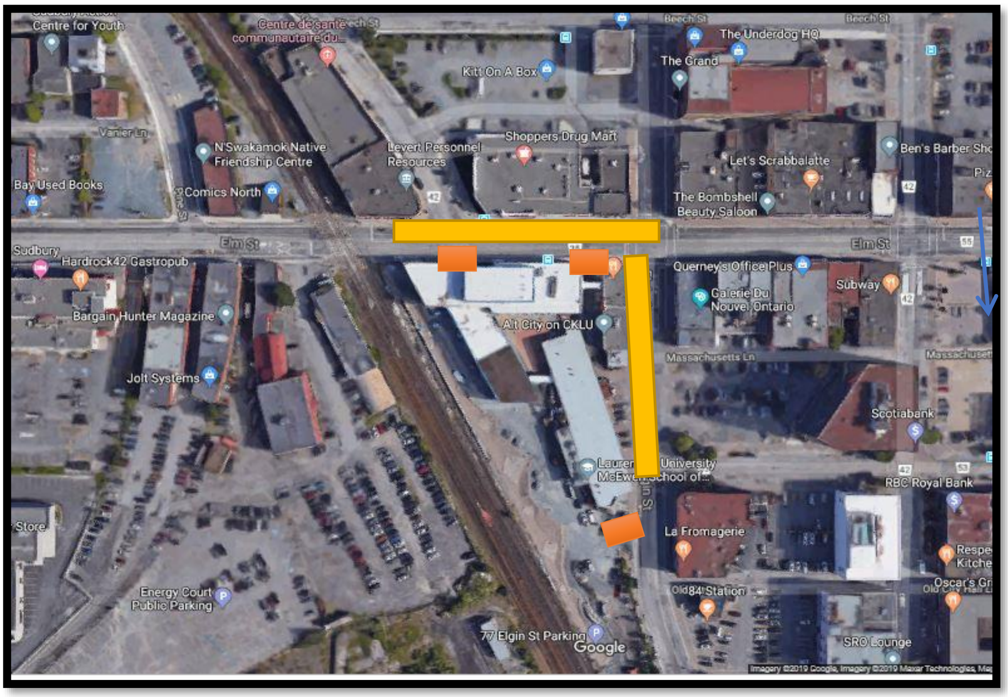
Accessibility



Mechanical access   Pedestrian access

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<td>Order and hierarchy</td>
<td>

Hierarchy:

the project is not in the same level it is hierarchy

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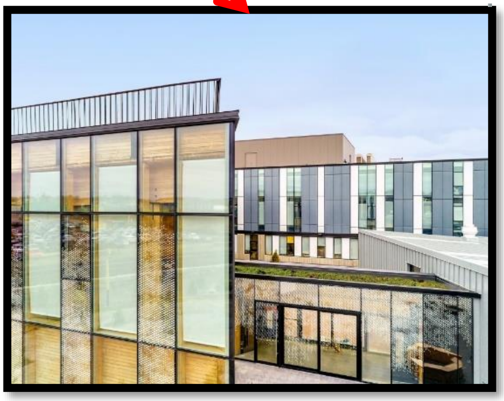
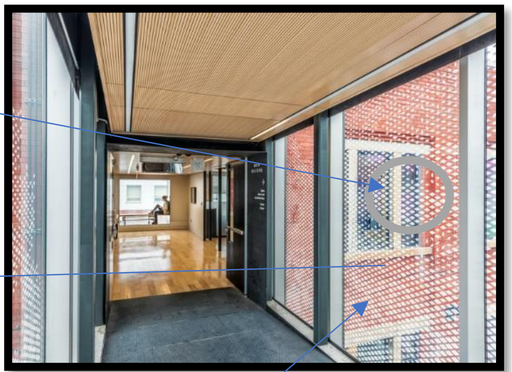
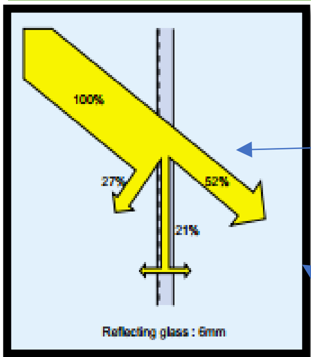
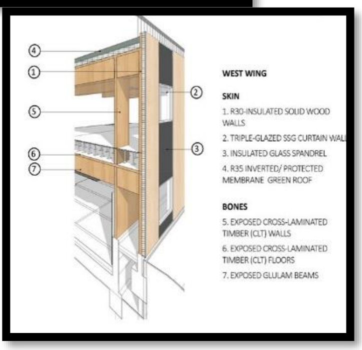
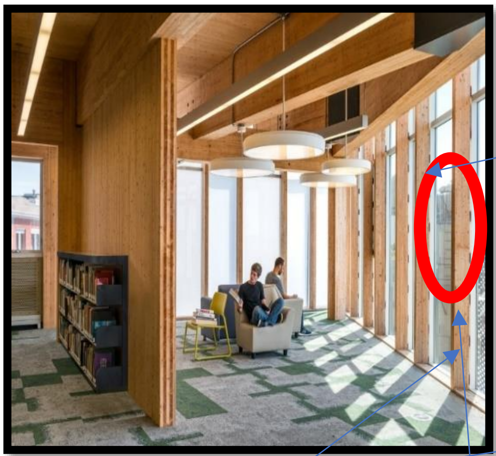
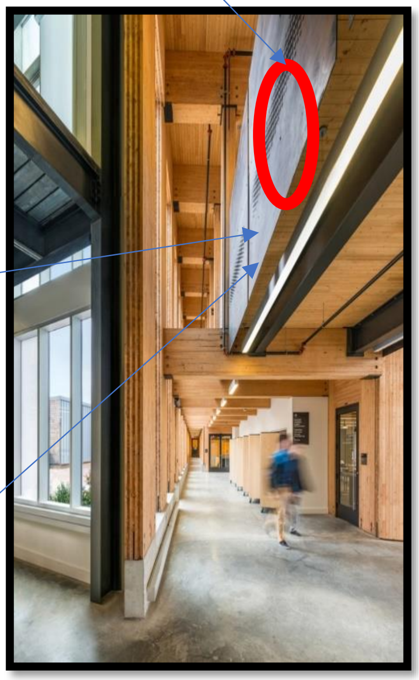
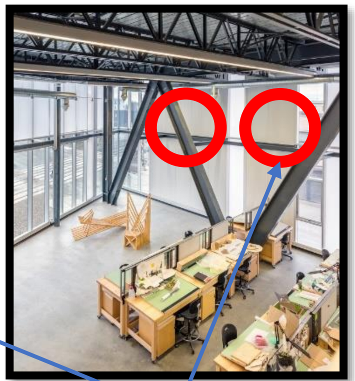
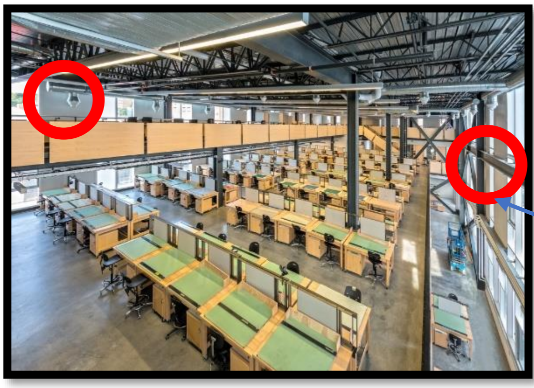
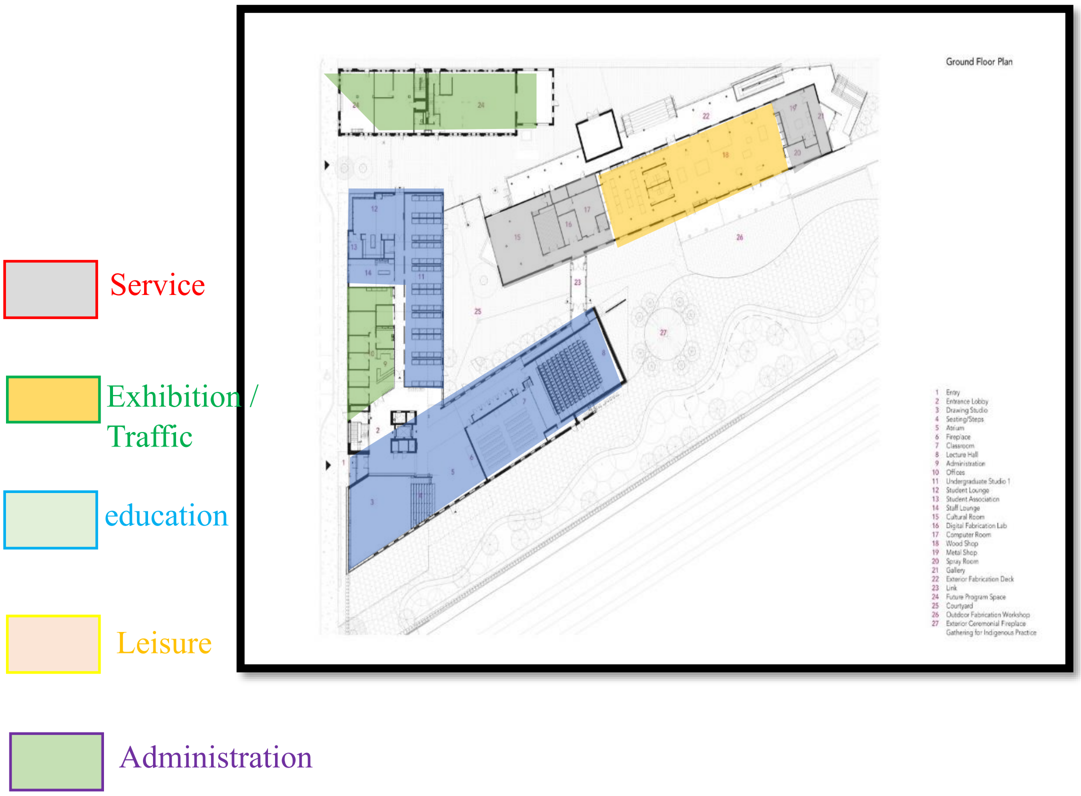
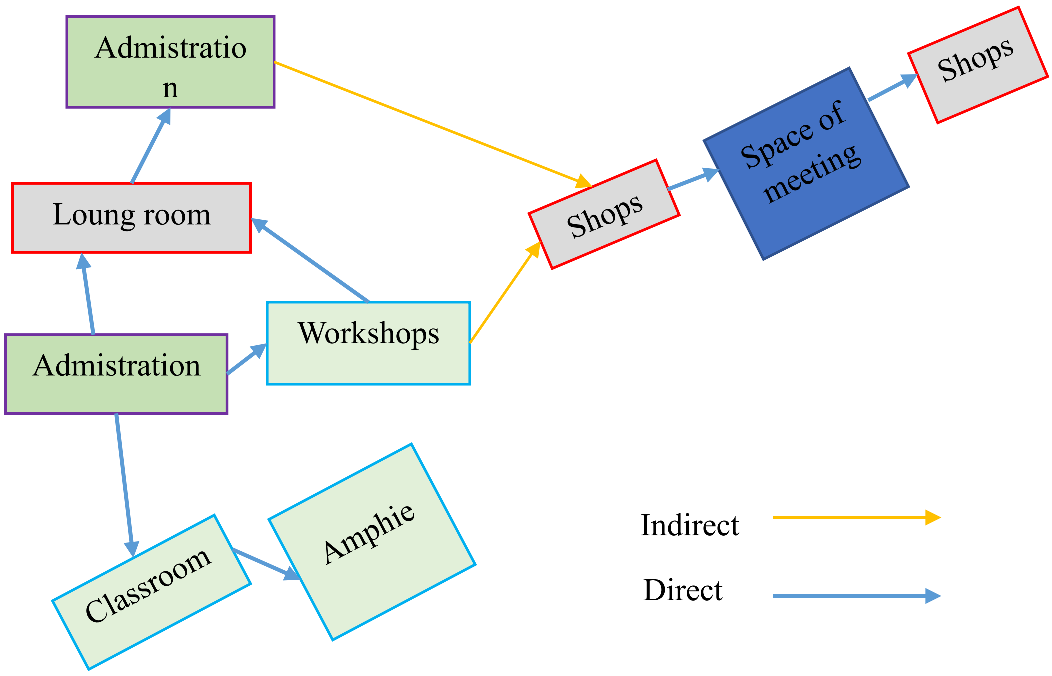
Order of facades	Order of facades Prefabricated panels  trancparency   Use of wood + glass
Shading system	**Advanced Glazing Systems**    advanced glazing systems influence the passage of light and heat through glass in some way. Their performance is measured in terms of reflectance, absorptance, transmittance and emittance

	 **Internel retractable Devices**  These devices avoid the compromise between adequate shading in summer and adequate sun access in winter. They are able to redirect sunlight
	  **Adjustable Devices**  Adjustability is most often found in internal shading systems, where manipulation is readily achievable and relatively inexpensive

Zoning	
Space relationship	

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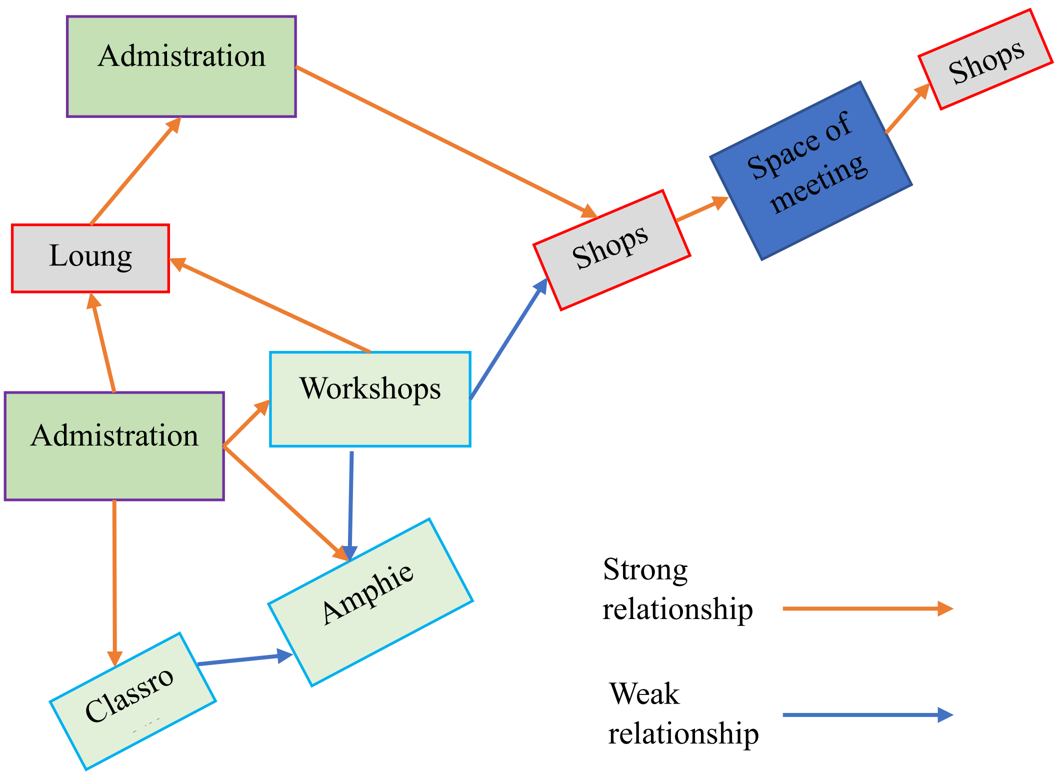
<td>
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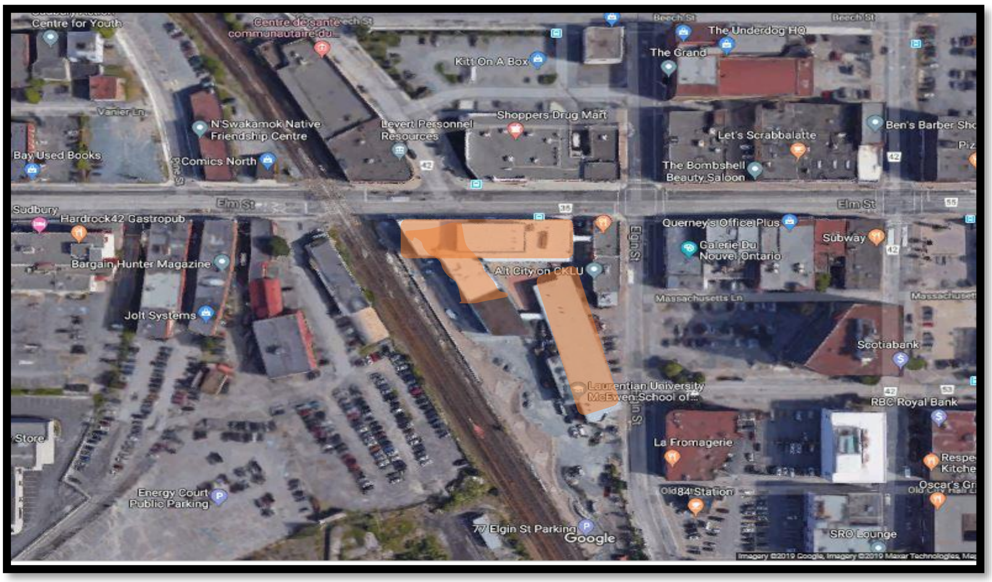
<td>Order</td>
<td>The architects chose to design the school as a didactic instrument, with exposed structure in each of its varied parts. It comprises two

Mass scheduling



Project not Compact</td>
</tr>
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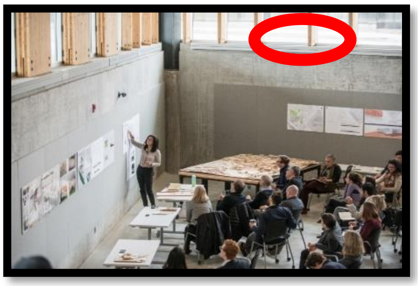
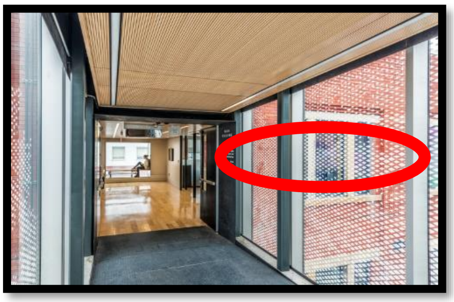
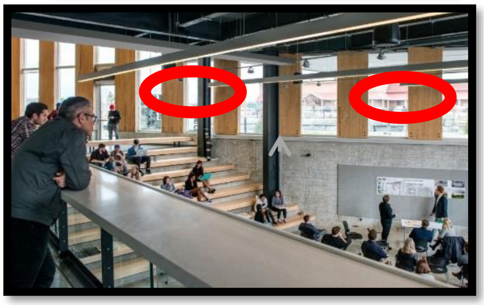
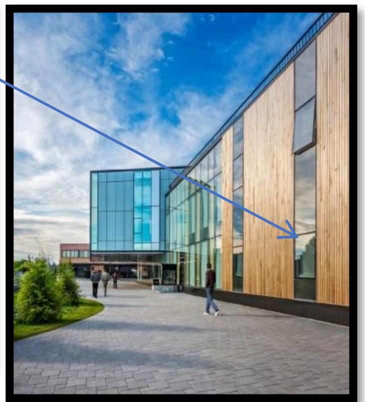
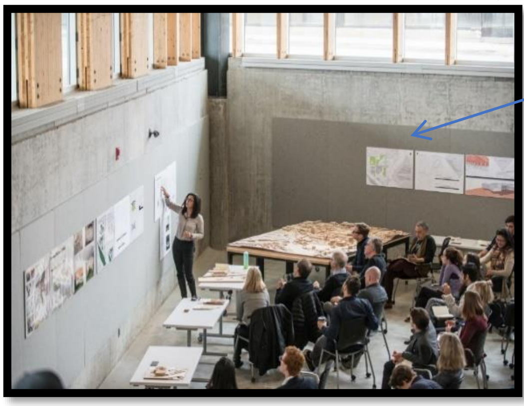
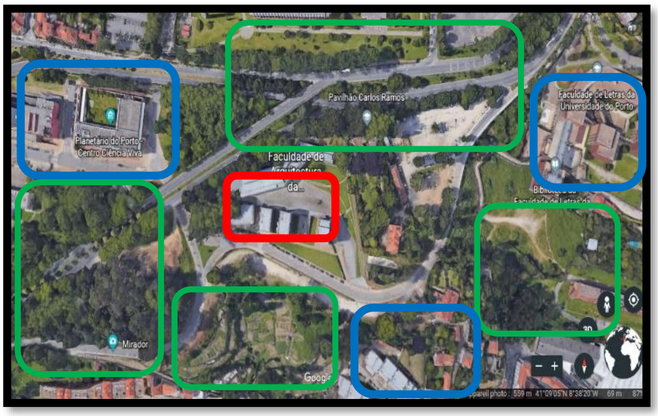
Ambience	**Natural Lighting** Also central to the realization of this outcome are the building's strategic orientation of glazing for abundant natural light and maximum solar gain for warmth in winter,     **Light colors**
Envelope and material	The outer These were developed with a "skin and bones" construction system,   a panelized "skin" offered efficient assembly with minimal waste, from materials that capture sun heat in the winter and passive ventilation in the summer and "bones" from simple, large-span structural systems, (steel and wood respectively) that allow for highly flexible, open-plan interior

	The inner envelope → Paint. wood. metal. concrete   
The structure	**The structure** → **Mixed structure** **Mixt Metal structure**   

<table>
<tr><td></td><td>Porto School of Architecture
(source: en.wikiarquitectura.com)</td></tr>
<tr><td>Far-away environment / city level</td><td>1.1 Far-away

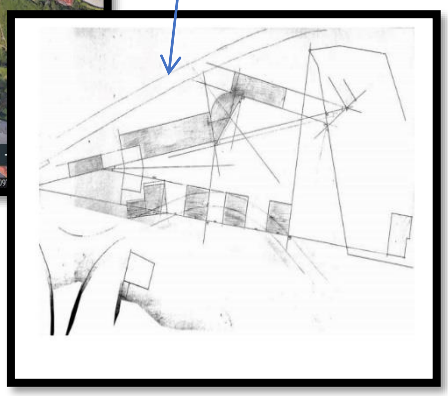
Urban and Natural :

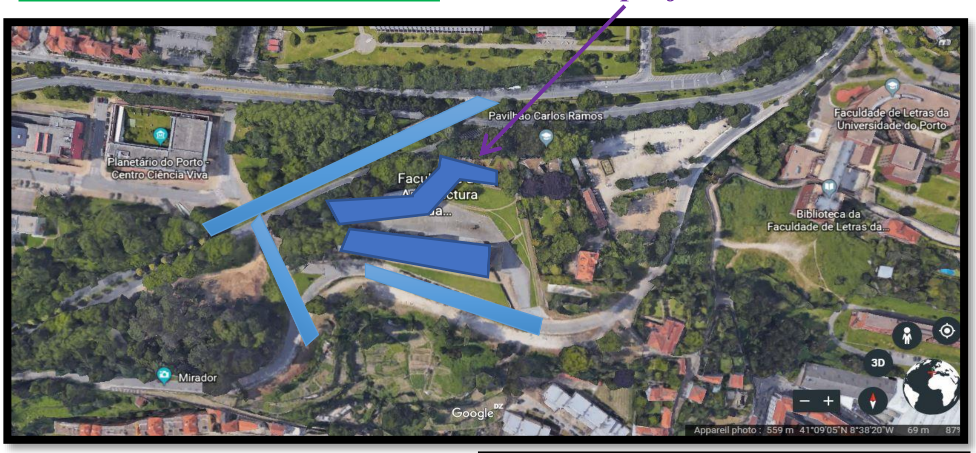
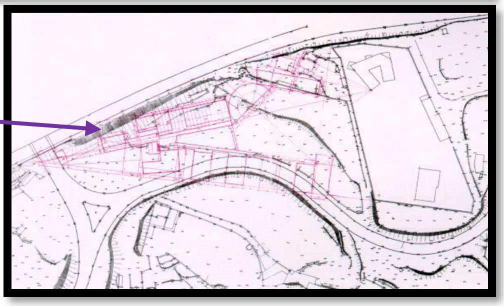
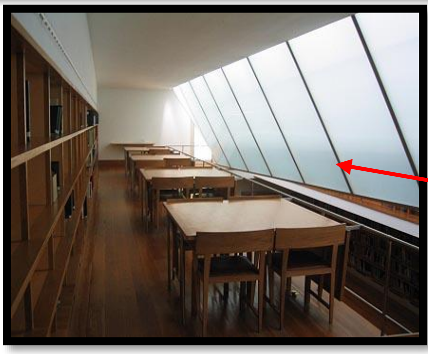
Project
Urban
natural


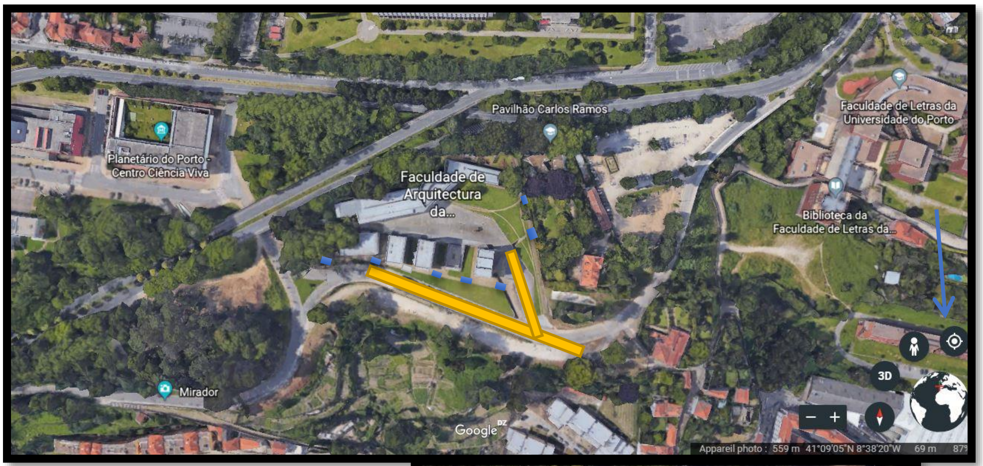
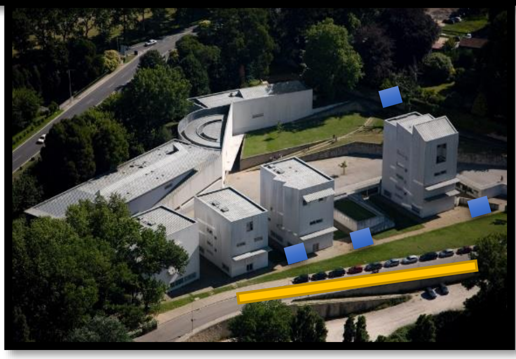
It is a space being on the banks of the Duero River presents a landscape and a remarkable vegetation.

Being located in the middle of the access to the Porto-Lisbon motorway is given an intermediate and peripheral character.</td></tr>
<tr><td>Integration / contrast</td><td>**Integration / contrast:**

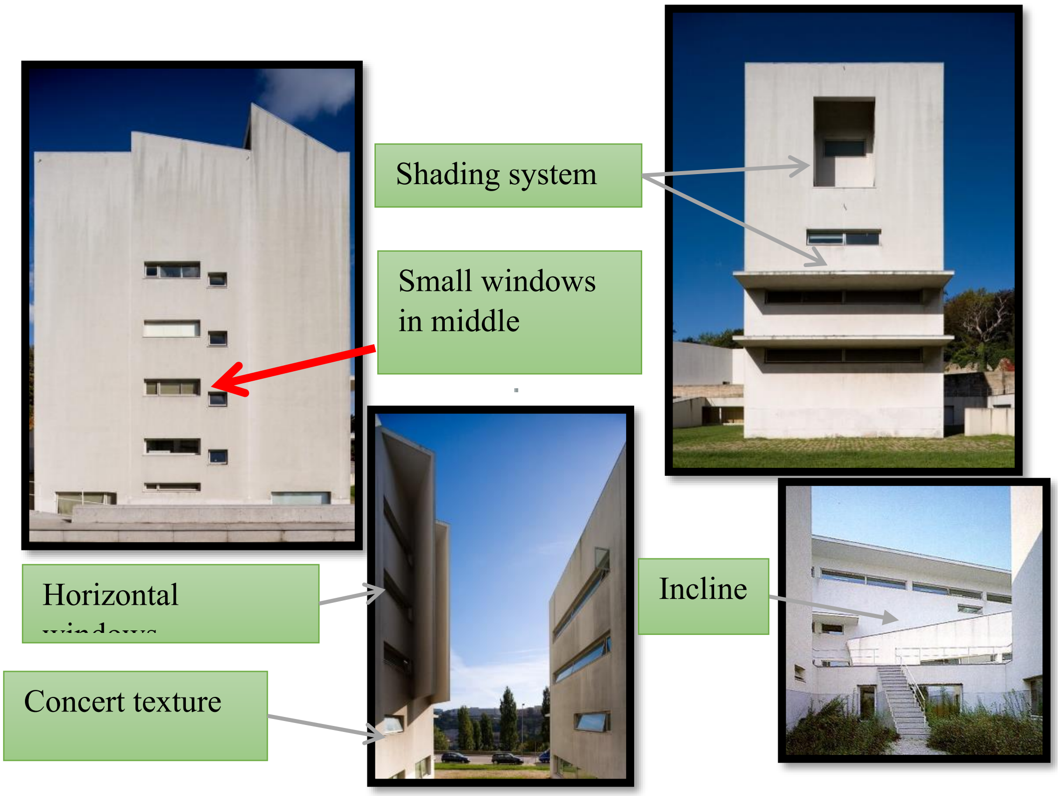
the site, on the south side volumes are exempt and follow a rhythmic separation opening to the river. On the north side they are continuous, thereby creating a backdrop that serves as acoustic and visual barrier facing the highway.


Integration

The volumetric shape fits the urban area</td></tr>
</table>

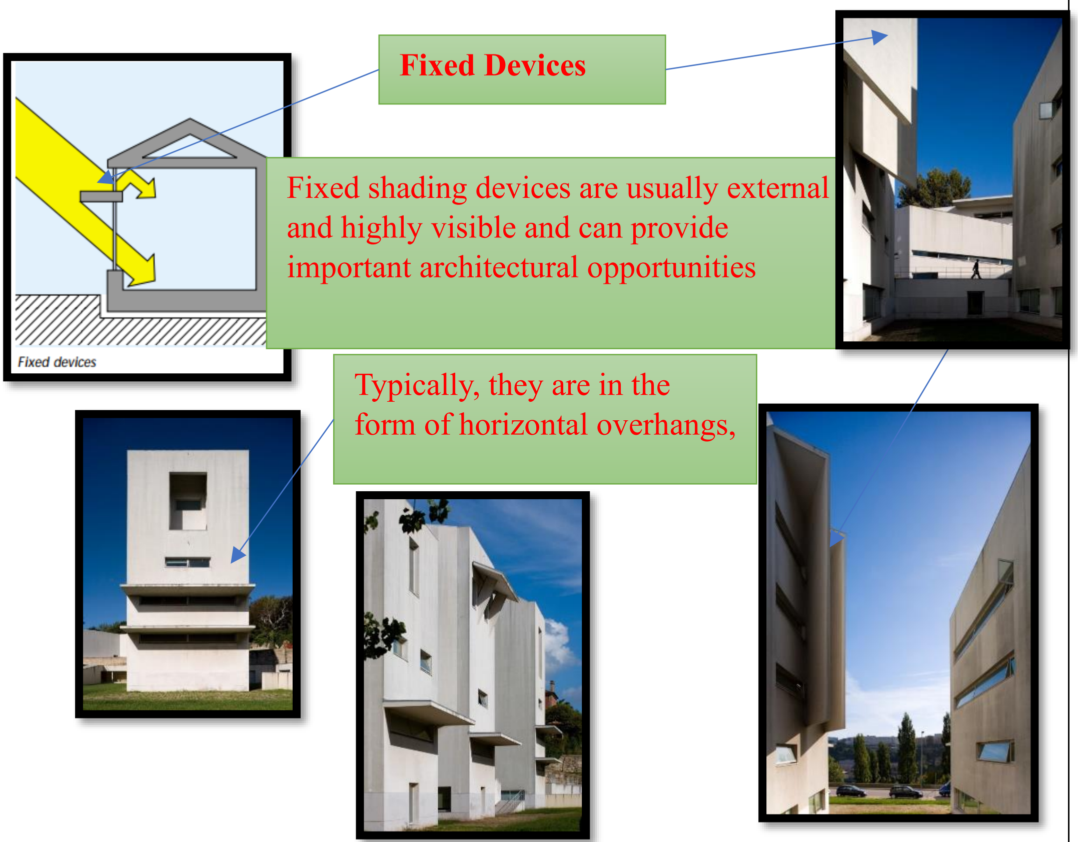
Structuring or structured role:	**Structuring or structured role:** **The project**  **Structured**  ➢ Follows the peripheral shapes
Report, inside / outside	**PUBLIC**    **PRIVATE** ***SEMI PUBLIC***

Accessibility	  Mechanical access Pedestrian access
Order	Mass scheduling The whole school of architecture is made up of 10 pavilions V-shaped and U surrounding a central plaza. These buildings are connected to each other, in some cases by more than one point Project not compact 

Order of facades

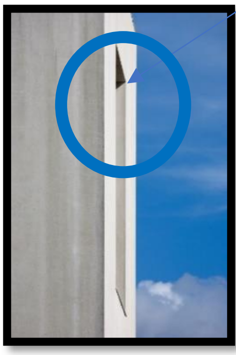


Shading system



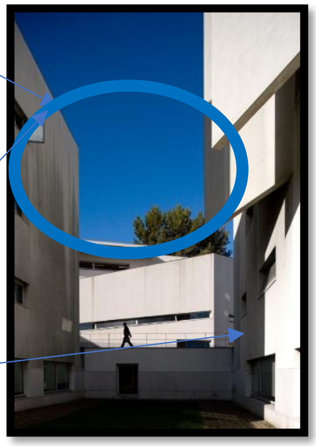
Retractable Devices

Retractable shading devices may be retracted to the upper or side portion of the window



Urban Morphology

the built urban environment is often compact in layout



shaded by neighbouring buildings at critical times.

Zoning

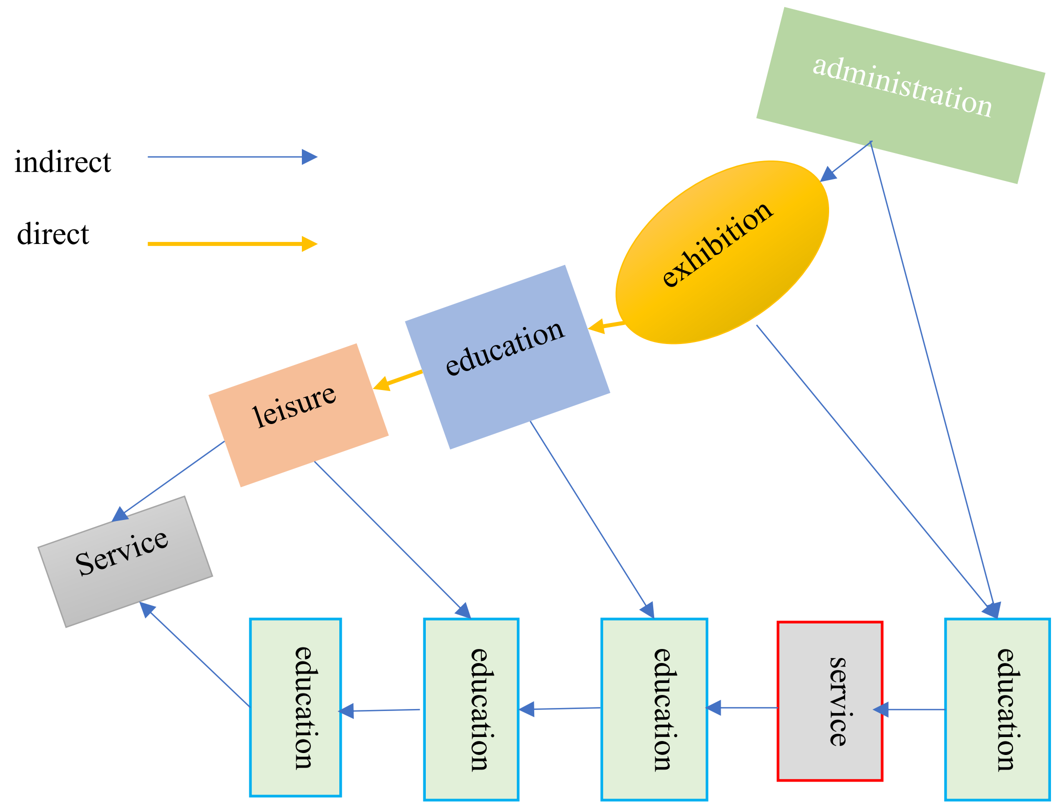
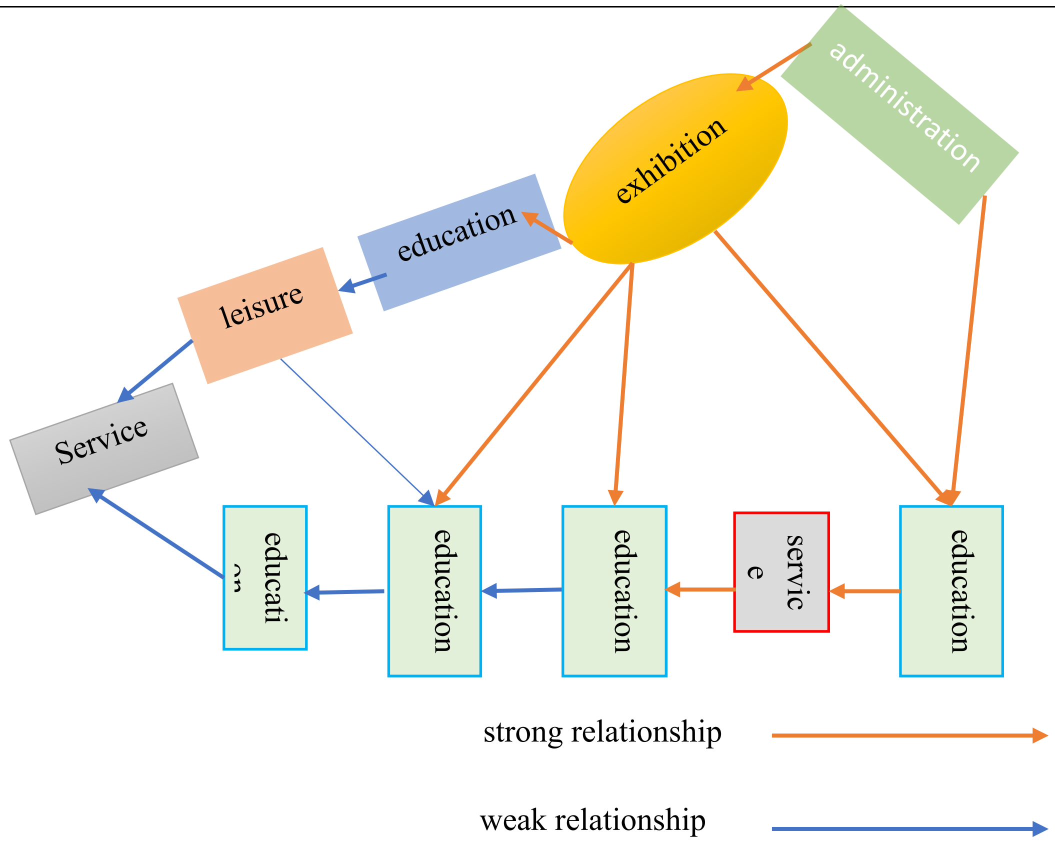
Servic

Exhibition / Traffic

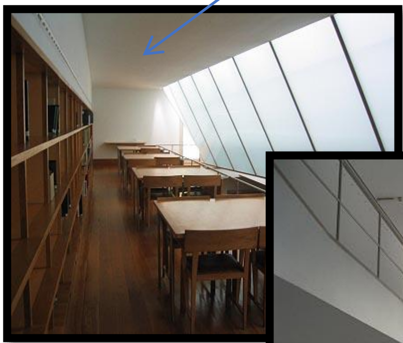
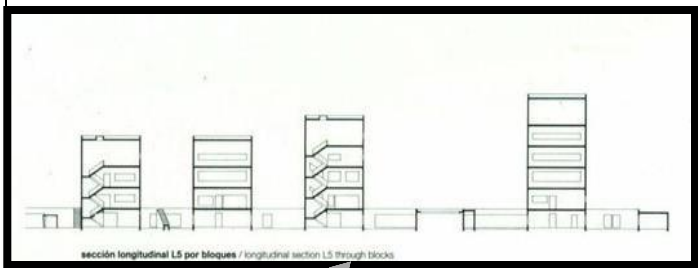
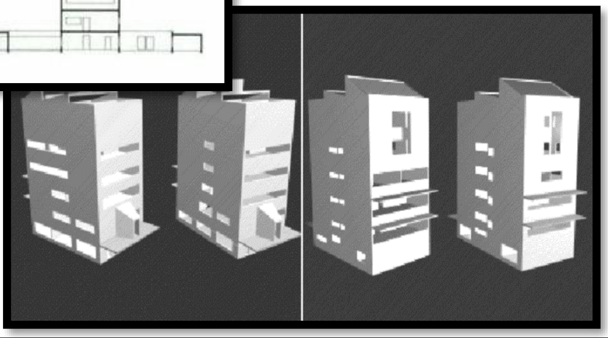
education

Leisure

Administration

Space relationship	
Functional relationship	

Ambience	The materials used inside the newest addition include exotic wood for the floors and paneling, marble foyers and stairs, specially designed furniture for the classrooms, auditorium and library, and skylights which draw natural light into the spaces main.     
Envelope and material	The outer envelope → concrete, vegetation, aluminum   

Order of facades	The inner envelope The slabs of plants, also of reinforced concrete, are solid plates allow armed cross with bidirectional resistance thin, large clearances. Paint, wood, metal,.glass   
The structure	**Sailing wall** **Sailing** Siza webs used for reinforced concrete structures in some cases function as vertical or horizontal beams, essentially in the large openings in the walls and cantilevers, since these are rare as the presence of pillars.   **Concrete slab** 

<table>
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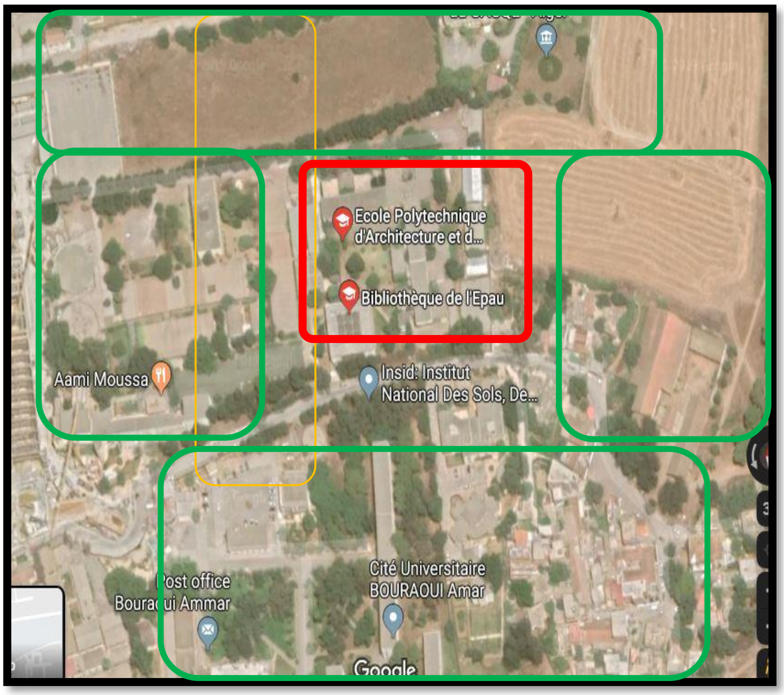
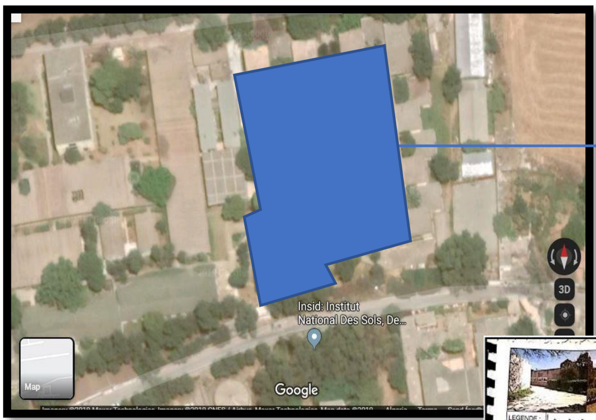
<td>Far-away environment / city level</td>
<td>
Polytechnic School of Architecture and urbanism, Alger

Urban and Natural:

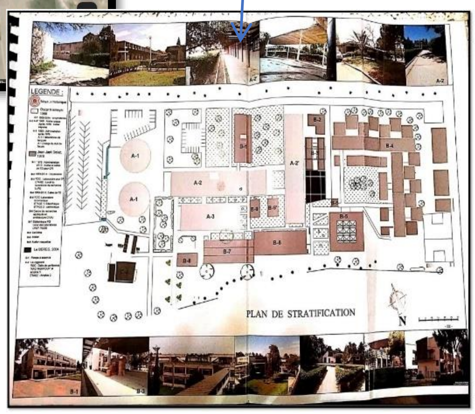
Project

Natural



</td>
</tr>
<tr>
<td>Integration / contrast</td>
<td>


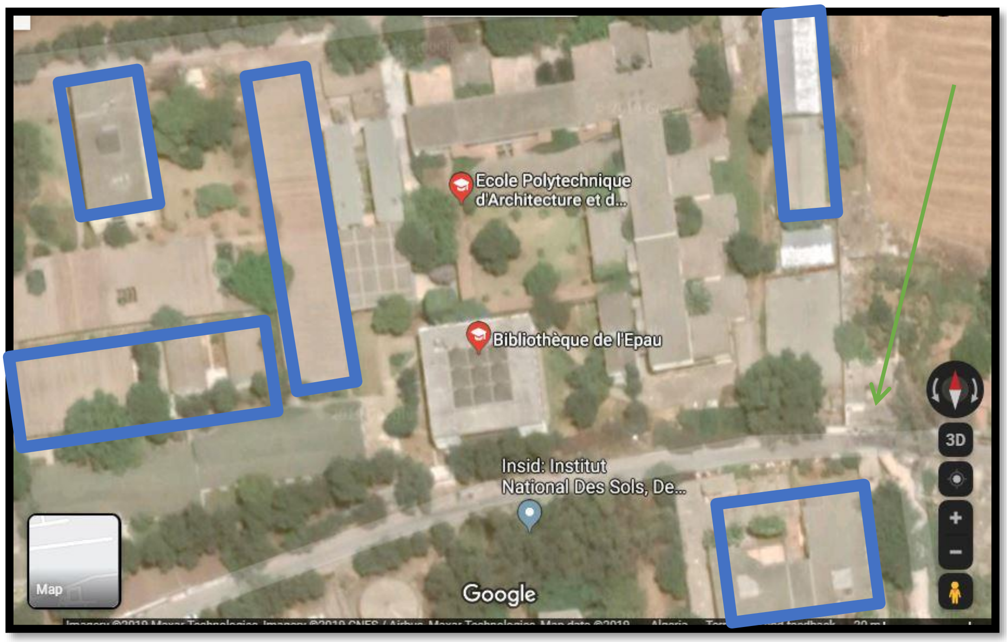
Integration



The volumetric shape fits the urban area
</td>
</tr>
</table>

<table>
<tr>
<td>Structuring or structured role:</td>
<td>

The project



Structuring

➢ Follows the peripheral shapes

</td>
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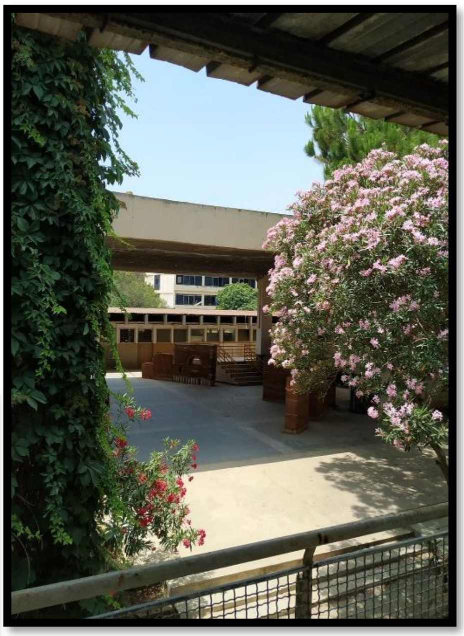
<tr>
<td>Report, inside / outside</td>
<td>

PUBLIC

PRIVATE



SEMI PUBLIC

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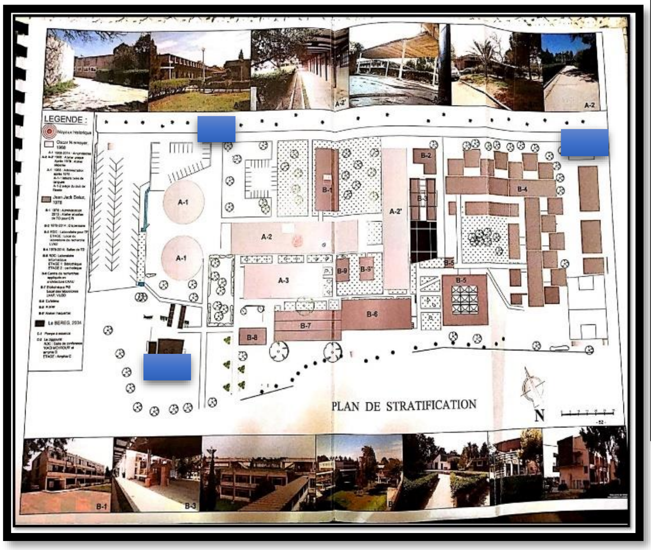
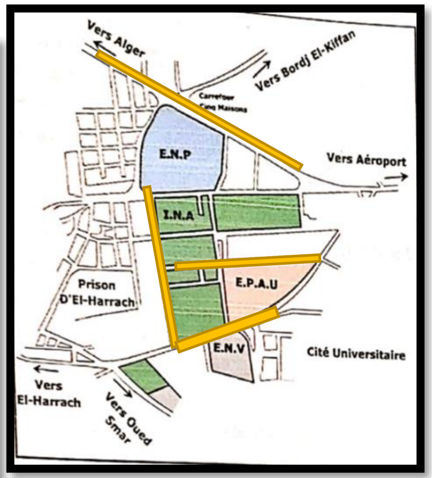
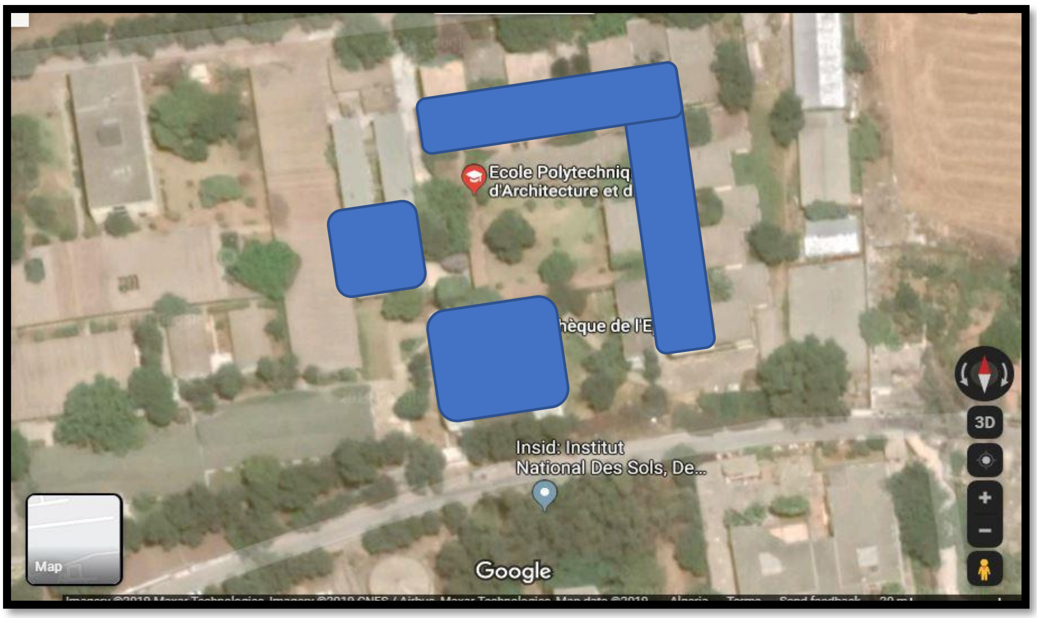
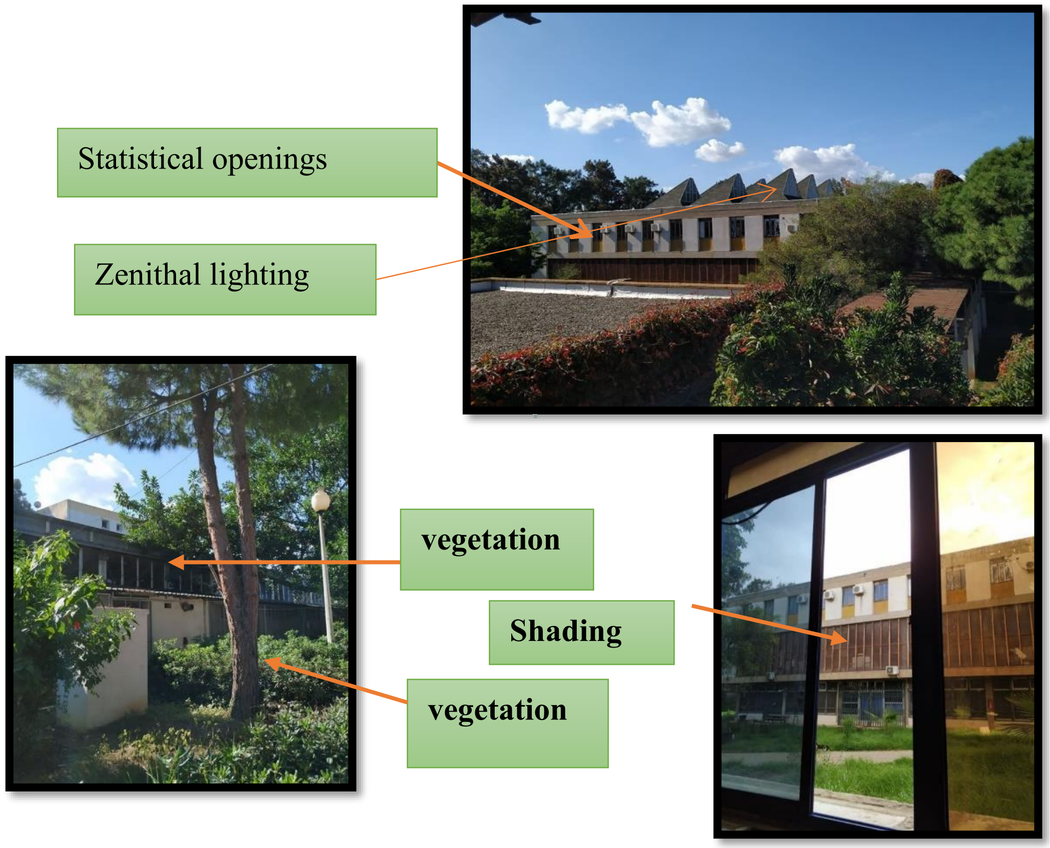
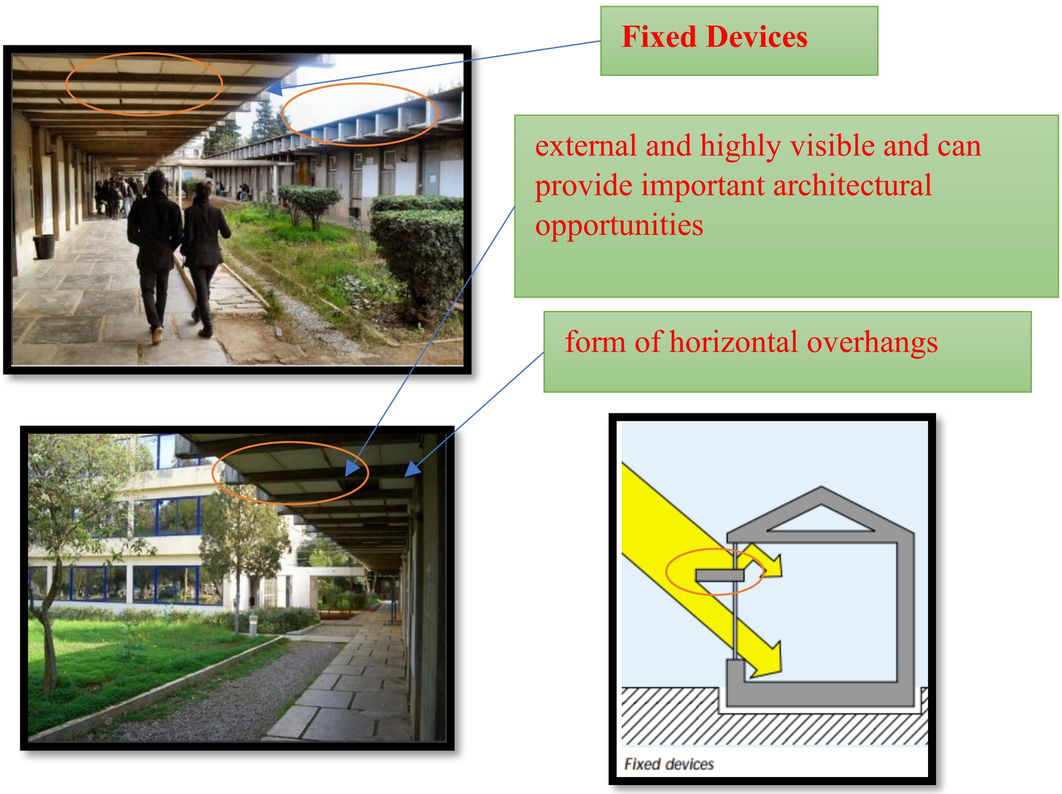
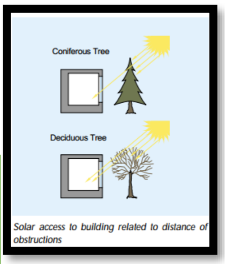
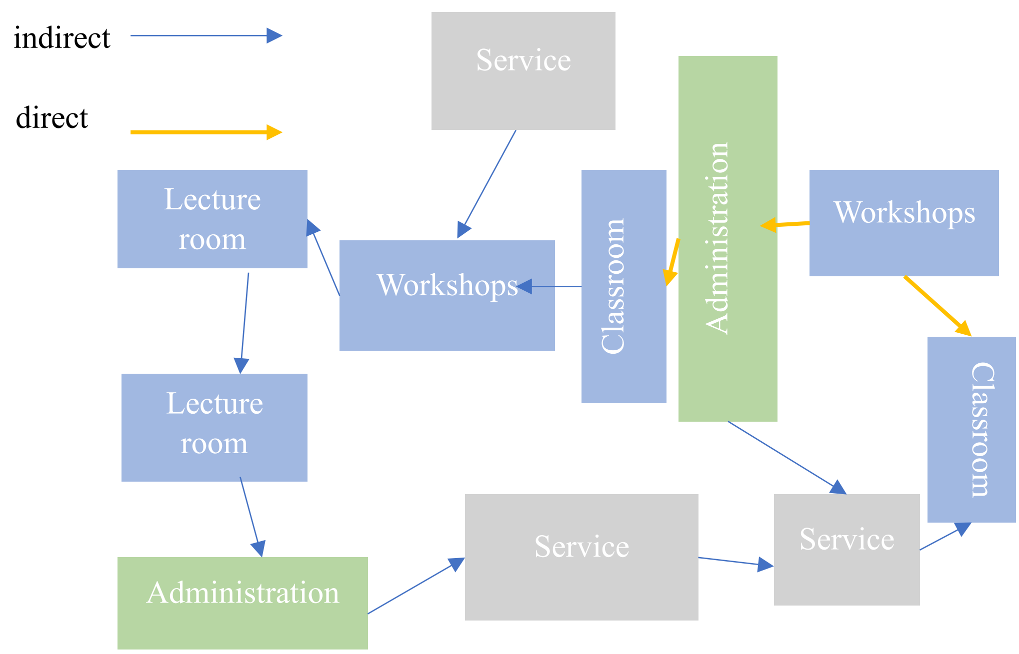
<u>Accessibility</u>	  Mechanical access Pedestrian access
ORDER	Mass scheduling  Project is not Compact

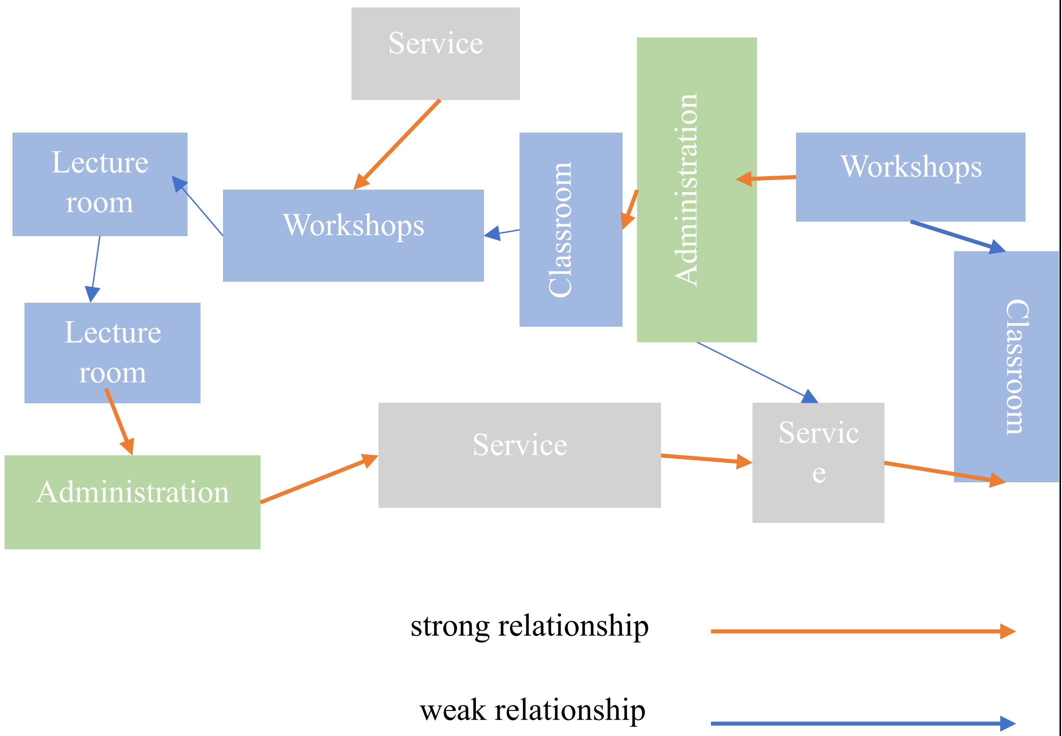
Order of facades	
Shading system	

	 **Vegetation** reducing conductive as well as radiative heat gains. help to modify the microclimate  These devices avoid the compromise between adequate shading **Retractable Devices**  
Zoning	Service Exhibition / Traffic education Leisure Administration 

Space relationship



Functional relationship



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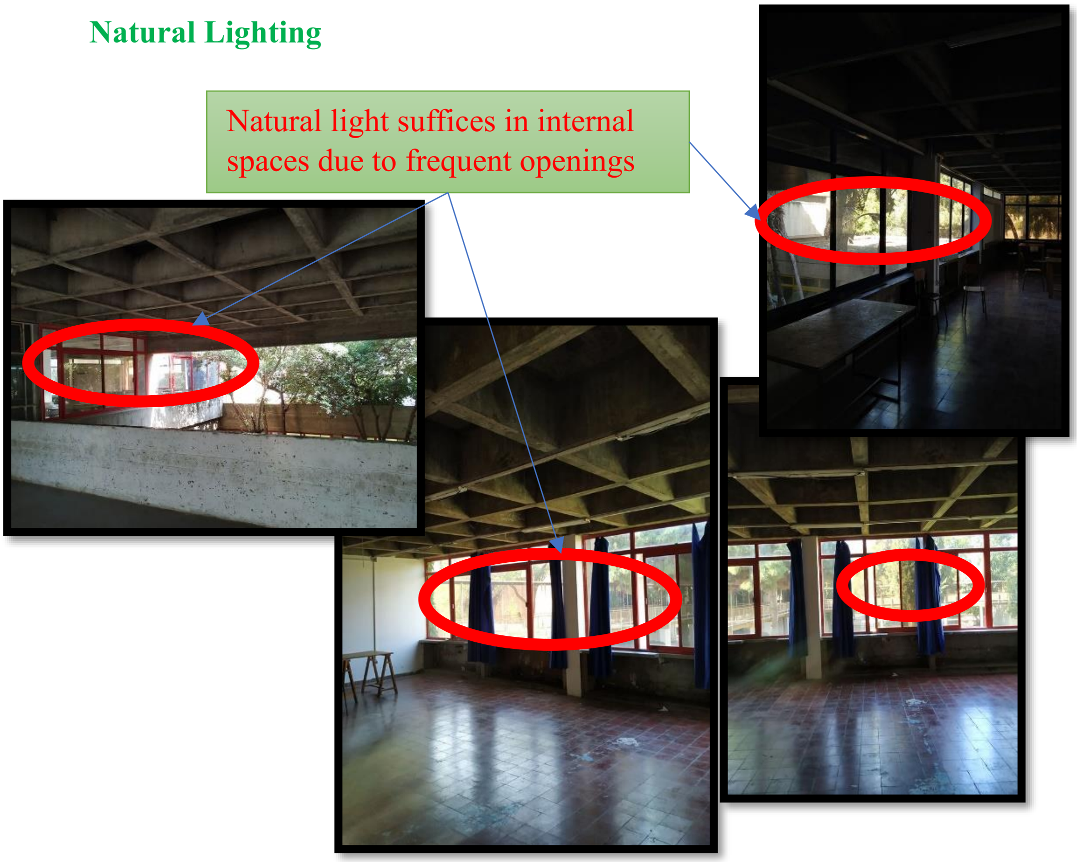
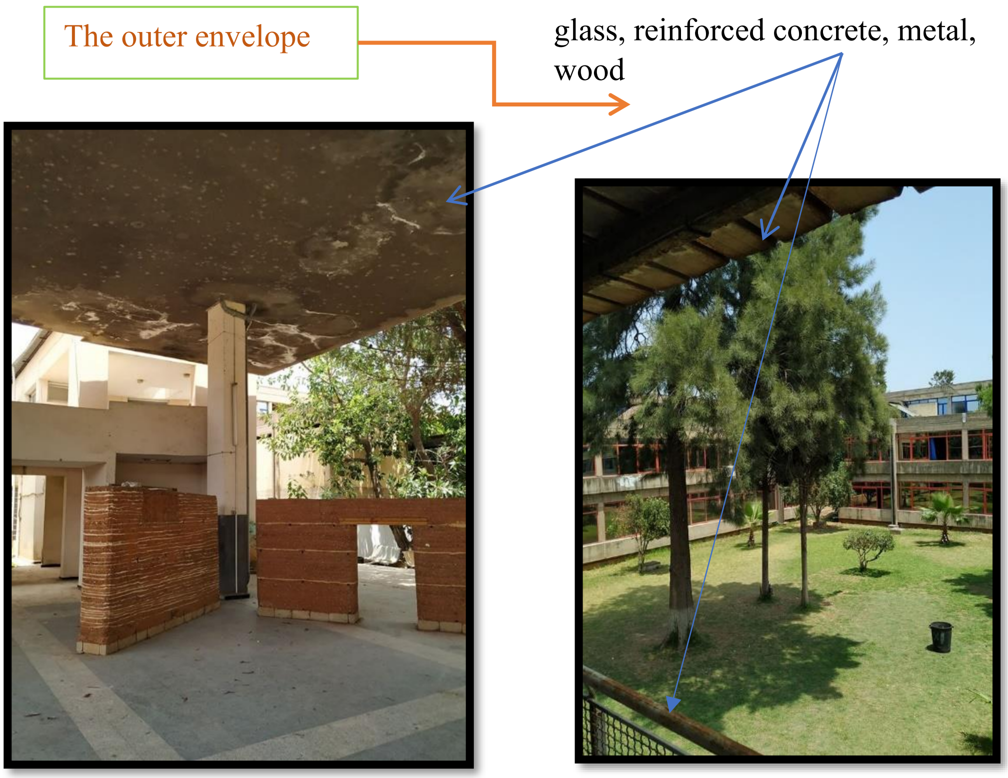
<tr>
<td>Ambience</td>
<td>

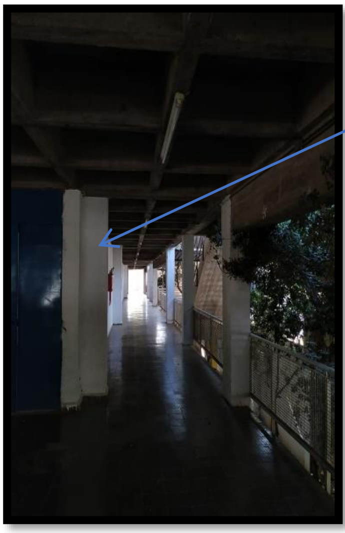
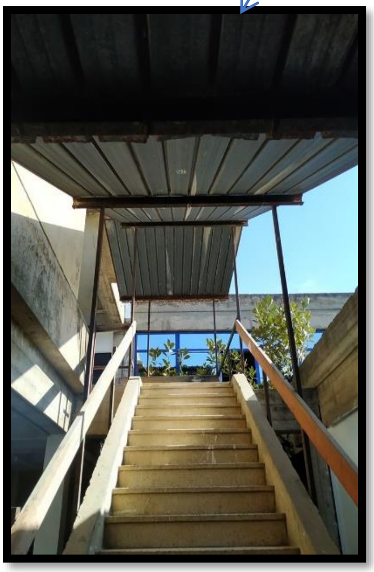
Natural Lighting



</td>
</tr>
<tr>
<td>Envelope and material</td>
<td>



</td>
</tr>
</table>

	The inner envelope Paint, metal, concrete 
The structure	**mixte** **Sailing wall** **waffle** **Colum** 

2 Site analysis

2.1 Situation of floor

The project floor is located in the city of Biskra in the high region next to the national road No. 31 leading to the province of Batna, Opposite to Road Leads to Sidi Okba

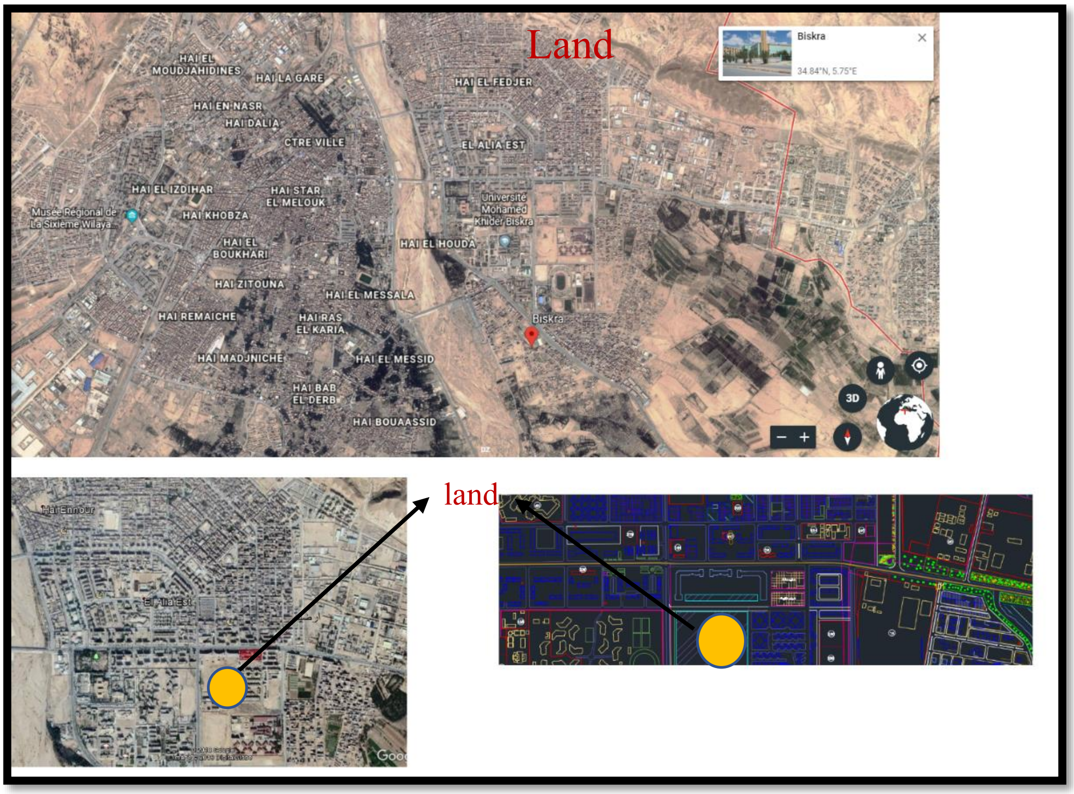


Figure 15:Situation of the land in Biskra (www.google.maps.com)

2.2 Urban Boundary

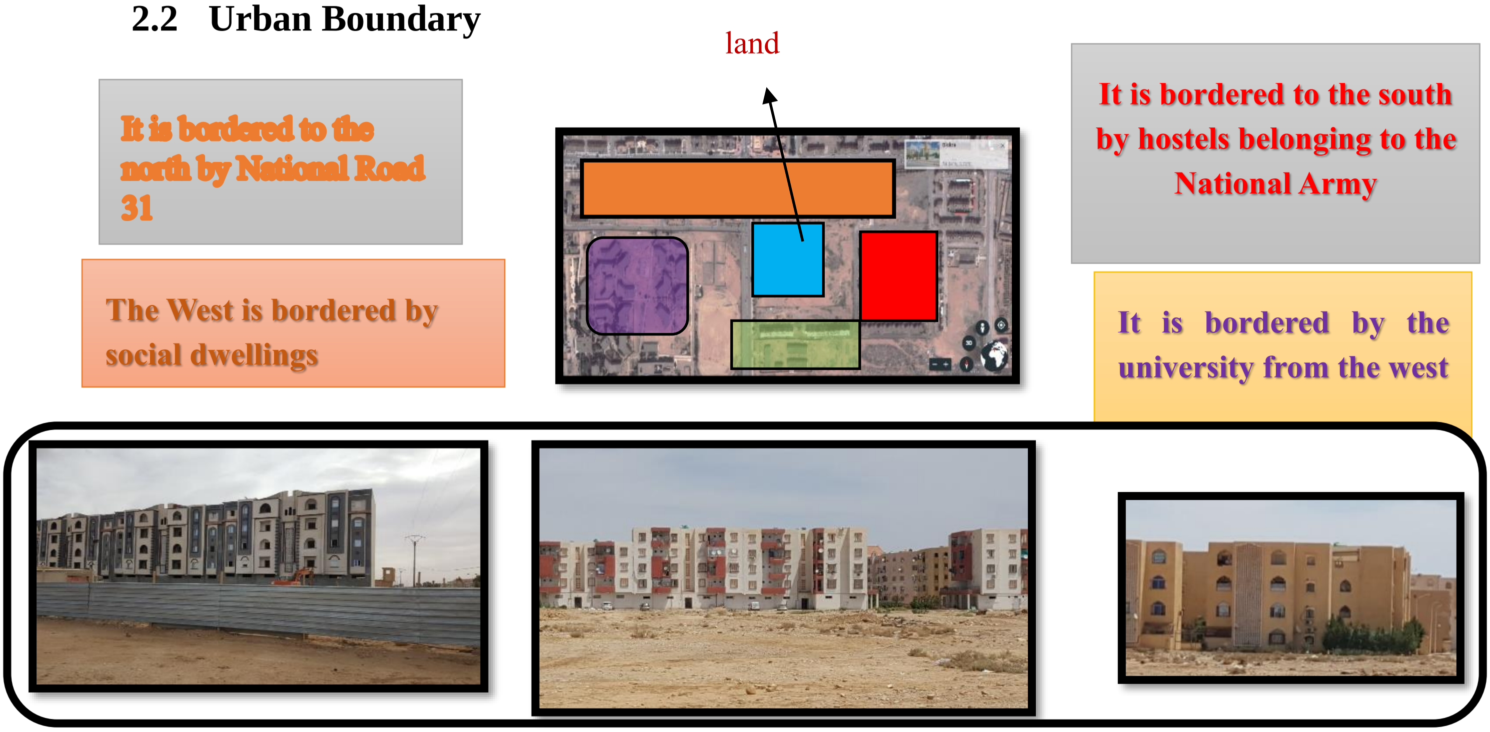


Figure 16:Urban boundary of the land (author)

2.3 Urban Interfaces

Local architectural style:

-The shape of the slots is simple
- Simple and repetitive rhythm
- Percentage filled more than empty
- Simple and repetitive rhythm

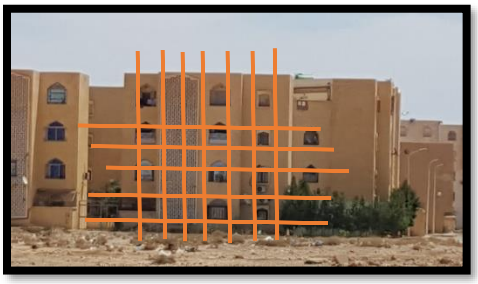


Figure 17:Facade rhythm (author)

- Rough plot
- The sky line is fixed
- The architectural elements in the interface are a cross network

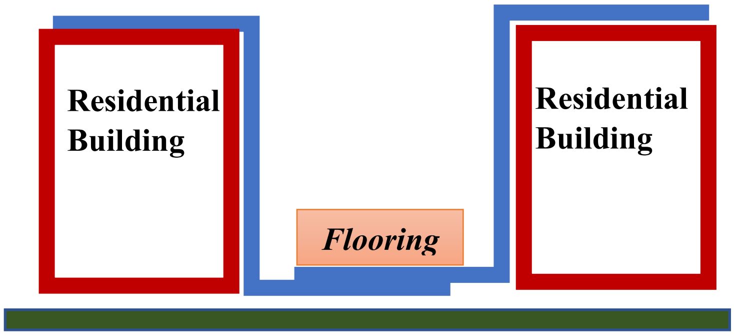


Figure 18:land peripheries shape (author)

2.4 Urban landscape

The urban landscape of the land is dominated by large residential communities and a large lack of green spaces

Figure 19:Urban landscape (author)

2.4.1 Elevations

The buildings adjacent to the ground have the same height as they reach a height of 15 meters and 12 meters

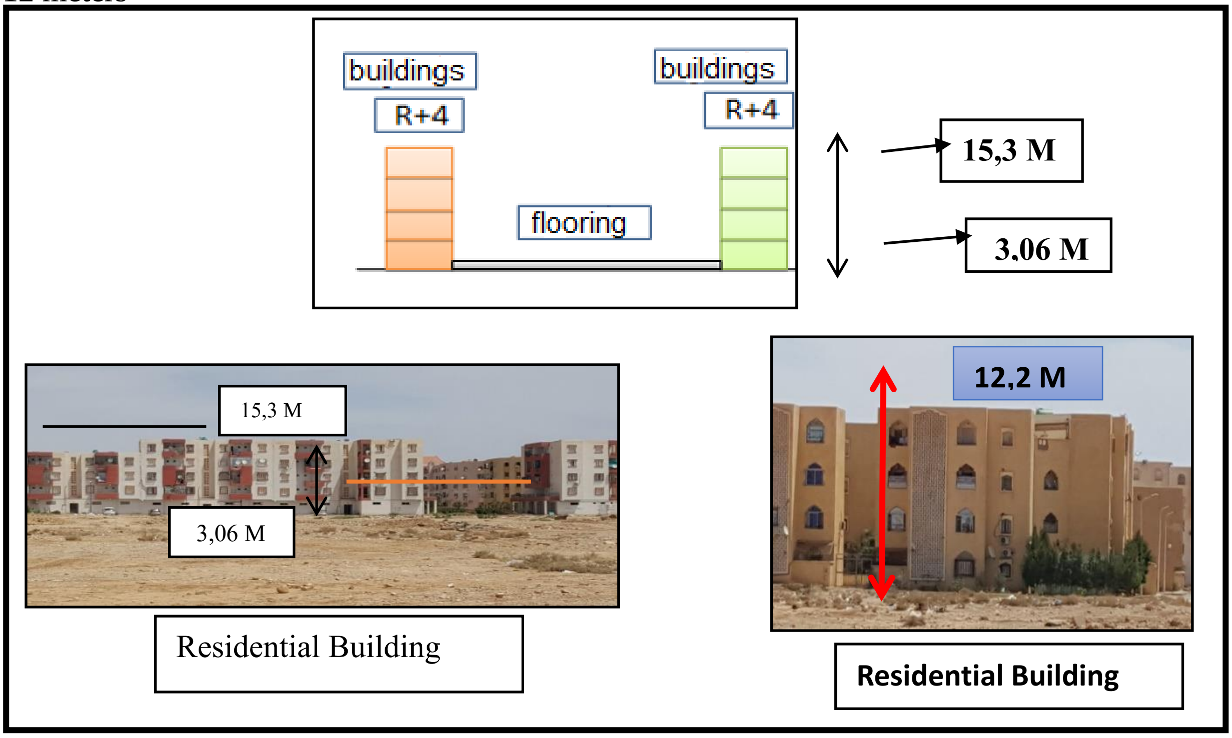


Figure 20: peripheries elevation (author)

2.4.2 the flow

Note that there is a large flow of traffic from the national road and a small flow of others

Figure 21:the flow around the land (author)

2.4.3 Conductivity

The ground is located in an important mechanical road network as it is opposite a main road leading Sidi Okba and two secondary roads

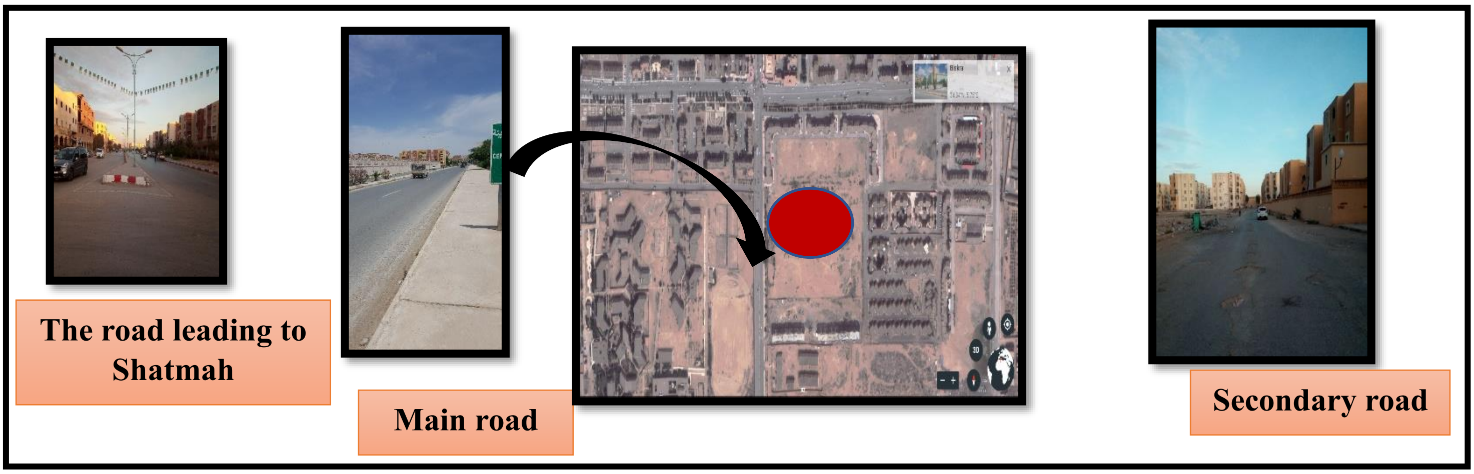


Figure 22:conductivity in the land (author)

2.5 the climate

2.5.1 Wind effect

The ground is exposed to cold winds from the north side, while the rest are not affected

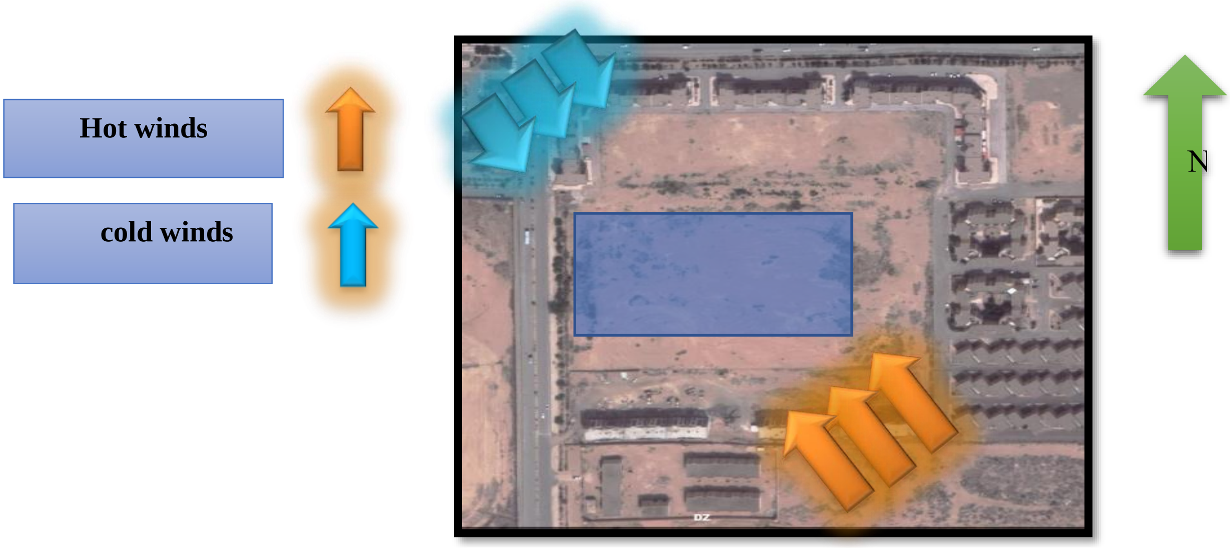


Figure 23:Wind effect at the land (author)

According to the winds effect and the adjacent buildings, the floor does not have a wind mask

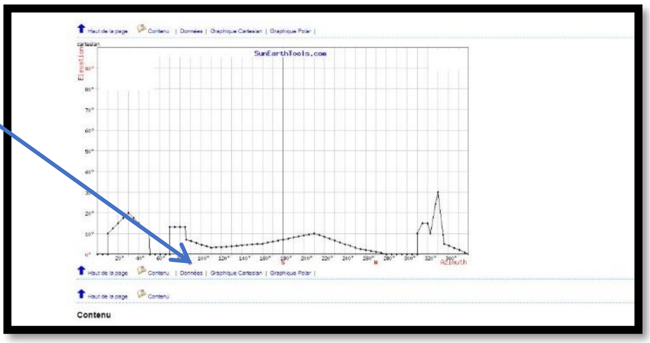


Figure 24:wind mask of the land(www.sunearthtools.com)

2.5.2 Sun pathing

Most of the project floor is exposed to the sun all day because the astray of the buildings does not cover all the floor

According to the shadow effect of the adjacent buildings, the floor does not have a shadow mask from the adjacent buildings

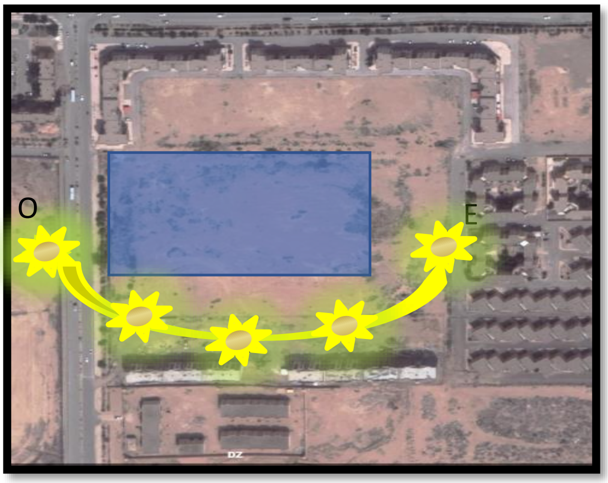


Figure 25:sun path for the land (author)

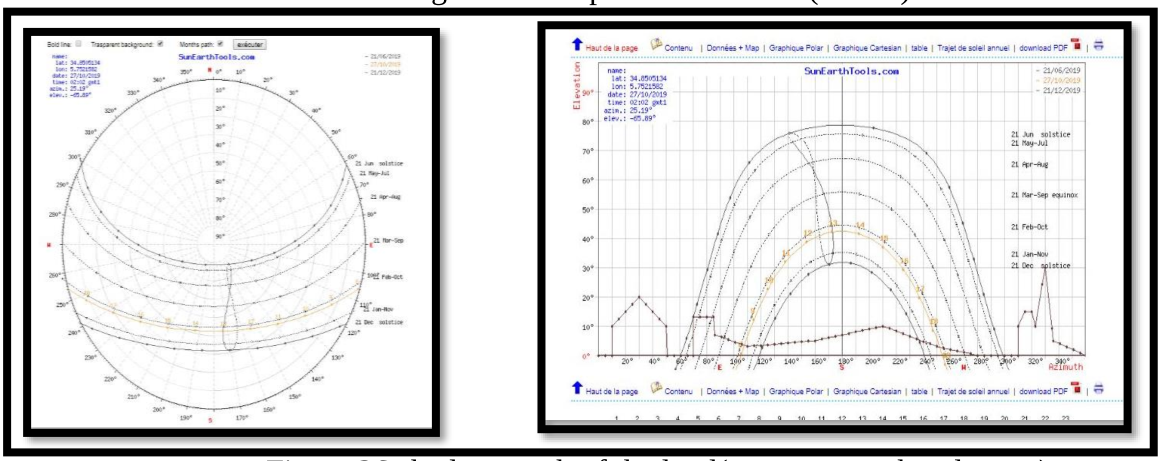


Figure 26:shadow mask of the land(www.sunearthtools.com)

2.6 Climate data:

2.6.1 Temperature:

Average monthly temperature in the region Low during January 12.2 It is high during the month of July the annual rate is estimated at 22.8

Climate Biskra - Algeria

Temperature - Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	16	18	22	26	31	36
Average low in °C	7	8	11	14	18	24
Av. precipitation - mm	9	8	12	10	13	6

	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	42	41	34	28	21	17
Average low in °C	27	26	23	17	12	7
Av. precipitation - mm	2	6	20	16	18	8

Figure 27:diagram of temperature in Biskra during the year (www.weather-atlas.com)

2.6.2 Humidity:

Note that there is one month of the total months of the year in which humidity exceeds 50% (average daily humidity) to record in January the highest humidity rate 58%

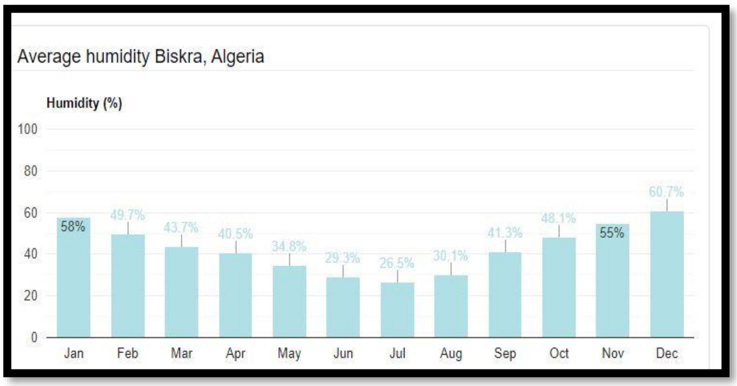


Figure 28:diagram of humidity in Biskra during the year (www.weather-atlas.com)

2.6.3 precipitation:

The amount of precipitation during the last 20 years for the city of Biskra. Where the largest precipitation in 2003. The smallest percentage was 2000

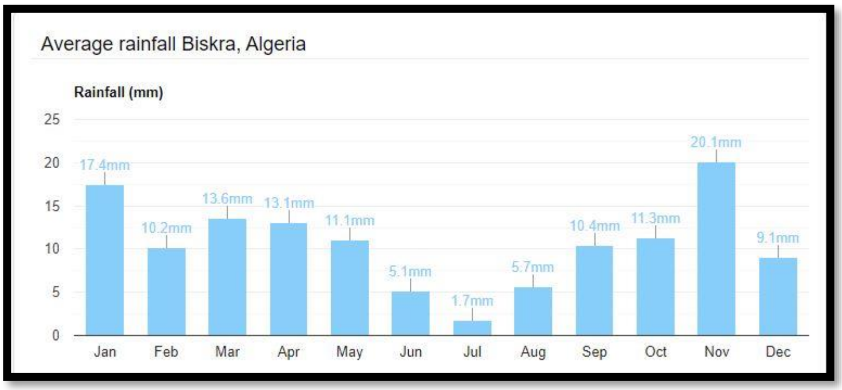


Figure 29:diagram of precipitation in Biskra during the year (www.weather-atlas.com)

2.6.4 Winds:

Wind power It was large in May 22.2 m / s and small in February 13.2 m /

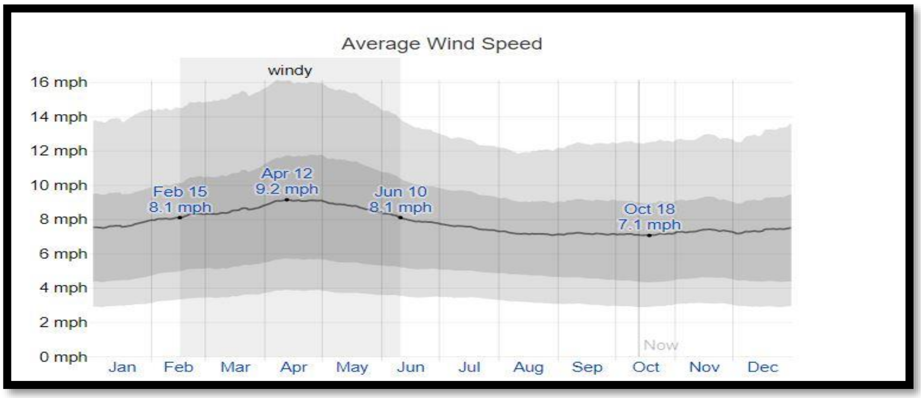
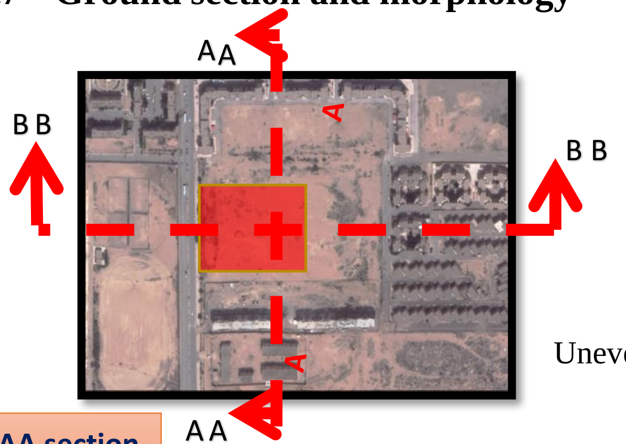


Figure 30:diagram of winds speed in Biskra during the year (www.weather-atlas.com)

2.7 Ground section and morphology



Floor Shape: square

Floor dimensions: 80X 80

Floor area: 6400 m²

Uneven floor There is a slope down and then up again

AA section

BB section

Figure 31:morphology of the land (google. Earth)

2.8 Pros in the floor

- The floor of the project is flat to some extent and there are no physical obstacles
- The project floor is close to urban fabric and a main road
- Location away from sources of noise, factories and amusement parks affecting students
- The surrounding landscape is healthy and does not cause any visual pollution.

2.9 Cons in the floor:

- The floor is exposed to the sun most of the time, so it is necessary to observe solarization, especially in the summer
- There is no significant vegetation around the floor circumference

2.10 Syntheses:

Despite the difficulty of achieving thermal comfort on such environment due to the natural conditions appropriate understanding of sun angles is critical to various aspects of design including determining basic building orientation and control the shading devices and Shading strategies that work well at one latitude, may be completely helpful to improve thermal comfort in our project

3 Syntheses of the analysis

3.1 Integration to site

- Take the consideration of the environment and try to collaborate with the peripheral urban
- Take on consideration the important of the vegetation and water area that influences the building microclimate
- control the orientation and posing of project which depends on the topography and climate characteristics of the zone
- Control the flux in the site to provide a good accessibility to the project
- Respect the historic aspect of the zone

3.2 Architectural

- the building is intended as both a place of learning and as a teaching tool in itself it should be a good example to students
- the sense of innovation and creativity and futurism in the building is needed for students to refresh their insights
- Light, shade, and shadows are the most important elements that affect the visual perception of space, so the students' eye is an upscale tool that transmits the surrounding objects because it depends on seeing things in light, shade, and shadows
- . The Materials used should be raw and exposed, allowing students an insight into construction techniques
- The volumetric should be attractive and gives a good reflection about architectures using (colours, materials, shapes....)

3.3 Functional

- The educative spaces (workshops, classrooms, library….) needs a hug amount of natural lightning
- . The exhibition spaces can be the same as circulation spaces or meeting places
- Transparency between spaces gives more educative aspect to the school and create an energetic atmosphere
- The relation between functions should be continuous from administration to education to service
- The repot spaces for students so important in school of architecture

4 Programming

4.1 Norms and standards

4.1.1 Lecture rooms and theatres

Utilisation of lecture room and theatres traditionally low in relation to space requirements and capital cost; therefore, consider designing flexibility to accommodate various functions. Such spaces could suit lectures, stage productions, demonstrations and cinema. Large theatre could be divisible to accommodate different audience sizes, similarly, with retractable seating system-p135, large lecturers can be converted into assembly hall or gymnasium. Number and extent of such activities will also determine the need for adjoining ancillary spaces such as preparation room, projector room, workshops, changing rm, studios and stock. If policy to hire lecture theatre to outside organisations during vacations consider improved space standards and environmental conditions to satisfy more sophisticated requirements of the business world.

Min ar/P: 0.46 m2 (based on moveable seats, armless 450 center to center)

0.6 m (fixed seats with arms at 500 center to center)

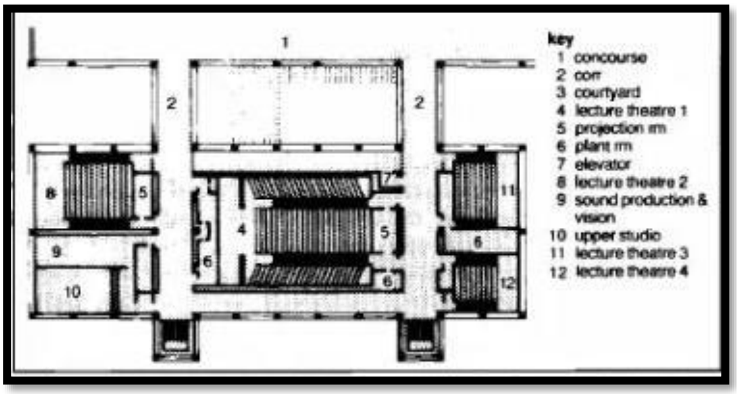


Figure 32: Lecture ha complex pre-clinical sciences Southampton University England (Ernst_Neufert_ARCHITECTS_DATA second international English edition)

Basic shape of lecture theatre becomes more important as size and volume increase. Square flexible but fan shape preferred for larger theatres where plan form relates to adequate sight lines for audio visual presentations, cinema etc. Small capacity lecture room up to approx. 80 persons quite satisfactory with flat floor: larger halls require either ramped floor (max 1:10) or stepped floor, dependent upon achieving adequate sight lines. Uniform change of eye level should be achieved at each seat row, min being60 and median 125.

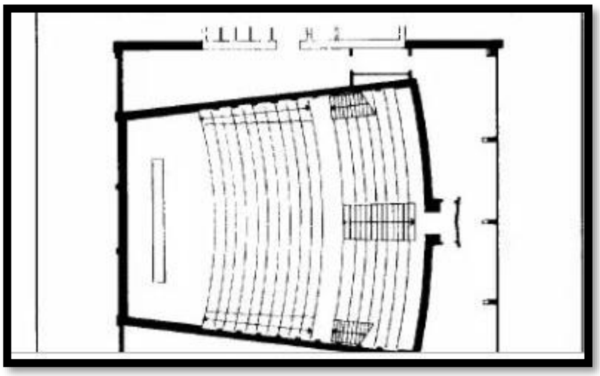


Figure 33: Basic shape of lecture theatre (Ernst_Neufert_ARCHITECTS_DATA second international English edition)

4.1.2 Seating types Categories

individual chairs capable of being linked together in rows, stacked and stored away, with or without arms, with or without writing tablets fixed seating of various degrees of comfort with or without tip-up seats, with or without arms retractable seating systems capable of folding down on to tiered staging (which usually includes aisles), whole arrangement being retractable and stored in relatively small area fiat auditorium floor capable of being used for other purposes Flexible seating

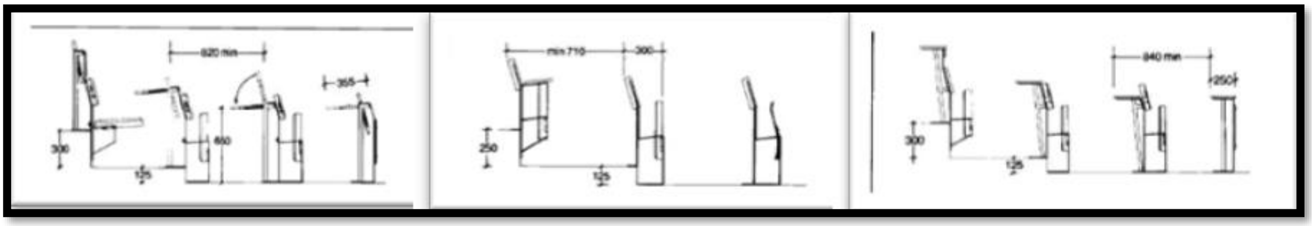


Figure 34: Fixed seating with tip-up (Ernst_Neufert_ARCHITECTS_DATA second international English edition)

4.1.3 Lecture rooms and fire regulations

Design of lecture rm or theatre must conform to safety reg. in particular fire and means of escape. Number of seals permissible in any row dependent upon clear distance apart of rows (back to back dimension A), resultant clear section (dimension E measured between perpendiculars) and distance of seats from gangway (0-W of seat) in turn clear width of gangways and number within hall must be related to number of persons to be accommodated

a

min seatway (measured between perpendiculars) E	max distance of seat from gangway (500 seats) F	max number of 500 wide seats/row: gangway both sides	gangway 1 side
300	3000	14	7
330	3500	16	8
360	4000	18	9
390	4500	20	10
420	5000	22	11

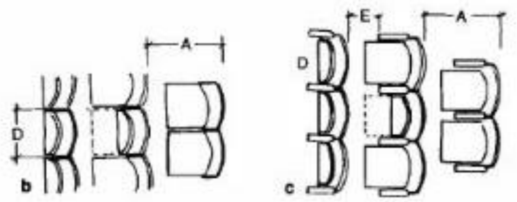


Figure 35: distance between seating with tip-up (Ernst_Neufert_ARCHITECTS_DATA second international English edition)

4.1.4 Acoustics

Just as important hear distinctly as see clearly, lecture hall must be acoustically isolated from other noise sources No internal acoustic treatment should be necessary formless than 300 m? but as size and volume increases shape of hall becomes increasingly important Design of ceiling as reflector of sound from original source important factor in achieving even distribution throughout hall Design of wall surfaces and finishes also important consideration in either reflecting or absorbing sound according to their relationship to stage or dals

4.1.5 Schools of art, design, drama and music

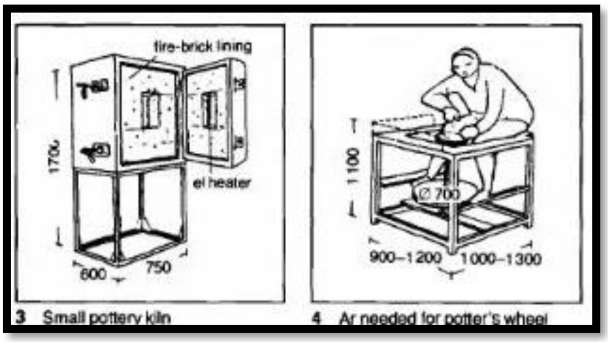
Scope and intensity of study in specialist art, design and drama subjects vary from college to college. Faculties likely include selection of: drawing & painting: fine art ceramics sculpture industrial design, engineering furniture & interior design theatre & television design graphics & related visual arts including photography Silver & jewellery textile design both print & weave stained glass drama music Schedule of accn for each will generally include design studio, work and practice mm, technical workshops and admin off. Communal lecture theatre or assembly hall usable also as exhibition center often required but display areas for both 2 and 3-dimensional work should also be provided throughout college.

4.1.6 Fine art studios

Studios for painting and sculpture require large areas: must have good natural daylight with high level windows, equal to at least 25-33% of floor area with Nor E aspect Roof lights may provide ancillary light: all windows should be fitted with some form of daylight control. Al surfaces should be durable and easy to clean.

4.1.7 Workshops

Siting will depend on type of work being done. Light work allied with graphics, silver and jewellery, photography and fashion may be placed on higher floor, metal, wood and plastics workshops where large machines may be installed best sited on ground or basement level Good workshop layout must conform to workflow and safety-Provide ample space round machines and for gangways to allow necessary movement without incursion on work space. Non-slip floor finishes should be specified; workshop technician should be able survey whole area from partially glazed off, if each student provided with sets of tools space for individual lockers needed in workshop area Workshop eqp spaces.



3 Small pottery kiln
4 Ar needed for potter's wheel

Figure 36: small pottery kiln and potter's wheel (Ernst_Neufert_ARCHITECTS_DATA second international English edition)

4.1.8 Stores

Methods of storing wide range of goods and materials needed support each activity should be closely studied, as should areas required house completed works before exhibition or disposal Al studio should be sited next to appropriate workshop, consider proper conditions of heat and humidity where these may be detrimental to materials being stored if not held within reasonable limits, eg timber, clay, plaster. Special racking needed for paintings and large canvasses, timber and timber-based board materials, plastics sheets, metal sections, rolls of textiles, glass and paper. All such sto will require element of control and security.

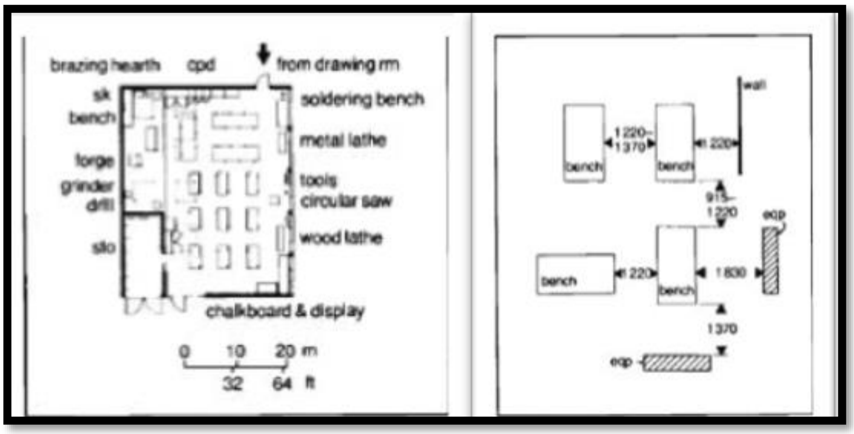


Figure 37: Clearances for layout of shops (Ernst_Neufert_ARCHITECTS_DATA second international English edition)

4.1.9 Drawing studios

Space requirements related to type of drawing and allied work, if any, to be undertaken Work station sizes in part conditioned by egp needed to accommodate drawing format to be adopted. Except in USA most offices committed to A series of international paper sizes: smaller formats obtained by halving larger dimensions in each instance. For most industrial engineering and design consultants drawing requirements can be accommodated by A0 format: drawing boards and drafting machines sized accordingly. Simplest form of work station: drawing board. eap trolley (cart) and draughtsman's stool, where drafting work requires reference contained on other drawings either reference tables or vertical screens may be used carry this information Screens have advantage of keeping floor area needed to min but at expense of controlled supervision Reference tables, which may also provide plan chest drawing studio below wok surface either to side of draughtsman parallel with drawing board or at right angles to it. Further possibility available with 'back reference where reference table also support for drawing board behind. Where drafting function only part of job requirement and admin work also to be done reference area may double as off desk or if space allows desk may form additional element within work station

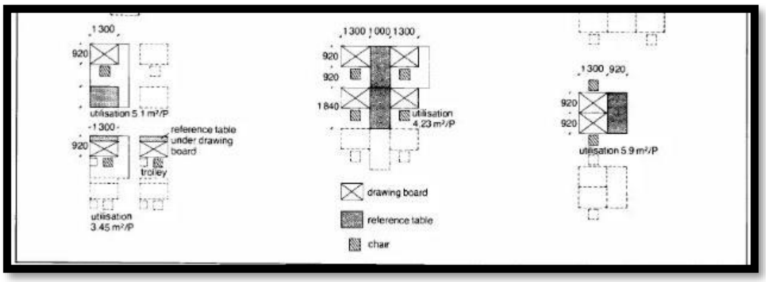


Figure 38: various planning arrangements (Ernst_Neufert_ARCHITECTS_DATA second international English edition)

4.1.10 Entrance

Community libraries should clearly declare building function, and be well coming Lobby should reduce entry of noise/draughts. Provide visual stimulation here. Adequate control needed to prevent high losses of books etc through exit: some have had to use turnstiles or electronic detectors. Remember needs of disabled people (ramps/elevator escalator). Should lead to control/guide area below, with display in route

4.1.11 Library

Close to or within sight of building entrance, and with space to absorb congestion at peak hours, but located 10 allow max visibility for super. vision, Function: to register new readers, issue and receive loan books deal with reservations and lines. In small barriers also handles reader's enquiries.

4.1.12 Recommendations for main spaces

Space	Activity	Orientation	shape	Surface
Workshop	Draw Information and exchange area Communication between the student and the tutor	South / East / West	Square or rectangle	From 3.5m2 to 4.5m2 for each student
Classroom	Information and exchange area. Communication between student and tutor	South / East / West	Square or rectangle	From 65m2 to 70m2 2.20m2 for each student
Exhibition space	Space to exhibit. Maybe takes a circulation space	Unspecified	Different form	/
Amphitheatre	Information and exchange area	Unspecified	Different form	1m20 for each student
Library	Consultation and reading space	Southeast to capture a uniform light	Different form	1.20m2 for each student

Table 6:Standards relating to the characteristics of spaces in architecture schools (Ernst_Neufert_ARCHITECTS_DATA second international English edition)

4.2 Examples programs

Melbourne School of Design University of Melbourne			
Spaces	**surface**	**number**	**Total**
Gallery	400	1	400
modelling workshop	60	16	960
Library	170	1	170
Cafeteria	100	1	100
Offices	30	9	270
Conference Room	200	2	400
Teaching Studios	40	12	480
Seminar Spaces	200	1	200
Print Room	40	1	40
Academic Staff	20	4	20
Graduate Research Workspace	40	2	80
Innovation lab	40	1	40
Society institute (MSS)	40	1	40
Digital Design Hub	40	1	40
Employees Services Team	20	1	20
Planning and Finance Team	60	1	60
Research and Industry Team	60	1	60

Table 7:Program of Melbourne School of Design University of Melbourne (www.archidaily.com)

McEwen School of Architecture LGA Architectural Partners			
Spaces	**surface**	**number**	**Total**
drawing studio	40	12	480
atrium	100	1	100
fireplace	60	1	60
classroom	35	10	350
lecture hall	250	2	500
offices	15	5	75
undergraduate studio1	30	4	120
student association	30	2	60
student lounge	40	1	40
staff lounge	40	1	40
cultural room	60	2	120
digital fabrication lab	80	1	80
computer room	60	1	60
wood shop /metal shop	150	1	150
spray room	40	1	40
gallery	300	1	300
future program space	600	1	600
courtyard	600	1	600
outdoor fabrication workshop	15	1	15
exterior ceremonial fireplace	180	1	180

Table 8:McEwen School of Architecture LGA Architectural Partners(www.archidaily.com)

Porto School of Architecture			
Spaces	**surface**	**number**	**Total**
1-workshops	60	11	660
2-lecture theatre	500	2	1000
3-courtyard	800	1	800
4-Art gallery	250	1	250
5-libirary	400	1	400
6-foyer	200	1	200
7-classrooms	45	13	585
8-workshop modelling	70	1	70
9-workshop sculpture	75	1	75
10-camputer classroom	80	1	80
11-audio studio	60	1	60
12-stores	40	2	80
13- offices	30	4	120
14-Staffs	30	2	60
15-Techniquel room	25	1	25
16-ruenion room	200	1	200
17-documentation	30	2	60
18-conference theatre	500	1	500
19- guard studio	15	1	15

Table 9:program of Porto School of Architecture(en.wikiarquitecture.com)

Polytechnic School of Architecture and urbanism			
Spaces	**surface**	**number**	**Total**
1-workshop	80	14	1120
3-workshop-salle de td	60	6	360
4-lecture hall	700	2	1400
6-cafeteria	150	1	150
7-classroom	40	10	400
8-workshop modelling	120	1	120
9-informatique	120	1	120
12-administration	900	1	900
13-ceber	200	1	200
15-workshop sculpture	150	1	150
16-workshop …	120	2	240
18-salle de conference	250	1	250
20-loge garden	15	1	15
21-ruservation technique	15	1	15

Table 10:program of Polytechnic School of Architecture and urbanism (School administration)

proposed program			
Spaces	**surface**	**number**	**Total**
1-paniting workshop	80	18	1200
2-modeling workshop	150	1	150
3-calssrooms	60	18	900
4-computer rooms	80	2	160
5-projection room	150	2	300
6-library	400	1	400
7-lecture theatre	300	2	600
8-sculpture workshop	150	1	150
9- exhibition gallery (open space)	180	4	720
10-shops (wood. Metal…)	150	1	150
11- cafeteria	500	1	500
12-space for clubs	80	2	160
14-offices			
*Directeur office	50	1	50
*secretary	20	1	20
*services	85	1	85
*reunion room	120	1	120
*documentation room	40	1	40

*WC	30	3	90
17-stock	15	2	30
18-Gardian studio	15	1	15
19-infermrie	85	1	85

Table 11:proposed program for school of architecture (author)

5 Methodology of simulation

5.1 Verification of hypotheses

In almost all projects, decisions made in the first few weeks have the greatest overall impact on building performance. Where it is on site, its basic form and orientation, internal layout, external materials, window size and position, To prove that, we have to do a simulation model that can help us to arrive into conceptual designs, taking into account wide ranges of criteria, such as layout, positioning, landscaping and lighting and heating . Simulation Research is capturing the complexity of real-world behaviours, Different kinds of outcomes can be obtained so as to calculate parameters whenever a physical or a virtual model requires evaluation. The influence of orientation of the building, sunlight, wind behaviour, etc.

5.2 Ecotect

5.2.1 definition of Ecotect

ECOTECT is a complete building design and environmental analysis tool that covers the full range of simulation and analysis functions required to truly understand how a building design will operate and perform. It finally allows designers to work easily in 3D and apply all the tools necessary for an energy efficient and sustainable future

5.2.2 the use of Ecotect

Autodesk Ecotect is a whole building simulation software that can predict the thermal, visual and acoustic performance of buildings. It is very user-friendly software that could potentially integrate with the architectural design process, Seeing is believing, and ECOTECT shows your results in 3D within the actual context of your design. Be it surface mapped information, spatial volumetric renderings or simple shadow animations, you can interact with data usually in real time and with stunning visual feedback.

5.2.3 Applying Ecotect to the school of architecture

This simulation, through a 3D numerical model on-site measurement, assesses the thermal comfort in educational spaces (workshops, classrooms, lecture hall) of different positioning, and orientation in the school of architecture, interacting with climate data of Biskra in real, the climatic zone of Biskra is one of the warmest region in Algeria with an average daily high temperature of 29 degrees centigrade. Several months of the year it is warm to hot at temperatures continuously above 25 degrees centigrade, sometimes up to 42 degrees. So, the simulation will be in different seasons and different times in a day

Conclusion

In this chapter we have studied the analytical approach which contain the examples relating to the project itself existing or bookish mentioning different aspects (situation, adjacent peripheries, elevation, function, ambient, structure). Furthermore, we analysed the land of the project distinguishing the pros and cons of it, to control the construction of the project in the land. finally, we illustrate some standards and norms about mine spaces in the school of architecture attached to programming and methodology of simulation.

So, to design school of architecture there are different factors we should consider:

- Layers of a project.
- vertical, horizontal and rotated planes.
- Outer Shell.
- Circulation, whether vertical or horizontal and types.
- Materials and colors.
- construction issues.
- Coherence with Topography.

CHAPTER III : PRACTICAL STUDY

Introduction

Architecture can be viewed as a strategy of problem solving in which creative ability utilises arts & science to generate solutions to problem situations. Designers solve problems in many different ways; however, they go through a pattern or sequence of steps that they have previously found effective for achieving their designs from conception to completion. The design process may be a conscious or subconscious effort the designers use on almost every project. Design process and methodology play a key role in the development of innovative design solutions for many architects. Many studies have been written on design methodologies, these studies critically analyse, evaluate, compare, and propose alternative methods for creative problem solving to help designers understand their own style and to offer new alternatives for achieving solutions. Further, the motivation for the research stems from the observation that each architect uses his own conceptual frameworks that can assist in setting boundaries and framing reasonable objectives, they can also enhance communication among an extended network of collaborators. By analysing the different methods & strategies of design process, then present a comparison between these different methods, to give a hole vision for the different views, to differentiate between the traditional design process and the integrative one during the information age, and it's implemented in Architectural design studio.

1 Intention

Since school of architecture is a building for teaching and learning, thermal comfort will be so important for health and well-being as well as productivity. A lack of thermal comfort causes stress among building occupants. When they are too warm, people can feel tired; when too cold, they will be restless and distracted. So, the main goal in my project is to provide thermal comfort in spaces for users, defining the comfort zone (monthly-daily) and involving different techniques and methods.

1.1 tools to achieve the intention

1.1.1 shading system

Shading devices can have a dramatic impact on building appearance. This impact can be for the better or for the worse. The earlier in the design process that shading devices are considered they more likely they are to be attractive and well-integrated in the overall architecture of a project, they have a great potential for architectural expression, adding to the texture and modulation of the facade. They also have the potential (and should) respond to the orientation of the facade, thus visibly reflecting the building's place in the natural world as well as its urban setting.

1.1.2 Design and build for some occupant control

people will be the most comfortable when they have control over some aspect of their indoor Environmental Quality. Therefore, allowing access to the thermostat, or operable windows and blinds, might boost perceived thermal comfort. Part of this is designing the building to maximise the potential use of natural ventilation and radiation from the sun that allow occupants to more precisely control their environment as they desire

1.1.3 Maintain the thermal environment

Climate responsive architecture takes into consideration seasonality, the direction of the sun (sun path and solar position), natural shade provided by the surrounding topography, environmental factors (such as wind, rainfall, humidity) and climate data (temperature, historical weather patterns, etc.) to design comfortable and energy-efficient buildings.

1.1.4 suitable orientation and positioning

Orientation is the positioning of a building in relation to seasonal variations in the sun's path as well as prevailing wind patterns. Good orientation can increase the energy efficiency of your home, making it more comfortable to live in and cheaper to run. Good orientation, particularly for a hot zone like Biskra, is critically important as it brings thermal comfort to the building occupants. The users are particularly affected by high temperature as they are more susceptible to illnesses related to thermal discomfort.

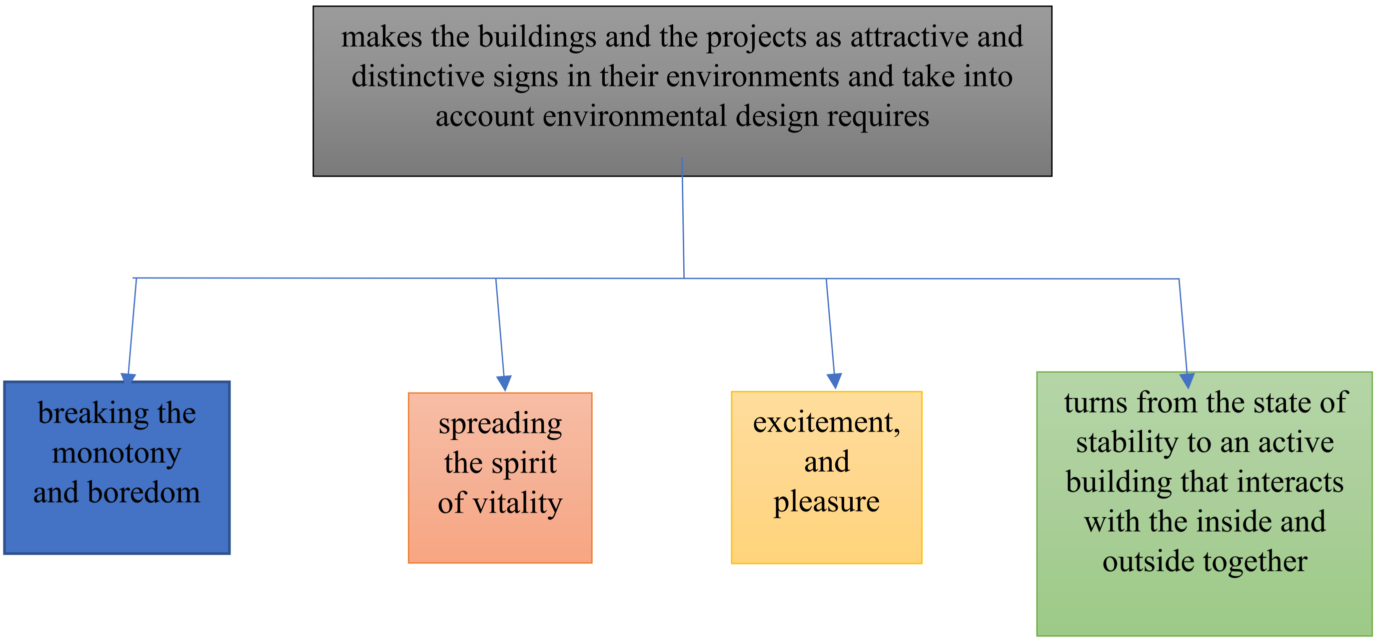
1.1.5 Perform a Site Analysis

Determine the weather patterns, climate, soil types, wind speed and direction, heating degree days, and path of the sun. Look at the water flows, habitat, and geology of the site. Document each with a qualified team of professionals to understand the ramifications of building in that specific place. It is an approach which considers the best environmental sustainability practices.

2 Passage elements

2.1 design idea

Architecture schools and the students, there is a strong relationship between these two since the architecture students value their school not only for studying, working, searching, but also as an example and model of a building in use. In this building they will learn first steps to understand and read architecture, therefore design schools become full-scale teaching tools that help new designers grasp knowledge and techniques about the field, ,So How do I give the project an important value that makes it an strong educational reference ?



2.1.1 The concept of dynamism and movement in architecture

The concept of dynamism is a concept that adds the life to the design by controlling in the dynamic strength of fixed elements, and guiding the user's eye in the project in an infinite experiment. The thought of movement in architectural design has a great importance in a reflection of psychological, environmental and aesthetic implications on human, which represents a new vision of human that helped a lot of technological progress that the world reached in all fields.

Figure 39: Plaster sculpture, Jean Arp, Ceramic art (https://www.ideelart.com/magazine/jean-arp)

2.1.2 process of developing the idea

Starting the idea from this picture that I elicited those concepts from to emphasize the idea of interactive architectural environments

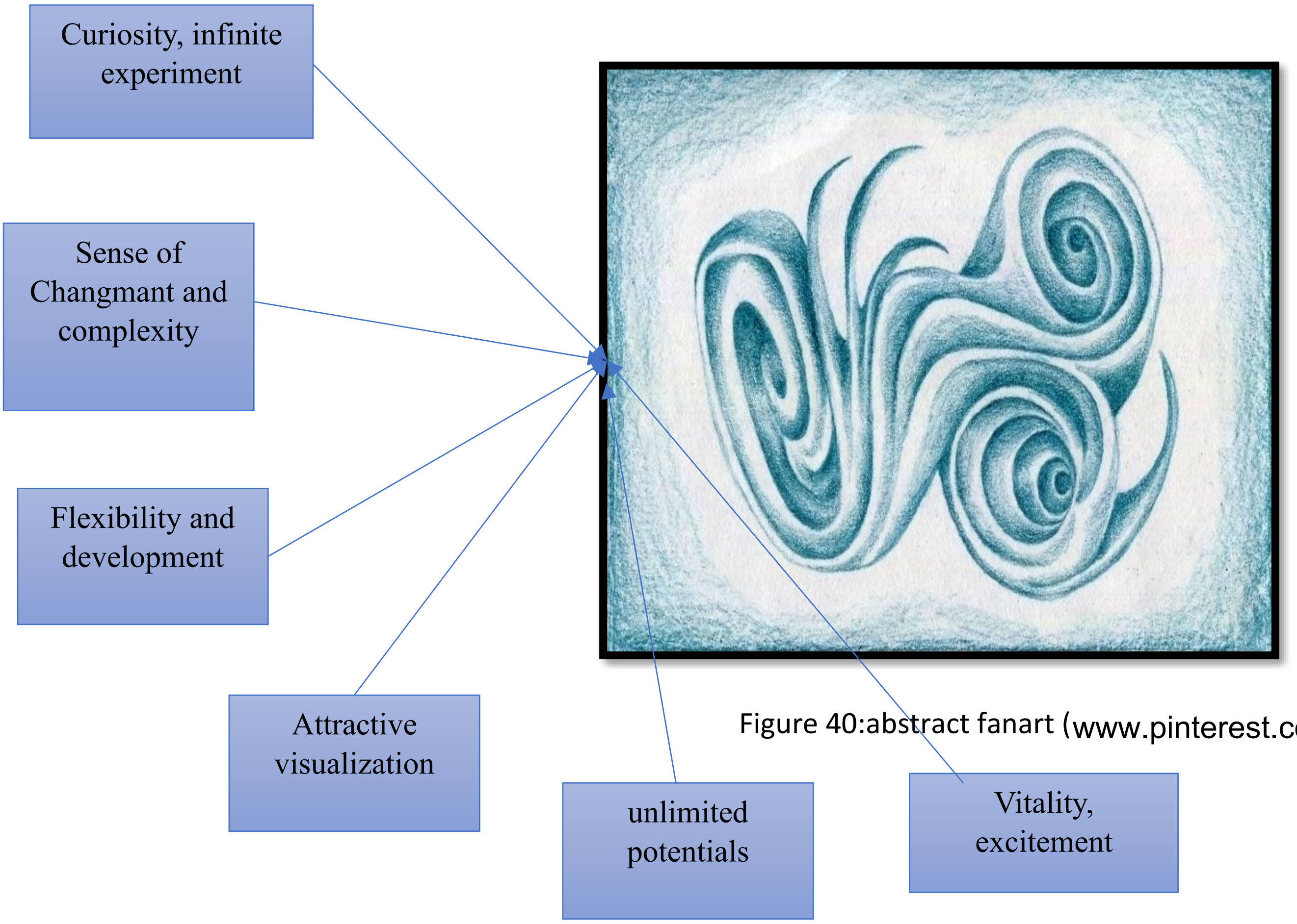


Figure 40:abstract fanart (www.pinterest.com)

Working with the third dimension by modelling and creating a shape according to the abstraction of artwork focusing in the 3 main cores

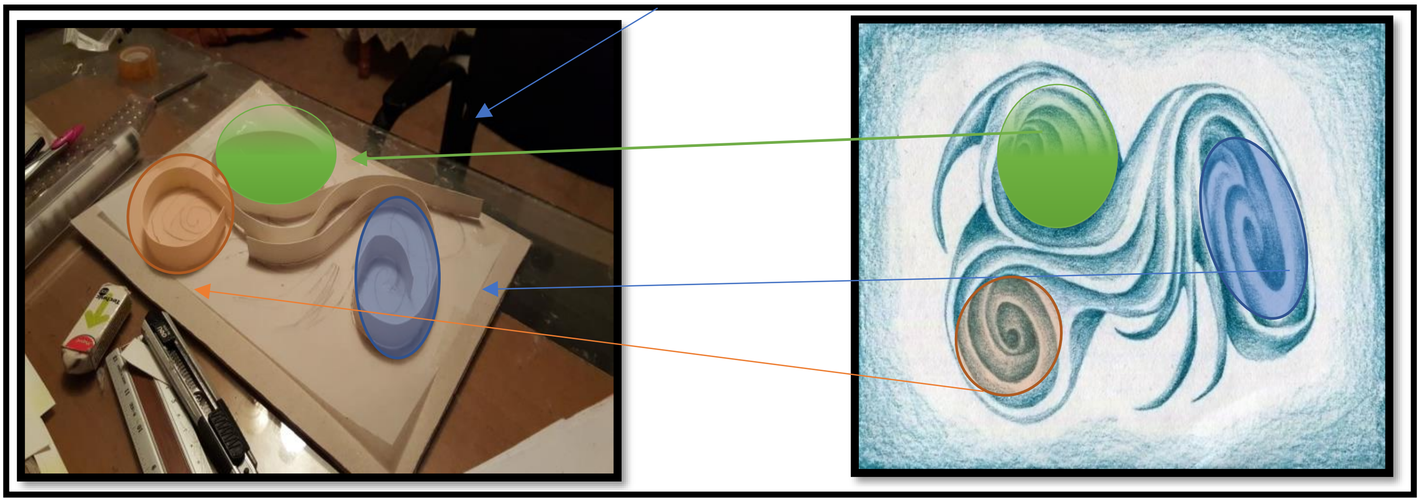


Figure 41:step one design prosses (author)

Connecting and creating a link between the three main cores to obtain a horizontal and a vertical circulation which considered the relation between functions (service, administration, education)

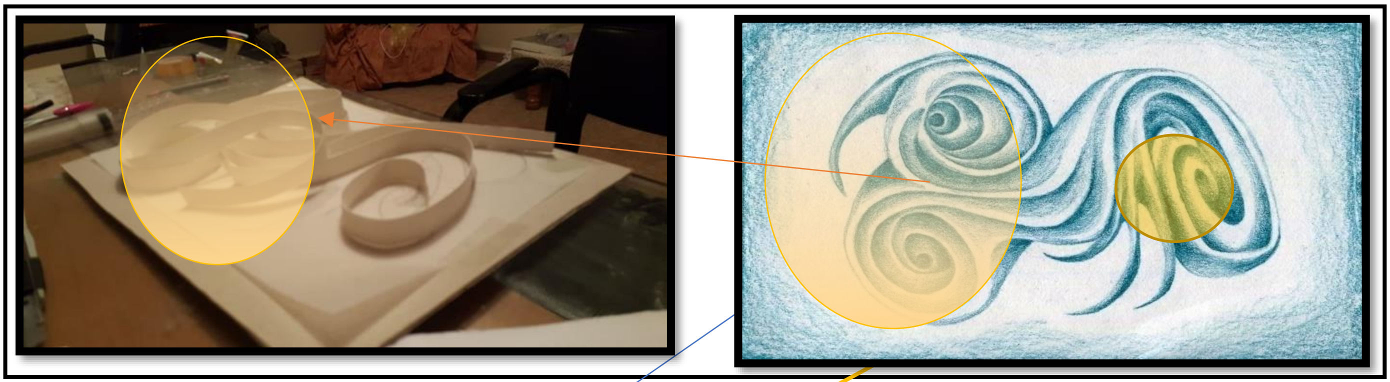


Figure 42:step two design prosses (author)

Figure 44 :step three design prosses (author)

Attain a dynamic shape that offers an amount of ideas and reflect the concept of **attraction and distinction**

In order to create an educational atmosphere, the connection between the levels (vertical circulation) and the permeability of the project are important.

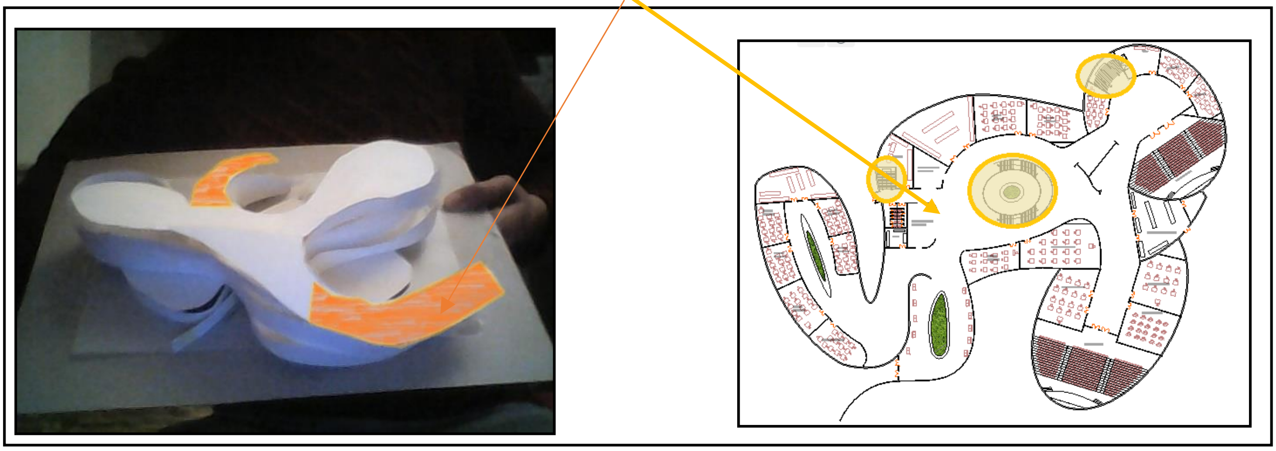


Figure 45:step four design prosses (author)

Creating a web according to the volumetric shape of the building to provide the shade to the outdoor and indoor spaces

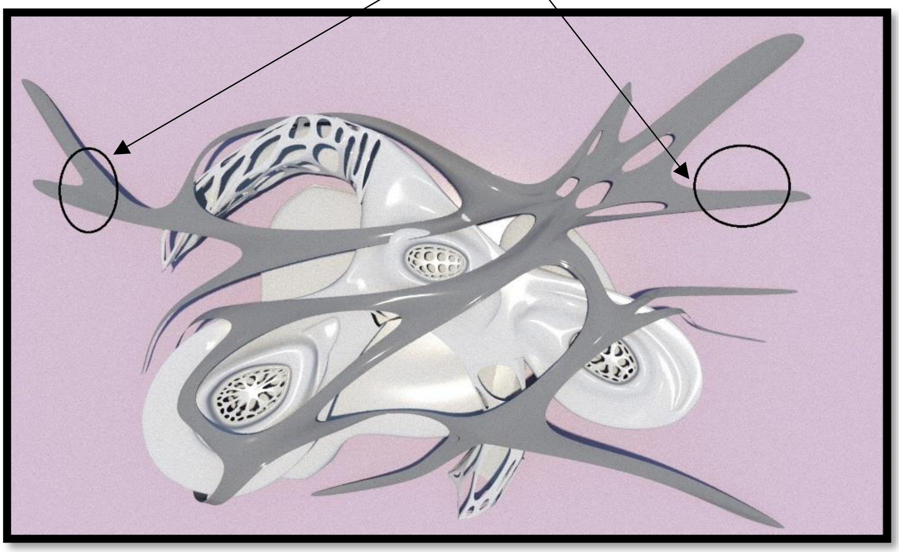


Figure 46:step five design prosses (author)

2.2 lecture and analysis of the result of simulation

Before we can do any analysis, we must locate our model on the earth. In the top toolbar, next to a group of time and date dropdown menus, is an earth icon. Clicking on that to choose Load Weather File… from the menu. Weather File… This will open up the Weather Data folder in the Ecotect install Data files and allows me to choose weather data file of Biskra.

1) Open Ecotect. 2.) Go to File → Open. 3.) Click on World Icon > Load Weather File

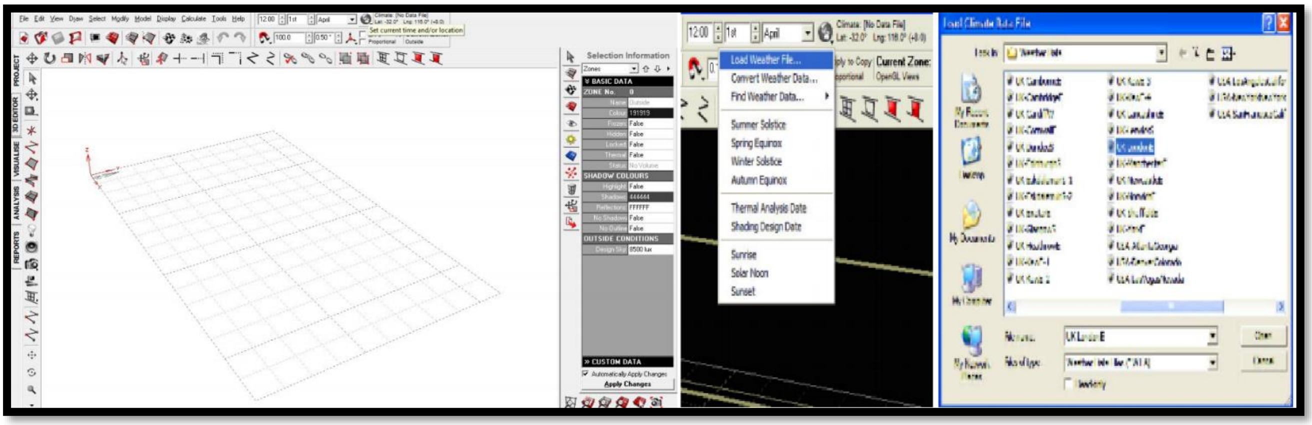


Figure 47:loading weather file in Ecotect (author)

2)Import the model as a 3DS file, choose the Import item from the File menu.

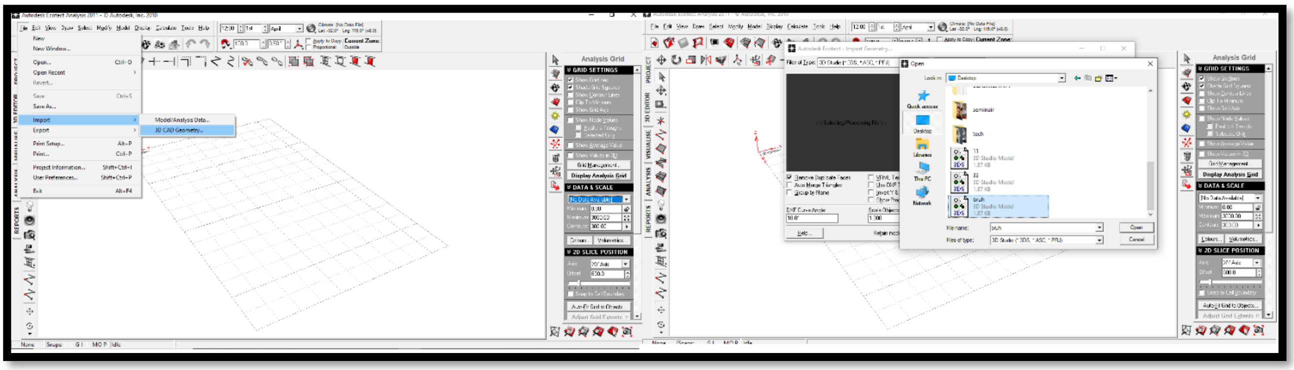


Figure 48:importing the 3D model into Ecotect (author)

3)Put the project in the right position and orientation according to the North

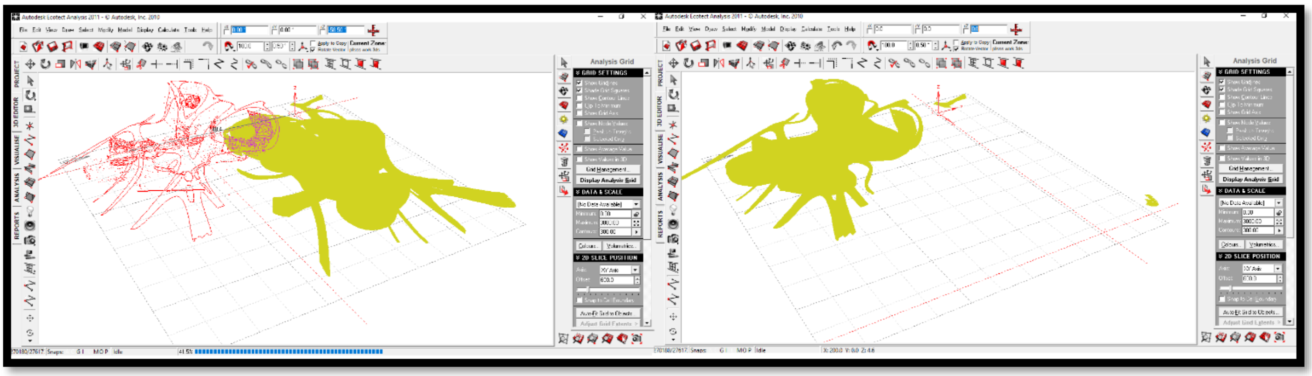


Figure 49:position of the model (author)

4)Select the zones for the simulation and chose the materials for the elements of the building

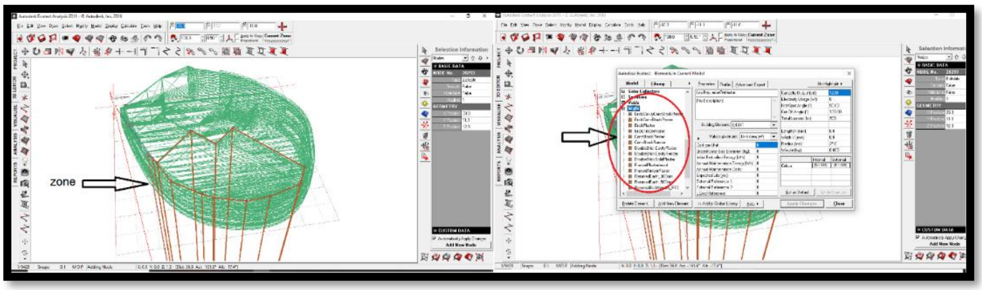


Figure 50:zoning for simulation(author)

5) Display the analysis grid and fiting it in the zone of simulation and putting the grid in the right position (the ground), and then select a date and time of the year, finally, choosing spatial comfort option in the calculation bar and start the perform calculation .

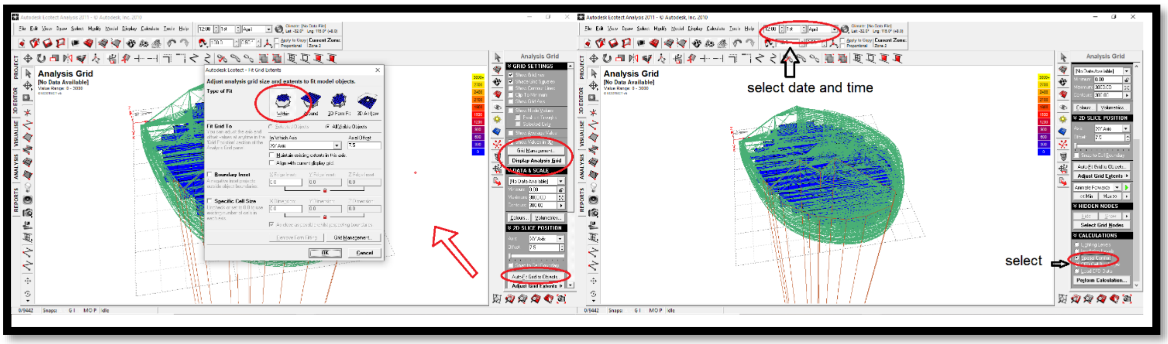


Figure 51:placing the grid (author)

6) After the calculation finished the resullts will show up in the grid and we can compare with the color scale in right side, and change the indicatores to see different results

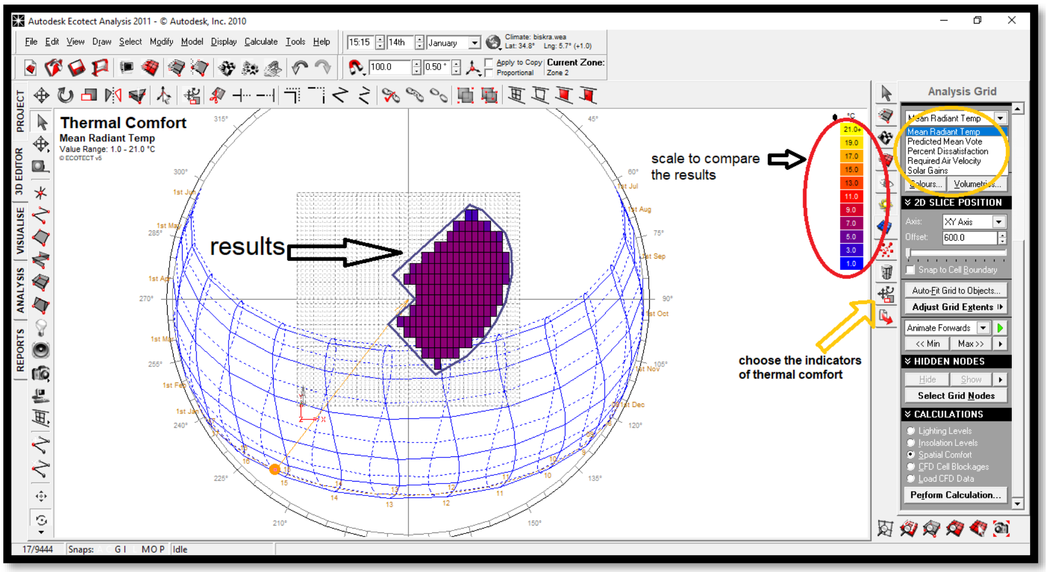


Figure 52:reading Ecotect the results (author)

7) Selected spaces for simulation

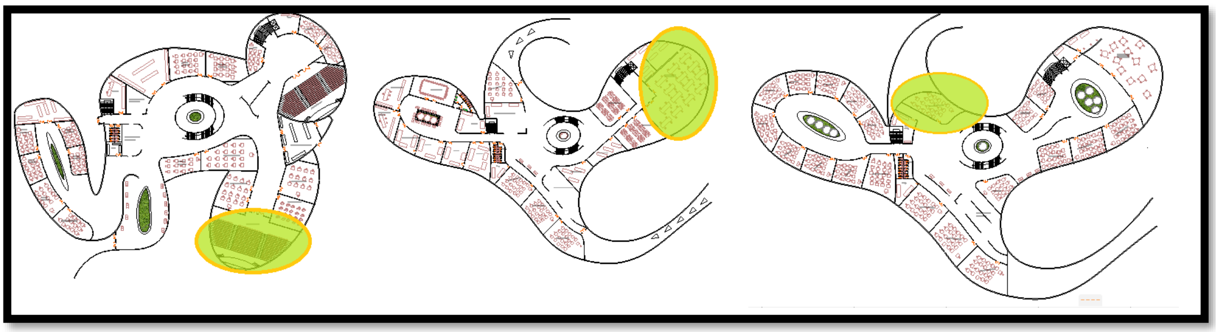


Figure 53:spaces chosen for simulation (author)

2.3 The results of simulation:
Zone (1) Workshop:

(date: 23/05, time:12:00) eastern side

- **Mean radiant temperature**

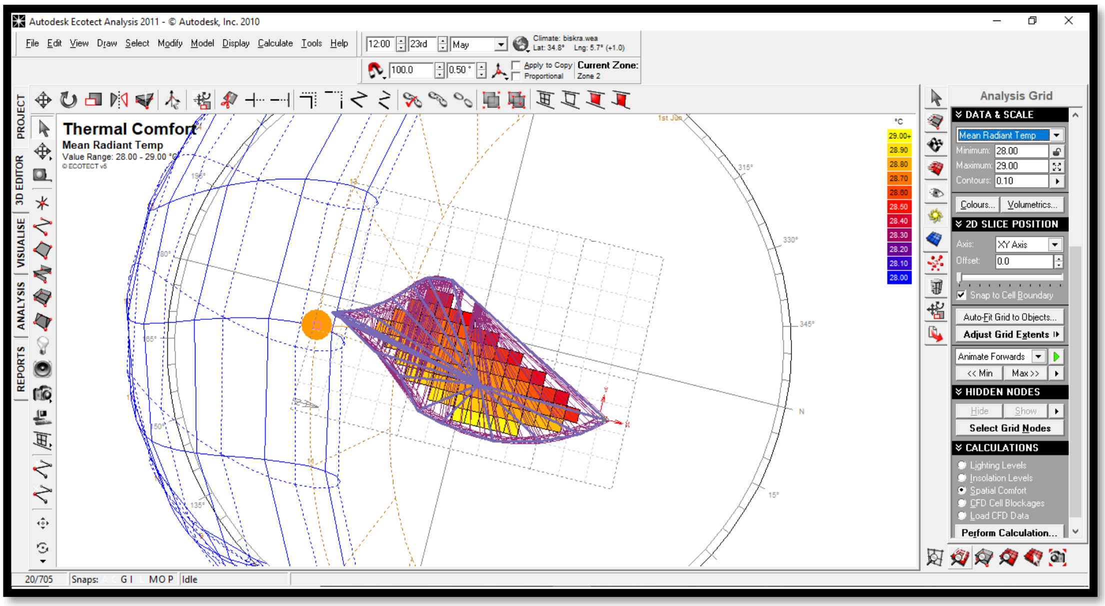


Figure 54:result simulation 1(author)

Mean radiant temperature is bounded between (29°c and 28.5°c) in indoor space where the outdoor temperature in Biskra in this period is considered as one of the hottest zones in the country.

- **Predicted mean vote**

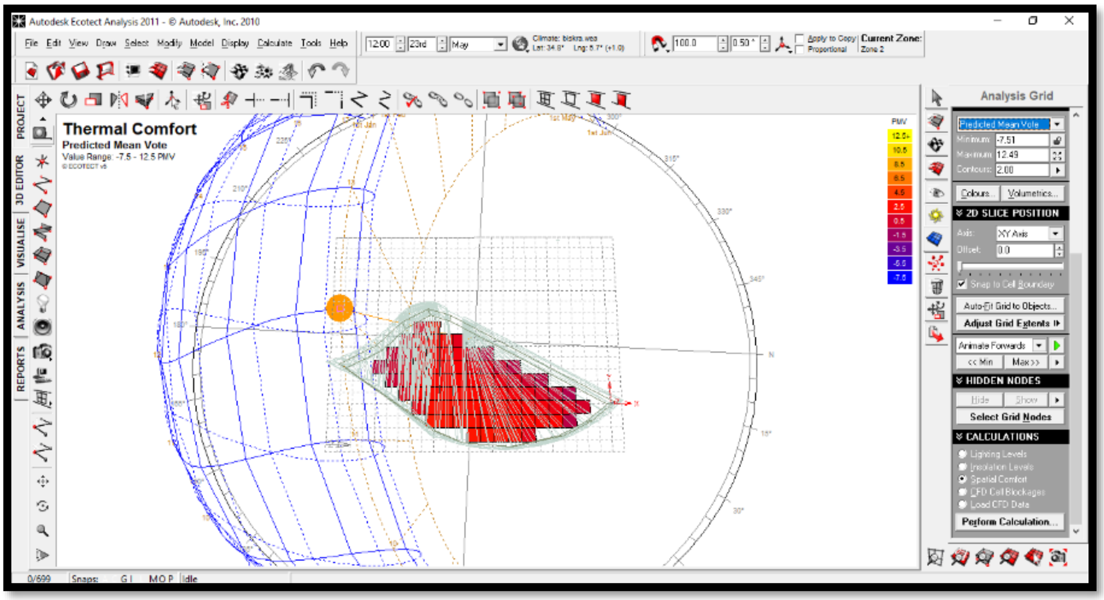


Figure 55:result simulation 2(author)

On 23rd May in the workshop the PMV value is 1.20 on all over the space, that means the space is slightly warm (date: 23/01, time:12:00) eastern side

- **Mean radiant temperature**

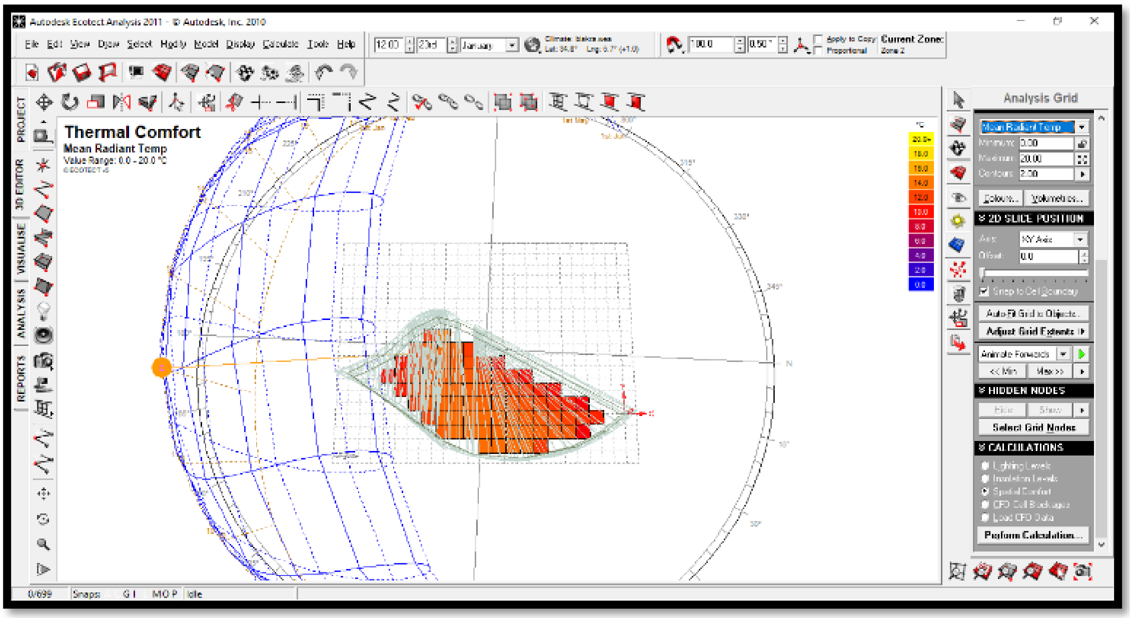


Figure 56:result simulation 3(author)

In Winter 23rd of January, mean radiant temperature is fixed at14°c in indoor space where the outdoor temperature in Biskra in this period is considered cold.

- **Predicted mean vote**

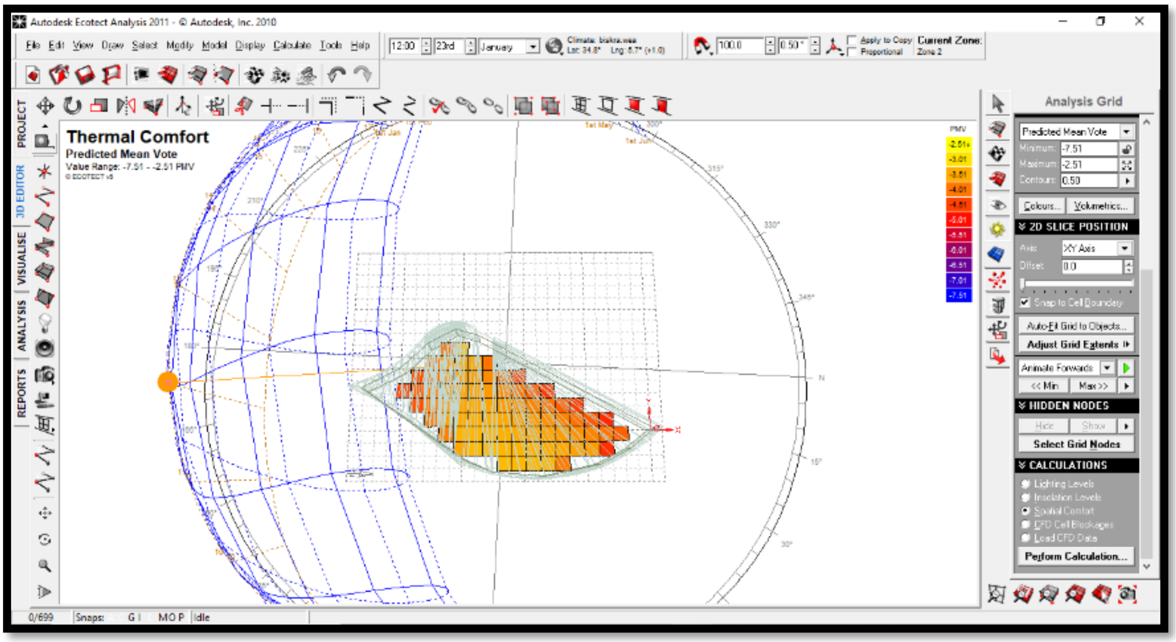


Figure 57:result simulation 4(author)

the PMV value is -3 on mostly all over the space, that means the space is cold in winter, we need HVAC system.

Zone (2) library:

(date: 15/05and 09/08, time:11:30) southern side

- **Mean radiant temperature**

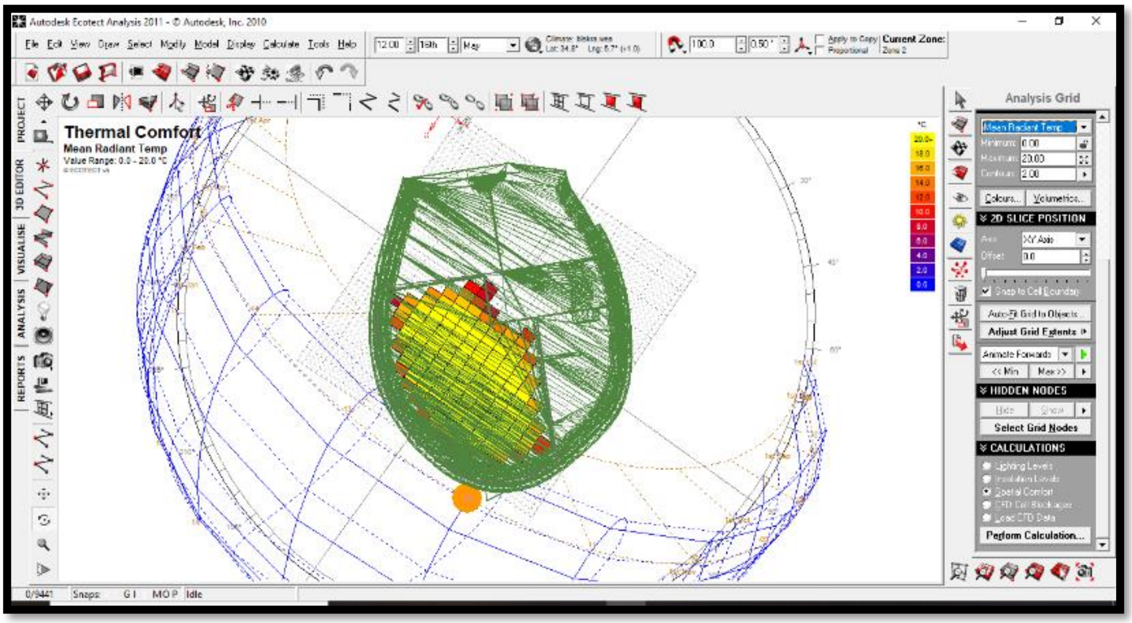


Figure 58:result simulation 5(author)

Mean radiant temperature is bounded between (18°c and 20°c) in indoor which is considered good (comfort) for occupants

- **Predicted mean vote**

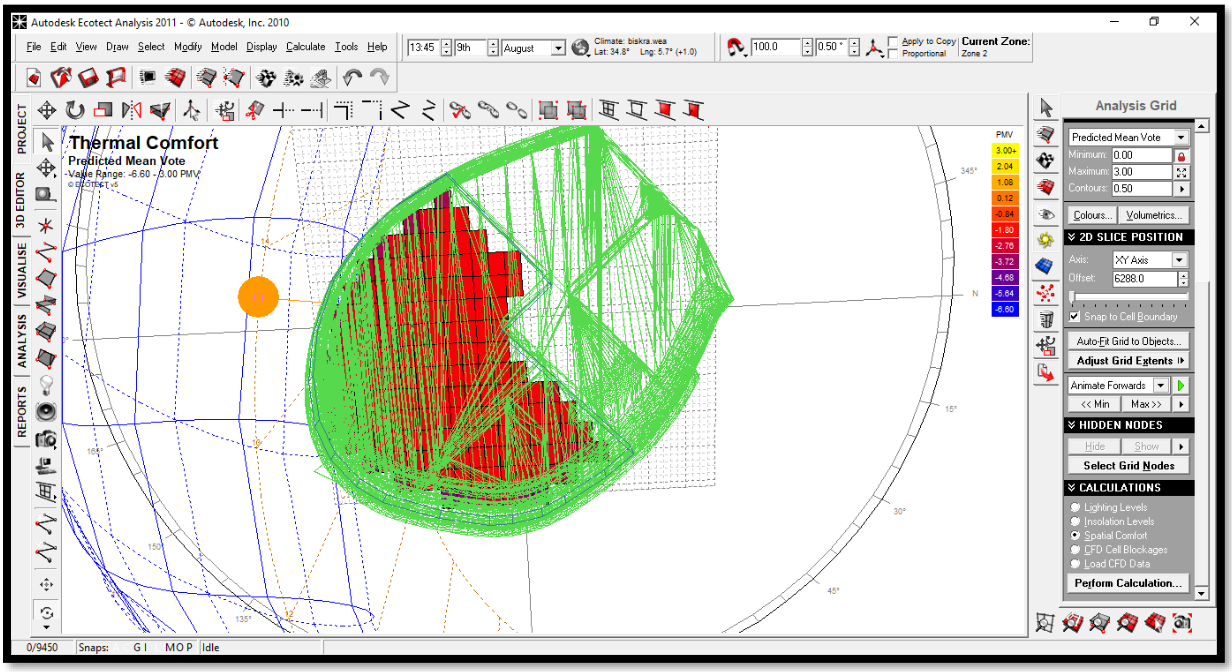


Figure 59:result simulation 6(author)

the PMV value is bounded between -1.8 and -0.8, that means that the library is not cool or hot (neutral) which is good for the occupants.

(date: 23/01, time:12:00) southern side

- **Mean radiant temperature**

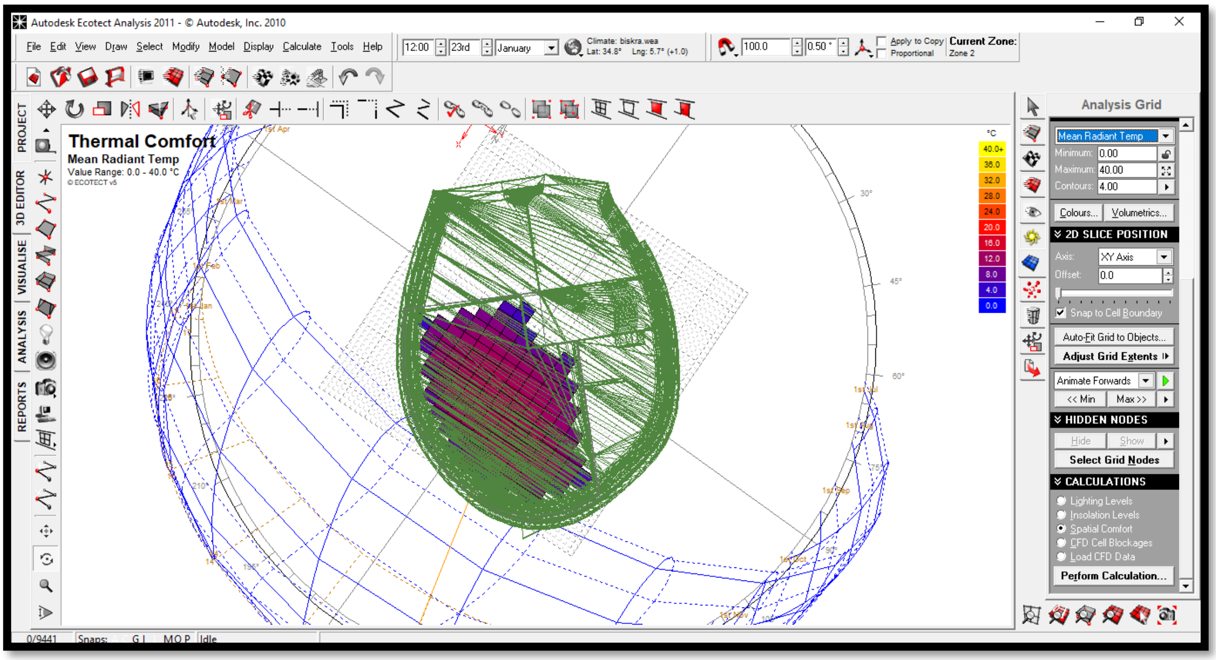


Figure 60:result simulation 7(author)

Mean radiant temperature is bounded between (18°c and 20°c) in indoor which is considered good (comfort) for occupants

- **Predicted mean vote**

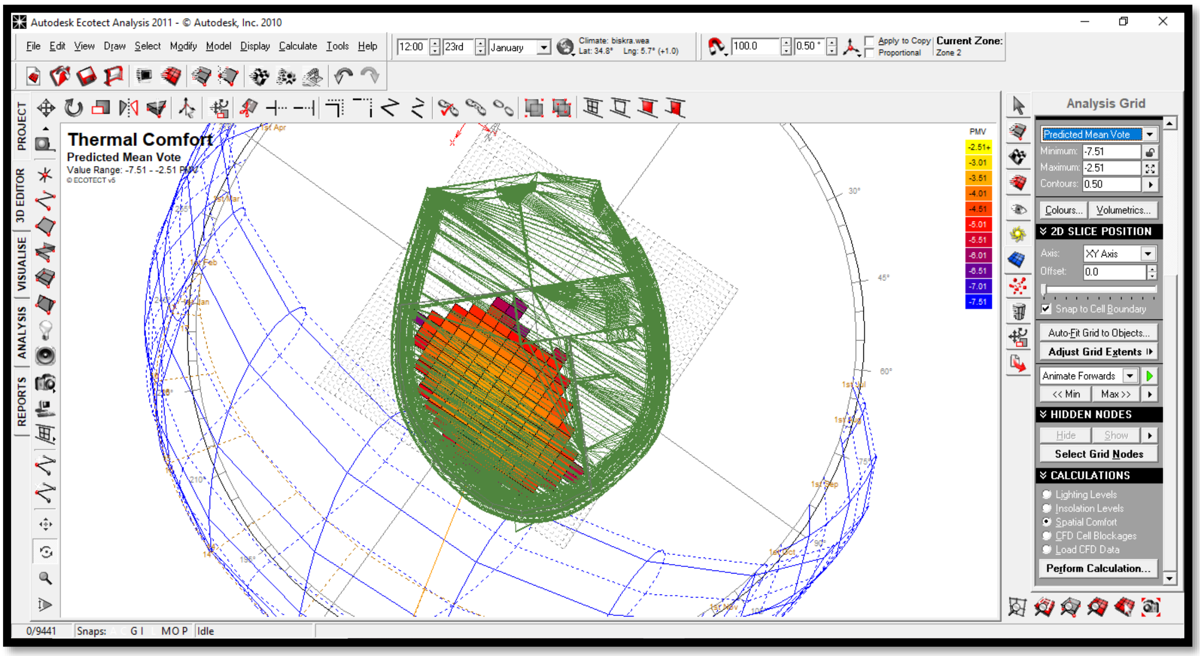


Figure 61:result simulation 8(author)

the PMV value is bounded between -3.5 and -4.0, that means that the library is cold in winter, we can improve this by good using of HVAC system inside the library.

Zone (3) lecture hall:

(date: 22/05, time:11:30) western side

- **Mean radiant temperature**

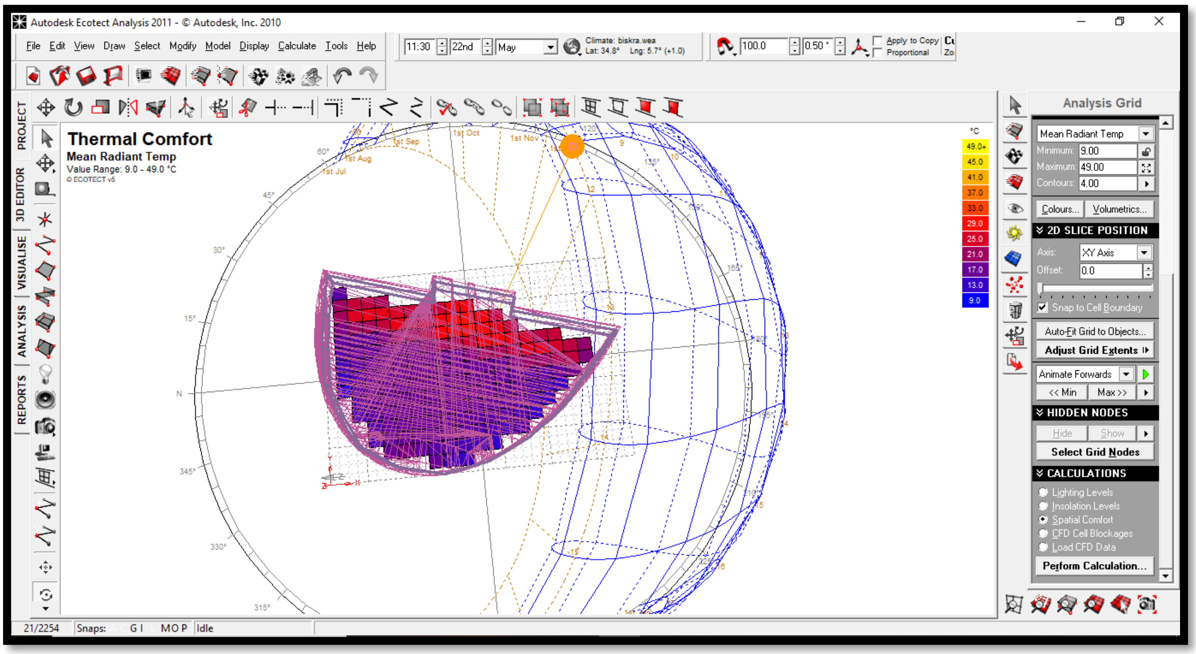


Figure 62:result simulation 9(author)

Mean radiant temperature is bounded between (21°c and 33°c) in the lecture hall which is considered good (comfort) for occupants

- **Predicted mean vote**

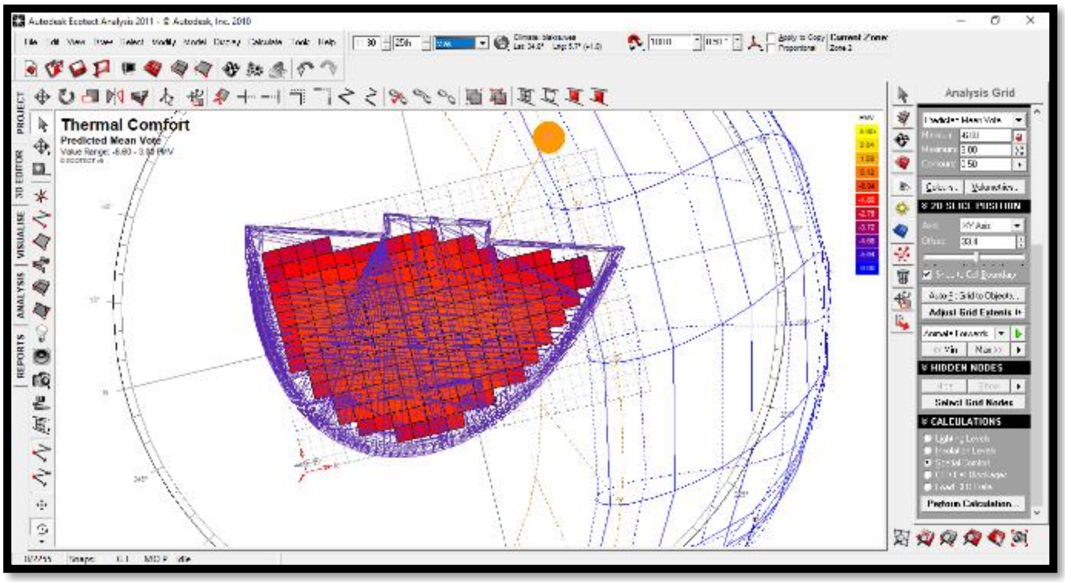


Figure 63:result simulation 10(author)

the PMV value is bounded between -1.8 and -0.12, that means that the lecture hall neutral (no cold, no hot), which considered comfort for students (date: 01/01, time:11:30) western side

- **Mean radiant temperature**

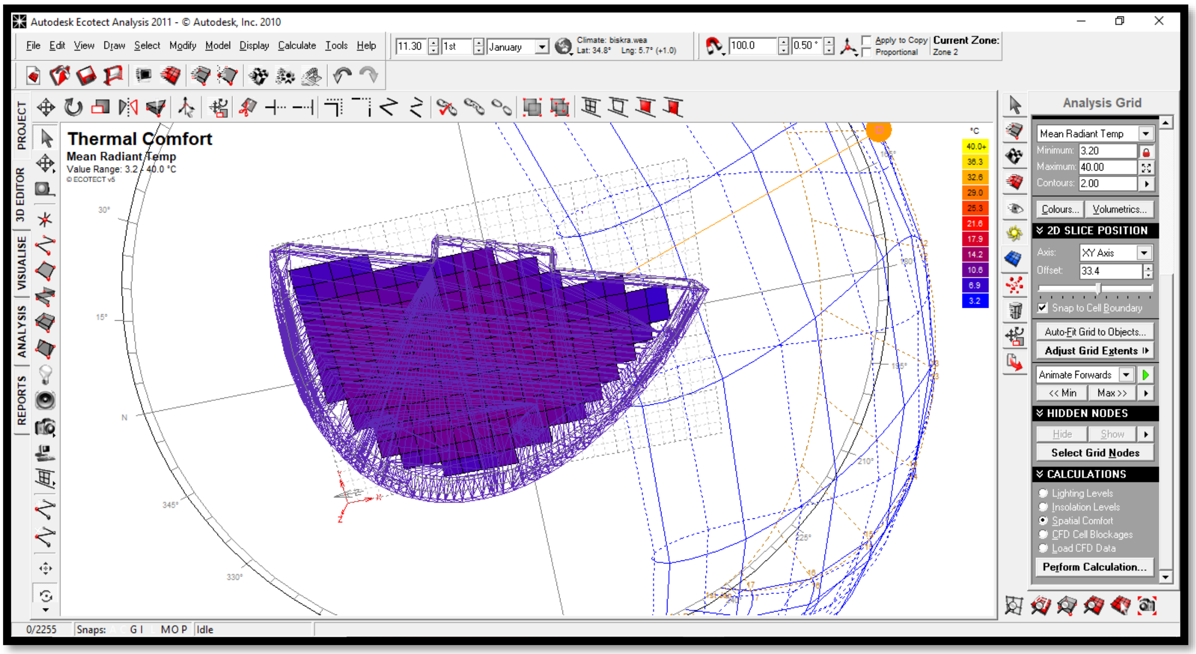


Figure 64:result simulation 11(author)

Mean radiant temperature in the lecture hall is bounded between (08°c and 14°c) which is considered cold for occupants, we use HVAC system to improve the thermal comfort here.

- **Predicted mean vote**

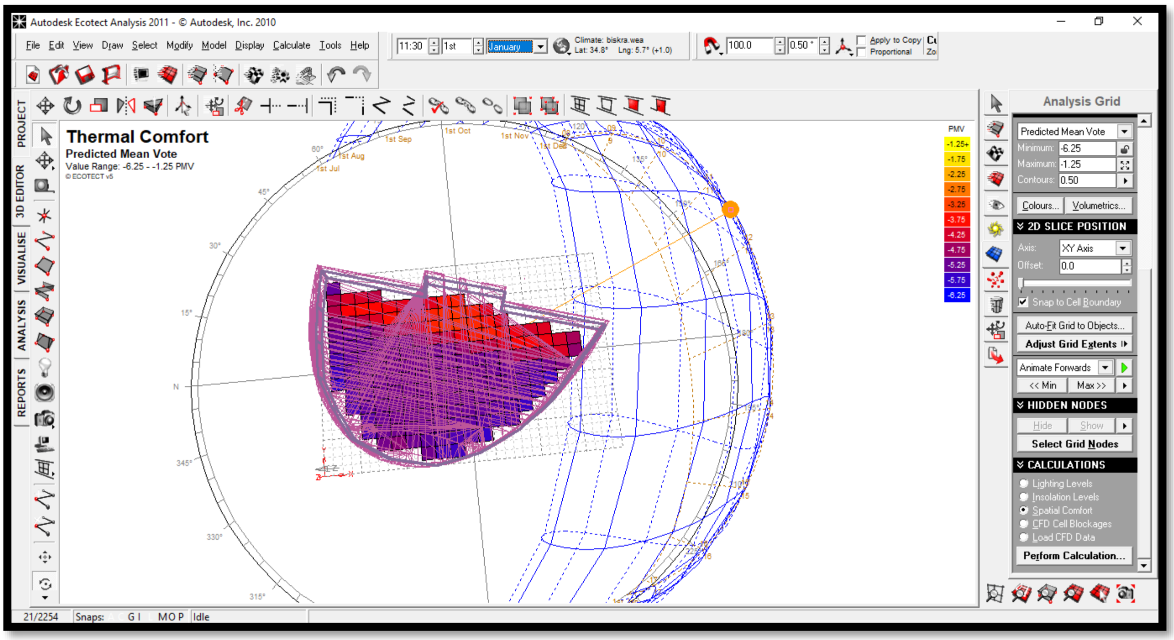
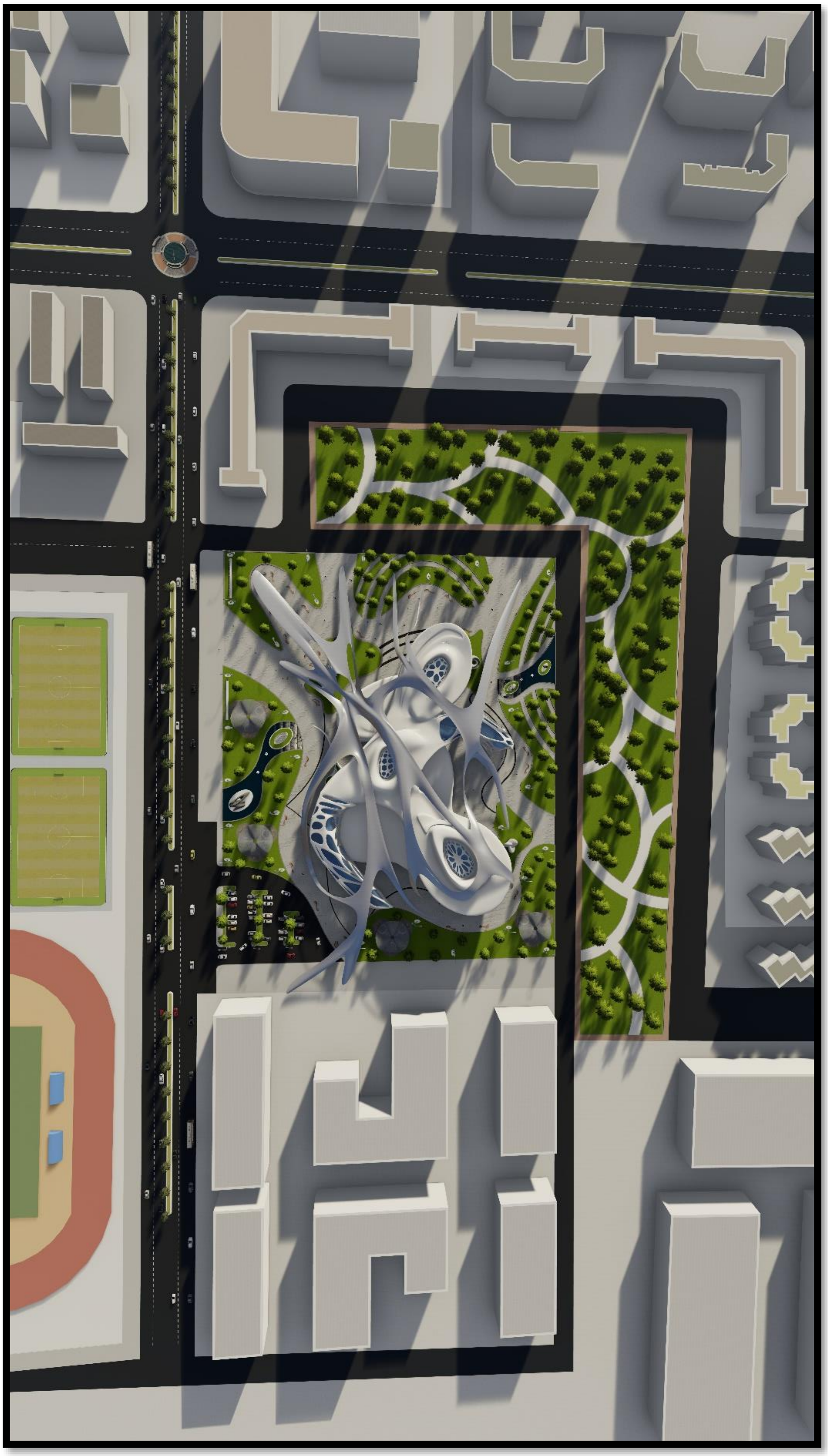


Figure 65:result simulation 12(author)

the PMV value is bounded between -4.75 and -3.25, that means that the lecture hall is cold in winter, we can improve this by good using of HVAC system inside the lecture hall

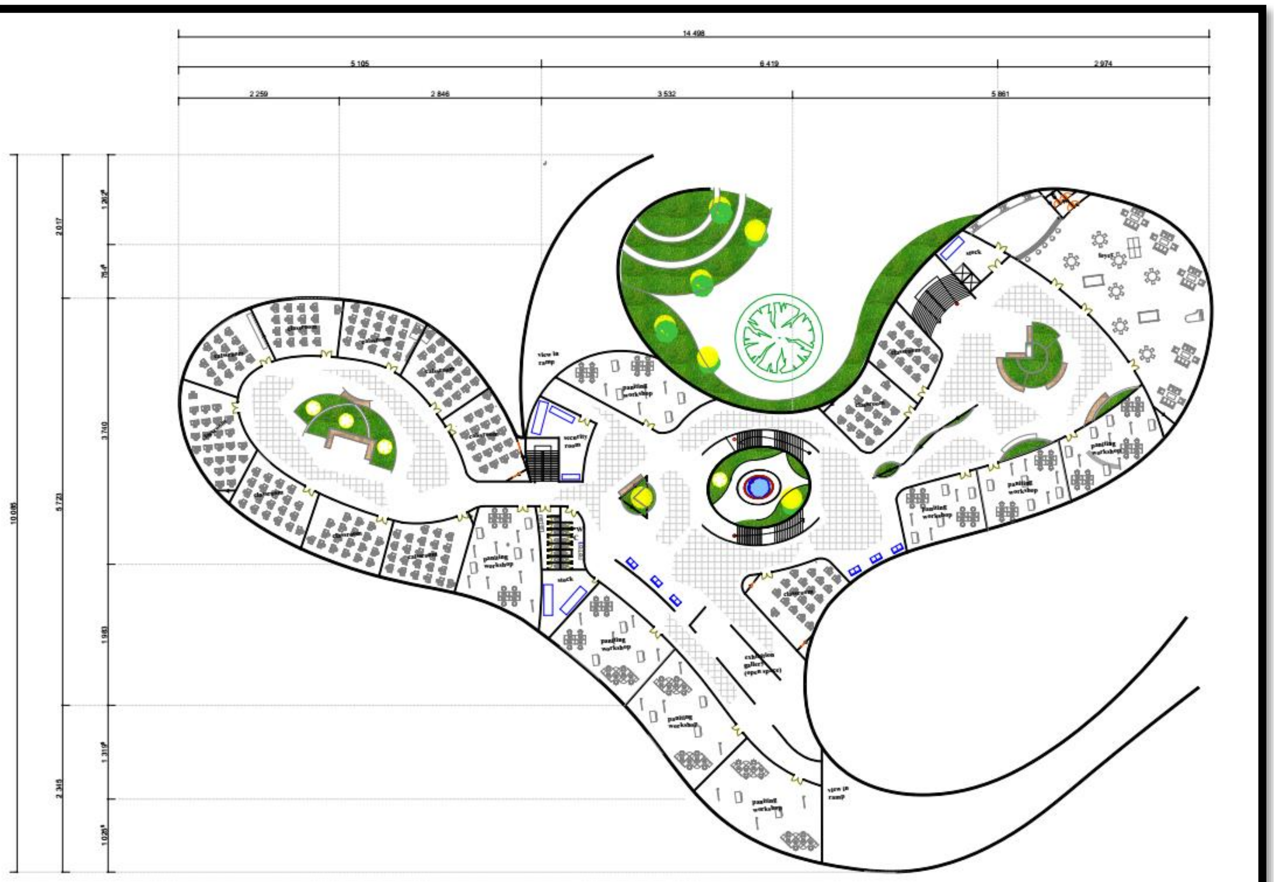
2.4 Presentation of graphic file of the project



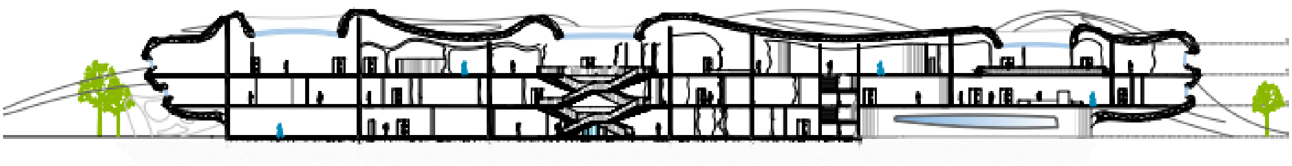
Mass plan

GROUND FLOOR

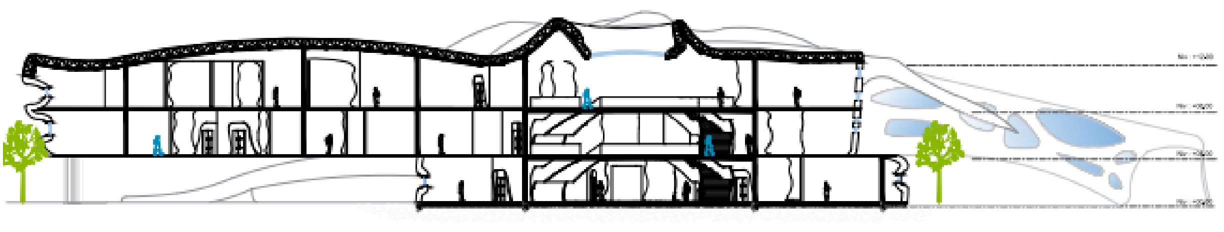
FIRST FLOOR



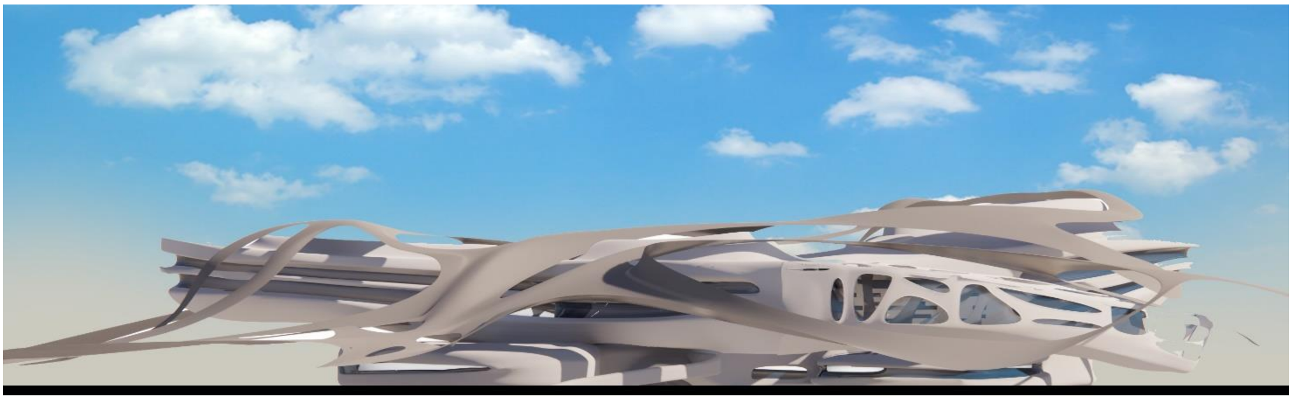
SECOND FLOOR



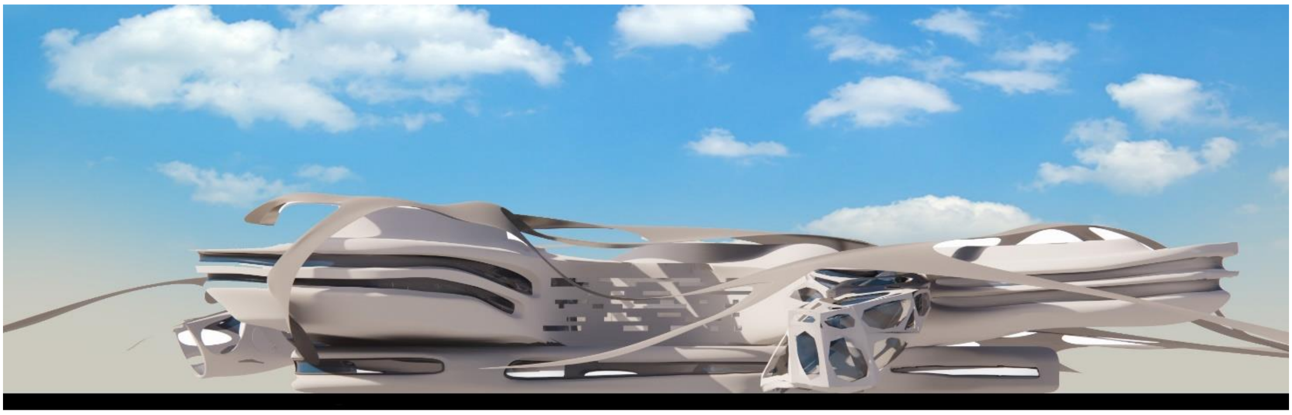
SECTION A-A



SECTION B-B

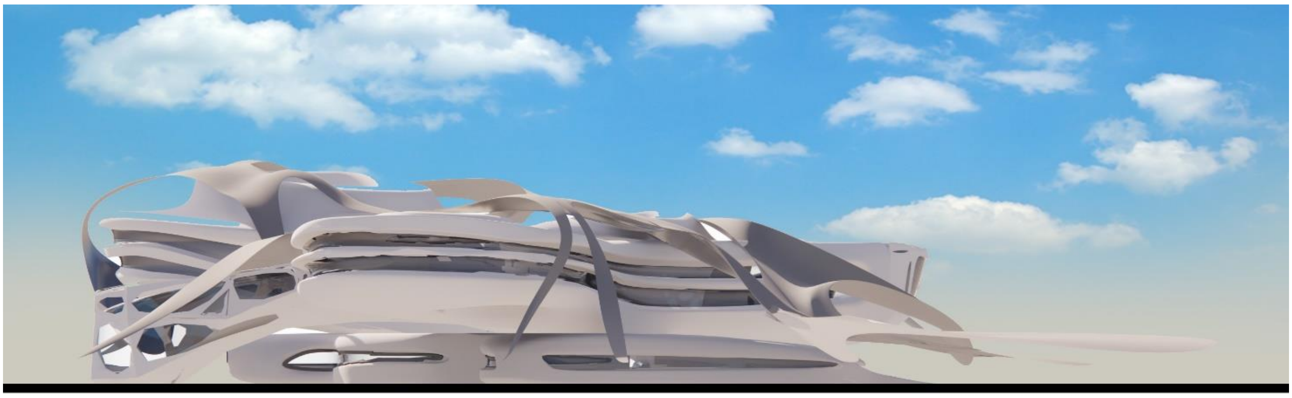


Eastern façade



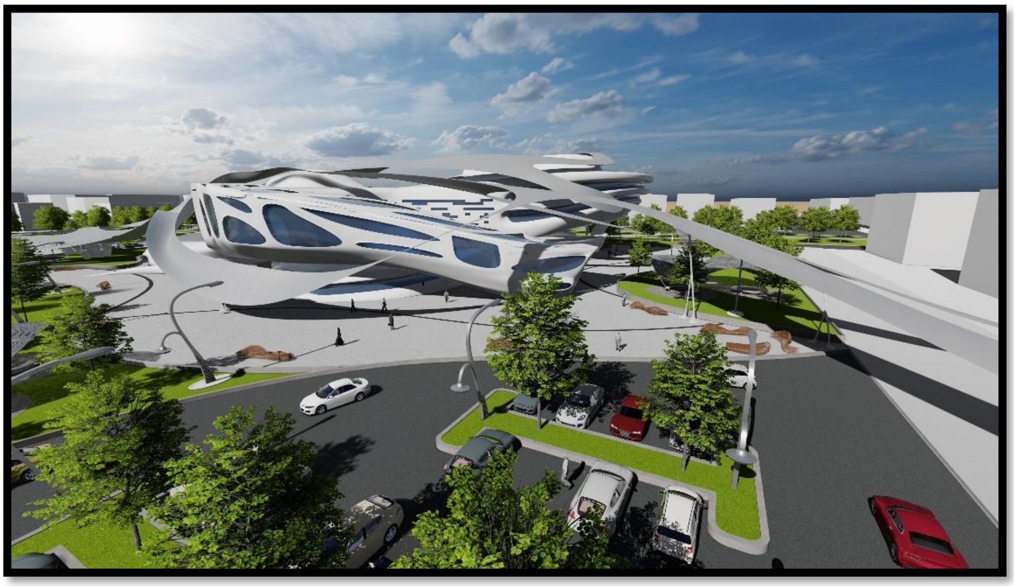
Western facade

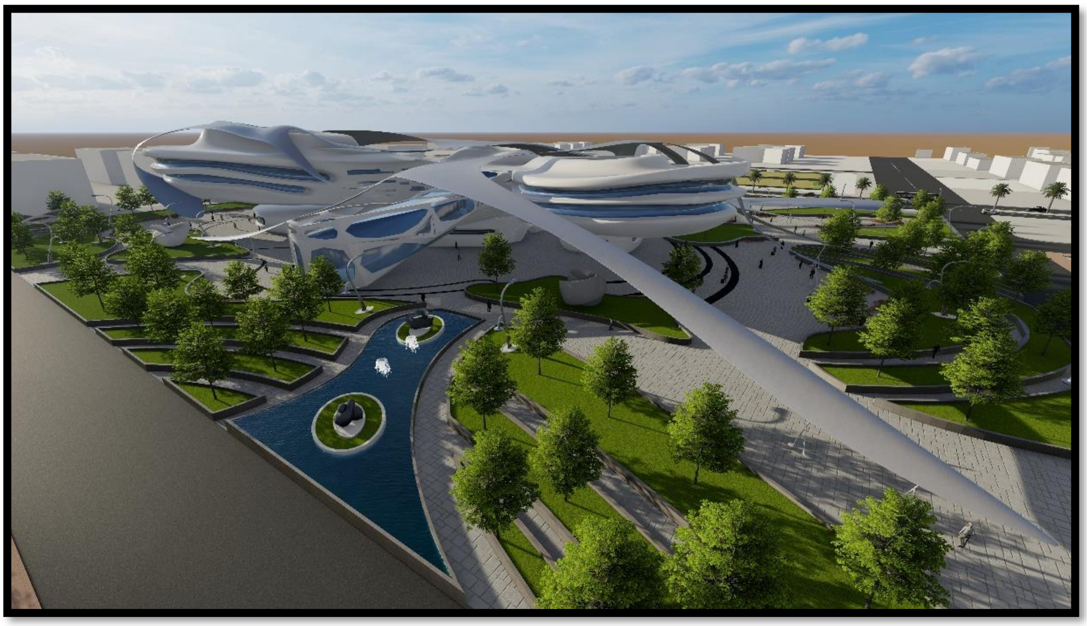
Southern facade



Northern facade

OUTDOOR VIEW:






SCHOOL OF ARCHITECTURE

INDOOR VIEW:

Conclusion

In this chapter we have studied the practical approach which contains the intention that clarify the main goal of the project in its environment mentioning the tools and the techniques used to achieve the goal, Furthermore, we indicated the prosses of developing the idea, and then the lecture and analysis of the result of simulation . finally, we represent the graphical file of the school of architecture.

General conclusion

Architects are demanded for simple and brief approach to assess the thermal comfort conditions, thereby to fulfil the requirement of human thermal comfort.

This comfort approach can be scaled to fit any situation. The core concept of considering all six variables when designing a building is applicable to every environment. This foundation can then drive a more integrated design that uses targeted systems to enable personal comfort approaches.

to achieve thermal comfort subconsciously every day. One of the main purposes of buildings is to protect us from extreme outdoor conditions. And using shading system against solar heat gain is the most readily applicable and flexible method of cooling which can be applied in all climate types in which the sun’s influence is significant, and to almost all modern buildings irrespective of latitude. The key to good daylighting and thermal performance lies in the design of the building envelope. Shading devices can be an integral part of the envelope, and thus influence thermal and daylighting performance and that’s what we applied in our school of architecture in classrooms and study spaces, providing thermal comfort for students.

The objective of this research is to achieve comfortable spaces for working by maintain or improve optimal thermal comfort. The theoretical part of this work studies thermal comfort and its parameters which are directly related to different aspects and its characteristics, and the shading system and its typology and techniques and then school of architecture, all this in the first chapter. The second chapter studies the analytical part of the examples and the site and mentioning the standards and the program, the results and the recommendations extracted from this analysis were taken into account in the design of our project (School of Architecture in Biskra). Finally, the practical chapter is about the intention of project and the simulation to examine the thermal comfort in spaces then the graphical file of the project.

The result of simulation showed that in summer the temperature in spaces generally is optimal according to the PMV results but in winter the spaces are cold. Since Biskra is a very hot city that suffer from long summer period (sometimes 6 months) it will be better to design a building that resist hot climate.

This study is specialized in thermal comfort through shading system in school of architecture which contains different factors and parameters, by research and analytical methods we attain to understand and maintain those parameters to achieve thermal comfort in our spaces, because those parameters have a significant effect on student performance.

Comfort in indoor spaces is generated by a complex interaction of a person with the building. The space people use in buildings is largely influenced by the architects and interior designers. The behaviour of the building envelope, structure, form and height of indoor spaces, building materials used in the building all affects the thermal comfort and indoor environment conditions that will be achieved indoors. The point here is that the approach of designing buildings should be an integrated design process between all the teams who works to design and create the buildings and the indoor spaces.to achieve an optimal thermal comfort for occupants in the building.

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A.B. Mohammed

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Thermal Comfort: Analysis and Applications in Environmental Engineering

Adaptive Thermal Comfort: Principles and Practice, Fergus Nicol,Michael Humphreys and Susan Roaf

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