BIOCLIMATIC INTEGRATION INTO THE ARCHITECTURAL DESIGN

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Thesis submitted to the University of Nottingham for the degree of Doctor of Philosophy

July 2007

The reader is asked to take into consideration and view with benevolence the fact that the author is not writing in his language.

ABSTRACT

This research studies the influence of architectural education and early work experience of a group of architects, whose work shows strong features of bioclimatic integration (such as Lele and Severiano Porto in Brazil and Spencer de Grey and Mario Cucinella in Europe). It also evaluates the relation of this background with their understanding of architecture itself and, consequently, with their understanding of their professional role. Nevertheless, the research also evaluates the principles and beliefs translated in their design philosophy, which affects their main considerations and approach to the design problem, regarding the integration of bioclimatic issues. It also embraces the evaluation of the impact of requirements of energy efficiency in building regulations on the integration of bioclimatic concepts into architectural design. Therefore, these evaluations also provided the information to establish a relation between background and practice. Establishing this relationship, the related problems or effective examples of the consideration of bioclimatic concepts in design were recognized and synthesized.

The analysis of their individual experiences, through semi-structured interviews, indicates that the integration of bioclimatic concepts into design is beyond the development or improvement of tools. First of all, it is fundamental that these concepts are part of the design philosophy of the professional, which is determinant on the application of research and innovation in architectural practice. Therefore, before the tools, the formal education can be a tool to promote the integration of these principles into their design philosophy. It happened in the cases in which there was a commitment of the school to develop a technical knowledge base in building physics through studio activities, with emphasis on the aesthetic character of environmental integration. This knowledge can be consolidated in the contact with the building site construction, which also strengthens the ethical commitment regarding the quality of the built object. It has the potential to generate confidence on the consideration of bioclimatic issues, also making it easier to get the right information from available resources and tools, via a critical understanding of the different issues.

PUBLISHED PAPERS

Maciel, A., Ford, B. and Lamberts, R. *Main influences on the design philosophy and knowledge basis to bioclimatic integration into architectural design—The example of best practices. In: Building and Environment*, *Volume 42, Issue 10*, *October 2007*, *Pages 3762-3773.*

ACKNOWLEDGEMENTS

I gratefully acknowledge the interviewed architects; Joao Filgueiras Lima- Lele, Severiano Porto, Leonardo Bittencourt, Sergio Pamplona, Romulo Bonelli, Luiz Buzato, Alexandros Tombazis, Mario Cucinella, Tom Jestico, Andrew Marsh, Spencer de Grey and Sunand Prasad. They were of fundamental help for the development of this research, being very collaborative dedicating their time to the interviews and giving their permit to publish their individual statements.

I am also very grateful to:

My supervisors Brian Ford and Roberto Lamberts (Federal University of Santa Catarina- Brazil) for the continuous support and guidance.

My friends from the Laboratory of Building Energy Efficiency (LabEEE) and my friends from the School of the Built Environment at the University of Nottingham, in special to Maureen Trebilcok and Fidel Meraz Avila, for the strong support on the development of the research.

The Graduate School at the University of Nottingham that also provided a fundamental technical support through the training courses.

The internal examiner Graham Farmer and the external examiner Paula Cadima for the profound evaluation and contribution to the final result of this work.

And to my family, Maciel, Diva, Renata, Leonardo, Marcela and Gustavo for the permanent support and faith on me.

This research was made possible in part by the Counsel of Technological and Scientific Development – CNPQ- Brazil, which sponsored the research developed at the University of Nottingham, and by the University of Nottingham itself, which also sponsored part of the period of my studies. I'm also very grateful to the National Program of Energy Conservation (PROCEL/ELETROBRÁS). It sponsored the research for the development of a database to support projects of energy efficient buildings, in which I worked during 2004 and 2006 (second and fourth year of my thesis). Therefore, it also provided the financial support for this period of my studies.

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1 INTRODUCTION

Buildings use at least 50% of all the energy produced in our planet for heating, cooling, lighting and in the industries and building construction (ERG et al., 1999). So the biggest part of this consumption is directly related to architectural aspects and the use of the space. And in this case, the environmental integration of the building design through passive strategies presents a very good potential of energy saving.

In the 1960's the environmental movement started to play an important role inspired by iconic publications such as Silent Spring written by Rachel Carson, in 1962 (CARSON, 2002). So, the first actions regarding a more conscious environmental attitude started to be explored in many fields. In 1963 the term bioclimatic was used for the first time by Victor Olgyay. Among other achievements in bioclimatology, he developed a bioclimatic chart, which relates climatic data to thermal comfort limits, to identify design strategies (OLGYAY, 1973). So, bioclimatology relates the study of the climate (climatology) to the human beings. The bioclimatic design is an approach that takes advantage of the climate through the right application of design elements and building technology for energy saving as well as to ensure comfortable conditions into buildings (GOULART and PITTA, 1994; ERG et al., 1999). If this approach is considered since the first design stages it has an even higher potential to save energy.

However, despite the proven advantage of integrating bioclimatic concepts into building design, there is a considerable difficulty in their real application, mainly in the early design stages, in which the main design solutions are defined (ROWE, 1987). The scientific knowledge accumulated since the 70's, with the definition of guidelines, analysis tools, case studies, among other results, has improved and developed a consolidated technical field in energy efficiency. But it has not demonstrated an effective influence on architects' design practices. There is a gap between the academic knowledge and the practice. Tombazis (2002) states that "bioclimatic design has indeed come a long way, but unfortunately at the same time it still has a long way to go before it is to be universally accepted by architects and the other members of the design team as being part of architectural design and not just a fad that will blow away with all the other "isms" that have come and gone."

Although issues of design methods and research have been articulated to integrate objective methods in practicing design (CROSS, 2000), for most of the architects and the general public, bioclimatic architecture is still a collection of additional equipment and technology. Bioclimatic concepts are not really part of the design concept. In a study

developed in Kuwait, Touman and Al-Ajmi (TOUMAN and AL-AJMI, 2005) point out that neglecting the climate as a design consideration is one of the main reasons for failures in building performance.

Also, the efforts to introduce these themes are not based on architects' real design needs. Furthermore, the appeal to the integration of these concepts has been based mostly on the economic appeal, which seems very limited; although in Europe legislation has had a gradual impact, particularly in Germany. Nevertheless, there is no consolidated information about what are the real barriers to bioclimatic integration.

It emphasizes the importance of identifying the parameters usually manipulated in the design process and the way bioclimatic concepts are considered in this process. These indications can constitute a set of fundamental information to develop or to improve a methodology to the effective integration of bioclimatic concepts into architectural design, regarding architects' real design needs.

Therefore, this research studies the influence of architectural education and early experience in architecture of a group of twelve architects, whose work is renowned by strong features of bioclimatic integration. It also evaluates the relation of this background with their understanding of architecture itself and, consequently, with their understanding of their role as professionals. Nevertheless, the research also evaluates the principles and beliefs translated in their design philosophy, which affects their main considerations and approach to the design problem, regarding the integration of bioclimatic issues.

The analysis of their individual experiences was done through semi-structured interviews. Regarding the importance that searching for building references assumes in architectural practice, the choice for renowned architects was settled to guarantee the reliability of the results and that their work would be accessible to readers interested in the present research.

The first amount of data was bigger than the twelve architects. However, there were some cases that, although the interviewee classified his work as "environmentally integrated", during the interview process strong conflicts of knowledge regarding bioclimatic concepts were identified. It agrees with Tombazis (TOMBAZIS, 2002) when he points out the increasing number of present day architecture which pretend that they are bioclimatically sound but in reality pick and choose only what can give some "in vogue", pictorial components of value for their design. And in this case it is often based only on extra unneeded technology or complicated M/E systems. In other cases, the speech was conceptually strong but the work of the architect would not be clearly focused on bioclimatic design solutions. In both cases the interview material was not used and three

interviews were eliminated. The data was limited to the architects, whose work showed the evidence of strategies to environmental integration to maximize internal comfort, being coherent to the concept of bioclimatic design.

Issues such as age, size of practice and buildings end-use, were not a limitation or distinguished on the selection of these architects and on the following evaluations because the first focus of investigation was on the principles which would guide and influence their design philosophy on the approach to design. Nevertheless, it would be before the first sketch and prior to the mentioned issues. In this case, it is their background that would assume a central role on the investigation. However, the implications of different social contexts were distinguished when the investigation focused on specific constraints of practice, such as the evaluation of the impact of building regulations and particular energy efficiency requirements on the integration of bioclimatic concepts into architectural design.

Therefore, these evaluations also search for information to establish a relation between background and practice. Establishing this relationship, the related problems or effective examples to stimulate the consideration of bioclimatic concepts in design can be recognized and synthesized.

1.1 RESEARCH QUESTIONS AND OBJECTIVES

The main research questions of this research are:

- Why, despite all developed knowledge in building energy efficiency and bioclimatic design, most of the architects do not integrate it into design?
- Why some of them do integrate it?
- How does it happen?

1.1.1 Main Goal

The main goal is the determination of the fundamental influences and practices to the real integration of bioclimatic concepts into building design, based on architects' real needs and practices related to the definition of the design concept.

1.1.2 Specific goals

- Identifying the design aspects and principles usually manipulated to define the design concept.
- Identifying the necessary level of understanding of bioclimatic concepts and building physics, to their effective integration into building design.
- Identifying influential issues on bioclimatic integration related to different social, political or economical contexts.
    - Identifying the influence caused by the existence of green labels and requirements of energy efficiency and thermal comfort in building regulation.
    - Identifying positive and negative aspects of support tools and devices based on the experience of architects.

1.2 OUTLINE OF THE THESIS/ OVERVIEW

The introduction and the research questions and objectives of the research are presented in Chapter 1.

Chapter 2 presents the literature review that was developed to bring the most influential themes related to the problem of integration of bioclimatic issues into the architectural design. It approaches the influence of the architectural expression and design on the energy consume of buildings and their impact on global energy consumption. Furthermore, it defines the concept of bioclimatology and its consideration or not in the design process. The chapter also approaches the history of environmental concerns in architecture into which concerns on bioclimatic design can be contextualized. Nevertheless, design tools, energy efficiency requirements of regulations and standards and the role of professional institutions are also presented and discussed.

Chapter 3 describes the applied methodology to achieve the defined goals of the research. Therefore, it describes the approached topics through the adoption of a qualitative research and the application of semi-structured interviews with selected architects.

Chapter 4 discusses the results acquired from the interviews according to the framework based on a phenomenological and cognitive approach to the process of perception and understanding of the problem. It discussed separately, the results related to the main influences on the design philosophy and knowledge base, the considered conditions and guiding principles, the main features of professional practice in architecture, the aids and interactions in the design process, the identified problems, the possible solutions and the effect of building regulations.

Chapter 5 presents and discusses the main findings that provide answers to the research questions. Based on these findings this chapter proposes actions to promote the integration of bioclimatic issues into architectural design and suggests future research themes following the findings of this research.

The appendix A presents the topic guides applied to each interview.

The appendix B presents the material of the categorization of each interview, available only in CD-ROOM.

The appendix C presents the condensation through the drawing panels of each interview.

The appendix D presents the spreadsheet of the grouping analysis, available only in CD-ROOM.

2 LITERATURE REVIEW

This chapter brings the most influential themes related to the problem of integration of bioclimatic issues into the architectural design. It approaches the influence of architectural expression and design on energy consume of buildings and their impact on global energy consumption. It approaches the concept of bioclimatology and its consideration, or not, in the design process. Nevertheless, design tools, energy efficiency requirements of regulations and standards and the role of professional institutions are also presented and discussed.

2.1 IMPACT OF BUILDINGS ON ENERGY CONSUMPTION

According to data of the ENERGY RESEARCH GROUP (ERG, 1999), the edifications use at least 50% of all the energy used in our planet. Most of this amount refers to fuel for heating, cooling and lighting and the rest of it for the industries and building construction. In the European Community, the residential and tertiary sector, the major part of which are buildings, accounts for more than 40% of final energy consumption in the Community. And it is expanding, a trend which is bound to increase its energy consumption and hence also its carbon dioxide emissions, which are one of the responsible for the global warming (EC, 2003). Therefore, the buildings are responsible for 47% of carbon dioxide emissions across the 25 nations of the European Union. And despite all the international conventions, carbon dioxide emissions from developed countries are showing little sign of decreasing (SMITH, 2005).

Until the early 20th century, the only way to control the indoor climate was through passive strategies. With the introduction of mechanical building services, it became a separate profession (HARTOG, 2004). The evolution of technology and the development of new artificial systems for lighting and air conditioning, as for example the air conditioning equipment developed by Willis H. Carrier in 1902 (TURNER et al., 2002), were great contributions for the internal thermal comfort of buildings. However, for some time, these new systems and the availability of cheap energy made the architects ignore the climatic characteristics of each region, resulting in dependence and indiscriminate use of such systems. Therefore, the majority of global energy use is employed in reducing the impact of the natural environment on us.

According to Geller, “just the air conditioning equipments represent 20% of the commercial consumption in Brazil” (GELLER, 1994). Artificial air conditioning in buildings in recent years have become the more representative final use in what concerns energy consumption due to a raise in the demands for comfort made by users and building

inefficiencies. The same has happened in southern European countries, which have seen a rise in the number of air-conditioning systems. This creates considerable problems at peak load times, increasing the cost of electricity and disrupting the energy balance in those countries. The European Community emphasizes in its directive on the energy performance of buildings (EC, 2003) that priority should be given to strategies which enhance the thermal performance of buildings during the summer period. To this end there should be further development of passive cooling techniques, primarily those that improve indoor climatic conditions and the microclimate around buildings.

Therefore most of the energy consumption in commercial buildings and offices is related almost exclusively to architectural aspects, because the final uses such as lighting and air conditioning are directly related to the type of architecture and occupation of the space. Building's form and orientation have been ignoring the local climate and it had severe effect on emissions. It also suppressed many experimental qualities that a concern with climatic issues had previously inspired. It is related to the phenomena in which cities and buildings through the world have begun to look the same, irrespective of location. In developing countries the problems generated by the importation of universal forms of architecture are particularly acute (FISHER, 2004; ROAF, 2004).

Broadbent notices that to avoid the problems that can arise from inappropriate styles, such as the glass curtain-wall, contributions from an adequate base of theory are necessary. Therefore, it would be necessary a changing of paradigms, to change the phenomena with which architects deal (BROADBENT, 2004). It's necessary to think about it and to integrate the architectural design to environmental questions, minimizing the need for auxiliary equipment and, consequently, reducing energy consumption. Buildings will have an impact on long-term energy consumption and new buildings should, therefore, meet minimum energy performance requirements, tailored to the local climate. Best practice should in this respect be geared to the optimum use of factors relevant to enhancing energy performance (EC, 2003).

According to Doug Seiter, Administrator of the program Austin Energy Star, in Austin, Texas, by improving the energy efficiency in residences, in 1991, the program saved about 165,000 dollars, which would be spent on residential heating or cooling, conserved 617,000 kWh and avoided the emission of 378,000 kilograms of carbon dioxide (DOE, 1995).

Therefore, such as emphasized by Peter Smith (SMITH, 2005), it is appropriate that the design and construction of buildings should be the prime factor in the drive to decrease the effects of climate change. And one of the guiding principles should be the

integrated design, meaning a constructive dialogue between architects and service engineers in defining the design concept.

2.2 THE BIOCLIMATIC DESIGN

Bioclimatology relates the study of the climate (climatology) to the human beings. The bioclimatic design is an approach that takes advantage of the climate through the right application of design elements and building technology to control the heat transfer process. Therefore, this control promotes energy saving as well as ensures comfortable conditions into buildings (GOULART and PITTA, 1994; ERG, 1999).

In this case, the bioclimatic design is indeed specifically related to the understanding of local climatic features and to the application of passive strategies related to this understanding. According to GIVONI (1994), the term 'passive' does not exclude the use of mechanical equipment when necessary, if it is used to increase the performance of the system. Therefore, the bioclimatic design differentiates itself from what is called sustainable design. The sustainable approach is looked from the perspective of the impact of the building on the local environment in which it also embrace the embodied energy of the material and its durability and the use of water and energy. In the bioclimatic approach, energy saving and a lower environmental impact are consequences of the integration of the design solution to local climatic features to achieve better comfortable conditions and it is not necessarily limited by the building material. There is also the concept of solar architecture, which was "high-technologically" driven and mostly focused on thermal heating solutions. The term appeared after the oil crisis of the 70´s but gradually fade away because, such as WINES (2000) points out, the components of environmental technology were treated as "installed" rather than "expressed" elements of design. However, such as Tombazis (2000) says "there is no such thing as non-solar buildings! There are just some that are clever and others that are stupid."

The association of these concepts to building design since the first stages of the design process has an even higher potential to save energy while maintaining the comfort of their inhabitants. In the parametric evaluation of basic design parameters of four air conditioned buildings in Sao Paulo, Roméro demonstrates the potential of up to 12,1% of energy conservation (ROMÉRO, 1998). Gratia and de Herde point out that, architectural solutions directly explored during the early stages, such as the overall form of the building, the depth and height of rooms and the size of windows can together have a fundamental influence on the eventual energy consumption of the finished building. They can also influence the daylight levels and increase the summer temperatures (GRATIA and HERDE, 2003).

Despite the proven advantage of integrating bioclimatic concepts into building design, there is a considerable difficulty in their real application, mainly in the early design stages, in which the main design solutions are defined. The design process is difficult to be put into a model due to its non-linearity and to the direct influence of architect's particular practices. However, as mentioned by ROWE (1987), it is possible to identify some common aspects, such as the definition of guidelines to help the decisions and the use of basic guidelines as starting points.

In order to implement a bioclimatic design it is necessary that architects start to consider among the complex number of constraints to be managed in the design, the thermal problem, which involves the double consideration of energy consumption and comfort.

However, there is some difficulty in incorporating these questions. All the scientific knowledge accumulated since the 70's, with definition of guidelines, analysis tools, case studies, monitored data, among other results has improved and developed a consolidated technical field in energy efficiency. But it has not demonstrated an effective influence on mainstream architecture.

Architects' discourse concentrates on aesthetic issues, while the analysis of the environmental strategy receives considerable less attention. Steane and Steemers recognize that is surprising how frequently either occupation patterns or the views of occupants have been ignored, "as if commentary on how buildings are inhabited somehow diverts attention from the finished artefact that is the building itself" (STEEMERS and STEANE, 2004). According to Stasinopoulos for most of the architects and the general public, the bioclimatic architecture is still a collection of equipment and technology and not a proposal to be implemented first through the architectural design (STASINOPOULOS, 1993).

Stasinopoulos indicates that bioclimatic architecture has become just a method to reduce the energy consumption and the act of energy saving is much more motivated by necessity than by choice. So, focusing on the dissemination of the bioclimatic design on the grounds of economy is of limited appeal. Furthermore, WINES (2000) also notices that even in well publicized "ecological buildings" there is almost no visible evidence of any attempt to resolve these contributions in terms of art. It is necessary to create and to promote an architectural language really integrated and of appealing visual message.

Some studies, based on structured interviews or questionnaires with architects regarding their working process, indicates that, although agreeing with the importance and benefits of energy efficiency issues in design, few architects actually apply these

principles. In the evaluation of questionnaires of 650 architects members of the Royal Australian Institute of Architects (RAIA) (62% answered the questionnaires), Sabine Wittmann observed that 56% showed a weak commitment to these questions, although 90% considered the energy efficient design important (WITTMANN, 1998). In a similar research with the application of questionnaires to students, professors and architects in Brisbane, Australia, Pedrini obtained results between 3.5 and 4.2 in a scale of 1 to 5, regarding the consideration of energy efficient design issues (PEDRINI, 2002).

In an open research question of Wittmann's questionnaire, related to the main considerations in the design process and quality criteria, the energy efficiency principle got 30% of the indications (WITTMANN, 1998). Therefore, less than one third of the interviewees consider it one of their main design considerations. This situation can be related to the results of PEDRINI´s research, in which the interviewed architects point out the intuition as a fundamental approach to the definition of the design concept. However, the scientific thinking and the use of charts and diagrams, to which the energy efficiency principles are related to, are not presented as relevant methods in this stage. PEDRINI (2002) also notices that during the definition of the design concept the interviewees are focused on the definition of the building geometry. Component properties are a secondary concern, followed by air conditioning systems and artificial lighting systems. In a survey applied, mostly to students and academics of architecture in Maceió- Brazil, the understanding of general principles was indicated as prevailing, although particular aspects of the building geometry are not considered properly (TOLEDO and PEREIRA, 2005).

However, the more specialized they are in energy efficiency, the more conscious on the environmental impact of their designs choices. In the work of PEDRINI (2002), only the graduated students indicated the analyses of available climatic variables as a routine for the climatic evaluation as opposed to a simple visit to the location, which was suggested by most of the interviewees.

Therefore, the problem is highlighted and statistically identified through these surveys; however there is no concrete evaluation of its reasons and its relation to the design practice. Tuschinski points out that this lack of commitment is related to the difficulty of access to the growing flux of information. Most of the currently available material is based on theoretical studies regarding technical thermal performance of buildings, lacking an efficient parallel to the practical design experience (TUSCHINSKI, 1997).

The work developed by Fernandez, presents an evaluation of the relation between the conception process and the integration of guidelines of energy efficiency to professional practice. The interviewed designers identify three distinct domains regarding the guidelines: local implementation (orientation, projections, vegetation, openings location...), treatment of density (inertia, insulation, opening typologies, spaces...) and complementary systems (regulation, performance and equipment) (FERNANDEZ, 1998). The bioclimatic issues are considered in the evaluation to identify their relation to design methods, however the way in which the architect deals with these matters in the design is not investigated. It could be observed that according to the sensitivity of each interviewee there was a preference for this or that method, but not exclusively for one, and there was no direct relationship between the designer's background and the coherent integration of environmental guiding principles.

2.2.1 Design tools for energy efficiency and bioclimatic integration

According to MARSH (1997) the name design tool is generally applied to a large amount of techniques, ranging from tabulated data on spread sheets and manual calculation methods to sophisticated programs on computational analysis. However, it may be observed that although they're classified by researchers as design tools, most of them focus more on the analysis of the consolidated project than on the decision making during the design.

It's necessary to understand that the tool will always be based on a theoretical model, in which estimations are made. To identify the most appropriate tool to your objectives it's necessary to observe the functionality of the tool. It includes which input data, the calculation method, the functions related to energy efficiency and environmental design and the required format of the output of the results.

SHAVIV classifies the design tools in two types, generators and those for performance analysis. The generative tools help in the definition of the geometry and generally require few input data and provide an envelope with many possible solutions (SHAVIV, 1999). These tools can be also referred to as qualitative tools because they provide general information and guidance to support the definition of the design concept itself and are precedent to any specific detail of the defined project. Therefore, design guidance reports, best practice and environmental assessment methods can work as qualitative design tools. Specific tools that inform about solar shading conditions are also qualitative or generative because they support the definition of primary decisions such as the building orientation. Some qualitative tools use expert systems that are based on rules-

of-thumb and acquired knowledge to support a global analysis of the design choices, such as the orientation, geometry and site treatment.

The performance analysis or quantitative tools, on the other hand, analyze quantitatively the performance of a given design. According to the definition of the European Community, the energy performance of a building is related to the amount of energy actually consumed or estimated to meet the different needs associated with a standardised use of the building, which may include, inter alia, heating, hot water heating, cooling, ventilation and lighting. This amount shall be reflected in one or more numeric indicators which have been calculated, taking into account insulation, technical and installation characteristics, design and positioning in relation to climatic aspects, solar exposure and influence of neighbouring structures, own-energy generation and other factors, including indoor climate, that influence the energy demand (EC, 2003).

Therefore, the tools related to performance analysis require the complete description of the building, thus they only evaluate the performance of a detailed solution. Marsh points out that computer tools in this area have focused on the accurate simulation of essential physical processes such as the mechanisms of heat flux transmittance through materials, turbulent air movements and the inter-reflection of light (MARSH, 1997). The simulation of these processes requires complex and detailed algorithms that demand a large number of input data.

For the bioclimatic design, the adequacy of design solutions to local climatic features is essential. A design tool can help on the interpretation of climatic data to guide the decision-making. This type of tool can be classified as a generative tool.

During the 80's some efforts were made to translate climatic information into an understandable format to the user. Aroztegui developed an innovative application of solar radiation data on the solar diagram, which helped the joint interpretation of these data to the design of solar shading (AROZTEGUI, 1980). Mahoney Tables[1] are a pioneer tool because they relate local climatic data to comfort limits, according to day and night periods, for the identification of specific design strategies. Bioclimatic charts were developed for the analysis of climatic data in order to establish design strategies. Olgyay was the first to develop a bioclimatic diagram in 1963, called Bioclimatic Chart (OLGYAY, 1973). This method relates the variables of dry bulb temperature and relative humidity and suggests strategies, such as natural ventilation and use of solar gains in the winter, as part of a philosophy of design. In a research of the educational effectiveness of using Bioclimatic Charts in a design exercise, McCartney and Matsika, identified that the use of

the chart offers effective support in designing for buildings in areas known only through abstract climatic statistics. It was improved through clearer representation of the design strategies in relation to zones of the chart (MCCARTNEY and MATSIKA, 2004).

It is possible to identify four main branches of tools for bioclimatic evaluation; 1) Tools related to the design of solar shading, using solar diagrams; 2) Tools for the systematization of climatic data; 3) Educational tools promoting the understanding concepts related to passive design and climatic integration and, finally; 4) The tools which associate climatic features with design strategies, generally through bioclimatic charts.

Environmental assessment methods, developed by government commissions, work as educational tools because they provide access to meaningful environmental data and information that helps on the decision of making-process to evaluate the environmental implications of some choices before building takes place. The existence of this kind of assessment contributes to studies, reports and guidance documents that promote the effectiveness of the assessment (http://ec.europa.eu/environment/eia/home.htm- (EC, 2003)). Guidelines also provide designers and the building industry with the best practice information on the development of environmental assessments and management plans. Best practice databases and programs are a powerful tool to demonstrate practical ways in which designers, developers and governments are working to improve the design of buildings regarding local climatic features and environmental conditions.

Some tools also aim at the integration of guidelines with simulation models. By means of expert systems, the architect is guided through the decision of making process with the application of guidelines and, whenever these cannot be applied, the system guides the designer using simulation models with precise methods. In the directory of design tools to building energy performance[2], it is possible to check the main tools available to design professionals and researchers. The Table 1 shows a range of available design tools for climatic and performance analysis.

[1] http://cma.alphalink.com.au/carlm.html
[2] www.eere.energy.gov/buildings/tools_directory

Table 1- Generators and performance analysis tools

Software	Source	Description	Observations	Group	
OVERHANG DESIGN	*Sustainable Design* (www.sundesign.com/)		Use of the solar chart- immediate response about solar position and dimension of solar protections. Input data: location, window area, period of the year. None of them relates solar incidence to thermal discomfort periods for an evaluation of the real need for shading.	1- Design of solar shading	Generators/ qualitative
SUNPOSITION					
SUNPATH					
SUNANGLE					
SUNCAST	IES (www.ies4d.com),	three-dimensional model			
LUZ DO SOL	Mauricio Roriz- UFSCAR (www.labeee.ufsc.br)	visualizing direct and diffuse radiation through the openings throughout the day and the year			
SHADOWCALCULATOR	*CA Design Associates* (www.shadowfx.com.uk)				
SHADOWFX		animation of the shade. Changing of the size of protections in the drawing			
SUN CHART SOLAR DESIGN	*Optical Physics Technology* (www.srv.net/opt/sunchrt.html)	calculates and plots cylindrical or polar solar charts and calculates the shaded portion according to window area and size of obstruction			
SOLAR 2	Murray Milne (http://www.aud.ucla.edu/energy-design-tools)	visualizing direct and diffuse radiation through the openings. Gives the percentage of window area that gets direct solar radiation on the window and a monthly summary of these information.			
AWNSHADE	Florida Solar Energy Center (www.fsec.ucf.edu)	calculate the unshaded fraction of windows to any given orientation. Calculations are made for direct radiation but not for diffuse components			
LESOSHADE	Solar Energy and Building Physics Laboratory (lesowww.epfl.ch/)				
SUNSPEC	Florida Solar Energy Center (www.fsec.ucf.edu)	calculates direct radiation and diffuse irradiance and the sum of both according to the solar position. calculates the incident irradiance on an arbitrary plan due to direct radiation, diffuse from the sky and reflections from the ground.	large amount of input data is needed such as ozone concentration, water steam, cloudiness, ground reflectivity, azimuth and solar altitude.		
WINDOW HEAT GAIN	Sustainable Design (www.susdesign.com)	solar gains through glass surfaces, with simplified input data such as location, monthly sky brightness, format, type and orientation of the window			
SUNDI	Volker Quaschning- Solargruppe (http://emsolar.ee.tu-berlin.de/simulation/sundi.html)	simplified calculation for cold situations, showing thermal losses through tables and graphs.			
ANALYSIS SOL-AR	LabEEE (www.labeee.ufsc.br)	Visualization of solar chart with hourly temperatures or solar radiation together with the local wind chart.	Design of solar shading can be done according to its real need.		

Software	Source	Description	Observations	Group	
CLIMPRO	ROBINSON, 2003	Treats climatic variables in an electronic spread sheet. Auxiliary drawing graphs relating solar, natural illumination, synopticals and ground parameters. visualization, side by side, of the graphs.	visualization of the joint behaviour of different variables.	2- sistematization of climatic data	**Generators/ qualitative**
uEXTREMES	ASHRAE (http://xp10.ashrae.org/bookstore/bookstore.html)	systematizes sequences of climatic data for periods of one week of a specific month for 329 American locations	Intended to support energy simulation programs		
IWEC		holds files TMY in ASCII format			
IWEC2		typical hourly data obtained in a form similar to TMY. calculated for the official local time for Canadian and American locations			
WEATHER DATA VIEWER,		large data bank for hourly climatic data. It allows for the formatting of output data	visualization of the joint behaviour of different variables. there is no interpretation of data, correlating them to architectural design solutions.		
BIN MAKER PRO	Interenergy software (www.interenergysoftware.com)	visualization through the systematization and treatment of ASHRAE climatic data in TMY-2 format, in spreadsheets.			
CLIMATE 1	Manfred Mueller (www.climate1.com)	climatic Atlas with data of over 1200 world stations, local maps with climatic classifications and the solar chart. visualization, side by side, of the graphs.			
IPSE/SOLARCH	Energy Research Group	description of the relevant physical proprieties of the materials and a psychrometric chart with specified comfort zones and strategies. main requirements of the Thermal Sections of the UK Building Regulations and embodied energy tables.	focus on the formulation of an energy efficient design, describing the influence of the building implantation, the physical properties of the envelope and the organization and occupation of spaces.	3- educational tools	
BATMAN	Solar Energy and Building Physics Laboratory (http://lesowww.epfl.ch/) available only in French	Use of an expert system that helps the student to evaluate his decisions and the influence of variables on the energetic performance.			
Building America Best practices series	U.S. Department of Energy. Building America Programme	Vol. 5- Give climate specific tips for energy efficient building in five different climate zones.	Specifically related to energy efficiency measures based on new technology (additional equipment and systems)		
EEBPP	Carbon Trust (http://www.thecarbontrust.co.uk/energy)	U.K. Energy Efficient Best Practice programme. It provides advice and assistance on all energy efficiency measures.			

Software	Source	Description	Observations	Group
Analysis Bio2.0	LabEEE (www.labeee.ufsc.br)	uses the Building Bioclimatic Chart (GIVONI, 1992). plotting climatic data presents, it percentages for the most adequate strategies.		4 climatic data, thermal comfort limits and possible strategies
CLIMATE CONSULTANT 2	Yung Hsin Li's dissertation (www.aud.ucla.edu/energy-design-tools)	many climatic data formats. Adaptative comfort zone in the psychrometric chart. *guidelines*- information regarding the concept of the strategy. small schematic drawings. Use of solar chart for solar shading project.	Despite the greater level of detail of design strategies, there is no relation of the indicated strategies to the climatic conditions in the discomfort periods, preventing the verification of its applicability.	
WEATHER TOOL	Andrew Marsh- ECOTECT package(www.squ1.com)	many climatic data formats. Adaptative comfort zone in the psychrometric chart. Use of solar chart for solar shading project and define the ideal orientation.		

Software	Source	Description	Observations	Group	
IDEA	Group for Building Physics and Solar Energy in Germany (http://nesa1.uni-siegen.de/)	Tools for climatic analysis, solar shading, thermal simulation performance and water consumption		5- software packages	**Performance analysis/ quantitative**
ECOTECT	Square One (www.squ1.com)	Tools for climatic analysis, solar shading, thermal, lighting and acoustic simulation. 3D model. allows an immediate visual response	calculation of shading of the selected facade is rather difficult. substitution of the design sketching activity by the simulation model		
PSA	Technion Climate and Energy Laboratory in Israel	Use of expert systems. Use of shoe box geometry (identification of potential strategies in the initial stages)	No relation between the guidelines and recommended strategies with the specific behaviour of the climatic variables	6- Thermal simulation	
PASYS					
ENERGY-10	Colorado National Renewable Energies Laboratory (www.eere.energy.gov/buildings/tools_directory/sofware)				
BDA	Lawrence Berkley National Laboratory (www.eere.energy.gov/buildings/tools_directory/software)	Use of expert systems. allows the evaluation of multiple models and includes links to a simplified module on natural and electric lighting and for the DOE-2.1			
ARCHIPAK	SZOKOLAY (1987)	integrates climatic analysis with solar geometry and a simple thermal analysis based on the admittance method of the BRE	joint evaluation of different areas of building performance. Still present inflexibility for the initial stage due to the complexity and accuracy of the analysis tools and input data.		
ENERGY	Technion Energy and Climate Laboratory in Israel (SHAVIV, 1999). It was developed just for research. It needs workstations SGI (2M flop for standard matrix LinkPack)	energy consumption calculation per final user, monthly consumption and peak power charge for a typical day in two months. Relation of these data with the comfort zone.			
DESIGNBUILDER	DesignBuilder Software Ltda. (TINDALE, 2004)	modelling and management of formulated alternatives and is mainly aimed for thermal analysis. Use of shoe box geometry in the initial stage. Database of Energyplus.			

Through the evaluation of the tools described in Table 1, it may be observed that neither the climatic analysis nor the solar shading tools relate the recommended strategies to the actual climatic behaviour of the respective period. The possibility of checking the applicability of the strategies for the periods in which it is recommended is not provided. The study developed by LOUREIRO et al points out this discrepancy. Although the bioclimatic chart indicates natural ventilation as the main cooling strategy in Manaos (Amazon), there is only 11,9% annual availability of wind, which makes the applicability of natural ventilation impossible in most of the year (LOUREIRO et al., 2001).

It can be verified that even with a growing amount of resources, there has been little progress in what concerns the possibilities of grouping and evaluating the climatic variables together. It would demonstrate a bigger coherence with the design process in which guiding principles and assumptions are generally considered all at the same time and the decisions are made according to the importance attributed to each one individually. According to Hartog in the conceptual stage, architects are interested in shape and flexibility of structural elements, while analysis tools use generalized geometry but require specific materials' properties (HARTOG, 2004).

In this case, the so-called educational tools, including guidelines, rules-of-thumb and best practices seems to be more coherent with the architectural practice, in which the construction of knowledge and decision making is strongly based on referential procedures. However, even the tools better connected to the architectural decision making are still not largely applied and not easily accessible.

The large amount of data required by most of performance analysis or quantitative tools leads the architect to make arbitrary and premature decisions to be able to define an acceptable model for the tool. These requirements are inadequate to the still subjective and incipient level of information of the early design stage. This kind of tool also does not allow for a joint analysis of the performance variables and proposed alternatives. Moreover, they represent a time increase in design process. Therefore, these tools are used almost exclusively in more advanced stages of the design, when relevant architectural aspects have already been defined and so there's little possibility of changing it. So, the simulation results are used just to satisfy the client, rule out the design or to design auxiliary systems.

MARSH (1997) points out that a tool that is applicable for the first design stage should allow a more informative analysis of the alternatives, translating the architectural sketch into a valid model of input data and translating the results in a fundamentally solid

design feedback. For the integration of the software into the design activity it is also essential that it does not interfere in the design process, in order to be really incorporated or accepted (BROADBENT, 1982; ROWE, 1987; ROBBINS, 1994). Therefore, it may be observed that even for analysis or quantitative tools that are only applicable to design detailing, the reduction in the amount and complexity of the input and output data is essential for the development of easier and quicker tools, reducing the design costs and operational decisions.

The designer can use a thermal analysis program to derive design guidelines through parametrical analyses in a “shoe box” model. Part of the knowledge basis of expert systems was derived from design guidelines developed from a large number of simulations. Despite the benefit of design guidelines it is necessary to create mechanisms for the evaluation of the climatic conditions to interrelate it with the recommended guidelines, in order to verify their applicability.

The result of interviews with architects, conducted by De Wilde in the Netherlands, shows that even in projects considered energy efficient, the decision making regarding environmental issues is intuitive (DE WILDE, 2004). In this case, the decisions relative to energy efficiency were made in the conceptual design stage and more than 70% of the interviewees did not use any software.

It is also necessary to increase public’s interest. Most of the developed tools share the same goals and objectives and follow variations of the same methods and developing principles. Hartog recognizes that analysis/ quantitative tools were developed by and for disciplines other than architectural design (HARTOG, 2004). Also, due to the unfamiliarity of architects with building services, they find difficult to relate the outcome to design and to draw conclusions based on the data. Due to reduced funding, research institutions end up concentrating their efforts in specific aspects, which result more in study prototypes than in usable tools because, in general, they are not focused on designer’s practice and needs. Therefore, there is also no consolidated information about the real barriers from the point of view of the architect in practice.

2.3 ENERGY EFFICIENCY REQUIREMENTS – REGULATIONS AND STANDARDS

In Brazil, there is no standard method or building regulation regarding energy efficiency (CARLO et al., 2006), although 42% of the energy consumed in the country is related to buildings. However, in 2001, due to an internal energy crisis, the Brazilian government approved the Federal Law no. 10295 that defines the National Policy for

Conservation and Rational use of Energy. It establishes maximum levels of energy consume or the minimum energy efficiency for equipments built or sold in Brazil and for residential, commercial and industrial buildings. As a consequence of that, a team of specialists was created to develop a standard to regulate buildings regarding their energy efficiency, which is still in progress. This national regulation intends to be adopted as a building standard for energy efficiency in the format of ABNT (National Association of Technical Standards).

Moreover, Brazil has not experienced yet an specific program of building certification as well, although some efforts have been done to develop a national certification program based on the adaptation of international programs such as the LEED (Leadership in Environmental and Energy Design) and BREEAM (BRE Environmental Assessment Method) (JOHN et al., 2006)

In the international scene, the use of guidelines and building standards has been effective in establishing energy efficiency measurements in edifications. Many independent organizations have developed energy requirements for residential construction in the United States, such as the Model Energy Code, the Energy-Efficient Design of Low-rise Residential Buildings, approved by ASHRAE, and the norms developed by the US Energy Department. These requirements can be used together with codes to encourage builders to find innovative methods that exceed the minimum standards. Moreover, the results obtained and the use of certification programs can add value to the edification, stimulating the construction industry.

The European Union has established a directive on the energy performance of buildings in 2002. This directive acts in accordance with the procedure laid down in Article 251 of the Treaty that establishes the European Community. The objective of this Directive is to promote the improvement of the energy performance of buildings within the Community, taking into account climatic and local outdoor conditions, as well as indoor climatic requirements and cost-effectiveness (EC, 2003).

The Council Directive 93/76/EEC of 13 September 1993 to limit carbon dioxide emissions by improving energy efficiency, which requires Member States to develop, implement and report on programmes in the field of energy efficiency in the building sector, is now starting to show some important benefits. However, a complementary legal instrument is needed to lay down more concrete actions with a view to achieving the great unrealised potential for energy savings and reducing the large differences between Member States' results in this sector.

The directive of 2002 also states that the certification process may be supported by programmes to facilitate equal access to improved energy performance; based upon agreements between organisations of stakeholders and a body appointed by the Member States; carried out by energy service companies which agree to commit themselves to undertake the identified investments. To the extent possible, the certificate should describe the actual energy-performance situation of the building and may be revised accordingly. Guides such as the Guide for a Building Energy Label (POUSSARD and PEUPORTIER, 2003) were developed to support the work to be carried out for elaborating certification according to the Building Directive of the E.U.

This Directive lays down requirements such as regards:

(a) the general framework for a methodology of calculation of the integrated energy performance of buildings;

(b) the application of minimum requirements on the energy performance of new buildings;

(c) the application of minimum requirements on the energy performance of large existing buildings that are subject to major renovation;

(d) energy certification of buildings;

The Building regulations in UK are in agreement with the directive of the European Community. The part L of these regulations defines specific requirements on conservation of fuel and power in new and existing dwellings and other buildings (part L1A, L1B, L2A and L2B). The part L has developed along the years a policy of progressive integration and improvement of requirements, mainly regarding the thermal transmittance (U-value) of building components, the maximum ratio of glazing area and air conditioning systems.

They have a new approved document that came into effect on the 6th of April of 2006. In this approved document the elemental method and the target U-value method are omitted and only one approach in showing compliance with the energy efficiency requirements is presented. This addresses criteria such as, the new CO2 emission rate of the completed dwelling, that must not exceed the target set by reference to a notional building, limits to building fabric and services performance specifications, solar shading and other measures to limit risks of summer overheating and fabric insulation and air tightness. This document assures that more guidance is given on testing the achievement of the intended energy performance, including arrangements for pressure testing samples of dwellings. Satisfactory information must be provided enabling occupiers to achieve energy efficiency use. The technical provisions will mean that higher fabric, heating,

ventilation and lighting systems designs will be necessary, delivering an overall improvement of on average 20%. The appendix A of the document provides a new checklist for builders and building control bodies to help in assessing compliance. Appendix B lists the threshold performance values that if exceeded will cause SAP 2005 approved software to warn the possibility of failing to comply (ODPM, 2006).

Therefore, considering these improvements, the new Building Regulations require a 25% reduction in energy consumption in new constructions. It only represents the legal minimum standard, and therefore, savings well beyond this are achievable (RIBA, 2005). However, Davis and Artonkitjawat state, based on a survey with design professionals of South Carolina, that although building energy codes have demonstrated their cost effectiveness in promoting energy conservation, there is still resistance to their widespread acceptance. Eighty percent of the respondents think that the ASHRAE 90.1 standards do not have any effect on energy conservation and sixty five percent were uncertain that the ASHRAE 90.1 was the best format for reducing energy in buildings, which shows their reservations to the enforcement procedures (DAVIS and ARTONKITJAWA, 2004). Interviewed architects in London, regarding the project of a large office project in 2005, mentioned that they “managed to squeeze the regulations before the deadline to avoid part L” (SHUTTLEWORTH, 2005). Shuttleworth points out that the architects should use their creativity to solve these issues than to try to circumvent regulations.

It emphasizes the importance of ethical considerations and the professional point of view regarding the importance of considering environmental issues to apply the regulations and go beyond the minimum standards. Peter Carl also recognizes that the vast array of codes which attend construction testify as much a distrust of the design process as to a wealth of knowledge and experience regarding best practice (CARL, 2004). Davis and Artonkitjawat recognize that codes are typically applied in practice and are not integrated within academic design. They emphasize that these codes should be included in education to bring their importance and relevance into the design process (DAVIS and ARTONKITJAWA, 2004).

2.4 PROFESSIONAL PRACTICE AND CRISIS

Professional services provided by the architect can vary considerably both in nature and extent. They could be full or partial services and vary according to the capacity in which the architect is engaged to act. They might be affected by the management structure set up for the project, and by the procurement method adopted. Although there

are many variables, some principles and good practice procedures can be applicable and defined. The professional institutions in general set up these principles in documents embracing the professional's role, obligations, rights and commissions (IAB, 1964; COX and HAMILTON, 1995; IAB, 2006). In the relation with the client the existence from the outset of a document which fully and clearly sets out the services, costs and procedures agreed will minimise the potential for misunderstandings and disputes arising later. Cox and Hamilton in the Architects' job book notice that in the mid-90's in UK, not different from the Brazilian situation, architects were willing to undertake a limited amount of preliminary work for a client on a non-fee basis, in the hope of securing a worthwhile commission in the future. It indicates the competitive features of the profession.

Schoun states that although the society has become dependent on professionals so much, there are strong signs of a crisis of confidence in the professions (SCHOUN, 1983). Simon Foxell, in the opening text of (Royal Institution of British Architects) RIBA's book, "The professional Choice" (FOXELL, 2003) has identified that the architectural profession in UK was living an identity crisis. Most of this crisis is due to new influences and references of power in professional and market relations. The increase of power of the market has heightened competition and reorientation in corporate behaviour. Also the industry has established some points to manage the risk of investment, such as box-ticking audits and targets that have weaken the independence of construction professional. Now the professional is often a subcontractor to the supplier and with the Internet, new forms of information have become available to all. So, they don't hold anymore a unique knowledge and the relation with the contractor became a relation of dependence.

It explains the reason for what this crisis is also discussed as a "crisis of trust", since the trust of the client and society was a reflection of a unique knowledge, integrity and independence that the professions were traditionally based on. According to Gasparski, the responsibility of a design specialist is qualified because his professional role is dependent of one's own choice. Furthermore, this responsibility inclines others who are not specialists and who have no way of evaluating designers' activity, to play great trust in a designer (GASPARSKI, 2005). Schoun affirms that, professionals themselves have shown signs of a loss of confidence in their claims of extraordinary knowledge and also the decline in professional self-image. It seems to be rooted in a growing scepticism about professional effectiveness in the large sense, a sceptical reassessment of the professions' actual contribution to society's well being through the delivery of competent services based on special knowledge (SCHOUN, 1983).

William Davies and John Knell comment on the chapter “The context and future of the profession” of the mentioned RIBA’s book, that nowadays, at least locally, the professional lost any distinction from other small knowledge-based business, such as aroma therapists. They make the point that knowledge is the key to distinguish them and to assure the profession’s independence and integrity. The target setting is a practice that certainly will not disappear, but a stronger knowledge basis will make professionals able to criticize and argue against the naiveté of certain methods of target setting. According to Schoun, it is time to consider the questions of professional knowledge not only seeking to build up a science applicable to practice but also to reflect on the reflection-in-action already embedded in competent practice (SCHOUN, 1983).

Michael Polanyi (McCOY, 2003) makes a distinction between codified knowledge and tacit knowledge. The codified knowledge is the kind of knowledge that nowadays is available on Internet embracing a body of information, which we can store, transfer and then refer to. However, it is what Polanyi calls tacit knowledge that provides the best distinction against market competition and makes the professional able to distinguish which information is really useful, because it is the knowledge developed on the basis of know-how and experience.

Francis Duffy, ex president of RIBA, points out a failure of the institution to advance the knowledge base of architecture fast enough. He says that although it has shown positive efforts, such as the compulsory CPD (continuing professional development) for all members of the institute, it has neglected research. Furthermore, he recognizes that the institution has not come to terms with the strong consequences of the use of information technology in architecture, which enable the architects to rethink the process by which buildings are designed and built. He points out that it is very evident in the way architecture is taught in the 90’s (DUFFY, 2004).

An ethical code of conduct is also an important factor to assure the trust in the relationship between the profession association and the public, laying out a set of core values that motivate its members. This ethics should be related to the quality of work, which in construction, according to Foxell (FOXELL, 2003), has a political dimension when the public built environment can be improved for all by high quality professional work. Gasparki states that a constant awareness of the experimental nature of any project and a reasonable effort to monitor them; autonomous and personal involvement in all steps of a project, protecting safety of and respecting the right of consent of human subjects; accepting accountability for the results of a project, are all primary obligations of designers

(GASPARSKI, 2005). Considering environmental ethics, the architectural professional must understand that architecture cannot stand apart from nature and view it as an end in itself and not as an instrument of exploitation to our own ends. Considering the notorious lack of environmental awareness within the building industry, the architectural profession can recover some of moral authority and leadership lost during the past thirty years (HAGAN, 2001). But in order to gain this position again architects have to educate themselves.

Therefore, creating this relation of ethics and the quality of work also calls into question the defining values of the professional. To promote quality, it is necessary to consider a wider range of aspects to define the problem and, once many problems in architecture are self-imposed, it is easier, and probably more lucrative, to avoid setting oneself too many difficulties. Values change rather slowly and, considering Smithies' comments (SMITHIES, 1981), changes in architecture are more likely to be a slow evolution for some time until the society itself can reaffirm its concern for what it builds.

2.5 THE CONSIDERATION OF BIOCLIMATIC ISSUES IN 20TH CENTURY ARCHITECTURE

The scientific discoveries of the 16th to the 18th centuries and the industrial revolution stimulated the earlier industrial and technological dream of the 20th century. It was based on the consumption of fossil fuel and led to a techno centric and anthropocentric view of the human habitat, according to WINES (2000). He points out the Arts and Crafts Movement and Art Nouveau, in the end of the 19th century, as the last architectural styles to celebrate the relationship between the buildings arts and natural forms.

Then, the industrial and technological influences, rooted in cultural and economical change, were persuasive arguments about the stylistic imagery which became synonymous with a progressive look in architecture. Buildings assumed forms from factories to turbines, rockets and space stations. The pioneers of Modernism embraced the seduction of technology, utilitarian ideals and social reform agendas for the "new" man of an industrial society. As a result, architects of early modernism were committed with formalist and functionalist invention and new technologies, rarely considering such issues as environmental impact.

However, the idea that an architectural agenda can be enriched by climate's consideration can still be illustrated by a number of early and mid-century modernist

examples, which were built before the widespread adoption of mechanical systems (FISHER, 2004). It can be also related to a simple difference of attitude to technology and mechanical systems and the consideration of climatic variation as a conscious architectural aim at a fundamental conceptual level.

"In his later work Le Corbusier came to recognise- amongst other things- the importance of shading and natural ventilation, even if from and arbitrary and predominantly aesthetic point of view (TOMBAZIS, 2002)." Peter Fisher mentions the work of Le Corbusier in the project of Mill Owners' Building in Ahmedabad in 1954, in which he rediscovers the building form as an elementary environmental filter (Figure 2-1). The response of the building fabric to environmental diversity is the primary strategy of environmental control.

Figure 2-1- Mill Owners' Building. Ahmedabad (source:. http://www.public.iastate.edu/~bfoth/mills.html)

The work of the architect Alvar Aalto also shows strong climatic concerns. These concerns allow the environmental strategy to become part of the building's defining concept. In the Wolfsburg´s library (Figure 2-2), although it belongs to the then prevalent international style, it also exploits a climatic typology highly appropriate to the specific context. It responds to the low level of daylight during the winter, making daylight the main concern.

Figure 2-2- Wolfsburg library, Germany. Source: Author's collection.

But no one could be more referential to the Modern architecture in the twentieth period and yet be the basis of reference of principles of integrating architecture with its context than Frank Lloyd Wright. By the turn of the 20th century, he was a strong voice of resistance and constantly reacted against the contemporary world around him in America and Europe. Wright proclaimed the need for a new "organic" architecture. Actually for him true modern architecture and organic architecture were the same (ALOFSIN, 1994). He argued the buildings should respond to the natural conditions of their sites. He showed a deep devotion to the "nature materials", arguing that each should be employed only in ways that were consistent with its innermost qualities, and yet he repeatedly pushed those materials to the extreme limits of their tolerance (CRONON, 1994). It shows that there is no need to believe that an integrated architecture should abandon all evidence of high tech features like we hear in the discourse of some architects and eco movements. Such as CRONON (1994) points out, Wright articulated a philosophy in which he believed underplayed all his work. And it is important to notice that his aesthetic view and moral philosophy was certainly imbibed in a core of values of the romantic idealism of the ninetieth century (he was already middle age at the turn of the 20th century).

When Wright uses terms like organic, individualism, democracy and nature, he was expressing 19th century values, showing a deep conviction that the main task of science and art was to discover underlying principles of order "which would reveal the hidden unity of humanity and nature". What Wright did with great ability was to take these ideas and demonstrate their possibilities for the future in an original way that they suddenly seemed

innovative and obvious at the same time. In an essay called “Philosophy of Fine Arts”, Wright synthesised his style, which he believed was the manifestation of an ideal based on a principle (CRONON, 1994). He declares that the artist must do more than merely imitate nature; he must see it with a prophetic eye, distilling natural beauty into its conventional essence, and architecture would be the art best fitted to teach this lesson. This is the essence of what he called “organic architecture”.

However, the elements of the Modernism and it’s the geometric purity “seemed more easily packaged, more accessible to imitation, more rigorously formal and tidier in theoretical terms” (WINES, 2000). It also found favour with building construction industry because it could be easily translated into cheap, functional and fast technologies. Although the glass curtain could be used in the Modernist movement in balance with the requirements of the context, integrating elements of shading devices, ventilated cavities and opening slots as part of a design philosophy, the understanding of these solutions and the attitude to technology and mechanical systems was not the same. Later these solutions started to be considered just a group of elements belonging to a “style” and applied with the absence of the landscape and lack of environmental commitment. Even the ideals of functionalism and a social program for the “new” man were buried by the iconic purity of a machine age imagery within the post-modern pluralism of a consumer age.

But, since the 1960s climatic concerns have been rediscovered again. In 1962 Rachel Carsons’ book, Silent Spring (CARSONS, 2002), brought into light the concerns with ecology and motivated the youth environmental movement that followed. In 1963 the term bioclimatic was used for the first time by Victor Olgyay, relating climatic data to thermal comfort limits (OLGYAY, 1973). The term ‘green’ also emerged in architecture, but became associated more with the counter-culture movement than to the environmental movement aligned with the left in the 1960s. Therefore, it lost its connection with a left-leaning critique of the economic and political status quo (HAGAN, 2001). The oil crisis of the 1970s also stimulated the development of a research field in energy efficiency, including building technology, which was still more related to the development of technologies to sustain than to put into question the existent economical structure and standard of living. This research field stimulated the so called ‘solar’ architecture, which embraced technical systems for thermal heating solutions in a still techno centric perspective. It gradually fade away once the components of environmental technology were treated as “installed” rather than “expressed” elements of design (WINES, 2000).

It was in the late 1980s and early 1990s, as a result of favourable press and an increasingly concerned global population; that the environmental movement started to win ground in the political process to require and work for tangible actions by the governments. Then, in the late 1980s, with the UN World Commission on Environment and Development's Brundtland Report, the term 'sustainable' overtook the term 'green' and gained also a political and economical meaning. Although in architecture it is open to a range of contradictory interpretations, it basically focuses on the perspective of the impact of the building on the local environment through the embodied energy of the material and its durability and the use of water and energy.

Now, the issue of global warming is a confirmed fact and government communities and international business are holding a series of urgent conferences to seek global actions. And in this context, the built environment is been identified as a big issue in the whole environmental problem, regarding its impact on global energy consume, use of materials and carbon dioxide emissions.

Unfortunately, it is still not influential on the architectural expression of mainstream architecture. The interdependent economic interests of the world and their equally profit-motivated governments are still keeping the status quo of 'progress' by the classic principles of mechanistic science and they have continued to determine the means and the messages of architecture (WINES, 2000). Therefore, the mechanistic imagery was kept with a kind of celebration of such fashionable "high-tech" features as plate glass, exposed structural systems and tilted or skewed steel. The formalist design is the realm even in the following derivations of the modernist period and the site-specific relationship between the climate and building and, the consideration of the dynamic of architectural environment, are frequently the exception rather than the rule. One example of the questionable assignments architects have undertaken in contemporary architecture is the willingness to perform for a commission to build the world's tallest skyscraper (which represents a strong environmental impact) without any reflection on the environmental problem.

The environmental design emerged as a critique of this market induced acceleration of the consumption of energy, materials and ideas. However, there is the serious risk of repeating the fad that happened with "solar" architecture in the 70's and soon dieing away if it keeps science driven with emphasis only on the quantitative dimensions of the approach (thermal properties, simulations, life cycle analysis, etc). HAGAN (2001) identifies that environmental architecture is now split between a minority that intent on returning to a pre-industrial state (calls for a revival of craft traditions and

vernacular techniques) and a rationalist majority that is interested in developing techniques and technologies of contemporary environmental design. The emphasis of the rationalist approach is on the building as physical object with its environmental devices such as stack vents, solar chimneys, buffer zones, etc, and not on whole building concept. Therefore, this rationalist majority still does not put into question the techno centric structure and does not integrate any aesthetic concerns into the architectural expression.

Wines (2000) says it is necessary to liberate architecture from the mechanistic view of humanity's relation to nature and it's usual constraints such as the industrial style, wasteful technology and obsolete notions of functionalism. The view of progress must be also evaluated in terms of ecological impact because the shape of buildings will be also forced to respond to demands of limited resources and environmental requirements. The expansion of the environmental movement is pushing for a radical re-evaluation of designers' priorities and preconceptions beyond the usual motivations of style and theory, to discuss environmental architecture also as a cultural expression. And therefore, there is the challenge of developing ecological standards and an ethical and philosophical frame of reference.

In her book "Taking Shape", Susannah Hagan (HAGAN, 2001) refers to "the still emergent state of an architecture that is engaging in a new contract of co-operation between the built and natural environments, (…)" Wines (2000) appropriately compared the evolutionary stage that environmental architecture is now to the growth and role of early Modernism. "The work of Adolf Loos, Louis Sullivan and Peter Behrens in the early 1900s still retained many of the stylistic references and deference to a metropolitan scale reminiscent of the 19th century (WINES, 2000)". Later, the work of architects such as Mies van der Rohe and Le Corbusier already represented a mature Modernism, in a well defined expression in form and content. In a similar way, the aspects of environmental integration will be expressed in the next decade in a more consistent and evident way in the development of the architectural design. Hagan (2001) suggests that environmental architecture is maybe "a more mature stage of modernism itself, in which the burden of universal applicability is again taken up, this time with a much more sophisticated acknowledgement of local variation". It is very early to be sure about such statements but what is certainly true, such as Wines (2000) affirms, is that "this is potentially one of the most challenging periods of architectural innovation in history."

Today, there are few examples of architectural design in which it is possible to clearly identify the influence of bioclimatic issues on the design concept. The bioclimatic

design is inserted into the wider concept of environmental design, which also embraces what is called sustainable design. However the bioclimatic approach differentiates itself from the sustainable approach because it is focused on the building integration to the local climate and is not limited by the building material. HAGAN (2001) points out that these architects take what they require from the pre-industrial and the rationalist environmental approaches. Therefore, they cannot be labelled to the low or the advanced technologies, the natural or the synthetic materials, the passive or the active environmental strategies, the expression or the operation. In fact they embrace advanced as well as traditional technologies. “The result is not an architecture generated from a technology, as in principle happened with the Modern movement, but a technology, or rather a range of technologies inserted into pre-existing architectures, which are then re-formed in different degrees, according to the rigour with which the environmental agenda is pursued (HAGAN, 2001).” In these examples the integration of environmental technology and aesthetic content is already very perceptible, and this can be the key of changing.

In the international scene the work of the architect Brian Ford is an example of present balanced solutions of formal and environmental issues into the architectural expression. His academic knowledge from his work as Professor and Head of the School of the Built Environment at the University of Nottingham and the practice, from his work at Brian Ford and Associates and at WSP Environmental and Peak Short Associates, stimulated his understanding of the practical application of environmental issues.

In his practice he developed works that focused on the architectural quality along with an innovative approach towards energy efficiency. He has considerable experience in designing naturally ventilated and passive cooling strategies in buildings all over the world, such as the Olympic Stadium in Sydney, Australia, the Duxford Aerospatial Museum in the United Kingdom and the Peake Short’s Malta Brewery.

The Building for the Farsons brewery in Malta (Figure 2-3) integrates built form, construction and internal environment. It uses architectural tradition’s concepts, in which built form and fabric are used to moderate the external environment. Brian Ford sees the control of the internal environment as the responsibility of the architect and not of service engineers.

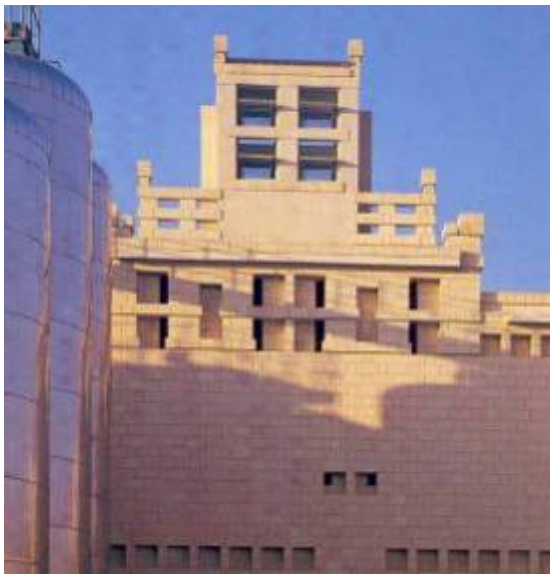


Figure 2-3 - Peake Short's Malta Brewery (source: (RICKABY, 1991).

The building is very successful in this sense, the solar radiation in Malta is very intense but the brewery's new process hall is maintained at temperatures below 27^{o}C purely by natural ventilation. Cooling is the main environmental task performed by the building. The architect's strategy is to enclose the process hall within a space that acts as a buffer between the hall and the external environment. So, the only surface of the hall, which is exposed externally, is the roof. On summer the process hall is sealed from this space, which is itself open to the exterior. The heat absorbed by the external walls is re-radiated into this space, and warm air rising within the space leaves through three towers on the roof, drawing in cooler external air at low level, in a stack effect ventilation (RICKABY, 1991). The stack effect is enhanced by solar gain through glazing in the towers and in the roof of the space buffer (Figure 2-4).

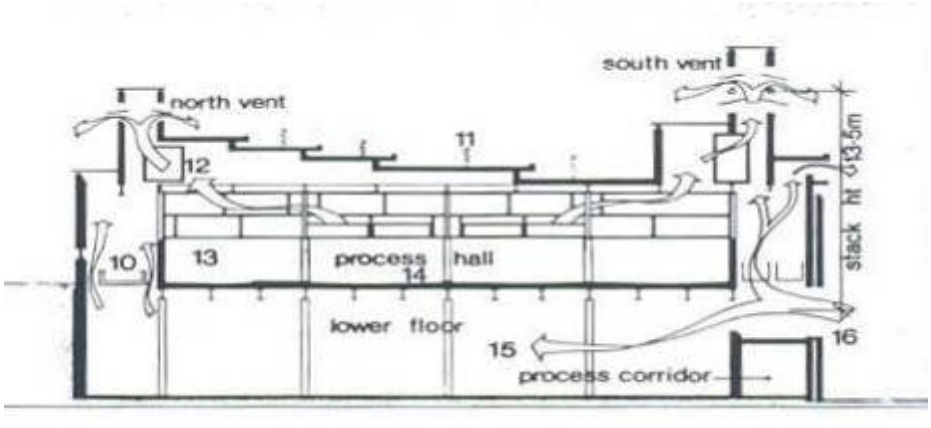


Figure 2-4- Illustration of the stack effect ventilation scheme.

In Brazil we can mention the work of Oswaldo A. Bratke (1907-97). He was one important member of the Brazilian modernist architecture. Initially impressed by the work of Frank Lloyd Wright, Bratke turned soon to an appropriate, cost-saving building method, which is implemented with traditional elements. The main principle of Bratke's work is the adaptation of the building to human needs, which led him to search for understanding client's needs and desires. His work is renowned by a large range of residential projects and the master plan of the Village of Serra do Navio, which is his most famous work (Figure 2-5) (SEGAWA and DOURADO, 1997).

Figure 2-5- Construction of Serra do Navio Village in Amazon. Source: (RIBEIRO, 1992)

The ICOMI mining company commissioned Bratke in the 50's to develop the master plan of two villages in the Amapá state, Village of Serra Leona and Village of Serra do Navio. He, together with the architects Ernesto Bonfill and Domingos Mazei, moved to Amapá and lived there during the four years of implantation of the villages and followed the development of their construction.

Bratke himself says "it wasn't simply a contract of a project of villages and houses; it implicitly was the responsibility for the functioning of the proposal. The rain level was high; the total annual average was 2000 mm, maximum of 100mm per hour. The average temperature was of 28^{o}C, and maximum of 32^{o}C. The prevailing winds presented a low velocity. Therefore, the climatic conditions could bring problems if not considered, such as mould which could reduce the life of many materials. So, it is a huge work to the architect to face and give a solution to these conditions".

Therefore, in this project, Oswaldo Bratke worked in agreement with the local natural environment, and did not impose a traditional urban model. He chose to evaluate

the living and building technologies that the local communities have found to live in harmony with the hot and humid climate of the area. Therefore, he created dwellings with mobile louvers and porous brick walls, everything to enhance the ventilation and decrease the heat (see Figure 2-6 and Figure 2-7).

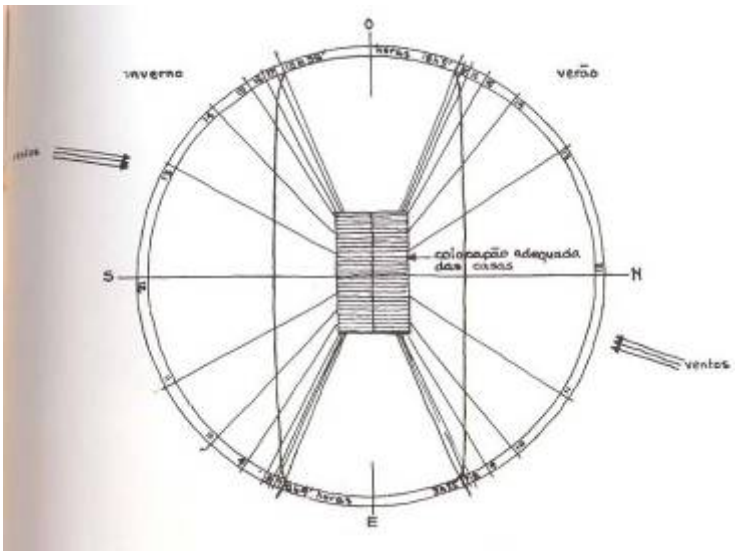


Figure 2-6 - Analysis of insolation, daylighitng and ventilation. Source: (RIBEIRO, 1992)

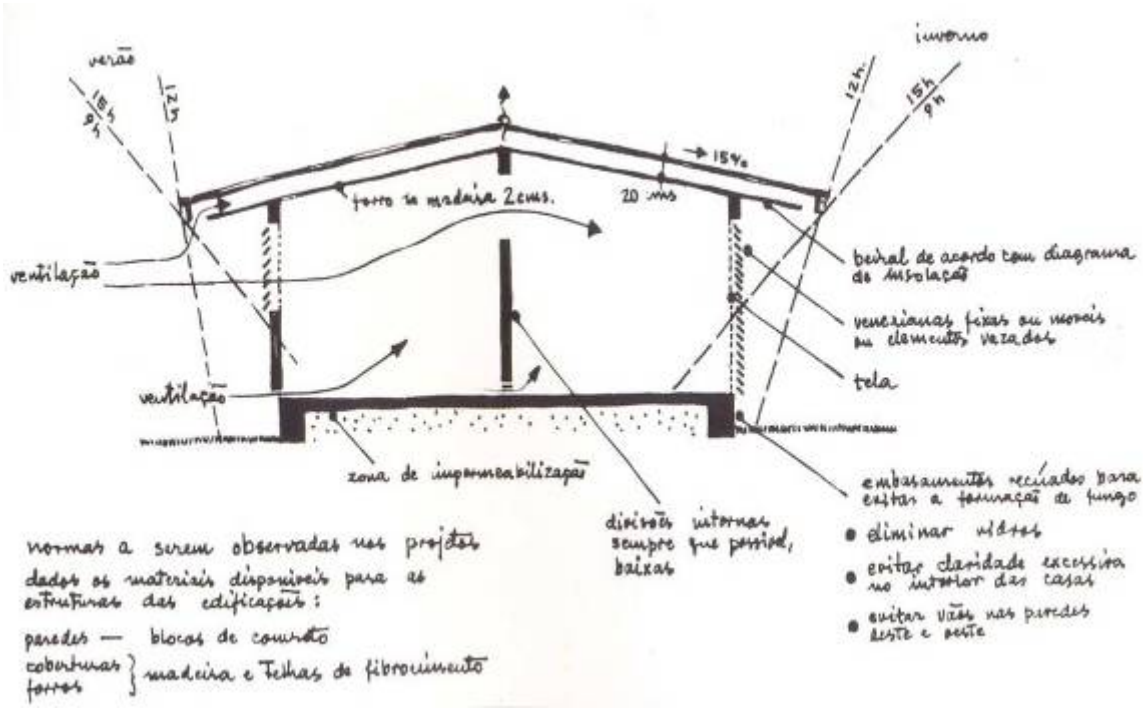


Figure 2-7- Strategy of cross ventilation and wide overhangs. Source: (RIBEIRO, 1992)

The innovative solutions made the Serra do Navio a model village, also embracing the consideration of public sanitation through the installation of a Station of Sewer

Treatment. Even now, the solutions developed by Bratke can be recognized on the facades of the houses and on the public lighting net. There are many testimonials of the community, which points out the environmental comfort in the middle of Amazonian hot and humid climate. This master plan represents one of the most positive examples of urban plan in the context of Amazonian area.

These examples show that the environmental and aesthetically perspective are not mutually exclusive and that, such as HAGAN (2001) points out, “they can inform each other to produce a possible model for architecture that exists only embryonically at present, an inclusive architecture that embraces both operation and formal expression within an environmental framework”.

2.6 THE ARCHITECTURAL DESIGN THINKING

The first part of this chapter shows that in the past thirty-five years there was a considerable progress in the field of bioclimatology and energy efficiency. But despite all the progresses, it hasn’t influenced the design practice. There is a gap between the academic knowledge and the practice. The bioclimatic concepts are not really integrated into design practice. They are not part of the design concept. In general there is just a simple addition of systems for energy saving during the detailing design. Also, the appeal for the integration of these concepts has been based on the economic appeal, which seems very limited. The efforts to introduce these themes are not based on architect’s real needs. And there is no consolidated information about what are the real barriers to bioclimatic integration according to architects’ point of view.

The architectural design is a very complex activity that comprises a body of technical, scientific and artistic values, in which the latter supplants the others in many cases (RIO, 1998; HARTOG, 2004). The lack of balance between these values in architecture has resulted in a separation between knowledge and its application. It strengthened the creativity myth in which the practice of architecture relies exclusively on vocation supported by artistic values. However, as Comas said “ (...) even if intuition/creativity plays a relevant role, it’s highly unlikely that it expresses itself out of nothing,(...)” (COMAS, 1986). In the Oxford Conference, in the late 50’s, the knowledge is recognized as the raw material for design. Although it is not a substitute for architectural imagination; it is considered necessary for the effective exercise of imagination and skill of design (BROADBENT, 2004)

According to Szokolay the scientific thinking must penetrate the early design stages to prevent architecture from stepping back to become simply a form of art, in which there aren't objective ways of classifying or qualifying it (SZOKOLAY, 2002).

It is essential to observe in what way the architect deals with aspects of bioclimatology, such as the local climate and materials, how the considered variables are structured and what are the architect's needs when he manipulates the set of these variables. It is necessary to take into consideration the fluidity of the process to include the environmental performance matters among the basic essential design considerations.

Certainly the design process is not limited to the figure of the architect. It is inserted into a wider context that involves not only the architect alone but also other practitioners in the design team, consultants, developers and statutory bodies that will influence the final result of the building design as well. However, the architect, as the leader of the design team, has a very influential role in this process. Therefore, it is very important to understand the influence of architect's knowledge basis and beliefs on the consideration or not of bioclimatic issues and its effective influence on the design choices. Nevertheless, this part of the literature review evaluates the logic beyond the methods or organizational procedures, not focusing on the process and its different actors but actually on the design thinking and the related philosophical and psychological elements.

2.6.1 Main elements of the design thinking

The classical definition of the Fine Arts School of the XIX century says that the design process develops from the whole to its parts and begins with the definition of the design concept (MAHFUZ, 1995). The design concept or *parti*, according to the academic tradition, would be a diagrammatic scheme to represent the conceptual design idea. According to Clark and Pause the generating idea furnishes the means to organize the decisions, to ordinate and generate the form consciously. The design concept would be followed by the development of the preliminary studies where the main characteristics of the design would be defined (CLARK and PAUSE, 1995).

As MAHFUZ (1995) emphasizes, in a more contemporary look of the design process, an analytical stage of problem definition could be defined based on the existence of four basic components: **pragmatic needs, cultural inheritance, location and climatic characteristics and available material resources.** The information gathered in this stage, considered to be quite objective, is later on submitted to a process of problem interpretation, which presents a higher complexity level and includes subjective aspects

influenced by knowledge and beliefs of the architect. Papamichael and Protzen point out that in the design, besides intelligence, emotion is also considered one of the main requirements, because the criteria of judgment can be also qualitative (PAPAMICHAEL and PROTZEN, 1993).

Judgment is considered a balanced weighting up of evidence preparatory to decision making. It is usually the outcome of an evaluation of alternatives. The judgment of the alternatives should satisfy a set of conditions and criteria. In the conditions that are commonly required, the evaluated statement must corroborate and be corroborated by the system of statements which are accepted as true. In philosophy, belief is usually a conviction on the truth of a proposition (NEWALL, 2005). According to Lawson (1997), for some designers the collection of attitudes, beliefs and values are confused and ill formed, for others they are more clearly structured and for some they may constitute something approaching a design philosophy. So, the judgment of alternatives in the decision making process also depends on the design philosophy of the professional.

In the analysis of the problem, there are the ones directly related to the prevailing conditions that can possibly influence the design choices. These conditions can represent opportunities to the development of the design as well as constraints, which will limit some choices, according to the purposes of the project. The aspects, which are raised to define the problem, can be directly related to requirements of the brief, but commonly many initial problems are self-imposed, according to the leanings that the design philosophy of the professional creates (SMITHIES, 1981).

Besides the design philosophy, the established criteria to proceed with the judgment of design alternatives are also required according to the priorities raised by the specific design problem. Smithies (1981) and Lawson (1997) refer to these criteria as guiding principles, holding that these guiding principles are also subject to re-evaluation along the process when new information is added. The set of guiding principles also influences the way in which some conditions of the design problem are considered, mainly those related to prevailing conditions, such as the local context. So, the established conditions and guiding principles have a strong influence on the judgment of some aspects or variables of design such as the orientation of the building, materials, space, and form, among others. These aspects when explored to achieve the requirements imposed by the guiding principles become the architecturally controlling element of the project. In the Beyeler Foundation Museum in Switzerland designed by Renzo Piano, the architecturally

controlled element is the roof plane, which is explored in order to follow the guiding principle of best use of natural lighting (BRAWNE, 2003).

Figure 2-8- South elevation of the Beyeler Foundation Musuem by Renzo Piano- Roof as the architectural controlling element. (source: Buchanan, 2004)

Therefore, the design philosophy or architect's beliefs can be very influential on the consideration of the problem and the following decision making process. The beliefs are also related to knowledge. In epistemology, the nature and variety of knowledge is investigated and, also, how it relates to similar conditions, such as truth and belief. For most philosophical history, knowledge was taken to mean belief that was justified as true to an absolute certainty (MOSER, 2005). There are many ways to acquire knowledge, such as by reason and logic, scientific method, observation, mathematical proof, trial and error, culture, language and traditions and experience.

So, based on these different procedures, of observed and learned facts, people develop structures of understanding, creating a theory based on those pillars of facts (BLACKBURN, 2005). Induction is the process of building these structures of understanding in which a general understanding is created of specific facts. Another approach is deduction in which new specific information is developed from their general understanding (ANDERSON, 2000). Belief is our thinking that this general principle or general understanding is applicable to this given situation, and it can be acquired through perception, reasoning, contemplation or communication (BLACKBURN, 2005). It indicates the influence of the design philosophy on the way the knowledge basis is applied in the decision making and judgment of the design problem.

Analogy also plays an important role in problem solving, decision making, perception, memory, creativity, emotion and communication (ROWE, 1987). However, it is an inference from a particular to another particular, as opposed to induction and deduction,

where at least one of the premises or the conclusion is general (ANDERSON, 2000). In architecture, intuition also plays an important role on the design problem solving. Intuition is an unconscious form of knowledge and it is unconsciously affected by experience. But, it is an immediate cognition, which is knowledge or conviction without consideration or inference. Anderson points out that, it can also help in induction to gain empirical knowledge. Some intuitive choices are sometimes, later on, rationalized through a chain of logic to demonstrate more structurally why they are valid. Behind intuition and inspiration there is also the notion of reference, which is understood as the relation between the symbol and the object being represented. Referential procedures make resolutions by analogy, in a work of interpretation, which is influenced by the peculiar characteristics of each architect (BRAWNE, 2003). Therefore it can be said that the architectural design involves the application of induction, deduction and analogy approaches, sometimes complementing one another.

In MOSER (2005), experience, as a general concept, comprises knowledge of, or skill in, or observation of some event acquired through involvement in or exposure to that thing or event. Therefore, experience usually means observation of the world through sense of perception. The epistemological theory of the empiricism argues that all knowledge is ultimately derived from some kind of external experience. Naïve empiricism holds that our ideas and theories need to be tested against reality, and accepted or rejected on the basis of how well they correspond to observed facts. However, the phenomenalism holds that objects and facts itself are not distinguished substances. It considers that all that really exists is the perception itself. It takes intuitive experience of phenomena as its starting point and, tries to extract the essential features of experiences and the essence of what we experience. Our perception of the external world begins with the senses, which lead us to generate empirical concepts representing the world around us, within a mental framework relating new concepts to pre-existing ones.

Wade states that the prior experience and the manner in which architect's view of the world has developed, both have an emphatic and powerful influence on the design choices (WADE, 1977). And the architect's view of the world, which includes the concept of architecture itself, is related to his/her experience and related perception, which will contribute to consolidation of his knowledge and design philosophy. Whenever a problem occurs, the designer imposes his already established values on it. Brawne also indicates the importance of the concept of architecture itself for the construction of the everyday design vocabulary (BRAWNE, 2003).

But for the consolidation of the individual knowledge, such as the scientist philosopher Karl Popper argues, the influence of the human knowledge expressed in its manifold forms such as books, papers, paintings and all the products of human mind, is at least as strong as the world of direct experience (POPPER, 1979). Therefore, considering the architectural design, not only the know how to apply the design strategy but also the knowledge of the concepts is fundamental to develop the knowledge basis of the professional, mainly on the consideration of innovative solutions. According to Lawson (1997), the production of imaginative and innovative design happens in response to specific problems. And Gasparski (2003) points out that the professional designer must know the relationships between structural elements, which are dictated by laws of physics and logic. Hartog studies indicate that design information is the most influential element in the overall design process.

Furthermore, the application of this knowledge basis can be strongly influenced by the architect's design philosophy. In the light of the phenomenological approach, it can be strongly related to architect's view of the world, his perception that leads him to generate empirical concepts which improve and change with the addition of information. Understanding this relation can create a bridge between the academic knowledge and practice in architecture.

In Almeida's studies on the knowledge development in architecture (ALMEIDA, 2001), the phenomenological approach is used as a framework in a post occupancy evaluation. The phenomenological dimensions of liveability were a very efficient method to the understanding of the relationship of the human being with the space regarding the quality of the architectural practice. Furthermore, this research also emphasizes the importance of the reflection on the architectural practice to support the consolidation of the conceptual aspects of architecture.

In this case, there is also an ethical dimension on the consideration of some conditions and criteria on the design problem solving. It is also related to the part of the moral code, related to beliefs and truths, which concerns the social responsibility of its practitioners (GASPARSKI, 2003). Meta-ethics in philosophy evaluates the nature of ethical statements and attitudes and if it can be really a motivation. In architecture it is of fundamental importance once aesthetics can be considered a form of meta-ethics and the design choice can be also motivated by the concept of what is aesthetic or not (TATARKIEWICZ, 1970).

2.6.2 Structures of thinking in the Design methods

It was through the relation with the work of the philosopher Merleau Ponti that cognitive sciences established a relation with phenomenology (BLACKBURN, 2005). In psychology and the cognitive sciences, perception is the process of acquiring, interpreting, selecting, and organizing sensory information. The cognitive process refers to the processing of information from the world into the mind. Into the mind, the information is further processed and related to other information. It gives rise to particular mental states related to desires, beliefs and motivations. The main motivation of cognitive psychology is the investigation of the intellectual activity, how the knowledge is acquired and how it is related to aspects of intelligence to make the improvement of intellectual skills possible. It is applied to processes such as memory, attention, perception, reasoning, development of concepts, problem solving and creativity. The abstract evaluation of the cognitive process is very important to understand sophisticated human behaviour aspects such as the problem solving. In this case, it is not focused on describing the necessary operations behind the act, but the relation between function, discussion and values (ANDERSON, 2000).

Cognition, in the light of phenomenological processes related to perception, knowledge and the design philosophy, can be a useful framework to focus on the process of interpretation and application of information on the problem solving. Then, relating the peculiar information associated to this process to the knowledge, perception and application of environmental issues in the architectural design, according to the purposes of the research.

Part of the empirical research in cognition involves creating models to describe or explain certain behaviour. The research in design methods involved the development of a series of relevant humanistic problem solving procedures and techniques to systematize the design process. Therefore, most of these methods also included design models to illustrate the process.

This field started on the basis of the series of work developed from the Conference on Systematic and Intuitive Methods in Engineering, Industrial design, Architecture and Communication, organized by John Christopher Jones and Christopher Alexander in 1962 (JONES and THORNLEY, 1962). Many models of design process were developed and used as a basis for teaching and development of design projects. The work of Denis Thornley at Manchester University, who was one of the participants of the conference of 1962, has been used as a model of systematic method in teaching architecture in the

Royal Institute of British Architects (RIBA) (BROADENT, 1982). The issues of design methods and design research are still being articulated to integrate objective and rational methods in practicing design (CROSS, 2000). Most of the design methods used the scientific method as a framework. The scientific method is essentially the application of the inductive approach to investigation. So, most of the design methods are still based on the consideration that the design is a series of steps, which are characterized by central activities such as analysis, synthesis and evaluation. This approach was very useful for fields such as industrial design, focusing on the development of prototypes of new products and processes to adapt these prototypes into models fit for mass-production. Other design methods are based on heuristic processes, basing the solution on defined rules, rules of thumb, analogies or models to help the designer to make faster judgments.

However, the design process refers to both a state and a process, as stated by FERNANDEZ (1998). The state would be the design concept itself and the process would be the development of the ideas that lead to the design solution. And it is noticeable that the development of the design process is not necessarily linear. It is a fluid process in which some conditions and premises have to be manipulated at once. It is based on interactions between the analysis of the context and the elements external to the context (references). Therefore, not only induction is involved in the problem solving but also deduction, analogy and intuition, which are all cognitive processes. Then, a simple division of the process in stages or steps without taking into account the particular features of the design thinking such as logic, intuition and beliefs, may lead to results not really related to real design practices and needs.

That is why most of the design process models were questioned regarding the behavioural aspect, which prescribes the automatic transfer from one stage to the other. HARTOG (2004) points out the design methods were unable to completely capture design semantics in a manner that allowed flexible application in design practice and were often proved counterproductive in situations that required expertise and fast development. They do not consider the cognitive aspects in which one makes associations and analyses to make decisions and to choose a way to follow in the development of the design.

The theory of information processing, developed by the researchers Newell, Shaw and Simon, is the dominant theory of the cognitive psychology, regarding the problem solving (ANDERSON, 2000). This approach tries to explain the behaviour for the resolution of a problem through basic information processes, considering the cognition associated to the information (NEWELL et al., 1960; ROWE, 1987; ANDERSON, 2000).

The term information is applied to different mentally operated objects (the question, the representation of its meaning, the memory and the plan to generate the answer).

The information processing can be sequential or parallel and both can be centralized or decentralized (distributed). A parallel distributed processing can be represented in a decision tree diagram. It shows the search for a solution as presented in Figure 2-9.

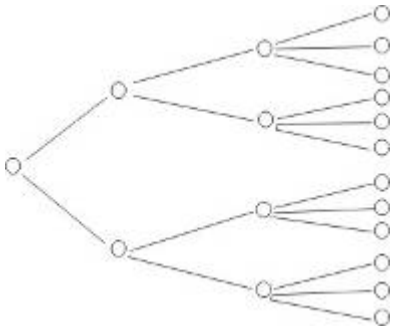


Figure 2-9 Decision tree diagram for problem solving. (ANDERSON, 2000)

The nodes represent decision points and the connection lines represent the courses of action associated to different exits for each decision point, which are taken through cognitive processes. Seeing cognition as being essentially computational in nature, the use of scientific methods to simulation of human problem solving was very important for the development of artificial intelligence, and expert systems (SIMON, 1971). As a model, the cognitive process analysis is limited in a finite number of basic mechanisms, which do not translate complex problem solving processes, such as the architectural design. Although, as a theory, it has the merit of considering the cognition associated to each decision point that leads to different actions and outcomes.

Some other models integrate the cognitive approach to identify possible procedures in the design problem solving, although they are based on assumptions from laboratory tasks and protocol studies to solve simple problems to represent more complex problems. The development of research in problem solving has been showing that empirical findings and theoretical concepts derived from laboratory tasks cannot be necessarily generalized to more complex, real-life problems. The design problem is defined as a well defined problem regarding the goal, the initial conditions and the allowable transformations (THOMAS AND CARROLL, 2000). Furthermore, Cross points out that the systematic design method has not in fact happened and a gap of applicability has opened between research and design (CROSS, 2000).

However, there are some other design methods, even being essentially based on the scientific process through a sequence of stages, in which is possible to identify

features of cognition associated to information, which can bring useful information for the research.

Cross (2000) notices that the models developed by Thomas and Carrol, Hillier et all and March are very similar in the early stages because they take into account the influence of cognitive processes in the design choices, in which the initial pre-structures or presuppositions are based on pre-existing knowledge and values of instrumental sets, solutions types, informal codes and referential procedures. Thomas and Carroll state that a crucial aspect of design is specifying goals. The architect needs to pre-structure his problems in order to solve them, and according to Hillier et all these pre-structures are cognitive schemas.

The studies of scientist philosopher Karl Popper (WADE, 1977; BRAWNE, 2003) were the basis for the development of the scientific method. It embraces the recognition of a problem, and then put forward a hypothesis, a kind of tentative solution, which needs to be tested in order to eliminate errors, and end with a corroborated theory. But it recognizes that this corroborated theory is the start of a new sequence, in which it becomes the initial problem. It agrees with the classification of the researcher Herbert Simon that the design is a wicked problem in which every solution creates new problems (SIMON, 1971).

Schon (1983) states that, in the design process, there is a conversation with the situation, and in the back-talk situation the designer reflects in action on the construction of the problem and the strategies of action, which have been explicit in his moves.

When describing his concept of architecture, Renzo Piano (PIANO, 1997) has commented that designing is a circular process: your idea is drawn up, tried out, reconsidered, and reworked, coming back again and again to the same point. However, the process would be better represented with the spiral model of Asimow, as shown in Figure 2-10 ((SMITHIES, 1981; ROWE, 1987; SZALAPAJ, 2005)). Although it is structured in sequential stages, it has the merit of considering the return to previous stages, but not exactly to the same starting point. As we progress through each cycle, the problem is changing and the information and objectives tend to increase. It agrees with the consideration that one’s perception leads him to generate empirical concepts which improve and change with the addition of information.

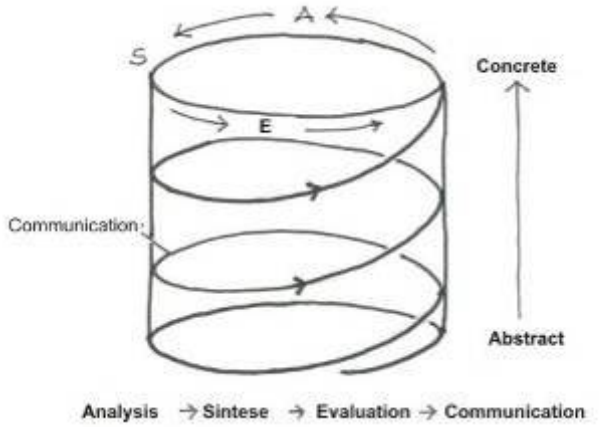


Figure 2-10 Model of Asimov's design process

2.6.3 Empirical evaluation of the design problem solving

Studies based on empirical evaluation of the design process have showed that the practical working process goes beyond the theories of problem solving. It helps to clarify some mechanisms through which the designer goes from analysis to synthesis and the main influences on the adopted considerations, which cannot be represented or translated in the design methods. However, some particular features of the process, identified through empirical evaluation, corroborate with some meaningful elements of the design methods. This relation is in agreement with the features related to the epistemological and cognitive approach to perception and its influence on architect's knowledge and design philosophy. The particular information gathered in the following studies is fundamental to the consolidation of the defined framework to support the research approach of the thesis and following analysis.

An experiment with first year and fifth year students of architecture at the University of Birmingham (LAWSON, 1984) indicated that the addition of information and knowledge along the years influenced the applied methodology. In this case, the students developed the ability to recognize problem structure by exploring aspects of possible solutions. It shows designers would evolve a methodology, which does not depend on the completion of the problem analysis, it starts before synthesis has begun.

In Rowe's case studies of the professional practice of some designers, the sequence of steps and other logical procedures were identified (ROWE, 1987). The interviewees described in detail the reasoning behind each step. An interesting characteristic, observed in all cases, is that the lack of constraints and specific direction was an obstacle to define the main concept. This event is useful to knock down the creativity myth. The evaluation of alternative sketches was based on the systematic

evaluation of some aspects of each alternative, according to the initial proposal. The practice of spontaneously establishing guidelines and norms to help the whole decision-making process was identified.

In Le Corbusier's work it is possible to identify the use of alternative decision-making rules, in which he specifies precise guiding principles and conditions to solve issues related to spatial planning (CORBUSIER, 1951). However, the linkage of rules and means can lead to a variety of acceptable results. It agrees with the aspect of the theory of the information processing, in which each decision point leads to different outcomes. The purpose for planning the problem-space is to define the process of searching for a solution, orienting it to actions that lead, economically, to a solution.

Furthermore the initial design ideas, taken from the closest context of a specific problem, frequently influence to a large extent the development of design proposals. The dominant influence of the initial design ideas on the problem solution can be observed. Even when there are strong restrictions, the effort to make the initial ideas prevailing is more frequent than the return to the starting point. It shows the influence of the design philosophy to keep the generating ideas of the design concept on the judgment of alternatives.

The architect starts from basic lines of work influenced by limitations derived from the problem or by his own characteristics and personal attitudes and frequently uses analogies to objects or logical systems, which agrees with the referential characteristics and the heuristic process. John Johanson, apud ROWE (1987), points out that in his design process he makes analogies to electronic circuits to identify connections (accesses) and structural supports. The Brazilian architect, João Filgueiras Lima, Lelé, also states that he thinks a design as a designer thinks an automobile, looking for components assembly (LIMA and MENEZES, 2004). In a research analysis of the design process of energy efficient buildings by interviewing their authors, DE WILDE (2004) identified that the selection of components (strategies) was based on analogy. There was the adoption of similar components to the ones used in previous designs, demonstrating that the decision making process rests on simple heuristic decision rules. Architects prefer this type of action when confronted with complex situations. It looks as if the architect prefers the application of decision rules with multiple criteria to components selection, emphasizing that different requirements are considered in the decision making process.

The aesthetics of the solution is also a result of a visual preference and a model and it is also a question of individual choices related to the design philosophy of the

professional. In one of the case studies evaluated by Rowe (ROWE, 1987), in his research of the design thinking, he observes that the option adopted by one of the architects to use a villa type at the outset of the process was much a preconceived idea than a response to the broad array of the site conditions and the building program. This practice shows the influence of a particular visual preference besides the influence of the direct aspects of the problem. The influence of the visual preference can be related to a style, of what is visually desirable and acceptable at a particular period (SIMON, 1971). It tends to limit the range of possible models. It is also fundamental to state the importance of models or references in the design process. It is evident in the work of many famous architects, such as the Getty Centre in Los Angeles by Richard Meier, which had the Uffizi in Florence as a model for its movement system, or the buildings of Louis Kahn, which had become a model for designers such as Richard Rogers in the Lloyd's bank building (BRAWNE, 2003).

In an empirical research using semi-structured interviews with 10 volunteer architects, FERNANDEZ (1998) tried to validate theoretical models such as the inductionist empirism and heuristic processes. He also aimed at the identification of the relation between the process of conception and the integration of energy efficiency principles. Although, he could not verify such relation among the interviewees, he noticed the practice of searching for references that was present in all cases.

Although all these common characteristics are identified, it's noted that the structure of the design thinking processes is episodic. Architects establish a practice of going back and forth among the exploration of the architectural form, briefing evaluations, structure and other technical aspects, thus confirming the non-linear characteristic of the design process. An experimental evaluation carried out by Anshuman (ANSHUMAN, 1999) to verify the mental image potential in the design process through protocol analyses, it was noticed that the architects tended to a back and forth process to solve some aspects identified during the process. However, in the work of ROWE (1987), it can be observed that as the scope of the problem becomes better defined, the episodic character of the process becomes less evident and is replaced by a more systematic practice. It means that mainly in the beginning of the process the design methods and models could not represent the actions and motivations on the considerations taken to define the concept.

2.6.4 The cognitive process behind the graphic component and the computer aided design

As defined very appropriately by MAVER e PETRIC (2003), the architectural design is a modelling activity. It is the creative working process of an abstract

representation of the building concept that exists in architect's mind. GASPERINI (1988) points out that, unlikely other fields, in the design thinking, the idea becomes concrete in a graphical image.

It's through drawing that the architect represents his ideas, using it to illustrate distinct points of view of the approached problem, to record ideas still being conceived and, later on, to establish a dialogue with the client. The type and complexity of the drawings will depend on the stage of the design. But, as observed by ROBBINS (1994), the sketch is always a handy resource to record the ideas and to develop solutions, while making design decisions. Sketches on various small pieces of paper around the working area of the architect characterize the working material during the development of the design (ROBBINS, 1994). The conception and development of the project are usually illustrated by means of drawings, graphic images. As ROBBINS states, the drawing is considered the connection between different aspects of the architectural practice. It produces architectural knowledge and is a knowledge production as well. When the drawing is used as a tool to think about the project, its level of complexity and the type of approached issues varies significantly. Since it is used to communicate ideas, drawing is also considered a language. It is the instrument by means of which architecture is brought to existence, virtual and real.

In the design problem Daley (CROSS, 2000) states there are special cognitive abilities related to the imaginative manipulation of objects in space and time, within the general context of human abilities of perception and imaginations.

The floor plan, elevations and perspectives together with physical models helped the architects for a long time. Only after 1960, new technologies have started to be developed to support the modelling process. With the advance of technology in the last 30 years, it became possible to use digital models, which allowed a more precise evaluation of the performance of proposed design alternatives. The model can be seen as a system in which the input data are the design hypotheses, and the output data the predictions of performance and formal characteristics of the design, according to a specific group of context variables.

But beyond the support of new tools, the possible directions to be taken in the design choice depend on the judgement of implicit subjective values. According to Maver and Petric (MAVER and PETRIC, 2003), the models in CAD (computer aided design) were not created to eliminate this process. The complexity of the problem is recognized to provide information on the performance of the proposal and, then, making an explicit

judgement of the values easier to be justified. MAVER and PETRIC (2003) describe a series of advantages of the existing computer models mainly regarding the evaluation of the design performance. This performance is based on values through which the designers judge the appropriateness of the design solutions.

Maver and Petric also mention these tools as devices to search for the information that will circumscribe the problem. Furthermore, the CAD tools can help in the judgement of subjective criteria, because proposals can be made emphasizing different attributes, which facilitate the analysis, yet subjective, of such aspects. Lastly, the sophistication of the computer graphic simulations should be mentioned, which allows for the creation of close-to-real images. It includes the virtual reality technologies, which multiply the possibilities for communicating ideas. However, the teamwork in the development of a design with a CAD system is still limited, because there isn't a mechanism to allow the synchronized work in the design.

Szalapaj studied the potential of new computing technologies within the context of working practices of architectural and engineering offices, where his studies were carried out (SZALAPAJ, 2005). He states that technology follows design demands regarding the many design situations and solutions that were made possible with the advance in some computer tools. He mentions the example of the design of the Guggenheim Museum in Bilbao, Spain, that, Frank Gehry recognizes, would not be possible without the use of the CATIA software.

However, architect's work remains the same despite all the technological advances obtained with the development of CAD tools to design development. As noted by Haapasalo, CAD put into a pattern and facilitated the final result of the architectural design but the computer remains out of the sketch, which emphasizes the incompatibility of the available interfaces to the early design needs (HAAPASALO, 2000). But Brown recognizes it can still be a powerful tool on the representation of the graphic image of the already formulated idea or phenomena, and to stimulate the design process. He also states that in order for digital visualization to have optimal impact on the design process we must take into account a higher level of cognitive processes (BROWN, 2003).

The importance of the cognitive and phenomenological processes was indicated in different levels in this part of the literature review. These processes, related to perception, knowledge and beliefs, are then presented as a useful framework to focus on the architect's interpretation and application bioclimatic issues into the architectural design.

3 METHODOLOGY

The need for the evaluation of the logic structure behind architect's decision processes, related to the consideration of bioclimatic issues and focusing on architect's real needs and influences, has been observed. This evaluation is considered fundamental to recognize effective ways to integrate bioclimatic considerations into architectural practice. It is necessary to clarify that the research purpose is neither to evaluate nor to define the design process. The objective is not to configure a process model, but focus on the design thinking and the related philosophical and psychological elements that could influence the consideration or not of the requirements of the local climate and environment and its effective influence on the design choices.

The architect works with basic conditions and guiding principles, which are considered in the design concept definition. In general, these considerations guide the design choices according to the importance given to each one. Regarding the purposes of this research, it is important to evaluate the consideration of bioclimatic issues in this process. In this case, a qualitative approach is considered more appropriate for the evaluation. The quantitative/qualitative terminology places emphasis on distinctions at the level of the techniques for gathering or interpreting evidence or data (GROAT, 2002). The qualitative evaluation is applied when it is not possible to eliminate the subjectivity of the analysis on the understanding of complex relations. It focuses more on the meaning of the phenomena than on its quantification, applying techniques of interpretation to describe and decode the phenomena. In this case, it is not a hypothesis-testing approach, because some accounts develop gradually as data and interpretations accumulate.

Therefore, the qualitative approach allows knowing subject's perception of his/her reality, avoiding preconceived analysis (BAUER and GASKELL, 2000). Also, in the qualitative research, quantitative results are not included because they cannot be evaluated and generalized to a bigger population. The purpose of the qualitative research is to explore the different opinions and what bases and justifies the different points of view.

According to Bauer and Aarts (BAUER and GASKELL, 2000) every empirical social research identifies precise signs to study and needs to justify the selected base of investigation. In many cases in the qualitative research, a representative sample is not applicable. The registering of more data than the limit of time leads to a superficial analysis. Gaskel emphasizes that although some experiences seem unique to the individual, the understanding of these experiences does not stem from individual minds, it is the result of social processes (BAUER and GASKELL, 2000). Thus, an alternative

principle of selection is used to typify unknown attributes because in the qualitative research, some still unknown varieties of the behaviour and social practices are studied. Bello emphasizes that the sample must include people who have the necessary knowledge to satisfy the research purposes of information. The subjects might be part of natural groups, which share a common project, past, practices, interests or similar values (BELLO, 2004).

As noticed in Chapter 2, in general, the bioclimatic concepts are not really integrated into design practice. They are not part of the design concept and mainstream architecture still considers these issues optional or related to later additions of equipment. However, few architects show, in their work, the influence of bioclimatic issues on the design choices. Therefore, the focus of this research are renowned architects whose work is example of best practices in what concerns the integration of the requirements of the environment into building design. The research looks for indicatives into their design practice related to their motivation, understanding and application of bioclimatic concepts. It is essential to observe in what way the architect deals with these aspects, how these variables are structured and what are architect's needs when he manipulates the set of these variables.

This research also evaluates these indicatives in the work of architects from different social contexts and practices. Therefore, the work of Brazilian architects and European architects is evaluated as example of best practices from developing countries and developed countries, respectively. Regarding the major economical resources of developed countries and the advance in building technology and regulations, the professional reality of European architects is a potential reference for Brazilian professional practice. On the other hand, the different practices associated to limited information, technology, material and economical resources of Brazilian practice as well as the situation of being a culture in development can also bring very useful information to European practice. Therefore, the exchanging of information based on the social, economical and cultural differences can generate a more complete material in what concerns the understanding of the reasons and means to the application of bioclimatic issues.

Qualitative researchers gather their data through three major modes: participant observation (experiencing), interviewing (enquiring) and studying materials prepared by others (examining) (WOLCOTT, 1994). The design process can be analysed through participant observation, in which the researcher observes and records the process being

developed. DE WILDE (2004) points out that it can be also indirectly analysed by means of interviews, daily spread sheets or questionnaires.

Although following architect's design process would be really interesting to register the mechanisms involved in the development of the process, the interview method was considered better applied to the purposes of this research, as well as to the time and resources available. Through the interview, the construction of knowledge is based on architect's own impressions of his/her work, experiences, values and influences in his/her social context.

3.1 THE SELECTED INTERVIEWEES

This research studies the influence of architectural education and early experience in architecture of a group of twelve architects, whose work is renowned for strong features of bioclimatic integration. It also evaluates the relation of their background with their understanding of architecture itself and, consequently, with their understanding of their role as professionals. Nevertheless, the research also evaluates the principles and beliefs translated in their design philosophy, which affects their main considerations and approach to the design problem, regarding the integration of bioclimatic issues.

Therefore, it is important to define very clearly the concept of bioclimatic design, which was used as a basis to establish the criteria for judgement and classification of the work of these architects. In this case, bioclimatic design is indeed specifically related to the understanding of local climatic features and to the application of passive strategies related to this understanding, expressed in the design concept. According to GIVONI (1994), the term 'passive' does not exclude the use of mechanical equipment when necessary, if it is used to increase the performance of the system. In the bioclimatic approach, energy saving and a lower environmental impact are consequences of the integration of the design solution to local climatic features to achieve better comfortable conditions and it is not necessarily limited by the building material.

Regarding the importance that searching for building references assumes in architectural practice, the choice for renowned architects was settled to guarantee the reliability of the results as well as the accessibility to their work by readers interested on the present research. The selection of the interviewees was also established according to their availability and agreement with the interview and publication of results.

The first selection had fifteen interviewees. However, in two cases, although the interviewee classified his work as "environmentally integrated", strong conflicts of

knowledge regarding bioclimatic concepts were identified during the interview process. In both cases, these conflicts were related to the absence of any study or understanding of local climatic features, such as prevailing winds and sun paths. The elements and projects indicated as bioclimatic and environmentally integrated could not be justified in their speech for reasons which not exclusively aesthetic. An example is the case of brises-soleils and overhangs applied in some of the indicated projects that had no relation to orientation and sun paths. It agrees with Tombazis (TOMBAZIS, 2002) when he points out the increasing number of present day architecture which pretend that they are bioclimatically sound but in reality pick and choose only what can give some “in vogue”, pictorial components of value for their design. And in this case it is often based only on extra unneeded technology or complicated M/E systems.

In other case, the speech was conceptually strong but the work of the architect had no clear focus on bioclimatic design solutions. Therefore, in these three cases the interview material was not used and three interviews were eliminated. The data was limited to the architects, whose work showed the evidence of strategies to environmental integration to maximize internal comfort, being coherent to the concept of bioclimatic design.

Issues such as age, size of practice and buildings end-use, were not a limitation or distinguished on the selection of these architects and on the following evaluations, because the first focus of investigation was on the principles which would guide and influence their design philosophy on the approach to design. Nevertheless, it would occur before the first sketch and prior to the mentioned issues. In this case, it is their background that would assume a central role on the investigation and, actually, the different schools and periods of graduation can bring useful information regarding particular details of the educational structure. However, the implications of the different social contexts were distinguished when the investigation focused on specific constraints of practice, such as the evaluation of the impact of building regulations and particular energy efficiency requirements to the integration of bioclimatic concepts into architectural design.

Therefore, these evaluations also search for information to establish a relation between background and practice. Establishing this relationship, the related problems or effective examples that stimulate the consideration of bioclimatic concepts in design can be recognized and synthesized.

Considering Hagan’s classification, there are two distinct approaches in environmental design; the pre-industrial approach that calls for a revival of craft traditions

and vernacular techniques and, the rationalist that see the building as a physical object with its environmental devices, without a response in the architectural expression (HAGAN, 2001). In the case of the selected interviewees, what all of them have in common is that they are not restricted to traditional or advanced expressions, low or high technologies in the process of integrating the design solutions to local climatic features and achieving better performance, in terms of comfort and energy efficient conditions. In fact, they take what they require from the pre-industrial and the rationalist, in different degrees according to the specific situation. HAGAN (2001) points out that “architects like Mario Cucinella are quite relaxed about the degree to which their designs will achieve optimum environmental performance.” She recognizes that “for them, design is more than environmental design, and the environment is more than a set of energy exchanges; it is also a cultural formation.”

The Brazilian architects interviewed in this research were:

- João Filgueiras Lima- Lelé (retired academic of University of Brasilia, leader of the architecture department of Sarah Kubitschek Hospitals, graduated at UFRJ, in 1954);
- Severiano Porto (retired academic of University of Manaus and practitioner, mostly, in the Amazon area, graduated at UFRJ, in 1955);
- Leonardo Bittencourt (academic of UFAL and practitioner in Maceio-Northeast of Brazil, graduated at UFPE in 1977, PhD AA-London);
- Sergio Pamplona (practitioner in West-centre of Brazil, graduated at UnB, in 1989);
- Romulo Bonelli (practitioner in West-centre of Brazil, graduated at UnB, in 1999).

Europeans architects, whose work is a reference on the European and international scene for the environmental concerns of their architectural design, were also interviewed. In Europe, the interviews were conducted with:

- Alexandros Tombazis (practitioner in Europe, mostly in Greece, graduated at University of Athens, in 1962),
- Mario Cucinella (practitioner in Europe, mostly in Italy, graduated at the University of Genoa, in 1983),
- Tom Jestico (practitioner in Europe, mostly in Britain, graduated at Cambridge in 1967, co-founder of Jestico and Whiles);

- Spencer de Grey (practitioner mostly in Europe, graduated at the University of Cambridge, in 1968, deputy chairman of Foster and Partners),
- Sunand Prasad (practitioner in Europe, mostly in Britain, graduated at the University of Cambridge in 1969),
- Luiz Buzato (practitioner in London, graduated at University of Westminster, MSc Arch & Sustainability, in 1993)
- Andrew Marsh (was a fellow researcher at the University of Cardiff, head of Square One Software Company, graduated at the University of Perth in Australia in 1993, PhD in Western Australia University).

The personal and professional experience of these architects support their accounts on the theme approached during the interviews, supporting possible generalizations.

The Brazilian interviewees work mostly with the design of public buildings, including institutional and educational buildings, in small and big scales. Only the architect Sergio Pamplona concentrates his work in residential buildings, lodges and hostels. All of them are the leaders of small design teams, which embrace the responsibility for all stages of the project, from the design concept to detailing. Most of the Brazilian interviewees, except Lele, are practitioners in a specific climatic zone of Brazil.

The European interviewees work mostly with public and commercial buildings, in small and big scales. Most of them are also the leaders of the design team, but work with big design teams (more than 15 architects). These teams also embrace the responsibility for all stages of the project. Their work is spread through Europe in different climatic zones, although most of their work is concentrated in the climatic zone of their studios. Only Luiz Buzato works as a member of the design team, but not as the leader, and Andrew Marsh, who works mostly being consultant of energy efficiency for these design teams.

Romulo Bonelli and Luiz Buzato were selected as examples of young architects, who are just starting their professional practice (in Brazil and in England, respectively), in which the environmental requirements for comfort and efficiency have a strong role. Therefore, the information obtained from their interviews explored just some particular accounts identified on the other interviews to give weight to the further interpretations of the information condensed in the defined topics.

The interview with Sunand Prasad, due to a shorter time and, consequently, fewer data, was also explored just to add information to specific topics approached during the

interview. In the case of the interview with Andrew Marsh, the interview was focused on the use of tools to the first analysis of the problem and deeper thermal and lighting analysis, because of his work on the development of the Ecotect software package. This software has been applied worldwide and detaches itself for trying to integrate the requirements of the design process in its routine and interface.

Therefore, due to different purposes of analysis, the interviews of Andrew Marsh, Luiz Buzato, Sunand Prasad and Romulo Bonelli did not follow the same process of analysis. So, in the case of these interviews, the analysis was limited to the categorization of the transcripts, adding information to the final process of interpretation in the grouping analysis.

The following sub-sections present a brief description of interviewee's profile. It also describes one of the building projects that had the interviewees as the head of the design process and that translated the mentioned balance between pre-industrial and rationalist approaches in the aesthetic expression. These were also the projects possible to have access in more detail to evaluate and detach the features of bioclimatic integration. They are part of a wider body of work of each architect that certainly evolved through the years of practice and that vary from residential to high-rise buildings into the most varying climatic situations. Although the different conditions of the problem can generate different outcomes of the bioclimatic expression, they have in common the concern on the environmental context translated into a variety of approaches.

3.1.1 João Filgueiras Lima

Figure 3-1- João Filgueiras Lima- Lelé

João Filgueiras Lima, Lelé, finished his architecture course at the National School of Architecture (School of Fine Arts) of Rio de Janeiro in 1954.

He presents a wide professional experience such as the work in the construction of the Brasilia's Institute of Bank Employees during the construction of the city, the masterplan of the University of Brasilia under supervision of Oscar Niemeyer, advisory to Hospital Foundation of Brasilia and the technical management of the office of pre-moulded components of Salvador city hall. He is still working

as the head of the design team of the Centre of Technology of Sarah Kubitschek Support Centre for the Seriously Handicapped, which includes a factory of pre-fabricated components of steel reinforced mortar and metallic structures.

In his work in Sarah Centre, he developed projects of hospitals for seriously handicapped in many different cities in Brazil. According to Oscar Niemeyer, his experience has developed since the project of Taguatinga's Hospital in 1968 and has made Lelé the more distinguished specialist in the design of hospitals in Brazil. During his career he received many awards such as the first prize in the 1ª Ibero-american Biennial in 1998, the Grand Latin-American prize in Buenos Aires International Biennial in 2001 and a prize for his whole work in the IIIª Ibero-American Biennial (LIMA and MENEZES, 2004).

He also worked as a lecturer at the Faculty of Architecture at the University of Brasilia (UnB) and as lecturer of courses of construction technology at different Brazilian Universities. His professional activity produced more than 70 projects in many different regions of Brazil, and his work is very well know by the creative structural solutions and by the dedicated effort on the development and application of pre-manufactured systems, which explore the daylight and natural ventilation in a very aesthetical manner. Lúcio Costa defined Lelé as technician and artist.

In the project of Sarah Kubitschek's hospital of Salvador (see Figure 3-2 to Figure 3-6 - (LATORRACA, 2000)), Lele applied for the first time a ventilation system, used later in other projects of hospitals in the Northeast of Brazil. The climate of Salvador is hot and humid. The monthly mean temperatures vary between 26.5^{o}C (Jan) and 23.7^{o}C (Jul) and the mean relative humidity for the whole year is 81% (GOULART et al., 1997).

The design concept of the building was based on the premise of exploring the natural ventilation, which defined the adopted design strategy. Technical galleries partially under the ground are used as wind catchers. The external air enters the rooms into the hospital through pipes in the walls on the upper floor. Sheds on the roof exhaust the air and also promote diffuse daylighting. The generation of specific microclimate with the use of vegetation is also adopted as a design strategy, in his projects (see Figure 3-2 to Figure 3-8). It is important to notice that there was not yet any official process of measuring the internal environmental conditions in these buildings.

Figure 3-2- Technical galleries. Salvador Hospital

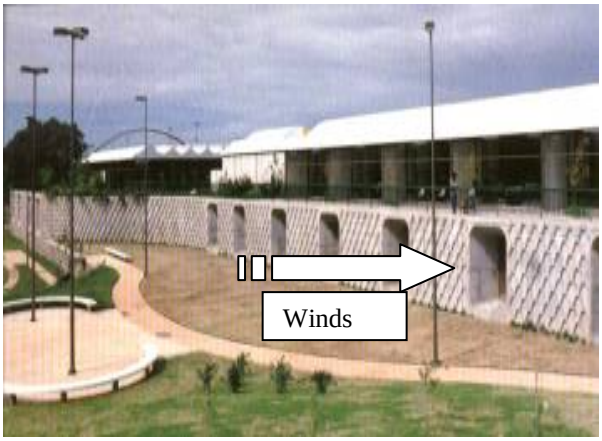


Figure 3-3- Air intake – galleries' openings. Salvador Hospital.

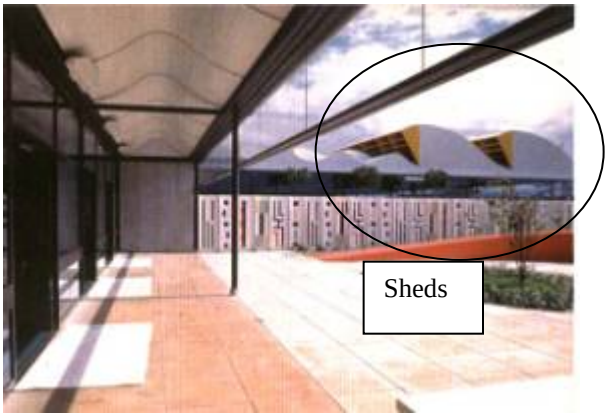


Figure 3-4 – Internal Patio, overhang to protect the facade- view of the sheds. Salvador Hospital.

Figure 3-5- Waiting room – natural light and internal garden (evaporative cooling)

Mobile wings- the patients in nursery area have individual control of the air openings next to their beds.

Figure 3-6- internal Air openings.

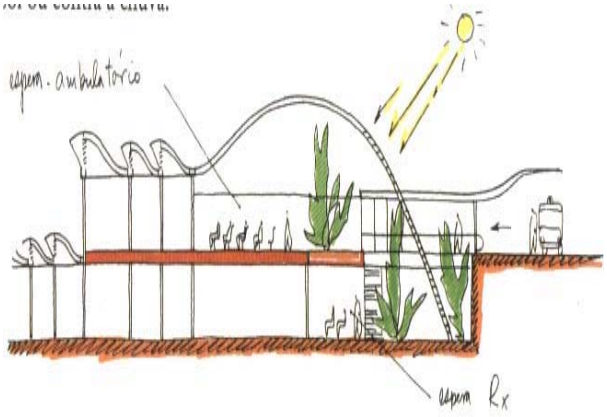


Figure 3-7- Lele's sketch of a section of Belo Horizonte waiting room.

Figure 3-8- Internal view of the waiting room of Belo Horizonte hospital.

3.1.2 Severiano Porto

Figure 3-9- Severiano Porto

Severiano Porto finished his course of architecture at the National School of Architecture (School of Fine Arts) of Rio de Janeiro in 1955. In the 60's he went to Manaos (Amazonas' capital) and developed there a renowned work, known for its environmental integration, which integrates materials and local techniques to the architectural expression of the projects. In partnership with Mario Emilio Ribeiro, he designed and built a wide body of work, which is defined as Amazonic architecture (TZONIS et al., 2001).

He also worked 26 years as a lecturer at the Engineering School at the University of Manaos. He had to deal with local prejudice against the use of local techniques, natural ventilation and local materials. Only after receiving a prize of the Brazilian Institute of Architects (IAB) in 1966, for the project of a restaurant in Manaos, his work started to be accepted by local people, who were used to copy external references (SABBAG, 2003).

The Football Stadium of Manaos, the Manaos' court of civil pole, the Centre of Environmental protection of Balbina, Suframa's Headquarters in Manaos and the masterplan of the University of Manaos are among his most important projects.

The climate of Manaos is hot-humid, presenting annual mean temperatures above 22°C, high levels of rainwater, around 2.500 mm per year, high solar radiation and

humidity and low air velocities (NIMER, 1979). The design of the masterplan of the University of Manaos of 1973, was awarded the first prize by the IAB/RJ in 1987 and it is an important reference on the integration of regional and bioclimatic concepts. All the buildings were located in a East-West axis, therefore the Northeast wind (prevailing in the area) enters by the East facade and is exhausted by the upper openings on the opposite side of the roof. The roof is detached from the blocks of the rooms, which allows the air flow between these elements. The wide overhangs provide an efficient shading for all rooms and facades. Each laboratory was defined according to its needs and the construction system and the designed modules are very flexible (see Figure 3-10 to Figure 3-15). However, a recent study of the present conditions of comfort at the university showed that due to the lack of maintenance of the windows, the shutting of the upper openings and the unexpected low air velocity, the strategy of naturally ventilating the buildings is not efficient. Nowadays, most of the buildings are air conditioned (NEVES, 2006).

Figure 3-10- Universidade de Manaus. Vista aérea do campus. Arquiteto Severiano Porto (Sabbag, 2003)

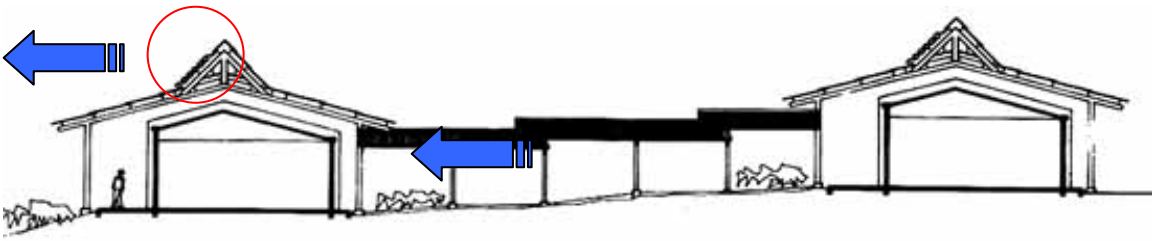


Figure 3-11- Cross section of the classrooms.

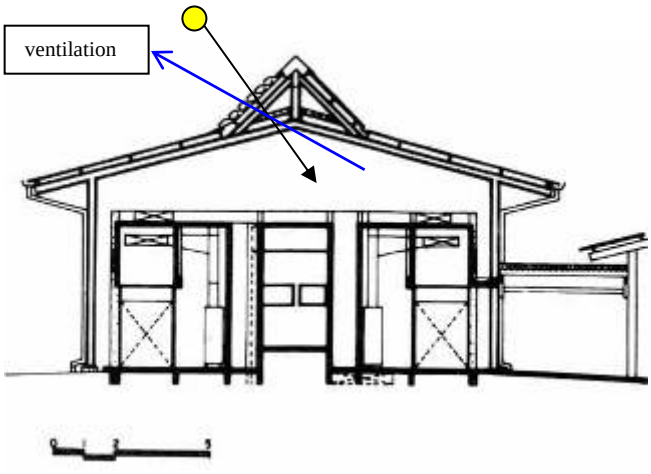


Figure 3-12- Cross section of one of the modules.

Figure 3-13- Internal view of the module

Figure 3-14- View of the restaurant

Figure 3-15- Wide roofs and overhangs.

3.1.3 Leonardo Bittencourt

Figure 3-16- Leonardo Bittencourt

The architect Leonardo Bittencourt (Figure 3-16) is a renowned architect and academic in the Northeast of Brazil. He studied architecture at the Federal University of Pernambuco from 1972 to 1977. In 1993 he finished his PhD thesis in Environment and Energy studies at the Architectural Association Graduate School (AA) in England, under supervision of Simos Yannas. In his thesis he studied the performance of perforated block wall geometry to improve ventilation inside low-rise buildings, considering ventilation as a fundamental cooling resource in warm-humid climates.

He is a lecturer and researcher at the School of Architecture at the Federal University of Alagoas (UFAL) since 1980. There he has had the opportunity to develop

many research projects, including the design of institutional and commercial buildings, which explore the application of bioclimatic strategies and their aesthetic potential.

The Multidisciplinary Research Centre of UFAL is one of his buildings. It is possible to distinguish the integration of recommended bioclimatic strategies for the climate of Maceió (Figure 3-17).

Figure 3-17- Multidisciplinary Research Centre of UFAL (source: Leonardo Bittencourt)

Maceió is the capital city of Alagoas state and its climate is warm and humid. The mean temperature varies between 25.6^{o}C (Jan) and 22.3^{o}C (Jul) and the mean relative humidity is 84% (GOULART et al., 1997). The improvement of natural ventilation and solar and rainwater protection are the recommended strategies for this climatic conditions (KOENIGSBERGER et al., 1980; GOULART et al., 1997). Leonardo Bittencourt recognizes his search for the consideration of local climatic conditions, environmental comfort and energy efficiency were integrated into the architectural design process (CANDIDO et al., 2005). Wind catchers, louvers, wide overhangs, light shelves and "ventilated sills" were the design strategies adopted to improve daylighting and passive cooling performance and to decrease the dependence of mechanical devices for cooling and lighting.

Due to the typology of the building, the cross ventilation was not possible. The proposed architectural solution was the adoption of wind catchers combined with other strategies of ventilation (see Figure 3-18). The wind catcher is an alternative particularly positive to increase the air speed in rooms located at the leeward side of buildings.

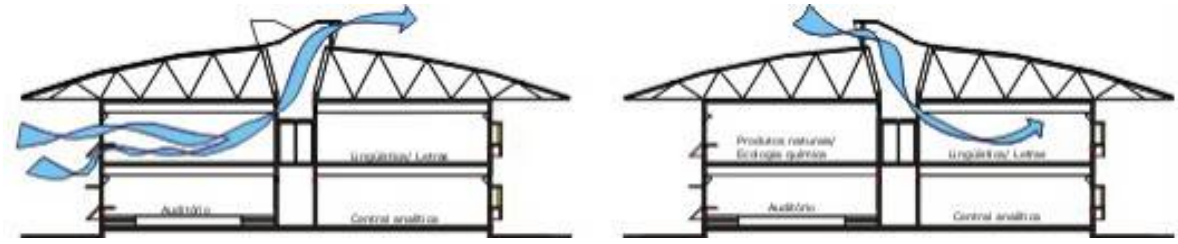


Figure 3-18 – Air in-take to the West rooms and Exhaustion to the East rooms (source- Leonardo Bittnecourt)

The ventilated sills were used as a complementary resource to improve the natural ventilation promoted with the windows. The opening on the sill is protected from the rain by vertical and horizontal faces in L shape. Because of its small dimensions, it is also an efficient device to allow night cooling of the building avoiding security problems. In the case of this building, mobile fenestrations were also integrated to the openings of the ventilated sill. Therefore it allows the users to control the device (see Figure 3-19 and Figure 3-20).

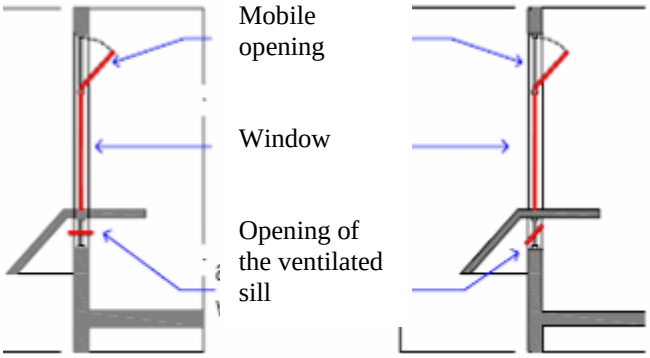


Figure 3-19- Detail of the ventilated sill

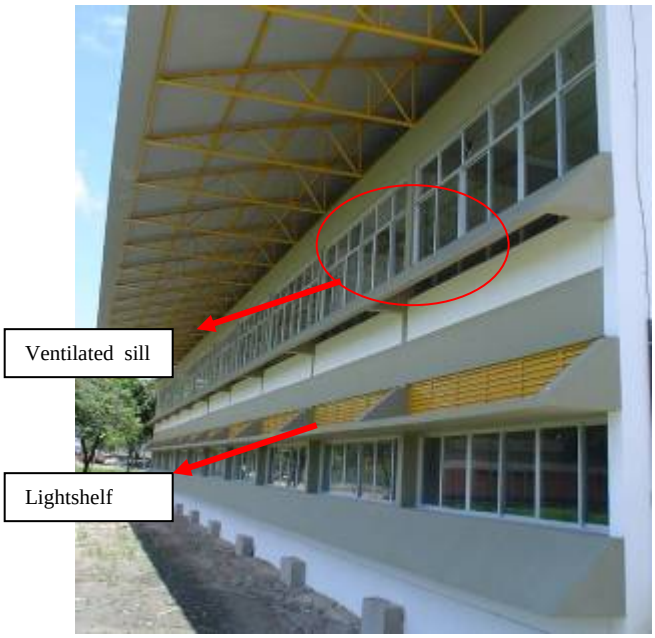


Figure 3-20- View of the ventilated sill used in the building.

3.1.4 Sergio Pamplona

Figure 3-21- Sergio Pamplona

Sergio Pamplona (Figure 3-21) studied architecture at the University of Brasilia during the period of 1984-1989.

After school Pamplona worked as a trainee in the building construction of the Centre of Excellence in Tourism (CET) at UnB (one of Zanine[3]'s projects) and in the office of Luiz Otavio Chavez and Eliana Doria (LOBA architects), in Brasilia. In both experiences he worked with timber structure. He considers it was a very important school to develop the modular and structural thinking, and a clear knowledge of the

[3] Zanine Caldas is one of the most important references of timber working in Brazilian architecture.

connection between structure and volume.

Figure 3-22- Entrance of Pamplona's house. Southwest.

The relation between architecture and sustainability influenced his adoption of permaculture criteria as a design tool, guiding the concept of energy optimisation. He started to work with permaculture principles in architecture in 1997 and since 2005 he is a member of the *Permear Net of Permaculturers*. According to Pamplona, permaculture principles are based on the energetic cycle. It guides the relative location of the elements of the system, which is based on how their relation can avoid the waste of energy.

His work is more focused on residential design in the Centre of Brazil, which climate is Tropical Upland according to Köppen classification. It is characterized by two seasons, one hot and humid (from October to April) and other dry (from May to September). Due to the high thermal amplitudes and low air humidity, the recommended bioclimatic strategies are the use of natural ventilation, high thermal inertia and evaporative cooling (MACIEL, 2003).

Figure 3-23- High ceiling. Cross ventilation. Timber structure in the aesthetic character.

The project of his own house (Figure 3-22) is an example of Pamplona's search for strategies and practices to integrate the building to the site and local climate. The narrow form of the house follows the slope of the site to avoid a higher impact on the use of land. This form makes cross ventilation easier, with the

location of openings in opposite sides of the rooms (Figure 3-23). The structure is in timber and some of the rooms have green roofs that increase the thermal inertia and promote evaporative cooling (Figure 3-24). Wide overhangs help on the solar shading of the openings. However, they are not efficiently dimensioned to provide total protection of the openings during the summer. Pamplona uses temporary vegetation on a simple structure on the surface of the Northwest façade to protect it during the summer (Figure 3-25). It is important to notice that there was not yet any scientific process of measuring the internal environmental conditions.

Figure 3-24- Small or no windows on the Northwest facade and use of green roof.

Figure 3-25- Structure to protect the Northwest facade during summer.

3.1.5 Romulo Bonelli

Romulo Bonelli is a young architect, who shows through his initial working projects that he represents a positive example of his generation regarding his awareness of the importance of environmental issues to the building design.

He studied architecture at the University of Brasilia (UnB) and finished the course in 1999. During his course he was a trainee in the program of construction in bamboo techniques developed at the School of Architecture by Professor Jaime Almeida. The opportunity to work on the project and construction of different building typologies, using bamboo in the construction system, developed his interest in explore the potential of local and low impact materials and in understanding the related technologies. Furthermore, it promoted the development of detailing skills through the application of these techniques in the contact with the construction site.

In 2001 he co-founded the Non Governmental Organization (NGO) Domo Institute of Sustainable Technologies. The aim of this NGO is the development of spaces using simple building techniques and studies for the integration of renewable energy. It also promotes professional development in sustainability through CPD activities (Continuing professional development). Through his work there, he has developed a wide professional experience in environmental design including the development of urban furniture in Brasilia using natural fibre and other renewable material, the masterplan and design of residential units to the families from the National Park of Grande Sertao Veredas in Minas Gerais, the masterplan and design of building units for the Ecovillage Arca de Gaia in the Federal District and the design of institutional buildings for the Association of Krahô indigene communities in Tocantins. In his work, Romulo Bonelli promotes a contemporary reading of traditional and local techniques, which are translated in the architectural expression of the buildings.

The Indigene Arts and Crafts Building in the Krahô community is an example of the projects developed at the DOMO Institute (Figure 3-26). The choice of the materials was discussed with the community to promote the acceptability of the building (Figure 3-27). Traditional materials such as bamboo and timber were applied in non conventional applications and are mixtured to glass, industrialized tiles and brick walls, resulting in a contemporary building design. The climate in Krahô reserve, in Tocantins, is hot and humid from October to March and dry in the rest of the year. The mean temperatures are between 25^{o}C and 27^{o}C during the whole year. The average humidity varies between 80% in the summer and 50% in winter.

In the project of the building, the strategies of natural ventilation and solar shading were the main considerations to define the design concept. The roof detached from the walls allows the extraction of hot air by the stack effect and cross ventilation. The design of the walls itself works as vertical louvers and the whole building can be opened to natural

ventilation through big doors on the four façades (Figure 3-27 and Figure 3-28). The walls are also protected from the direct incidence of solar radiation by the use of pergolas and a wide overhang in the main entrance. It is important to notice that there was not any process yet of measuring the internal environmental conditions.

Figure 3-26- Indigene Arts and Crafts Building of Krahô community.

Figure 3-27- Use of local materials. Permeability of the building. Use of "mobile" walls.

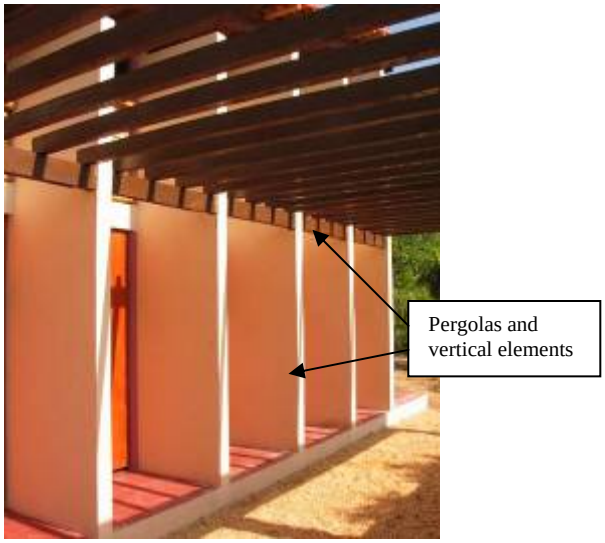


Figure 3-28- Pergolas and vertical louvers to solar shading.

3.1.6 Alexandros Tombazis

Figure 3-29- Alexandros Tombazis

Alexandros Tombazis graduated at the School of Architecture at the University of Athens in 1962. In 1963 he founded Alexandros N. Tombazis and Associates Architects and Engineers. Together with his associates and consultants, it undertakes architectural design, town planning, bioclimatic and solar design, interior and furniture design, landscaping, surveying, feasibility studies, structural engineering, electromechanical installations and studies of energy conservation.

The work of the firm has been awarded prizes in more than 85 national and international competitions. Besides the projects in Greece, the practice has undertaken commission projects in Cyprus, Dubai and the Middle East, Portugal, the Netherlands, Bulgaria, Rumania and the Ukraine.

The office of the practice in Polydroso, Athens, is a three storey building, in an open plan and split level space. It represents the practice's philosophy, concerning environmental friendly, bioclimatic and passive solar architectural design, for which it has become known in Greece and abroad (TOMBAZIS and SCHMIEDEKNECHT, 2002b).

The building of the Greek Refinery Headquarters in Attica, Greece, is also an example of this design philosophy (Figure 3-30) (Tombazis e Schmiedeknecht, 2002).

Figure 3-30- Greek Refinery Headquarters, Aspropyrgos, Attica. Client- Hellenic Petroleum S.A.

The building is a right angle triangle in plan to achieve the best possible use of the available space. Large atria, externally open and internally closed, divide the volume, while the glazed parts of the roof create openings in the building shell providing natural lighting into the interior. All office spaces thus have access to natural light. The planting of both, the open and the enclosed atria, provides green areas. The south elevation is characterized by the interruption of the volumes of the building by the exterior atria (see Figure 3-31 and Figure 3-32). The facade has small openings to avoid overheating, while the interior glazed facades of the office spaces towards the atria provide adequate daylighting. Metal structures with perforated metal panels shade the east and west facade between the office buildings facing the exterior atrium. These panels are designed in a way that provides shading and adequate daylighting.

Figure 3-31- South elevation

Figure 3-32- Exterior atrium between 2 office wings

Figure 3-33- First Floor, corridor balcony

The central corridor spine connects the different office wings. The staircases and balconies are metal and glass block floors that let daylight from the zenithal openings penetrate all levels down to the ground floor (Figure 3-33). The wall of the offices is in perforated acoustic panels (TOMBAZIS and SCHMIEDEKNECHT, 2002b).

It is important to notice that there was not yet any process of measuring the internal environmental conditions in this building to verify the real internal environmental comfort.

3.1.7 Mario Cucinella

Figure 3-34- Mario Cucinella – on the left

The work of Mario Cucinella is internationally recognized and he has won many competitions and awards. He graduated in architecture at the University of Genoa in Italy and worked in Renzo Piano's RPBW studio in Genoa and in Paris from 1987 to 1992. In 1992 he set up MCA- Mario Cucinella Architects in Paris, concentrating from the beginning on the formation of multidisciplinary teams, in order to ensure an integrated approach to design in all scales, which is very similar to the

structure of Foster and Partners. MCA practice embraces industrial design to technological research for the design of buildings, renovation to landscaping, studies of environmental strategies for climate control to large scale urban projects. In 1999 Mario Cucinella founded MCA Integrated Design in Bologna, Italy, together with Elisabeth Francis, an associate partner with MCA since 1997. And since 1999 he has been a lecturer in technology of architecture at the faculty of Architecture at Ferrara University. He has been chosen for the Outstanding Architect Award at the 8th World Renewable Energy Congress (Denver) in the year of 2004.

One of his buildings is the iGuzzini Illuminazione in Recanati, Italy, 1997 (Figure 3-35- (CUCINELLA, 2004)). The building is designed to house the administrative, commercial and management offices of the iGuzzini company, and seeks to optimize control of natural light, exploitation of natural ventilation, and use of thermal mass.

Figure 3-35- iGuzzini offices, Recanaty, Italy.

Figure 3-36- Internal view of the atrium.

The offices occupy four floors and are organized around a central atrium that contains a garden made with stone and bamboo canes (Figure 3-36- (CUCINELLA, 2004)). The central space constitutes the fulcrum for a natural system of air circulation, working as a mechanical void where the hot air from the office is exhausted through ventilation grilles next to the skylights.

Together with controlled openings of the façade, the central space contributes for cooling in the mid-season. The north and south facades are completely transparent, but the protection from solar radiation is ensured throughout the building by a shading roof. It partially covers the south facade, which ensure appropriate radiation and shading for different periods of the year (Figure 3-37 and Figure 3-38- (CUCINELLA, 2004)). Inside of the building, further control of lighting is provided by Venetian blinds and by a light shelf which reflects natural light towards the ceiling for better distribution in the back of the offices.

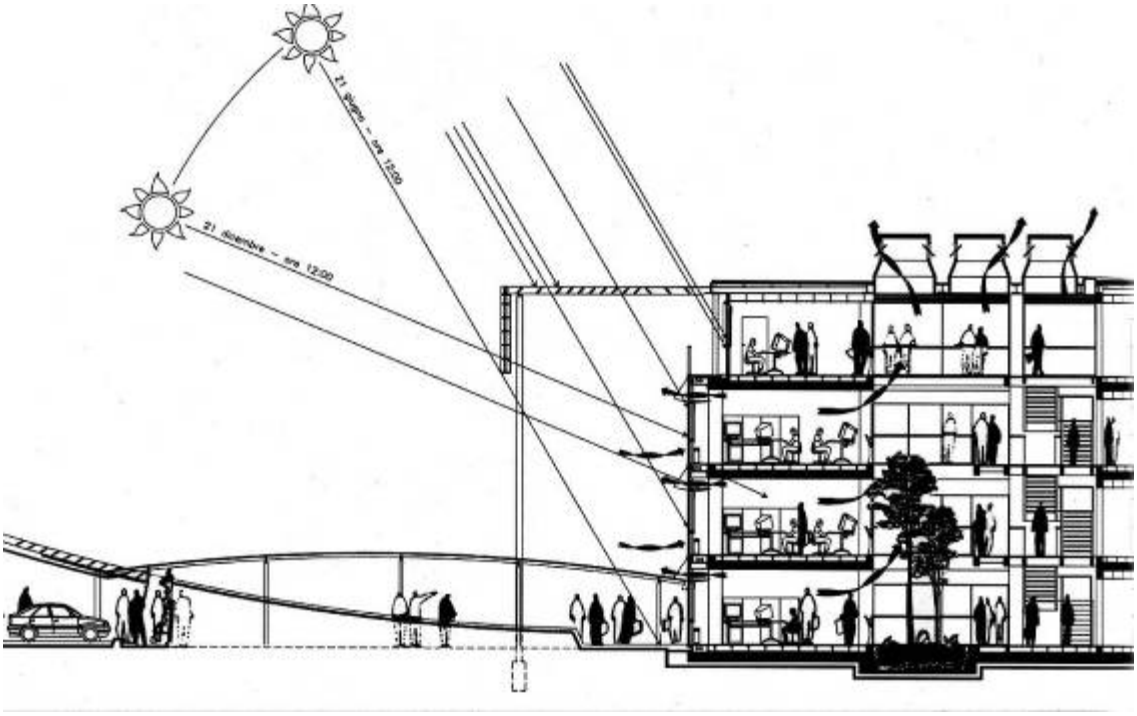


Figure 3-37- Cross section showing the shading and ventilation strategies.

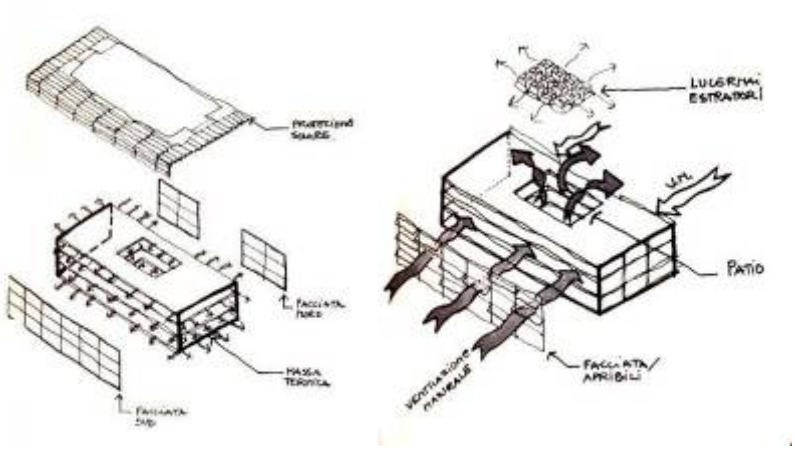


Figure 3-38- Sketches of the applied strategies.

Analysis and study models of natural lighting are made using the artificial sky of Lausanne Polytechnic (Figure 3-39- (CUCINELLA, 2004)).

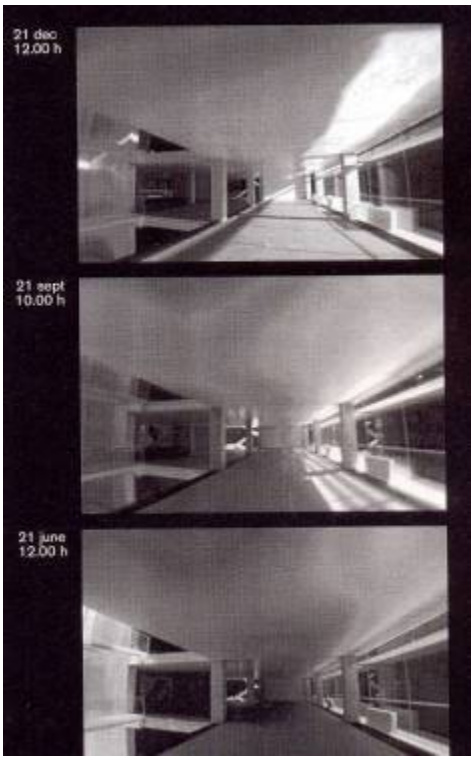


Figure 3-39- Interior photos of a study model of natural lighting.

3.1.8 Tom Jestico

Tom Jestico is a renowned architect in England, with a wide experience on the design of institutional, commercial, residential and educational buildings. He studied architecture at Cambridge School of Art, where he has received RIBA part 1 (first part of the degree of architect in England). And at Birmingham school of Architecture he received RIBA part 2 in 1966. In 1967, he received RIBA part 3.

He is co-founder of Jestico+Whiles[4], which is a practice involved in many housing and education projects of sustainable architecture. The concern of the practice for environmental issues stems from its inception in 1977 and its internal policy is to seek to design buildings composed of materials which have minimum CO_2 emissions and as far as practicable are from renewable sources. All buildings are designed to exceed the minimum requirements for insulation and energy consumption as defined in UK's Building Regulations. The practice is member of the Sustainable Future Committee of RIBA (Royal Institute of British Architects).The objective of the committee is to keep members informed

[4] www.jesticowhiles.co.uk

on issues relating to bioclimatic design and technological developments, to generate environmental policy for the RIBA and to maintain pressure on government to meet its environmental obligations.

Figure 3-40- House for the Future. National Museum and Gallery of Wales. Wales, UK.

One of Jestico's buildings is the House for the Future (Figure 3-40). The House for the Future is a competition winning design (Welsh Housing Design Award 2002, National Homebuilder Design Award 2001), commissioned by The National Museums and Galleries of Wales and BBC Wales. It was completed in December of 2000, and it is an exemplar of low energy design within a contemporary design approach.

The design is directly informed by the key issue of sustainability with the use of local low embodied energy, natural and recycled materials and challenges the energy profligate status quo of volume house building.

The house is proposed as a model for the future, capable of reproduction and repetition in a multitude of configurations and is designed to meet the forthcoming changes in Part M (accessibility) of the Building Regulations in UK, and Lifetime Homes Standards. It responds to local conditions, the climate of Wales and material availability (Jestico+Whiles, (2005)). All systems are low maintenance, and the structure consists of a structural timber frame (locally grown and certified). A very heavily insulated (wool or newspaper) infill wall 'wraps' around three sides of the building, allowing maximum flexibility for openings. To the south, large areas of double glazing (low-e and argon filled) allow controllable passive solar gain. However, the effect of this strategy is not known yet for the conditions of high insolation and temperatures of the recent European summer conditions. The north facing roof is covered with wires that allow vegetation to grow (see Figure 3-41 and Figure 3-42). It is important to notice that there was not yet any process of measuring the internal environmental conditions in this building to verify the real internal environmental comfort.

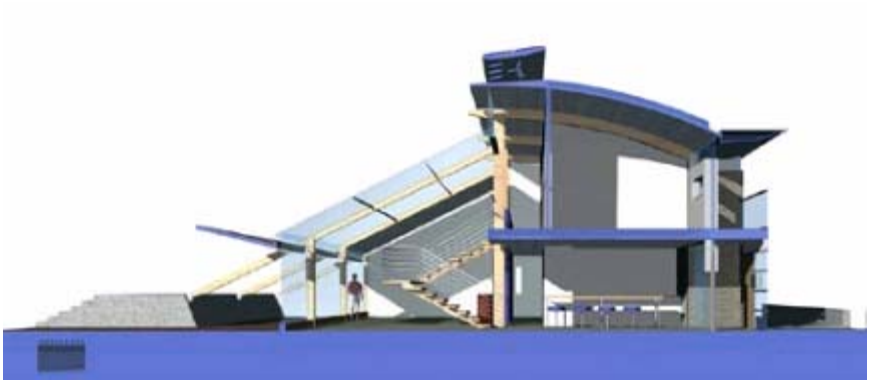


Figure 3-41- 3D Cross section S-N. (source: www.jesticowhiles.co.uk)

Figure 3-42- View of the North Facade and the green roof. (source: www.jesticowhiles.co.uk)

Figure 3-43 and Figure 3-44 show internal views of the South facade.

Figure 3-43- View of the kitchen

Figure 3-44- Solar passive gain in the south facade.

A conventional slate roof (heavily insulated) is proposed for the opaque elements on the south side (see Figure 3-40). Rainwater is collected and stored in the oversized eaves gutter for use within the building. Thermal mass is provided by the handmade clay bricks, made from the fill material on the site. The House has been designed to incorporate a ridge mounted wind turbine (combined with photovoltaic) to contribute to the power

demand. Additional space heating can be provided by an electric ground-source heat pump that is powered from renewable energy sources.

3.1.9 Spencer de Grey

Figure 3-45- Spencer de Grey

Spencer de Grey is a renowned architect for his architectural work, which is strongly related to the integration of technology and design solutions to the requirements of the environment and energy efficient conditions. He studied at Cambridge University and finished the course in 1969. In 1973 he joined Foster and Associates and became deputy chairman of Foster and Partners[5] in 2004. In his work there, he is usually the leader of the design teams involved in the projects clearly environmentally driven. He "has overseen a wide range of projects, including the Cambridge Law Faculty, the Commerzbank Headquarters in Frankfurt, the Great Court at the British Museum, the Great Glasshouse at the National Botanic Garden of Wales, the World Squares for all Masterplan for central London, the Music Centre, Gateshead, the New Lyric Theatre, Dallas and Boston Museum of Fine Arts Masterplan, (Foster and Partners (2006)).

He also lectures in schools of architecture and at locations such as the RIBA in London. He is also a trustee for the Royal Botanical Gardens in Kew and a governor of the Building Centre Trust, and is also on the board of London First (Foster and Partners, 2006).

[5] www.fosterandpartners.com

Figure 3-46- Commerzbank in Frankfurt- Germany. Source: BUCHANAN, 2005.

The structure of work at Foster and Partners is organized into six design groups. Each group has a rich cross-section of projects, large and small, around the world. The tight-knit nature of the groups also ensures personal service and close contact between the design team and the client throughout a project, from the first meetings to the hand-over of the finished building and beyond. A sustainability forum was also established in the practice to raise the level of environmental awareness throughout the office, and promote the use of sustainable technologies and methods.

The design of each new project is reviewed regularly; this process takes place under the direction of the design board, which has executive responsibility for design across the office. Alongside Norman Foster, the board comprises Spencer de Grey, David Nelson, Graham Phillips and Stefan Behling (Foster and Partners, 2006).

Spencer de Grey was in charge of the design group of the Commerzbank in Frankfurt (Figure 3-46). It is a skyscraper (the tallest building in Europe) “in a structure with a hollow shaft around which spiral sky gardens that are intrinsic to both, the energy saving strategy and social life of the building” (BUCHANAN, 2005). Considering skyscraper are in general responsible for a huge environmental impact, Spencer de Grey searched for a concept that could embrace strategies to reduce its impact.

The climate in Frankfurt is cool temperate, with cold winters and warm summers. The average daily temperature varies between -1.7^{o}C (min.) and 3.3^{o}C (max.) in the winter to 14.4^{o}C (min.) and 25^{o}C (max.) in the summer (BUCHANAN, 2005).

Through the sky gardens, natural light and fresh air enter the hollow core and the offices that face in on it (see Figure 3-47). Therefore, the fresh air and natural light is brought to all parts of the building along with the close proximity of vegetation.

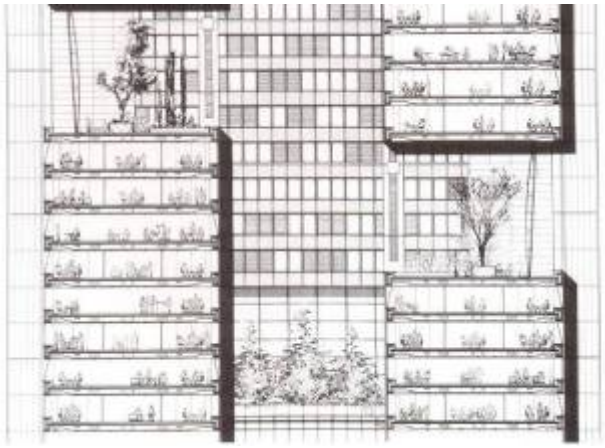


Figure 3-47- Cross section showing sky gardens and offices. Source: BUCHANAN, 2005.

In the summer, the outer offices are naturally ventilated through windows in the inner layer of the double facade. The inner offices are ventilated by air drawn in through large windows in the glazed screens closing the sky gardens and exhausting through others higher up (Figure 3-48). A double layered facade intercepts the rain and breaks the force of the wind, which allows the outer facing offices to be naturally ventilated (Figure 3-49).

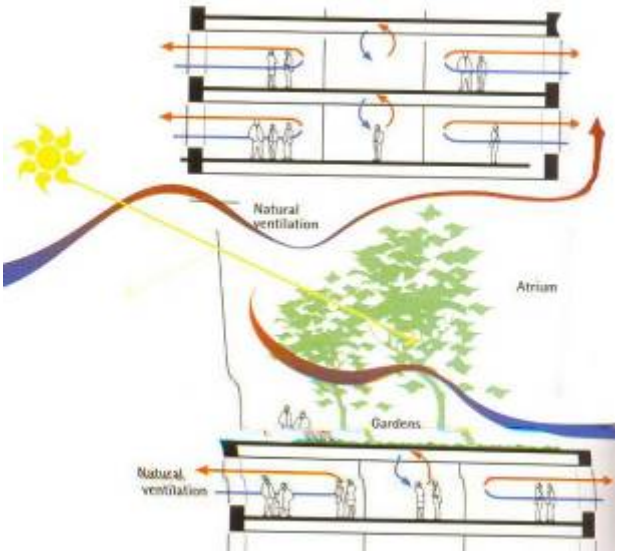


Figure 3-48- Conditions in the Summer. Source: BUCHANAN, 2005.

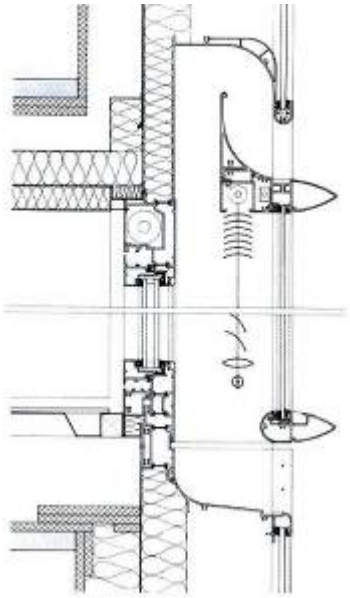
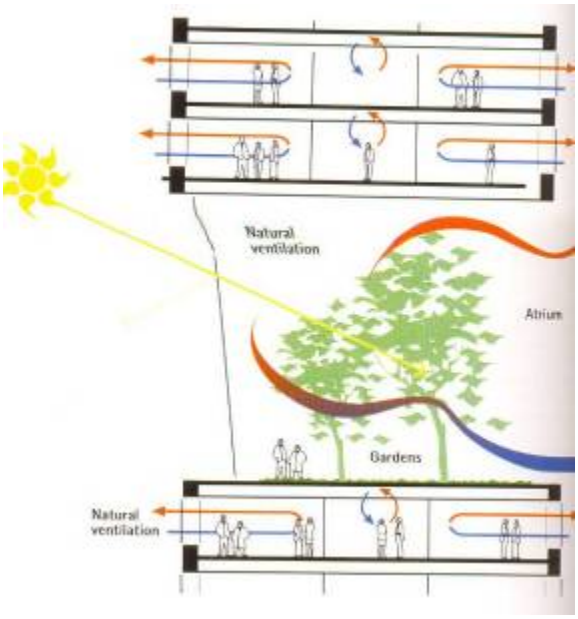


Figure 3-49- details of opening windows in double layered facade. Source: BUCHANAN, 2005.

In winter the windows in the sky garden screens are partially closed to decrease the inlet of cold air (see Figure 3-50). In the heat of the summer, offices are cooled by chilled ceilings and in winter receive perimeter heating.



Only in part of the winter and summer the building is also automatically sealed and air conditioned, but monitoring shows it is less than the thirty percent predicted per year. The building was designed in close collaboration with engineers of Roger and Partners to analyse wind flows and air movement, temperature and pressure gradients.

Figure 3-50- Conditions in Winter. Source: BUCHANAN, 2005.

3.1.10 Sunand Prasad

Figure 3-51- Sunand Prasad

Sunand Prasad studied architecture at the University of Cambridge, and got RIBA part 2 at the Architectural Association (AA) in London. After school he worked for 8 years with Edward Cullinan Architects and then conducted studies in urbanism and domestic architecture in North Indian for his Doctorate.

Sunand Prasad is co-founder of the practice Penoyre & Prasad, which was founded in 1988 and has grown to be a studio of over than 60 people while retaining a close teamwork spirit shared with many professional collaborators. He oversees all its designs and is a member of the UK Government's Commission for Architecture and the Built Environment (CABE) and a member of the RIBA Council Board and the Institute's Chair of Policy and Strategy. He played a central role in the development of the Construction Industry Council's Design Quality Indicators and he was recently elected the new president of the Royal Institute of British Architects (RIBA). He has written about architecture and cultural diversity, the value of design, architecture and construction, hospital design, urbanism and the domestic

architecture of North India, and the work of Le Corbusier. Sunand has taught and lectured in many schools of architecture, acted as external examiner and continues to be occasionally involved in teaching.

He searches for the development of an environmentally conscious design in a diverse range of sectors: culture, education, healthcare, homes, libraries, masterplanning, offices and urban design. The Millenium Centre in Dagenham, England, is one of his buildings and it was designed as a demonstration centre of the ideals of sustainability (Figure 3-52 to Figure 3-55- www.penoyre-prasad.net). It is a award winning project and was completed in 1997. Its materials, insulation, energy and even foundations, all embody sustainable principles.

The centre generates some of its power needs by a wind turbine, and has provision for future photovoltaic cells, to aim at making buildings net producers of energy. The specification included timber from sustainable sources, reclaimed steel and aluminium, which itself is highly recyclable. It uses waste newsprint for insulation and is naturally ventilated. Even the foundations are innovative, using reusable steel screw anchors driven through the landfill into the gravel below, with minimal disturbance. To minimise energy consumption and provide protection against vandalism, metal shutters cover the windows at night and then open up during the day to allow views out and provide shade. It is important to notice that there was not yet any process of measuring the internal environmental conditions in this building to verify the real internal environmental comfort.

Figure 3-52- Use of additional source of energy through wind turbine (www.penoyre-prasad.net)

Figure 3-53- Roof designed to adapt photovoltaic cells. Orientation of the building to make passive solar heating possible. (www.penoyre-prasad.net)

Figure 3-54- Use of Double glazing. (www.penoyre-prasad.net)

Figure 3-55- Timber from plantation farms. Designed overhangs, protection in the summer. (www.penoyre-prasad.net)

3.1.11 Luiz Buzato

Luiz Buzato is Brazilian; however he took his architectural education in United Kingdom and still works there. Before studying architecture, Buzato studied civil engineering during 2 years at the Federal University of Parana in Brazil, from 1983 to 1985. He studied at the University of Westminster in London, where he got the RIBA part 1 (BA Hons Architecture) in 1992 and the part 2 in 1995 (Post-graduation Diploma in architecture). In 2000, he got the professional practice exam, RIBA part 3 at the University of South Bank in London. Therefore, he is a young architect, practicing mostly in London, who shows a particular interest in environmental issues. In 2003 he got a MSc. Architecture in Low Energy and Sustainability at the London Metropolitan University. In his master he studied principles of passive cooling and other energy efficient strategies for buildings in general and focused on the typology of hotels in hot and humid climates. He used a CFD code (computational fluids dynamics) in simulating and assessing some of the identified design strategies towards thermal comfort and the internal environments of hotels in coastal equatorial conditions.

He has worked in small, medium and large practices in London, developing a wide range of projects from residential buildings to offices, hotels and schools. His interest and studies in sustainable and energy efficient issues attracted him to organize CPD (Continuing Professional Development) activities in the later practices where he worked, such as the Gensler Architects plc.

Since 2004, he works at Paul Whitley architects, where he is currently working on a Sustainable Hotel at the Ranthambhore National Park in Rajastan, India (Figure 3-56 to Figure 3-58). The climate in India is mostly hot and dry, except during the monsoon season from July to September, when torrential rain prevails. The project includes the

main building consisting of 10 bedrooms and ancillary spaces and the provision of infrastructure for 12 tends. The site is located adjacent to the Rochester Conservation area. The scheme consists of a part two, part three building, comprising 3 commercial units on the ground floor and 8 residential units above. The scheme is currently awaiting planning permission.

The sustainable strategies for this scheme include: passive cooling, monsoon water harvesting and treatment, use of local materials and constructional methods, evaporative cooling, ground cooling and thermal mass. There was no simulation of performance analysis of the strategies.

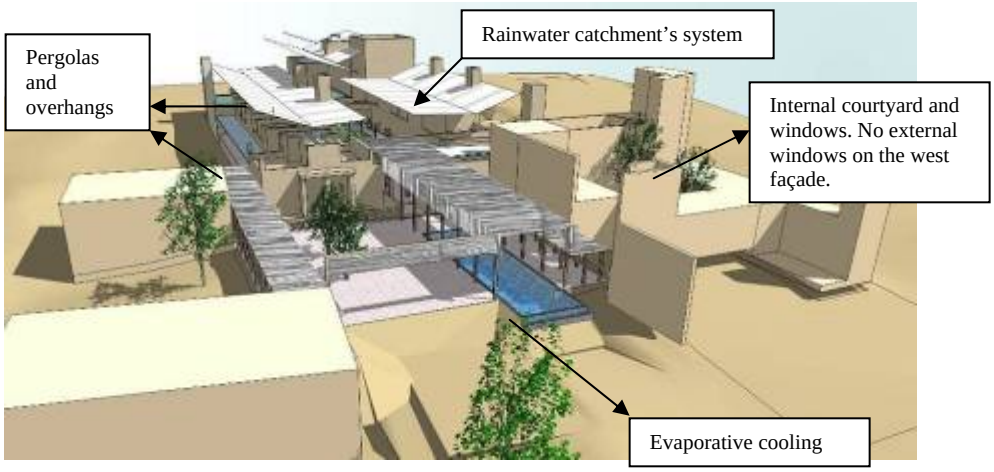


Figure 3-56- Rendering of the hotel at the Ranthambhore national park in Rajastan, India.

Figure 3-57- Solar shading strategies- pergolas and perforated blocks.

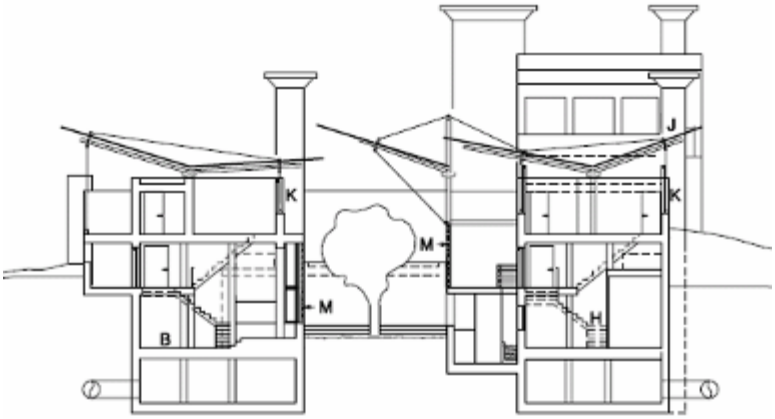


Figure 3-58- Cross section of the hotel in India. Internal courtyard, overhangs and rooms partly underground.

3.1.12 Andrew Marsh

Figure 3-59- Andrew Marsh

Andrew Marsh (Figure 3-59) is an internationally known architectural researcher and software author. He got his degree in architecture at the University of Perth in Western Australia. In 1997 he got a PhD degree at the School of Architecture and Fine Arts at the University of Western Australia. The title of his thesis was ***Performance Analysis and conceptual design.*** In his thesis he was interested in the application of thermal simulation and performance analysis tools to the conceptual stage of design. Therefore, he developed the software package Ecotect to promote the integration of the climatic analysis to the solar geometry and the use of simple thermal analysis based on the admittance method (MARSH, 1997).

He is co-founder and head of research & development at Square One (www.squ1.com). The company was founded in 2000, as an environmental consultancy and software firm. Nowadays the primary focus of Square One is to promote and support the energy efficiency and environmental design of buildings, through their developed software, online resources and publications. Andrew Marsh is the principal author of all the architectural science and design tools available at Square One, including ECOTECT, Weather Tool and Solar Tool.

Marsh is also creative director of the Natural Frequency journal and, until recently, he was a Research Fellow at Cardiff University - but now he is working full-time on research and development at Square One.

The Ecotect software combines an interactive building design interface and 3D modeller with a range of environmental analysis tools for a detailed assessment of solar, thermal, lighting, shadows & shading design, energy & building regulations, acoustics, air flow, cost & resource performance of buildings at any scale (MARSH, 2006). Figure 3-60 shows user's interface.

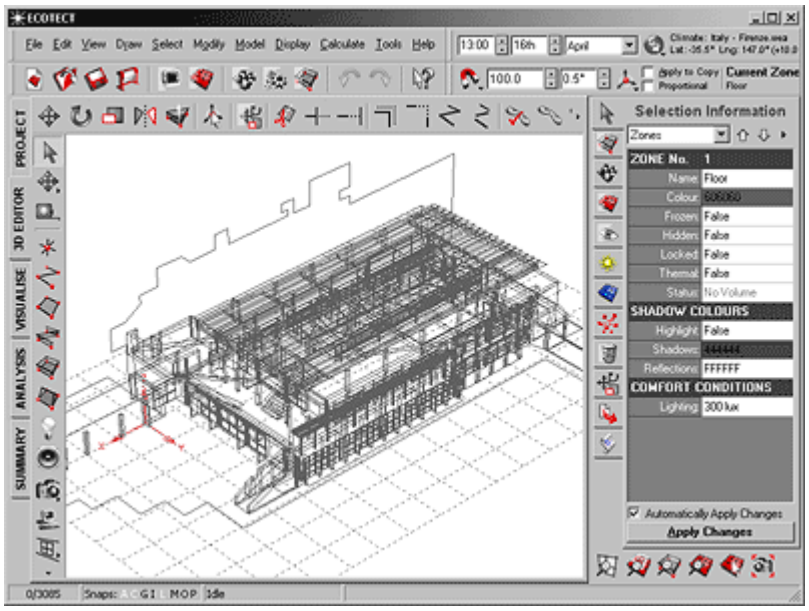


Figure 3-60- User interface (www.squ1.com)

This interface allows the visualization of complex shading and light redirection systems (Figure 3-61 and Figure 3-62).

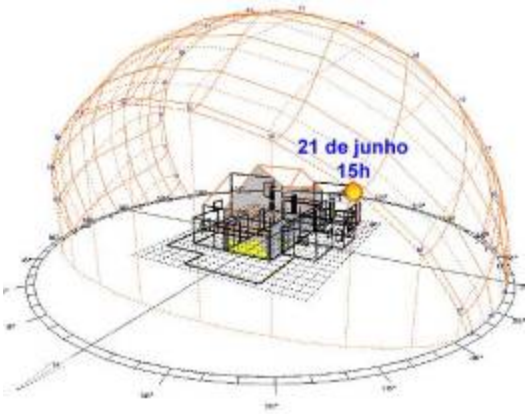


Figure 3-61 Visualization of Solar paths.

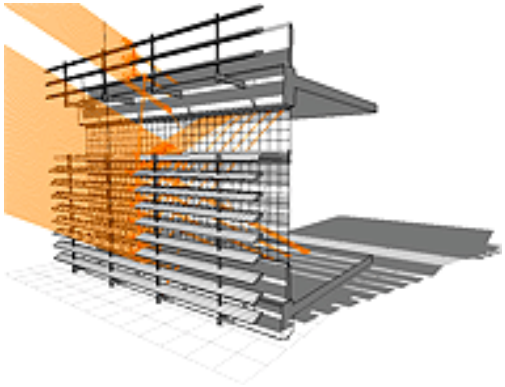


Figure 3-62- Solar incidence on shading devices (www.squ1.com).

An important potential of ECOTECT is the ability to track the path of incident gains (MARSH, 2006). It is, thus, possible to select one or more objects and with the analysis grid, using the spatial intensity of the radiation as a shading design tool. By setting a

maximum threshold, the exact size of the required shading device can be instantly displayed.

ECOTECT uses the CIBSE Admittance Method to calculate heating and cooling loads for m odels with any number of zones or type of geometry. You can assign detailed material properties to all objects as well as annual hourly operational schedules to occupancy, internal gains, infiltration and individual items of equipment (see Figure 3-63 and Figure 3-64).

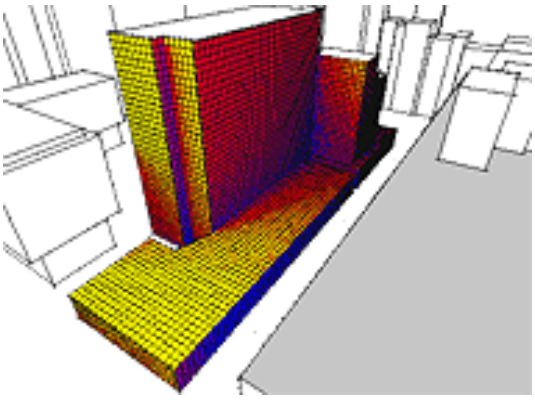


Figure 3-63 Insolation in an urban situation (www.squ1.com)

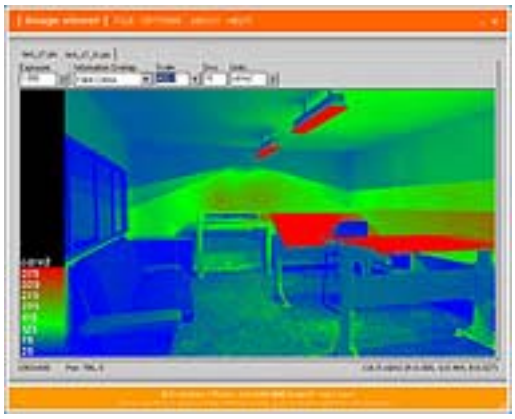


Figure 3-64- Internal radiation on the surfaces (www.squ1.com).

3.2 THE INTERVIEW METHOD

The interviews can be of exploratory character or for information registering and they can be structured or fixed- response, semi-structured or open-ended (FREEBODY, 2003). Being of exploratory character, the interview can be semi-structured (BAUER and GASKELL, 2000; BELLO, 2004). A semi-structured interview has a sequence of themes to be covered, as well as suggested questions. At the same time, it is open to changes of sequence and form of questions, in order to follow up the answers given and the stories told by the subject. This means that the interviewer will follow particular lines of talk with follow-up questions. In the semi-structured interview, the knowledge evolves through a dialogue in an interpersonal relation and, the data is co-authored and co-produced by interviewer and interviewee (KVALE, 1996; FREEBODY, 2003). Groat indicates that in the epistemological framework, the qualitative research assumes a view of the researcher as interactive with the subject of inquiry (GROAT, 2002).

Therefore, the posture of the interviewer during the interview is very important to be established, in this relationship. A good contact is established by attentive listening. There is the phenomenological ideal of listening without prejudice, without interruptions. A

hermeneutical approach involves an interpretative listening to the multiple horizons of meaning involved in the interviewee's statements. Bello (2004) recognizes it is important to avoid confrontation but at the same time the interviewer must show confidence in the theme and not showing too much admiration for the interviewee. It is necessary to be attempt to answers given just to satisfy what the interviewer wants to hear and therefore being critical to that. On the other hand, during the interview, GASKELL (BAUER and GASKELL, 2000) emphasizes the importance of not pointing out identified contradictions to avoid breaking the dynamic of the conversation.

In the start of the interview, the interviewee should be briefly told about the purpose of the interview, the use of tape recorder and so on; and asked if there were any questions before starting the interview. A debriefing always follow up the initial briefing, after the interview.

3.3 THE TOPIC GUIDE

It is very important to establish first which are the most important topics or situations to be covered and emphasized during the interview. An interview guide indicates the topics and their sequence in the interview. According to Kvale (KVALE, 1996) the guide can contain just some rough topics to be covered or it can be a detailed sequence of carefully worded questions. For the semi-structured interviews, the guide will contain an outline of topics to be covered, with suggested questions.

Bauer and Gaskell emphasize that to define the right questions, the evaluation of the interests and language of the group is fundamental. A good interview question should contribute thematically to knowledge production (relate to the topic of the interview) and dynamically to promote a good interview interaction (BAUER and GASKELL, 2000). Kvale makes the point that one research question can be investigated through several interview questions by approaching a topic from several angles. And one interview question might provide answers to several research questions. The interview questions must be short, open and avoid academic language. They must also be critical to confirm the liability and validity of interviewee's statements (KVALE, 1996).

Some questions and the way, in which they are conducted, are defined to stimulate the discussion and clarify the statements. The questions are defined to stimulate the interviewee to talk with his/her own words, having time to think about the question.

Regarding the type of questions, the defined topics are explored through a mixture of behaviour/experience questions, opinion/value questions, feeling questions and

knowledge questions (CARPENTER and HARRIS, 2005). According to Patton the behaviour/experience question is designed to arrive at information about interviewee's activities, behaviour and experiences (PATTON, 2001). In this case, the interviewee is asked to describe some lived situation or experience. The opinion/value question tries to uncover the cognitive and interpretative processes of the interviewees. It includes questions about interviewee's opinion, beliefs, goals, thinking and decision-making. The feeling question is used to elicit interviewee's emotions related to some experience. And in the knowledge question, the interviewee is asked to share factual information about the approached topic.

Kvale states that a well-defined interview guide is fundamental to the following analysis of the interviews. The content and purpose of the interview must be very clear before defining the method of analysis (KVALE, 1996). Therefore, the main topics of the interview must be defined in a logical progression according to the research questions.

An interview question can be defined to each main topic. Sub-topics are also defined to explore the topic from different angles. However, it does not mean that all defined questions are introduced in all interviews or appear in the same sequence. According to the discussion some questions can loose the interest if the interviewee does not have much to say about the specific theme. On the other hand, some important themes, not considered in the beginning, can appear in the discussion, and then be integrated in the topic guided in following interviews (WOLCOTT, 1994; KVALE, 1996; BAUER and GASKELL, 2000; FREEBODY, 2003)

3.3.1 Defined topic guide- Main topics and sub-topics

The first topic guide was used in a pilot interview with the architect Suely Ferraz to test its main structure. Suely Ferraz has been practicing architecture in Florianopolis-Brazil for more than 25 years. She lectured on acoustics at the Federal University of Santa Catarina (UFSC) and she is a teacher of environmental comfort at the University of the South of Santa Catarina (Unisul). The interview was conducted during 1 ½ hours and was recorded in a tape recorder. The length of the interview occurred in the expected time according to the defined structure. According to the evaluation of the interviewee, it was also considered satisfactory and there was no problem on the understanding of meaning of the approached topics and following questions. Therefore, the defined structure of the topic guide was kept for the following interviews.

In order to understand why the interviewed architects integrate bioclimatic concepts into their architectural design, it is fundamental to investigate their background. Therefore, the **first** defined **main topic** was the influence of their **background** on their knowledge and practice, including their formal education and past experiences. Their description and evaluation of their background was also fundamental to identify obstacles to bioclimatic integration into architectural design. During the interviews with the Brazilian architects, ethic issues were emphasized several times in their discussion of the background. Therefore, for the following interviews with the European architects, the ethic viewpoint was integrated as a sub-topic to be approached. Lelé's interview also raised the importance of approaching their concept of technical knowledge and its relation to the project. The subtopics related to the investigation of their background are presented in Table 2.

Table 2- Background - Topic of investigation

Topic	Sub-topic
BACKGROUND	Their formal education related to issues of environmental quality and comfort. Their evaluation of the structure of schools of architecture (negative and positive aspects) Aspects of their education they think were influential in their practice; Influence of schools or movements of architecture; Ethic viewpoint Concept of architecture and its relation to the project.

To understand how the integration happens, the main questions of the architect for the definition of the design concept are necessary to be focused and identified. So, the investigation of their **design practice was the second main topic** approached. Their description of their design practice is complemented with the information provided in the sub-topics of Table 3.

Table 3- Design practice- Topic of Investigation

Topic	Sub-topic
DESIGN PRACTICE	Relevant professional experiences Considered guiding principles and constraints to the problem definition Influence of new technologies Use of software and design tools The role of consultancy (dialogue with experts)

Focusing on bioclimatic issues, and on the reason of their integration, raises the importance of taking into account the relation of the building to external conditions and their effect on the building. Therefore, the **third topic of the guide was the bioclimatic design**, in order to evaluate their understanding of bioclimatology and how the project is

affected by the requirements of the environmental context and climate. This evaluation was also fundamental to identify problems related to the design practice and the use of tools to bioclimatic integration. This evaluation is also related to climatic parameters and the identification of how these parameters are better understood regarding the design choice. In the beginning, one of the sub-topics required a description of design solutions related to the requirements of the local climate. But after some interviews, it was suppressed from the topic guide because the theme was naturally approached when the interviewees were discussing about the sub-topic of the influence of climatic parameters.

The investigation of design preferences related to the graphical language of available climatic data was also considered an important sub-topic to be approached. But, it was later suppressed because the interviewees did not really see its importance without first establishing a connection to the building physics and the design solution. Therefore, to make it clear, the considered necessary level of building physics knowledge to bioclimatic integration became one of the sub-topics. After the interview with Mario Cucinella (the first of the Europeans to be interviewed), the qualitative aspects of the integration of bioclimatic issues to the final solution were also included as a sub-topic. Therefore, the sub-topics related to bioclimatic issues are presented in Table 4.

Table 4-Bioclimatic Design- Topic of Investigation

Topic	Sub-topic
BIOCLIMATIC DESIGN	The influence of climatic parameters Use and understanding of solar geometry Use of bioclimatic diagrams Data sources Use of specific tools Unexpected results associated to the application of passive strategies Level of understanding of building physics Qualitative aspects of the bioclimatic integration to the final solution

Additional issues to **energy efficiency and environmental comfort were defined as the fourth topic** of the guide to evaluate their concept of environmental integration and the requirements related to that. The exploration of this topic was conducted through the sub-topics in Table 5.

Table 5- Energy Efficiency and Environmental Comfort- Topic of Investigation

Topic	Sub-topic
ENERGY EFFICIENCY AND ENVIRONMENTAL COMFORT	Consideration of envelope materials and use of glass Evaluation of thermal performance Use of tools and evaluation of their appropriateness

Finally the **last topic approached was the influence of building regulations**. Different purposes guided the approach to this topic for the Brazilians and for the Europeans. The building regulations in Brazil do not integrate requirements of energy efficiency and it is not part of a national policy yet. Therefore, in the case of the Brazilian architects, their hypothetic evaluation of the negative and positive effect of such integration in building regulation was explored.

On the other hand, the policy of the European Community is getting stronger in what concerns energy efficiency in buildings. And it is much consolidated in the building regulations of countries like United Kingdom and Germany. Therefore, the evaluation of its real influence on the design and the opinion practitioners of its efficiency and deficiencies are fundamental. It also includes their evaluation of green labels' impact.

In the end of the interview the architect was asked to give his own evaluation of the problem of environmental integration and to add possible comments. Asking the interviewee to finish the interview with his impression of the approached problem is fundamental because the interview can provide some new insights into his constructed social world (KVALE, 1996; FREEBODY, 2003).

Although keeping the main topics of the interview, the structure of the interview questions was also adapted to the particular features related to the social context and practice of each interviewee. Therefore, the construction of some questions was based on specific literature on the work of the interviewed architects (TOMBAZIS and SCHMIEDEKNECHT, 2002b; BITTENCOURT et al., 2003; CUCINELLA, 2004; LIMA and MENEZES, 2004). The defined topic-guides, including the suggested interview questions, are presented in appendix A.

3.4 CONTENT ANALYSIS OF THE RAISED MATERIAL

Such as Wolcott emphasizes, a consolidated analysis of the interview is more important than accumulating a big amount of data to guarantee the quality and reliability of the qualitative research (WOLCOTT, 1994). The reliability and validity of the qualitative research requires a diligent focus on the empirical details of the interviews. It is necessary to understand interviews themselves as cultural practices about cultural practices. What are revealed are architect's formulations of their lived world (FREEBODY, 2003). Therefore, cognition, in the light of phenomenological processes related to perception, knowledge and the design philosophy, is the adopted framework of the present research to focus on the process of interpretation and application of the raised material to the

consideration of bioclimatic issues into design. In the phenomenological process, the research looks forward describing the structures of experience (HENWOOD and GUBRIUM, 1993).

There is a common concern that qualitative research leads to as many interpretations as there are researchers. But Kvale states that “what is important is whether a reader adopting the same point of view as articulated by the researcher, can also see what the researcher saw, whether or not he agrees with it. That is the key criterion for the qualitative research” (KVALE, 1996). So, a well-defined analysis method as well as the expertise and knowledge on the approached theme are very important to guarantee the quality of the argument.

In this research the method of analysis was considered in advance of the interviewing and it influenced the preparation of the interview guide, the interview process and its transcription. Kvale states that there are no standard methods to arrive at essential meanings and deeper interpretations of what was said during the interview (KVALE, 1996). The theoretical conception of what is investigated provides the basis to define the method to be used for analysing the content. The investigation of architect’s logical procedures and their motivation, understanding and application of bioclimatic concepts in the light of cognitive and phenomenological processes related to perception, knowledge and design philosophy was the framework of this research to define the analysis of content and the identification of essential features of the interviews.

There are some general approaches to the analysis of qualitative data. Kvale identifies five main approaches for the generation of meaning; categorization, condensation, narrative structuring, deeper interpretations and ad hoc tactics. The analysis of the interviews was based on the ad hoc approach. Actually, the ad hoc approach is an interplay of different approaches and techniques, which can be used during the analysis. A combination of categorization, condensation and deeper interpretation was adopted during the analysis for answering the different thematic questions.

For explorative purposes, the analysis was first focused on the individual interviews, to interpret them in a greater depth. Then, the statements and descriptions of the group of interviews were analysed and compared to identify common practices or differences, regarding the different social contexts.

3.4.1 The categorization of the transcripts

The first part of the analysis of the raised material is the transcription of the interviews. As Kvale recognizes, the analysis of the transcribed interviews is a continuation of the conversation and the mean to identify and develop the possible meanings in the original interview (KVALE, 1996).

The talk was transcribed in full but eliminating superfluous material, such as digressions and repetitions, to clarify the material, once the main purpose was the analysis of content. The whole interview was read through to get a sense of the whole and to decide what to analyse in depth according to the patterns and themes that emerged (FREEBODY, 2003). Then, the essential parts of the interview, according to the purpose of the study, were highlighted and gathered into categories (Figure 3-65).

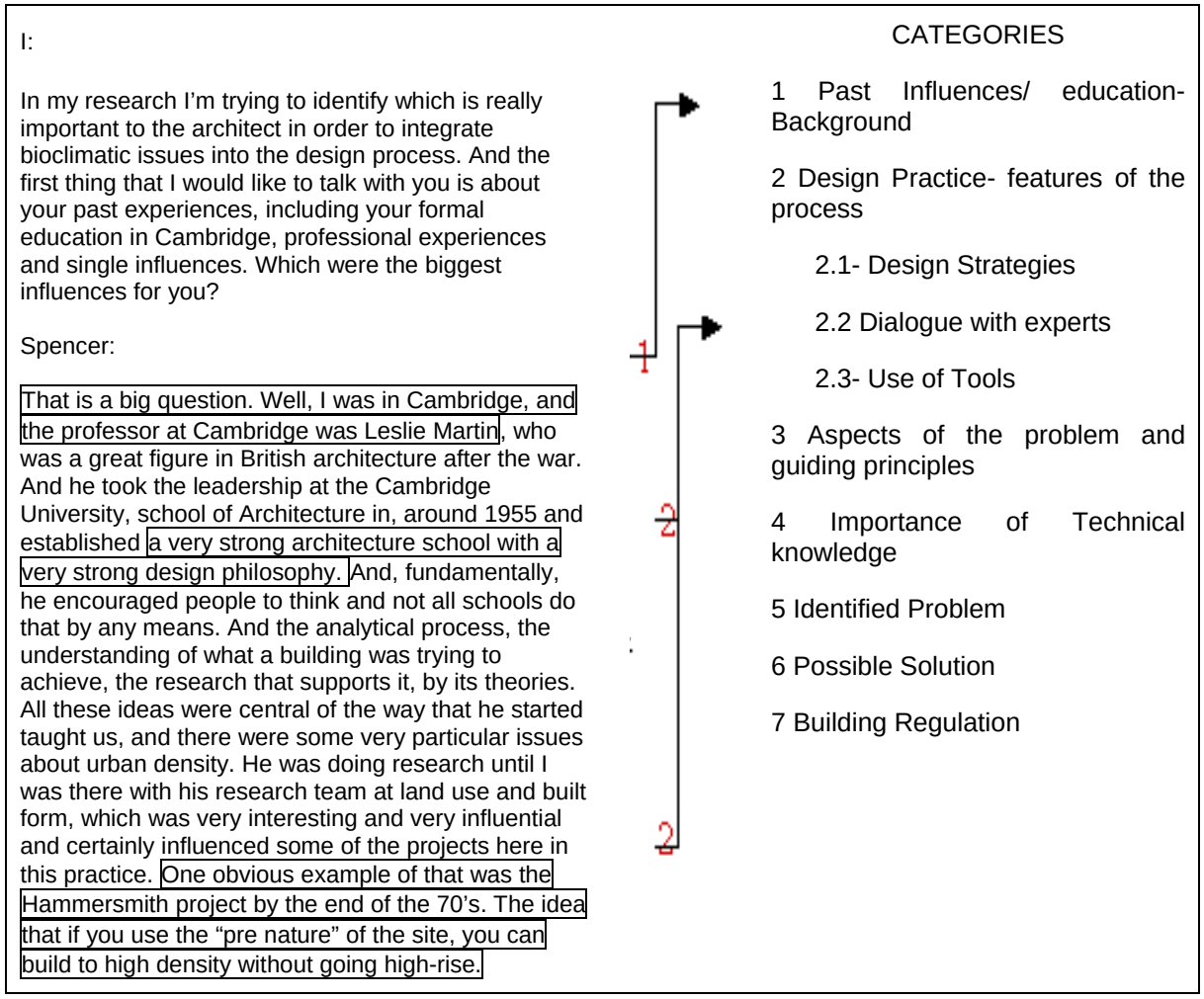


Figure 3-65- Example of the process of categorization of the transcripts.

Each category arose ad hoc during the analysis, in natural "meaning units" related to the main topics and sub-topics approached in the interviews. Some sub-topics of the

interview guide, such as the importance of technical knowledge and the considered aspects of the problem and guiding principles, were emphasized several times during the interviews. And, therefore, these sub-topics were defined as categories in the categorization process. This process of categorization and the grouping of the transcripts into these categories were applied to each interview.

The categorization of each interview is presented in the Appendix B, which is available in CD-room.

3.4.2 Condensation through drawing panels

The information detached and gathered into the defined categories was condensed through drawings. The condensation approach involves the condensation of the expressed meanings of the interview into more and more essential meanings. In general, it is done compressing interviewee's accounts in fewer words. But, in this case, the drawings were the tool to condense the meaning as simply as possible, according to the themes related to the purposes of the study.

Instead of a descriptive statement, the drawings addressed the meaning related to each category, tiding together the information in a panel, in which the approached topics are related in a kind of matrix. So, a drawing panel was developed to the condensation of the information obtained on the categorization of each interview transcript.

Figure 3-66 shows an example of one of the drawing panels, highlighting some parts directly related to the condensation of each category. In the condensation process, the drawings merged some categories to condense the information into their essential information. The drawing panels of the condensation of each interview are presented in Appendix C.

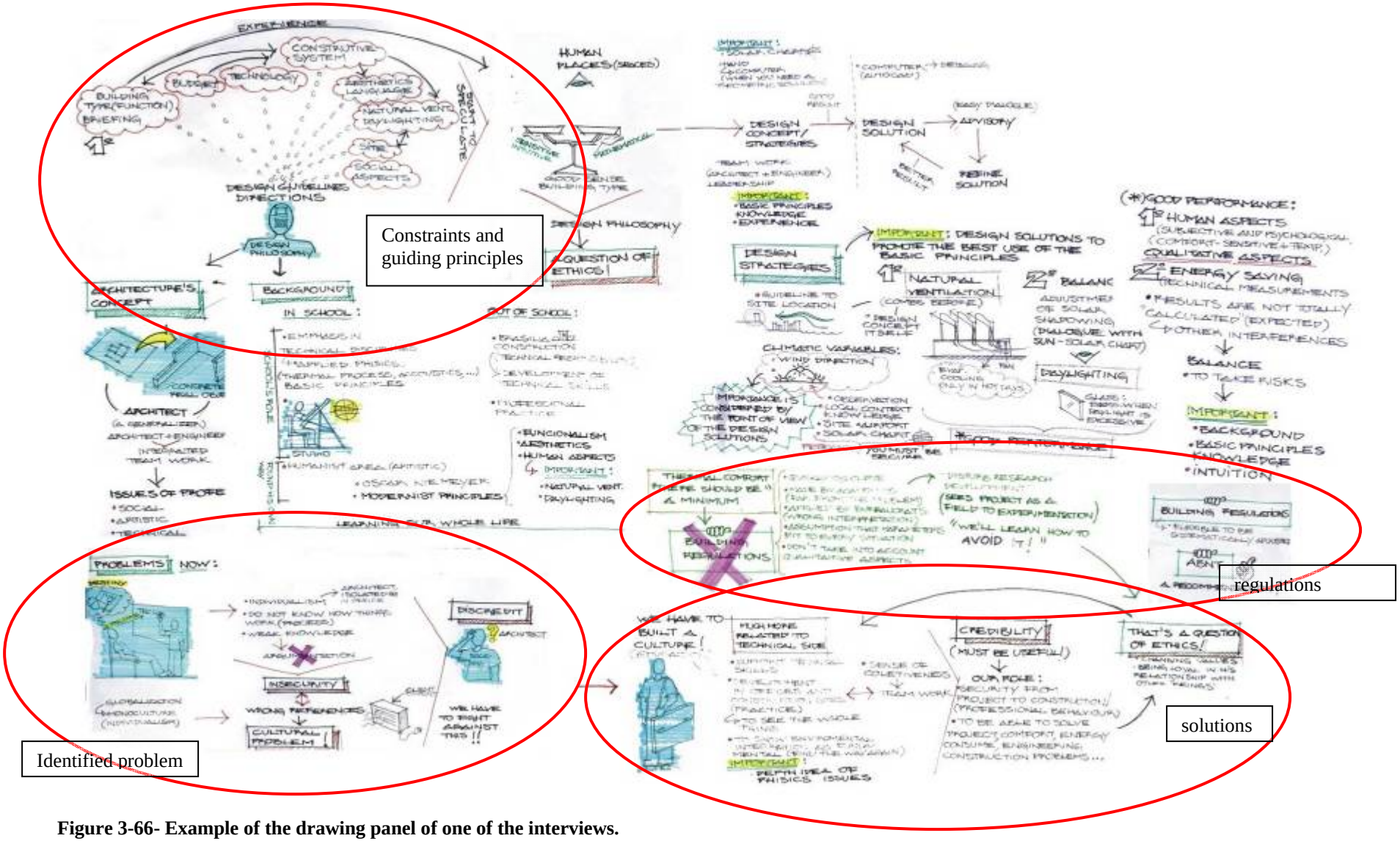


Figure 3-66- Example of the drawing panel of one of the interviews.

3.4.3 Interpretation of the panels

Reading the information condensed through the drawing panels, a deeper interpretation of the interviews was developed. So, in the analysis of the panel some main themes of investigation could be identified. These themes defined more representative categories, in which the information could be better condensed and interpreted. The defined categories were:

- the fundamental influences of interviewees' design philosophy;
- the opportunities, constraints and guiding principles;
- the main features of the professional practice;
- the aids to design process;
- the identified problems;
- the possible solutions
- the effect of building regulations.

Therefore, the information condensed in the drawings was contextualized into each of these main topics within broader frames of reference, in the specific conceptual context of the epistemological and cognitive processes to the consideration of bioclimatic issues into design. In the interpretation process, some parts directly extracted from the transcripts are integrated in the analysis to exemplify some of the interpretations.

3.4.4 Interpretation- Grouping analysis

The material obtained from the interpretation of the panels was grouped in a spreadsheet. Each individual interview analysis was put in each column and ordered according to the topics defined in the interpretation process of the panels.

So, another process of interpretation was developed through the reading of the analysed material of the whole group of interviews related to each topic,

In this process of interpretation, the particular information, of the individual interviews considered relevant for the purposes of the study, was detached in the general analysis of the topic. Furthermore, common practices and statements related to each topic were also identified in this process, as well as main differences related to their different social contexts (in development and developed countries).

Some parts of the interviewees' discourse were integrated in the analysis to support the interpretation. Specific drawings of the panels considered useful to illustrate the interpretation were also integrated.

So, the general analysis of the results obtained in this final process of interpretation brings the necessary information to satisfy the purposes of the research. It points out the

elements usually manipulated to define the design concept and the way the bioclimatic concepts are considered in this process. These indications can constitute a set of fundamental information to develop or to improve a methodology to the integration of bioclimatic concepts into architectural design, regarding architect's real design needs.

The results and discussion presented in this research is related to the process of interpretation of the panels and categorized topics grouped in the mentioned spreadsheet. The interpretation was developed through the reading of the evaluated material, as the arrows show in Table 6. The full version of this spreadsheet is shown in appendix D, available in CD-room.

Table 6- Part of the spreadsheet of the whole group of interviews related to each topic.

		Interviewees	
		European	
		TOMBAZIS	CUCINELLA
Summary Sketches			
Aspects of the problem	**Irrespective to the building type and function**	Understanding of the context (climatic context- annual variations, site, historical context), time.	Understanding the problem (kind of problem and which are the objectives and the expectations that stem from the ethical view of the problem); - embraces the understanding of the Context (means sense of place and it is directly related to the understanding of the climatic context and site) to define the problem and related guiding principles.
	Depend on the building type	Brief (defined with the client)	Brief is consolidated after the understanding of the problem.
Guiding Principles		Qualitative/aesthetic, sustainability, balanced relation with client and contractor for the quality of the final result. (Light, Air and Time)	Style/aesthetical character (previous definition is fundamental for the development of the process). Kind of material, Shape, light, energy, time. Sustainability.
Design variables		shape, material, technology, orientation (consideration depend on the building type and the constraints of the climate and its annual variations). Completely different object if it is here or there. Technology is a tool to achieve a solution.	Building materials, space, form, orientation, technology (tools to achieve the ideas raised with the speculation of the constraints and principles)

4 RESULTS AND ANALYSIS

This chapter analyses the results acquired from the interviews, using as a framework the phenomenological and cognitive approach of the process of perception and understanding of the problem of integration of bioclimatic issues into the architectural design. It analyses separately, the results related to the main influences on the design philosophy and knowledge base, the considered conditions and guiding principles of the design problem, the main features of professional design practice, the aids and interactions in the design process, the identified problems, the possible solutions and the effect of building regulations.

4.1 APPROACHED CONCEPTS

The way the architect deals with aspects of bioclimatology and their understanding and application in design were the central purpose of investigation in this research. Therefore, the focus was on the influences and practices related to the consideration of local climatic conditions and materials to the generation of comfortable and energy efficient design solutions. There was no approach or no intention to approach the consideration of elements and practices directly related to aspects of sustainability[6], such as the embodied energy of the materials, re-use of water and grey water treatment.

However, it is important to point out that the interviewed architects, practicing mostly in England (Tom Jestico, Spencer de Grey, Sunand Prasad and Luiz Buzato), use the term sustainability, sustainable or green architecture to refer to aspects exclusively related to the consideration of bioclimatic issues to development of passive strategies, to improve energy efficiency while keeping the comfort and quality of the space. In the case of Sunand Prasad, he used the term bioclimatic design very intuitively during the interview, understanding it also as a question of the embodied energy of the material. However, as he recognizes, in his work the embodied energy of the material is not an influential consideration.

In the case of the other interviewed architects, practicing mostly in Greece, Italy and Brazil, these concepts are very well distinguished. These interviewees were very emphatic on the fact that their work could not be classified as sustainable architecture but

[6] According to the World Commission on Environment and Development, sustainable development implies meeting the needs of the present without compromising the ability of future generations to meet their own needs. Therefore, a real sustainable project needs to consider its impact on the future generations. The main aspects to be considered on the built environment are the use of energy, water, materials, emission of pollutants and transport, where each of these issues are inter-related. WCED, (1987). Our common future: the

indeed related to bioclimatic issues, because their understanding of sustainability was also related to materials and water. However, Cucinella makes the point that the consideration of the climate and development of passive strategies in the building design can present a much lower environmental impact than using, for example, walls of recycled plastic bottles.

They state that when there is the opportunity they try to integrate more issues of sustainability such as the consideration of local and low embodied energy materials, although it does not determine their choices. Leonardo says;

> "Today I also take into account other aspects such as the rational use of water and low impact materials but I think I don't limit myself on the use of materials. If the aesthetic character allows, I like the opportunity to use bamboo, wood, stone, but I also like to explore other technologies such as steel, metallic structure, etc." (Leonardo's interview)

Most of the interviewees emphasize they avoid 'labelling' their work, relating it to strict and closed rules of a movement or school because they believe it limits the options and the balance of design alternatives. Only the work of Sergio Pamplona is characterized in the broader sense of sustainable architecture, once it also embraces, as a fundamental influence, the permaculture principle of the energy cycle on the consideration of local materials, its embodied energy, transport optimisation and treatment and re-use of water.

It can be said that the different understanding of the term sustainable architecture between the interviewed architects is not related to their formal education because it was not a theme approached during the period they were at school. It can be related to the knowledge embedded in the culture of the place, including the way it is approached by local media, professional institutions and regulations. However, to testify this kind of speculation, a comparative evaluation of these sources would be necessary, which was not the focus of this research.

4.2 MAIN INFLUENCES ON THE DESIGN PHILOSOPHY AND KNOWLEDGE BASE

Our perception of the world leads us to generate empirical concepts representing the world around us within a mental framework relating new concepts to pre-existing ones. Our beliefs, which are considered a conviction on the truth of a proposition, can be acquired through perception (BLACKBURN, 2005). So, the perception can also lead us to generate and consolidate our beliefs. Furthermore, our knowledge can be acquired from books, scientific methods, the knowledge embedded in culture, language and traditions, reasoning, logic and experience (POPPER, 1979). The experience means in general the observation of the world through sense of perception (ANDERSON, 2000). So, perception,

Bruntland report. United Nations Department of Economic and Social Affairs (DESA). . Oxford University Press.

our view of the world, our experience, is fundamental on the development and consolidation of our knowledge and beliefs.

Our beliefs will be determinant on the application of this knowledge to a particular situation, in our case, the design problem solving. In architecture it can be said that architect's beliefs are translated into his design philosophy. Therefore, in considering bioclimatic issues and its concepts, the design philosophy plays an important role. It is necessary, first to understand the level of knowledge in bioclimatology and related fields, and which the main influences are on the consolidation of this knowledge; second to identify what influences their perception of the world to make them considering bioclimatic issues as part of their design philosophy. So, it is necessary to evaluate the influence of their formal education and past professional experiences

4.2.1 Formal education

The architectural education had a very low influence on the European interviewees to awake their interest in bioclimatic issues. In their case, there was no specific module on this theme, except in the case of Luiz Buzato, who is from a younger generation than the others (degree in architecture 9 years ago, in PCL- Polytechnic of Central London, now University of Westminster, 1991-1995). Jestico and Buzato point out that, even when the theme was approached, there was no relation to design or studio activities. According to Jestico, it was always considered an option or an addition to the project, what he considers a negative approach. Luiz Buzato and Mario Cucinella highlight the focus they had as students on studio activities and on the formal aspect of architecture. In Buzato's experience at University of Westminster, at that time called PCL, the studio activities meant the practice, the direct contact with design, while the other aspects of architecture such as structure, thermal comfort and history were distinguished from that. Buzato recognizes that his particular awareness of the importance of the theme was the stimulus to search for knowledge and the reason for his interest in specializing in the field.

On the other hand, Spencer de Grey recognizes the importance his formal education had on his design philosophy (see Figure 4-1).

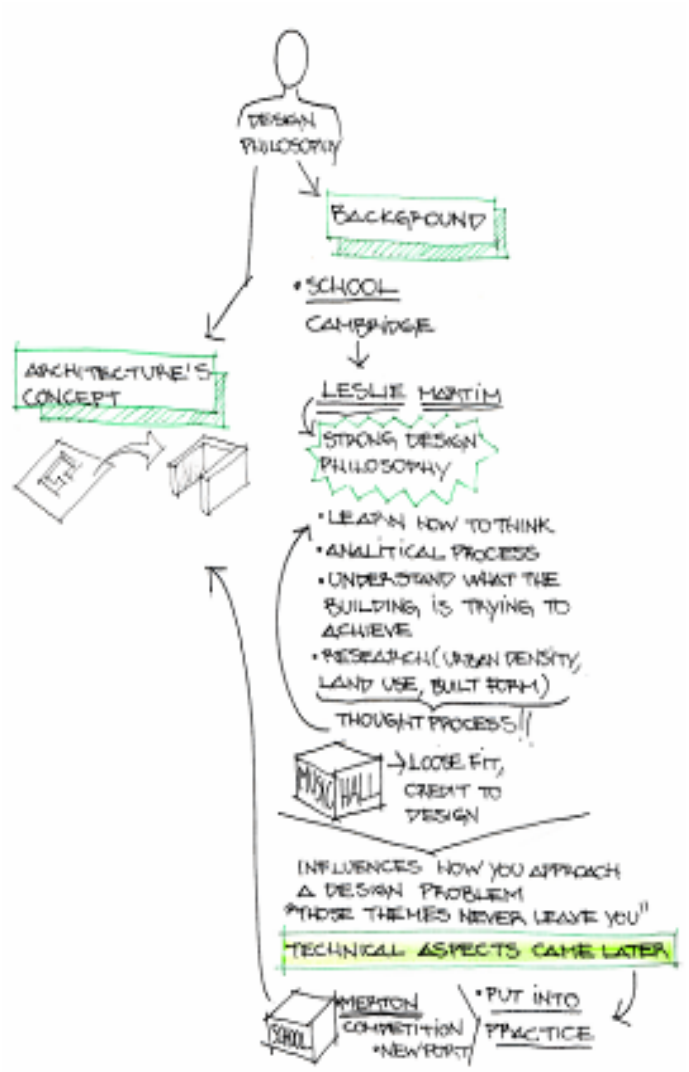


Figure 4-1- Influence of Spencer's background

The principles Spencer de Grey identifies that were introduced in his architectural education, stimulated the analytical process (in which induction is the main cognitive process (ANDERSON, 2000)) and the research to the understanding of the purposes of the building. According to his perception, this understanding meant understanding of how the building stands up and how it operates environmentally. So, the search for knowledge in structural and environmental aspects of the building was stimulated through the design philosophy adopted by the school itself, during the period of Leslie Martin's administration. As he says, all these principles are not required to every project but certainly influence the way he approaches a design problem, including his perception of the problem and the application of knowledge;

> "So there were a number of themes that I learned through my education in Cambridge. And I think those themes never leave you. (…) they are not required to every project, but the approach to design, how you approach a design problem is something that I continue today, I think that is always with you. So, I enjoyed my training and I think it makes quite a strong stamp on your later life." (Spencer's interview)

Andrew Marsh identifies a failure in his education in architecture, because it did not support his needs for justifying the design choices. The physical reason is pointed out as an appropriate ethical justification for the design choices;

> "I always wanted to explain, you know, there has to be a reason why you are putting a window in a wall, to me that wasn't enough to just say: It look pretty good. It wasn't something that I felt was an ethical justification. (…) I chose the physical reason. So the window is there to get light into the space, to allow breeze, etc." (Andrew Marsh's interview)

It was already part of his beliefs and, the difficulty to discuss and justify these beliefs, and knowledge through design, stimulated him to develop a tool to make this discussion easier. He recognizes that since an early stage he has been very interested in the environmental integration of the building, but the way building physics and environmental issues were approached in school was not stimulating. It was always very technical, based on the mechanical teaching of psychrometric charts. Marsh recognizes it as a reason for architects' general weak knowledge on the field.

The Brazilian interviewees, Sergio Pamplona and Romulo Bonelli (both from the same school – UnB- but from different periods, Pamplona 1984-1989 and Bonelli 1993-1999) also recognize that the theme of environmental comfort and building physics was approached in a very mechanical way in school, without any relation to design (see Figure 4-2);

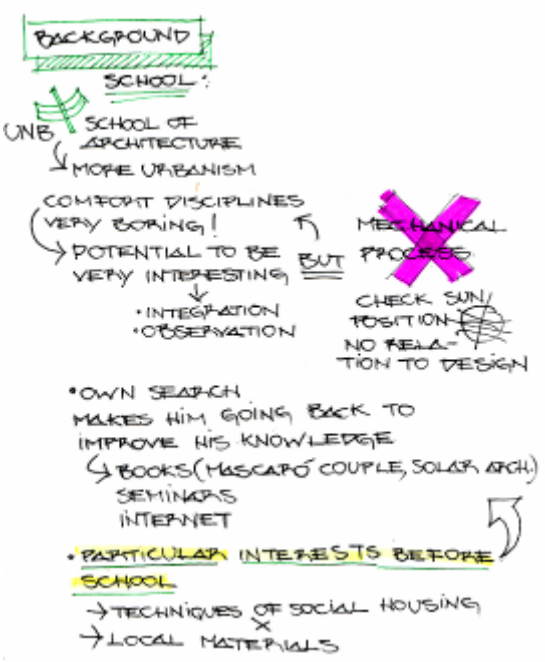


Figure 4-2- Schematic drawing of aspects related to Pamplona's formal education.

In Bonelli's case, such as in the case of Andrew Marsh, he states that;

"It was more the absence of something in school than the presence that was influential on me. (…) In the school you are trained to be the leader of a big team. Design projects that you are going to have the opportunity to do just when you have more than 50 years old. You are not prepared for the initial steps. You are not prepared for what you are going to meet in the market 6 months after school. That is one of the things that stimulated us to find a specific alternative of job. I'm not going to build a hospital right now, with my age. What I mean is, you are not prepared for what is outside, and what you meet outside is not what you were waiting for."

Bonelli also emphasize the importance of taking into account the human needs. John et al (JOHN et al., 2004) point out the importance of the consideration of the simple physical processes of nature and their interactions with human needs for the development of not only functional and productive, but also delightful buildings.

However, for the Brazilians Lele, Severiano Porto (both from the same school – UFRJ- and same period, 1950-1955) and Leonardo Bittencourt (UFPE, period of 1972-1977) the architectural education was very influential to stimulate the interest and knowledge in bioclimatic issues. Bittencourt points out that his interest was awoke through the exploration in school of the qualitative aspects of environmental integration and its

relation to the quality and beauty of the design itself. The physics of environmental integration was spread though studio activities, there was no specific module on that. It means his perception of the theme was not distinguished but linked to the main focus of design activity (Figure 4-3).

Figure 4-3- Schematic drawing of aspects related to Leonardo's formal education.

In the case of Lele and Severiano Porto there was a specific module in building physics. But the use of tools, such as the solar chart, was integrated in studio activities.

"At that time, 50 years ago, in the Faculty of Architecture of Rio de Janeiro (…) there was a big emphasis on technical disciplines. (…) there was, but it wasn't called Environmental Comfort at that time (…) it was called Applied Physics. So, in that course we had the briefs of thermal processes, acoustics, etc. (…) during the undergraduate course (…) we worked with solar charts as a basic design tool (..) I learned to make solar charts to any latitude (…)" (Lele's interview)

Lele recognizes the architectural education promoted a strong basis in technical knowledge, basically in thermal transfer, pressure differential and solar geometry. He also states that providing this kind of knowledge should be a strong commitment of the school. Severiano emphasizes several times the importance that field activities had in his architectural education to stimulate his interest in building construction and the practice of searching for references as an approach to the design problem.

4.2.2 Individual influences and references

Lele, Cucinella and Spencer de Grey identify Oscar Niemeyer, Renzo Piano and Leslie Martin, respectively, as strong individual influences. The working experience with them was very influential on the definition of their perception of architecture itself and their role as professionals. Therefore, it has a strong influence on the consolidation of their knowledge and design philosophy and, consequently, on their approach to the design problem.

In Lele's case, this influence was related to the principles of the modern movement, which, in his perception, were represented through the functionalism, aesthetic and the creation of more human spaces. The work with Renzo Piano stimulated Cucinella's interest in technical issues of building construction (Figure 4-4). According to his perception,

Piano's office "was a machine to make it real". It made him to understand architecture in a broader sense, from drawing to construction.

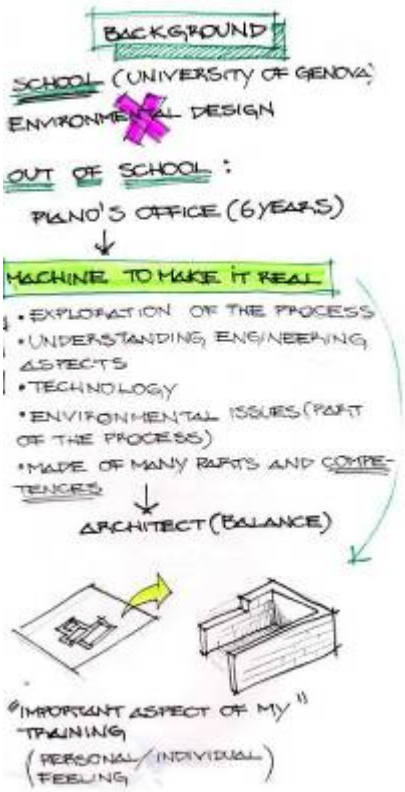


Figure 4-4- Schematic drawing of Cucinella's background.

Tom Jestico and Alexandros Tombazis recognize the work of some architects as strong references, revealing the practice of searching for references. Tombazis mentions the work of the Japanese metabolists in the 1960's, which attracted him because of the principle of innovation and integration to the environment, in a good balance between technique and aesthetic. As he comments, the metabolist architecture was characterized by the dynamic of the spaces, with the building as a non-finished organism, in constant transformation and adaptation to its use and its relation to the external environment. Schmiedeknecht (TOMBAZIS and SCHMIEDEKNECHT, 2002a) states that Tombazis early projects for the Headquarters of the General Cement Company in Lykovryssi, Athens, designed in 1971, the Svolos summer residence in Kineta, designed in 1968 and the "Difros" housing complex in Halandri, Athens, in 1971, display innovative and confident application of metabolist tendencies.

Similar reasons attracted Jestico to the work of Ray and Charles Eames, Buckminster Fuller and Arthur Erickson. Jestico recognizes that just when he improved his knowledge in technical and environmental concepts, he was able to identify the features of the work of the mentioned architects that attracted him in the first place;

> "When I started, I've been attracted by the work of various architects and it took some years before I realised that what I liked about them were the sustainable elements. Initially, I thought: those are great buildings. But I didn't quite understand why. And then 5 years later you begin to analyse and you say, that is what I like about them; the economy of materials, lean technology, no waste. Addressing these things of a hidden "below surface" and then, when you study those in more detail, these things become apparent and then, suddenly they become a reason why you liked the building in the first place." (Jestico's interview)

It agrees with the sense in cognitive psychology and phenomenology that as we acquire new information our perception shifts (ANDERSON, 2000; MOSER, 2005). His intuition and individual preferences attracted him to the work of these architects but the

acquired knowledge made his perception to generate a stronger concept of their work, understanding its quality and applicability.

What all the interviewed architects have in common is the interest in the technical issues of architecture, which was stimulated through their experience in school or in their past professional practice and references. In Cucinella and Severiano's case their interest is directly related to the materialization of the project.

In the case of all the interviewees, this belief and particular interest made them to go back to research and study to fulfil the gap left in their education. All of them emphasize the importance of researching and talking to experts to keep updated.

Tombazis recognizes that the participation in scientific conferences, the exchanging of information with other professionals and researchers and the occasional experience as a lecturer gave him a basis of information to understand the development of this field and the related concepts. Besides that, he emphasizes that he has a strong belief in competitions of architecture, which provide the environment to awake the interest of the young and to keep the vitality of the elder. He believes the participation in many competitions provided the necessary vitality to keep him updated and to preserve his interest in research.

For the architects who practice mostly in Britain, the RIBA (Royal Institute of British Architecture) has had an important role in their construction of knowledge (propositional). This institute recognizes the impact of architecture on the environment and has taken actions to stimulate the production of what they call sustainable architecture. It is an important source of information and makes available a trustful source of publications, researches and case studies showing the practical application of these issues. Furthermore, it supports and requires from its members annual CPD (Continuing Professional Development) with training, courses and seminars. It also provides specific CPD modules of sustainability[7]. It is important to notice that the modules, which are available in RIBA regarding sustainability, are exclusively related to energy performance through efficient systems of lighting, cooling and heating and integrated passive strategies. It agrees with the understanding of the interviewed architects in Britain of the term sustainability.

On the other hand, in Brazil there is no specific support or policy of the professional institutes at a national level. Even being aware of the importance of integrating bioclimatic considerations in design, the architects have a limited access to trustful sources of

[7] http://www.architecture.com/go/Architecture/Debate/Sustainability_2917.html

information and references that support their search for knowledge and keep them updated. Nevertheless, Bonelli and Pamplona try to fulfil the gap left in their education mostly based on an individual and intuitive search. They recognize the practice of talking to local people and searching in internet, in which they have mostly found links to weather websites. Pamplona also got in contact with internet publications of solar architecture. In this case, the contact with basic concepts of Solar Architecture improved Pamplona's concept of architecture, which added the concepts of bioclimatic and passive architecture;

> " (…) solutions of bioclimatic architecture, which in English they call Solar Passive Architecture. Of course for us, a lot of this doesn't have much to do with us because they talk about heating using the sun. But there is the cooling using it, isn't there? So, for us it doesn't make much sense, but some principles (…) can be applied not only in a temperate climate but also in an equatorial area." (Pamplona's interview)

4.2.3 Other Past experiences

The oil crisis of the 1970's was a stronger stimulus for the Europeans to awake their interest in environmental integration and in improving their knowledge.

Tombazis recognizes that the first appeal was on energy efficiency, only focused on equipment and not on design. But, he states it changed when the consideration of daylight was included. Then, it became also a matter of the quality of the space. It changed his perception of the problem. Therefore, as he recognizes, the role of the architectural solution itself, and not only the system, started to be considered. Then, the consideration of energy efficiency also started to be a matter of being sustainable.

He emphasizes that the opportunity to follow the construction of knowledge through the development of this field changed his perception of architecture itself. He started to understand its complexity and the need for balance all these questions;

> "When I started understanding that it is the building shell, which is…or building shape, the building itself and not the components which are the important thing, then, I mean, automatically I think I just looked at it in a different way. And you understand that there are not a set of projects, which you can think in this way and another set of projects where you cannot think in this way. So, I think that now to a larger or lesser degree these issues are part of my everyday way of thinking. It becomes, let say, a second nature." (Tombazis' interview)

Lele and Severiano believe the professional experience they had in the direct contact to the building site helped them to consolidate their technical knowledge. In Lele's case, the beggining of his professional practice during the construction of the city of Brasilia is considered a fundamental step for the development and consolidation of the technical knowledge provided by the school of architecture. These considerations testify Lele's beliefs that the learning process does not end up with the conclusion of the formal

education and, that it is consolidated through the practical application of the provided knowledge.

Severiano points out that his interest in building construction, highlighted in architectural education, made him to search for this contact and to believe that architecture was only complete with its materialization;

> "Then I went to work as a trainee in the office of one of my teachers, professor Castilho Sued. (…) Then, when I was drawing well, I told him that I would quit. (…) I would like to learn building construction, then, I went to work in Correa de Brito Construction Company and I worked there for 11 years.(…) My worry was that if I ended up in an architecture practice I would end as a drawer and I wouldn't be able to feel things." (Severiano Porto's interview)

Severiano believes that thinking on the materialization of the building makes him able to forecast the problems and to understand the complementary projects. This understanding is also translated in Cucinella and Spencer de Grey's statements. According to Cucinella's perception, the contact with the building site, provided by the work in Piano's office, generated a commitment with the quality of the final result, which includes the comfort and efficiency of the building.

Pamplona considers the professional experience with timber structure he had after school was very important to develop the modular and structural thinking, and a clear knowledge of the connection between structure and volume. He emphasizes the importance of having followed and detailed the building construction of Zanine's project to develop these skills.

Spencer de Grey also identifies that putting into practice the knowledge and design philosophy raised in school, through his first work in the construction of schools for the Council of Merton, was a very important opportunity to consolidate this knowledge and also the approach to the design problem.

Leonardo says his professional experience made him to understand and integrate the knowledge of solar geometry and the design strategies more appropriate to the local climate (Northeast of Brazil). In the case of Romulo Bonelli, his experience with indigene and remote communities pushed him to the adoption of passive strategies mainly for cooling and daylighting. And, therefore, it made him to search for more information and knowledge in the field. However, the gap left in his formal education and the limited access he has to trustful and comprehensive sources of information in the field make him to face difficulties and low performance on the design and application of these strategies in some design experiences.

It can be noticed that the experience of the interviewed architects in the building site construction, demonstrates that although having a propositional knowledge (MOSER,

2005) in the technical aspects of architecture, such as building physics and structure, the contact with the reality of the building site was fundamental to consolidate their procedural knowledge, or know how (McCOY, 2003; MOSER, 2005), in the application of the information. Lawson (LAWSON, 2005) points out the leaning about design problems by trying to solve them. The procedural knowledge is also defined as tacit knowledge in the work of Michael Polanyi (McCOY, 2003). Plato used the term "*techne*" for knowledge how and "*episteme"* for the propositional knowledge in which claims can be true or false (MOSER, 2005). The experience of these architects supported the knowledge of the concepts which are consolidated through the application of the "*techne*".

4.2.4 Concept of architecture and architect's professional role

In the case of Leonardo, his perception of architecture is related mainly to an aesthetic attitude. This perception was the element that influenced and called his attention to environmental issues presented in architectural education in relation to their aesthetical potential in design;

> "Armando Holanda's book "Building in the Northeast" showed the poetry of environmental integration, the beauty of the good results through architecture integration. (…) It showed the potential and features that only environmental integration would make possible. The language was what called my attention, the spatial/plastic possibilities of designing in balance with the environment." (Leonardo's interview)

For most of the interviewees, architecture is, first of all, seen as something which embraces the drawing to the building materialization/ construction. Cucinella states that being aware of the consequences and importance of the adopted design solution, was fundamental to the consolidation of his ethical view; because it generates a stronger commitment to the quality of the final result;

> "Your ethics is really a personal dimension, also whether the interpretation about what you think is ethical or not. In our work, in terms of professional experience, it is really about being aware of the consequences, being aware of the choices or proposals." (Cucinella's interview)

According to Lele, the materialization of the real object is obtained through the process to deal with social, artistic and technical aspects. It shows the influence of the modernist principles that he highlighted previously (functionalism, aesthetic and creating more human spaces) (see Figure 4-5);

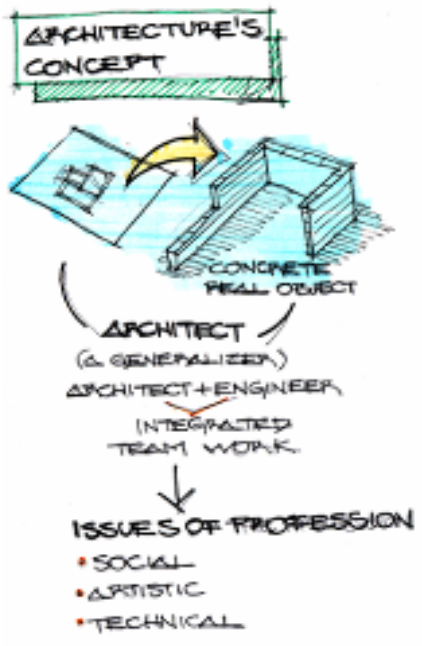


Figure 4-5- Lele's concept of architecture and architect's role

The particular concept that the architect has of architecture reinforces which are the issues considered most relevant and which choices should be taken. It guides the definition of guiding principles in the conceptual stage. All the interviewees state that architecture is made of many parts and that the environmental or bioclimatic issues are just one part of the whole problem.

According to Marsh's concepts, the quality of the space is directly related to environmental comfort. He understands that architects that work in respect to environmental issues are just taking their responsibility more seriously. It raises the importance of the design philosophy of the professional and the related concept of architecture to include environmental comfort among the criteria of quality.

Tombazis and Cucinella refer several times to the building as a live organism. According to Tombazis' perception, the building is part of the environment. He says this view makes the requirements of the environment, in relating the building to the site, a natural consideration in every building project since the analysis of the problem. He points out that since he started to face all the problems related to the building as an integrated problem he has started to understand that actually "Solar Design" was not the application of technology but a Design Philosophy. In this design philosophy, the building is a live organism, which is part of the environment and climate (see Figure 4-6);

> (…) I've said in many occasions that buildings are just as alive as all of us. It feels hot, it feels cold, it can change, it must be put on another extra cloth, or take off a cloth, and must be able to protect itself, in shade, or lye in the sun and be happy." (Tombazis's interview)

Figure 4-6- Schematic drawing of Tombazis' raised considerations related to the concept of architecture

The interviewees' statements regarding their practice and past experiences indicate a similar understanding of their role as architects. In this role, the architect has to weight up all of the conditions and criteria related to social, artistic and technical aspects. Cucinella and Severiano emphasize that forecasting and understanding the design problem related to the materialization of the building is very important to the application of this balance;

"The architect creates something that will be materialized. You are going to start a new stage of conception, and creation, a regency of all other complementary projects that are necessary to the materialization of the conceived building. (Part of the speech Severiano wrote on the occasion of the 10th anniversary of Manaos Trade Port, which he read during the interview)."

According to Cucinella, the role of the architect comprehends the leadership of the teamwork, understanding the context and site, understanding technology and all possible relations, including the relationship with the client and contractor. It shows the influence of his professional practice in Piano's office on the consolidation of his view of architecture. Piano himself states that "architecture is a great art but it is happily contamined by life, society, tradition, modernity, technology and science" (PIANO, 1997).

The preference of all the interviewees for technical issues and the awareness of the importance of their balance with other design considerations agree with their concept that the architect, as the leader of the design process, must understand a little of everything, integrating engineer and architect's work. Most of them see the architect as a generalist and synthesizer, who has a wider view of the problem and focuses first on the primary solutions. Sunand Prasad comments that;

> "Because I'm attentions to engineering (…) it seems to me, as an architect, that most of the job of the architect is to synthesize a lot of different things, we are synthesizers. We have a big overview. And things have to work together, have to work in thermal factors, have to work in functionality, the impact the building is making, all have to work together." (Prasad's interview)

Severiano emphasizes that, although the architect does not have to be a specialist, he/she has to have enough knowledge to know what he expects from the specialist for the best performance of the project;

> "The architect is like a composer, a regent, because he composes for an orchestra (…) and besides that, he will be the regent. -Look you are not in tune and you, etc- It is more or less how I see it. We have to understand, by the time you compose the melody that you don't have to know how to play violin, but you have to know violin's role. You have to understand music, you have to understand what you expect from the flute at that moment (Figure 4-7)." (Severiano's interview)

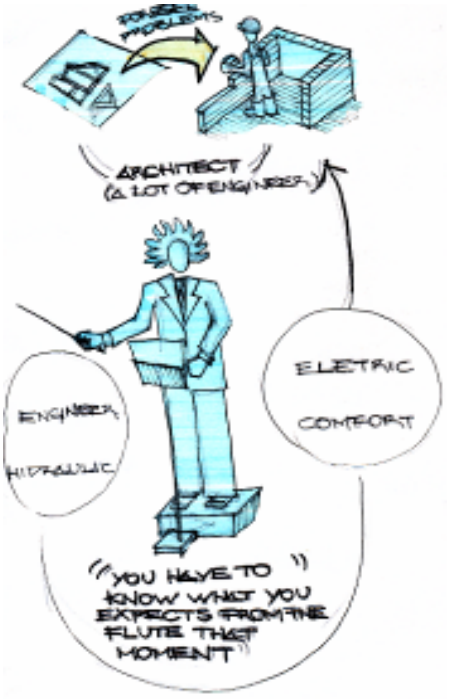


Figure 4-7- Schematic drawing of Severiano's concept of architecture

According to this concept, Cucinella, Lele, Tombazis and Tom Jestico point out the difference between the architect and the artist. The architecture field has to deal with constraints, different actors and more complex interactions of issues, such as context, shape and time. They emphasize that the artistic issue is only one of the steps of the process.

Cucinella comments that;

> "(…) architect is less free than an artist and much more complex than any other discipline we call artistic. So I say, being an architect you work in the centre of the society and not on the edge like other artists. It is very important to know that." (Cucinella's interview)

It reinforces the ethical character of the process, regarding the consequences and importance of architect's work. Tombazis distinguishes the difference between architecture and sculpture and points out that architecture "is a completely different object if it is here or there". It highlights the belief of the interviewees on the importance of the relation of the building with local context.

Regarding the role of the architect, Leonardo says the architect sells the space and therefore he has to generate the proper sensations for the space. And these sensations can be explored through daylighting, acoustics and thermal variations. On the other hand, Spencer de Grey points out the quality of the design stem from lesser prescriptive spaces to allow a longer life for the building based on the flexibility of the use of the space.

Nevertheless, it can be noticed that the design philosophy of the professional can be stimulated through his experience in architectural education or in their past professional practice, references or specific facts. The analysis of interviews also assured the importance of a strong knowledge base to the understanding of aspects of the design itself. The addition of information explicitly changes their perception of the problem. Once they start to understand the concepts and principles of building physics, they improve their understanding of the quality and applicability of the design solution.

The development of knowledge, through the experience in the formal education or in the first professional experiences of the interviewees, was very influential on their understanding of architecture itself and, consequently, on their understanding of their role as professionals. Nevertheless, it was influential on the principles and beliefs translated in their design philosophy, which affects their main considerations and approach to the design problem.

4.3 CONSIDERED CONDITIONS AND GUIDING PRINCIPLES

Lawson points out that the architect has the tendency to structure the problem by a judgement of design alternatives (LAWSON, 2005). The judgment of alternatives in the decision making process also depends on the design philosophy of the professional. Besides the design philosophy, the established criteria to proceed with the judgment of design alternatives are also required according to the priorities raised by the specific design problem. These criteria are classified as guiding principles (SMITHIES, 1981; LAWSON, 1997). The set of guiding principles also influences the way in which some conditions of the design problem are considered, mainly those related to prevailing conditions, such as the local context. So, the established conditions and guiding principles have a strong influence on the judgment of some design variables, such as the orientation of the building, materials, space, and form, among others.

Considering the definition of the design concept, Brazilian and European interviewees present very similar considerations. Apart from working in big design teams or in small practices, all the interviewees are in charge of the definition of the design concept, in which the design problem is first defined according to established conditions and guiding principles that help on the decision making and the creative process.

4.3.1 Design Philosophy

Tombazis, Leonardo and Spencer de Grey emphasize that every architect has a design philosophy, which is related to his view of the profession and to his concept of

architecture itself. And this understanding is clearly related to his background and professional experience.

During the interview, some of the architects, directly or indirectly, pointed out the main principle of their design philosophy, which can be clearly related to their concept of architecture and their background (see Table 7). The main focus of their design philosophy is basically related to the balance between aesthetic/formal issues and technical issues.

Table 7- Comparative table – design philosophy/background/concept of architecture

Interviewee	Main principle	Concept of architecture		Background (architectural education or past experience and references)
Alexandros Tombazis	Less is Beautiful- knowing how to balance environmental parameters and use their architectural potential when and how they are more appropriate	building is a live organism.	• Building is part of the environment and climate. Bioclimatic issues are just one part of the problem.	Oil crisis- opportunity to follow the development of solar design- from energy saving to quality of the space. Japanese metabolists.
Mario Cucinella	it is essential to be aware of the consequences of the final result, exploring material, light and energy in a poetic way to achieve comfortable and liveable conditions	Forecasting and understanding the design problem (materialization of the building)	• Embraces from the drawing to the construction.	Work in Renzo Piano's office- contact with the construction site. Oil crisis
Tom Jestico	balance between the aesthetic character/ architectural solutions and the problem		• Architect has to balance all conditions and criteria related to the social, artistic and technical aspects.	Ray and Charles Eames, Buckminster Fuller (references). CPD. Oil crisis.
Sunand Prasad	Design considerations have to work together, such as in aesthetic, thermal and functional factors			Experience in India, living the passive strategy integrated in his living conditions. Oil crisis
Spencer de Grey	necessary to take into account the understanding of what the plan or building is trying to achieve.	Life and quality of the building based on the flexibility of the space	• One integrated problem.	Architectural education- stimulus to the analytical process and research to the understanding of the purposes of the building (understating the needs of how the building stands up and how it operates environmentally- Cambridge (Leslie Martin)
Andrew Marsh	The designers themselves have to do what they are suggesting to become a reality.	Architect has to apply his knowledge and understanding of how to build, to make it come on the budget and to make it a nice space to be.	• Wider view of the problem and focus on the primary solution. Integrate engineer and architect's work.	Architectural education- lack of tools to justify his choice, showing the reason why he applied bioclimatic issues for the first time. Working in software development and consultancy.
Lele (João Filgueiras Lima)	generation of more human spaces	Materialization of the real object obtained through the process to deal with social artistic and technical aspects.	• Deal with complex interactions- context, shape and time. Architect different from an artist.	Modernist principles (functionalism, aesthetic and creating human spaces) – Oscar Niemeyer. Architectural education- module of building physics and solar chart integrated into studio activities. Technical responsibility in Brasilia's construction.
Leonardo Bittencourt	building has to work, producing the right feeling for the space in agreement to the aesthetic character	Architect sells the space and has to generate the appropriate sensation for that. Mainly an aesthetic attitude.		Architectural education- exploration of the qualitative aspects of environmental integration, its architectural potential. Physics of environmental integration spread through studio activities.
Severiano Porto	To integrate the building in space and time, in a logical, technical and beautiful manner.	Forecasting and understanding the design problem (materialization of the building) Enough knowledge to know what expect from the specialist		Architectural education- module of building physics and solar chart integrated into studio activities. Contact with the construction site- work in Correa de Brito construction company
Sergio Pamplona	Integration of the building to the site.	permaculture principles		Working in Loba architects and building construction in Zanine's project– working with timber structure. Contact with permaculture group.

Jestico, Cucinella, Tombazis, Lele and Severiano Porto emphasize that the exploration of design variables, according to the balance and judgment of design considerations, depends on their experience and knowledge. It agrees with the fact that only the architects with less than 10 years of practice, Buzato and Bonelli, did not make clear their concept of architecture and consequently, did not present a distinguished central point in their design philosophy. However, they already present clear interests that stimulate their search for knowledge and influence their perception of their professional experience and, consequently, their considerations on the balance of design alternatives.

Lele recognizes that the professional experience in different briefs of different building types consolidate the knowledge of related aspects of the specific problem. Therefore, it makes the information process faster in the balance of design alternatives;

> "(…) I design hospitals for Sarah Kubistchek Institute (…) I am used to hospitals' briefs (…) for me it is very ripened while undertaking the design (…) the computer of my brain is already well fed due to previous experience." (Lelé's interview)

Cucinella says the experience in building construction is fundamental to improve the understanding of the complexity of the process to achieve a faster balance. It influences Cucinella and Jestico's beliefs, in which the architect becomes really good, just late in his career, when according to Cucinella, he/she has already accumulated enough experience in building construction to dominate the complexity of issues.

Considering Asimow's model (SMITHIES, 1981; ROWE, 1987; SZALAPAJ, 2005), the starting point in the spiral of information processing changes with the addition of information. Therefore, a more experienced architect would already start from an advanced point in the spiral, such as indicated in Figure 4-8. It agrees with the consideration, in cognitive psychology and the phenomenological approach, in which one's perception leads to generate empirical concepts, which improve and change with the addition of information.

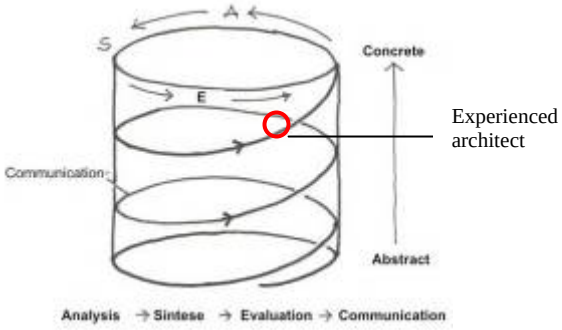


Figure 4-8 Model of Asimow's design process.

In the analysis of the problem, there are the aspects directly related to prevailing conditions that can possibly influence the design choices. These conditions can represent opportunities to the development of the design as well as constraints, which will limit some choices, according the purposes of the project. But, Lele points out that defining conditions of the problem is very important to the process, and not a limitation to his creativity. Actually, he says it helps creating guiding principles to guide the design choices.

Pamplona and Tombazis also state that it is fundamental to put targets and defining guiding principles in the early stage of the process (Figure 4-9). It agrees with Rowe's case studies on the professional practice of some designers (ROWE, 1987), in which the lack of constraints and an specific direction were an obstacle to define the main concept. The practice of spontaneously establishing guidelines and rules to help the decision-making process was identified. This event is useful to knock down the creativity myth.

Figure 4-9- Schematic drawing – need to put targets (Tombazis's drawing panel)

According to the interviewees, the design variables explored for the definition of the concept are the shape, material, orientation of the building and openings and the constructive system (technology and structure). Then, it is important to notice which conditions and guiding principles are taken into account in the judgment of design alternatives. Also observing what are the considerations directly related to the adoption of environmentally integrated design choices and what is their weight in the balance of alternatives.

4.3.2 Guiding Principles

The established guiding principles can be directly related to the design philosophy of the professional or being defined according to the priorities raised by the specific problem.

In this balance, according to interviewees' perception, every consideration on the definition of the problem and judgment of design alternatives is done having in concern its consequence for the aesthetic of the project, which agrees with the main focus of their

design philosophy. The aesthetic character is the dominant guiding principle. Therefore, even the consideration of technical issues is taken regarding their qualitative aspects. De Grey and Pamplona point out that technical issues, such as structural and environmental issues have to be defined as part of the architectural expression.

When asked about the guiding principles related to environmental integration, the interviewees in Europe mentioned sustainability as a guiding principle for their choices, although with different meanings, as explained in the beginning of this chapter. The Brazilians were more emphatic on the achievement of environmental comfort as a guiding principle to the adoption of passive strategies, basically related to daylighting, natural ventilation and shading. These strategies are mostly related to cooling strategies once the heat is a more common condition of the design problem in Tropical areas. It also agrees with their guiding principle of not using air conditioning system as a first design choice, which is considered a very poor approach, according to Pamplona.

According to Pamplona's particular concept, architecture needs to be coherent to the local features and it is related to a view of sustainability. This relation between architecture and sustainability influenced the adoption of permaculture criteria as a design tool, guiding the concept of energy optimisation. According to Pamplona, permaculture principles are based on the energetic cycle. It guides the relative location of the elements of the system, which is based on how their relation can avoid the waste of energy.

Daylighting is a principle strongly related to the integration of the building into the environment and it was much consolidated in the vocabulary and descriptions of the design experiences of all the interviewees. Their perception of the use of daylighting and passive strategies for cooling or heating is, first of all, related to the architectural quality it can bring for the space. Lele emphasizes that his choice for daylighting and natural ventilation is due to the aim of designing more human spaces. This perception makes them looking for passive strategies and for understanding the technical aspects to achieve their application. Energy efficiency is a secondary guiding principle in the process, which is seen as a natural consequence.

4.3.3 Main conditions in the definition of the problem

Regarding the conditions considered in the definition of the problem, the brief is considered the starting point, followed by the available budget.

However, De Grey states that, in the beginning of the process, sometimes it is necessary to put the cost and time apart from the problem, otherwise it is not possible to

make a progress on the development of innovative solutions regarding performance analysis. It can be a key question on their considerations, considering that in design it is almost an obligation to be innovative (GASPARSKI, 2005). Hartog (HARTOG, 2004) notices that architects take pride and pleasure in inventing novel solutions for environmental issues even if it implies that they have to familiarize themselves with underlying physics. Spencer de Grey mentions that it is necessary to challenge the cost engineers;

> "I think we often challenge our cost engineers in terms of trying to achieve as much as, I mean, more perhaps than you think it is possible." (Spencer de Grey's interview)

Lawson (LAWSON, 1997) notices that designers in general put their emphasis more on reaching a solution rather than understanding the problem. However, it is not the case of the interviewed architects. As Smithies (SMITHIES, 1981) holds, commonly many initial problems are self-imposed, according to the leanings the design philosophy of the professional creates. De Grey emphasizes that basing the design purely on the brief is a very superficial approach. He and Cucinella emphasize that, first, the understanding of the purposes of the project and the requirements beyond the brief are very important.

All the interviewed architects consider the understanding of the context a fundamental condition to define the problem. Tombazis states that the exercise of relating the function of the project to the context - identifying when and how they relate and balance - is the fundamental key to creativity and, consequently, to the generation of design solutions. This understanding is mainly related to climate and site, and there is a common perception of the climate among all the interviewees. When they refer to the climate, in this initial definition of the problem, to define the design concept, their main focus is on prevailing winds, solar geometry and maximum and minimum temperatures, in winter and summer seasons. The constraints of the climatic context guide the definition of design strategies, such as the solar position guides the orientation of the building.

Jestico recognizes that some particular features of the context define, which are the most important climatic variables to be taken into account on the definition of the design concept. For instance, if the building have to be placed on the top of a mountain in a cold climate, it is important to consider the prevailing winds and the periods of lower temperatures on the adoption of design strategies, to avoid the cold wind. On the other hand, Leonardo points out that sometimes the adopted design strategy can define which climatic variables should be evaluated in the specific project;

> "The adopted strategy will tell me which aspect of climate I need to observe, if I want to use natural ventilation I will check the wind." (Leonardo's interview)

In the case of Severiano Porto, Tom Jestico, Cucinella and Spencer de Grey, the guiding principle of using the building to create public spaces also influences the actions or choices related to the connexion to the site. It highlights the influence of the guiding principles on the way some conditions of the problem are taken into account.

For the architects who practice mostly in UK (Tom Jestico, Spencer de Grey, Sunand Prasad and Luiz Buzato) building regulations are also very influential although not determinant on the aesthetic solution. In the case of the choice of materials, the material is first evaluated regarding its appropriateness to the aesthetic character of the project as a whole. In the case of Jestico, the aesthetic potential of the material defines the investigation of its performance and cost. It also emphasizes the practice of investigation as a principle to improve knowledge and guarantee the application of the design choices. The knowledge base in building physics allows Jestico to be able to qualify the material or strategy to be adopted according to its thermal properties.

The Brazilians, Leonardo, Severiano, Pamplona and Bonelli, also consider the local resources a condition of the problem that can be influential on the choice of the material. It can be also influential on the adopted constructive system and consequently on the aesthetic solution. However, as Lele and Severiano Porto recognize the adopted constructive system/technology can be also a condition to define the materials and the aesthetic solution. In Lelé's case, the constructive system of industrialized components is a determining constraint to be considered in the early design stage. In his case aesthetic, daylighting and natural ventilation are very strong guiding principles, but they are considered under the constraints the industrialized constructive system creates.

Furthermore, other constraints imposed by specific conditions of the problem and brief can vary the influence of adopted guiding principles such as environmental comfort. Such as Lele recognizes;

> "The hierarchy changes (…) according to the project, you establish a hierarchy of certain things. For example, if I'm going to design in Belem, or Macapa (North of Brazil- hot and humid), the environmental comfort assumes a high level of importance because these are both very hot cities (…) and to solve the problem using natural ventilation, the ventilation strategy assumes a very high level of importance (…) it starts to be the guiding principle of the project; but if the issue is the budget then I have to think first in a more rational structure (…)". (Lele's interview)

Although the level of influence of the environmental principles, such as the use of passive strategies, can vary according to the specific project, all of them emphasize that these principles have to be at least part of the process and the conditions related to the requirements of the climatic context have to be part of the brief. It points out that the establishment of guiding principles is also related to the design philosophy of the

professional. Such as Spencer de Grey, Lele and Tombazis recognize, it will depend on the design philosophy adopted in the practice if the bioclimatic agenda will be included on the design alternatives.

> "(…) It is a question of having natural ventilation and daylighting as a primordial guiding principle. It is an individual choice (…) but others can think that the answer is an air conditioning system (…)". (Lele's interview)

Tombazis believes that in the judgment of design alternatives you just have to do what is logical. Therefore, the principle of environmental integration should be part of this logic. And observing the design philosophy of the interviewees, their concept of architecture itself has an important role on the consideration of bioclimatic issues into their logic of design.

4.3.4 Relation with the client

In what concerns the establishment of bioclimatic themes with the client, Tombazis makes the point that it is fundamentally related to the awareness of the client to these issues and to his/her preferences. According to the perception of the interviewees, in general, if the client is especially interested in these issues the work of the architect itself can attract client's attention. Therefore, as Jestico points out, it is then, necessary to build a track of good environmental design. Pamplona emphasizes that then, it is easier to achieve a satisfactory result for both sides (Figure 4-10).

Figure 4-10- Relation with the client, building a track of good results.

Prasad, Tombazis, Cucinella and Lele believe that there is no need to impose the approach to this theme, because bioclimatic issues are a natural part of architecture. The simple consideration of what is logic –for the interviewee- is considered enough to achieve these issues and because of this, they become self-evident. However, Cucinella emphasizes that the technical knowledge of the process is very important to generate trust and confidence in the relation with the client.

All of them agree that the relation with the client is an exchanging relationship, in which the client has preferences and demands and the architect presents the answers. But these answers can be direct or indirect. THOMAS and CARROLL (THOMAS and CARROLL, 1984) point out clients do not state all their goals explicitly, because they are probably not even aware of them before interacting with the designer. So, it agrees

with interviewees' statements, in which all of them point out that sometimes the client does not really know what he/she wants and that their clear understanding of the problem makes them able to show to the client the better responses to the problem. It is in this point where their knowledge and design philosophy makes the difference to bioclimatic integration into design, because its consideration is included in these responses. Spencer de Grey and Tom Jestico recognize that sometimes it is necessary to "*educate*" the client, establishing a relation between cost and design.

Therefore, most of them also agree that it is important to show a vocabulary of positive examples through a set of building solutions that shows a balance between aesthetic and passive strategies, in which comfort and energy efficiency are natural consequences of this balance. So, they believe that first you have to highlight the qualitative aspects related to comfort. Leonardo believes it helps to exemplify the intentions in practice, validating the discussion and also making the client to live a positive experience embracing comfort and the aesthetic solution.

> "The client is very important but what is more important is discovering what he really wants. He says what he wants but it is not always exactly what he wants, because I just ask for something that I know that exists.(…) It is important that you make it clear for the client.(…) Regarding that the client wasn't seeing that this other way would be better, so he couldn't ask for it. (…) And in the end of the process he chose the last propose, that was not what he asked first. (…) The same is related to environmental comfort. Some people use to say that they hate natural ventilation, that it doesn't work (…) And when they come into my house (located in Maceio- Northeast of Brazil- Hot an Humid climate) they say: - (…) I think if I had a house like this I wouldn't use air conditioning (…) Until that moment they hadn't experienced a pleasant space by the point of view of comfort." (Leonardo's interview)

Spencer de Grey, Leonardo and Pamplona agree that the opportunity to live a positive experience in passive design promotes the possibility of a cultural changing. Spencer de Grey identifies that the adoption of passive cooling strategies can be an unusual experience for the people, who are used to fully air-conditioned buildings. But, the contact with an integrated built environment can "*amaze the users*", which calls attention for the possibility of a cultural changing through the opportunity of living a positive experience in this kind of space.

Therefore, the consideration of environmental issues among the main principles to define the design problem is identified. They are considered in relation to the quality it can bring for the space, regarding the architectural expression of the project. The search for the quality of the space makes them looking for passive strategies and for understanding the technical aspects to achieve their application. Regarding their main considerations to define the design concept, the interviewees consider simplified climatic variables and deal with simple concepts of building physics to control the considered aspects of the climate. It

shows the influence of the design philosophy of the professional on the design choices, in which technical issues, such as environmental issues, have to be defined in balance to the architectural expression.

4.4 MAIN FEATURES OF PROFESSIONAL PRACTICE IN ARCHITECTURE

The particular features of interviewee's professional practice are fundamental to clarify the main influences on the adopted considerations and the mechanisms through which they go from analysis to synthesis. This evaluation was based on the content of the interviews. Through the interviews the construction of knowledge was based on architect's own impressions of his work, experiences, values and influences in his social context.

4.4.1 Building physics/ knowledge basis

All the interviewees point out the importance of understanding the effect of external conditions on the building. This understanding is mainly related to the effect of the sun on building's thermal gains and lighting, and the wind and its urban and internal flows. It agrees with the fact that the prevailing winds, the solar geometry and the maximum and minimum temperatures are the climatic parameters considered in the problem definition. Pamplona recognizes he also considers rainwater conditions, but only when he is designing rainwater catchment's systems. In this case, he notices that knowing the rainwater peak is much more important than the annual mean to define the size of the tank. It emphasizes that having a knowledge base is very important to be able to get the right answers from the available information. Tombazis and Lele notice that this kind of knowledge makes them to put targets to make the best use of external conditions. The best use of external conditions, according to Spencer de Grey, Lele and Tombazis' perception, pushes the boundaries of technology and provides the aesthetic freedom to make the idea real.

The way Tombazis explores solar radiation and daylight in his projects is an example of the way he understands the use of technology as well as the way the design solution is generated. He observes that, first of all, it is necessary to understand the effect of solar geometry on the building, such as periods of solar incidence, lighting and thermal gains;

> "I would say that much more than any new technology, it is the logic of things, let's say, I think it is much more important to understand how the sun enters in the building, how it penetrates the space, how it behaves, the thermal result of this penetration, what are the problems it creates, how it can be avoided, I think it is much more, the laws of physics if you want, and the thinking, the rational behind everything, than the technology itself. (Figure 4-11)" (Tombazis' interview)

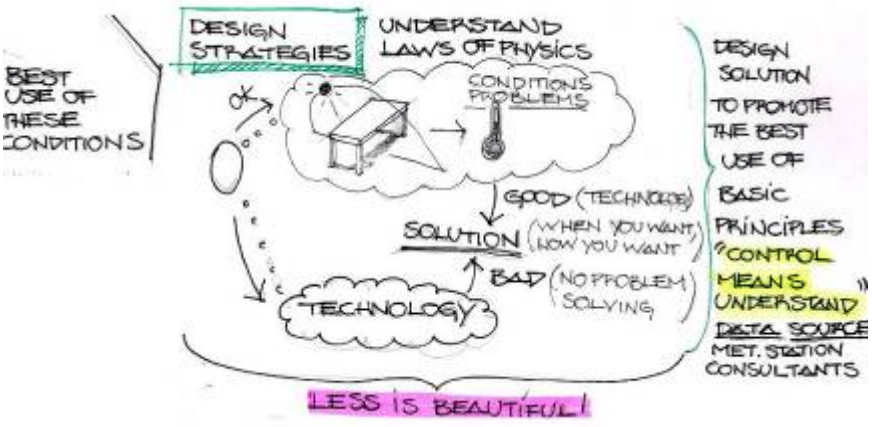


Figure 4-11- Schematic drawing of the main features of the professional practice of Tombazis

According to the perception of Cucinella, Pamplona and Severiano Porto of the design problem, understanding the technical requirements of the problem makes them to consider the technical point of view among the design considerations and, consequently, it makes them aware of the consequences of their design choices in balance with the aesthetic character of the project.

In architecture, intuition also plays an important role on the design problem solving. Tom Jestico recognizes that, in his design process, the first steps are more intuitive, based on his own knowledge and experience. It agrees with the definition that intuition is an unconscious form of knowledge and, it is unconsciously affected by experience. It is an immediate cognition, which is knowledge or conviction without consideration or inference (ANDERSON, 2000; BLACKBURN, 2005). However, the work of ROWE (1987) indicates that further in the process, as the scope of the problem becomes better defined, the episodic character of the process becomes less evident and is replaced by a more systematic practice.

Lele, Leonardo and Tombazis point out that the knowledge in building physics allows the exploration of intuition in a very confident and creative way. Lele emphasizes that confidence is fundamental to have environmental integration as a priority and to assume all the risks.

All the interviewee's recognize the importance of the knowledge in building physics to understand the dynamic relationship of the building with external conditions and to integrate environmental issues, guaranteeing that the main design concept is based on the awareness of the thermal problem. It agrees with Gasparski's definition of the professional designer, in which part of designer's responsibility is related to the knowledge of the

relationship between structural elements, which are dictated by laws of physics and logic (GASPARSKI, 2005).

Their building physics knowledge is mainly in basic concepts of thermal properties and of heat transfer, difference of air pressure and solar geometry. It can be identified in their descriptions of some design experiences and their main considerations in the decision making;

> "The system is designed empirically. Of course we know that evaporation decreases temperature 2 or 3 degrees. It is a physical principle, everybody knows. So, I think that the idea of water's aspersion into the galleries (technical floor) to decrease the temperature of the air that is entering in the space, and at the same time this aspersion of water also filters dust (…) it was something based on sensibility, basically." Salvador is very humid (…) but actually with this ventilation that we create, the increase of humidity isn't much of a problem." "I think that the concept of environmental comfort is strictly connected to ventilation and wind velocity. This is a subjective issue, every time there is wind in contact with your skin there is sweat evaporation, the temperature decreases and you have the feeling of cooling. (…) these things are subjective; actually when evaporation is created on your skin you have the feeling that the temperature is decreasing some degrees when the breezes pass by." (Lelé's interview- description of the project of Sarah´s Hospital in Salvador)

Tom Jestico states that the envelope becomes more important when the methods of cooling and heating are passive and, therefore, the understanding of those aspects of building physics becomes fundamental. However, the Brazilian interviewees were more focused on the design strategies directly related to the knowledge of solar geometry and difference of air pressure; because they deal mostly with strategies related to the application of natural ventilation, daylighting and solar shading. For the European interviewees, the material's properties were more relevant in their descriptions, mainly the transmittance of the component (U value). It is related to the stronger effect of heat losses to environmental comfort in cold climates and the existence of specific requirements on U value in their building regulations (EC, 2003; ODPM, 2006).

Super adobe walls on the ground floor and rammed earth walls on the upper floor were the first of Pamplona's choices when defining the concept of a house in Brasilia (Figure 4-12). But, because the client was afraid of the technique, Pamplona had to change the option;

> "I proposed rammed earth walls. And they agreed. So I made the upper walls in rammed earth and the walls on the ground floor were supposed to be made of super adobe with green roof. But the clients weren't really secure about that (…) just the wall of the garage was made of super adobe with local masonry. The super adobe is a great thermal insulation material (…)" (Pamplona's interview)

Figure 4-12- Hammed earth walls. Pamplona's project- Brasilia.

It calls the attention for the cultural influence on the acceptance of alternative design options. It is also important to notice that a technical knowledge basis is necessary to the proposal of alternative solutions, in agreement with architect's design philosophy. Although Pamplona applies the strategy of thermal inertia in a right way, his description shows that he confuses the thermal mass properties with insulation properties (thermal resistance). It shows that although having a consolidated design philosophy on these themes, the gap left in his formal education is a problem on his understanding of some concepts.

4.4.2 Design Strategies

Tombazis points out that understanding the effect of external conditions makes him able to control these conditions, using them when and how they are more appropriate according to aesthetic and comfort principles. It agrees with his belief that control means understanding.

All the interviewees explore this control through orientation, shape, technology, shading devices and materials, mainly to optimise the design strategies to promote daylighting and passive strategies for cooling and heating. Some design strategies are a direct response to local climatic conditions, such as solar radiation and prevailing winds. This response depends on the knowledge of basic building physics. Such as Lele points out, whether there is knowledge in building physics, the design solutions are developed to promote its best use.

This knowledge also makes the interviewees able to keep the aesthetic choice, even when they are not bioclimatically favourable. The awareness of the environmental problems related to the aesthetic choice makes them to balance this choice with

alternative strategies. It is emphasised when Leonardo describes the choices made on the design of his own house in Maceio (Figure 4-13);

> "There must be a comprehension of the principles and a clear notion of the premises and of the aesthetic character. (…) In my house I wanted to use a blue roof, even knowing that this colour would absorb more heat, so being aware of this….I kept the aesthetic premise and developed solutions to extract the heat more efficiently." (Leonardo's interview)

Figure 4-13- House of Leonardo Bittencourt in Maceio, Northeast of Brazil. Openings to natural ventilation, extracting the over heat generated by the dark roof.

Daylighting was also the guiding principle for the adopted design solution in the projects of the Carré D'Art in France and the Law School in Cambridge, according to Spencer de Grey's description. Both buildings present a solution with a central patio, which allows natural lighting into the space. However, the main guiding principle in Carré D'Art (see Figure 4-14 and Figure 4-15) was the height of the surrounding buildings. The choice to keep the same height was determinant on the definition of a building partially underground. It led to the choice for the mentioned daylighting solution. It shows that the architect tries to keep the main design choice, being aware of its consequences to balance the other strategies;

> "if you take the project light of the cultural centre inside France, we wanted to keep the height of the building in level with the buildings in the square. So it was a very large basement, which has the library and then opening the base of the lower levels up to the main floor, at the edge, I can get natural light down. (…) better space by the use of the basement. It is the same in the Law school we did in Cambridge where a hole on lower ground level was open down to the light." (Spencer's interview)

Figure 4-14- External View of the Carré D'Art- France.

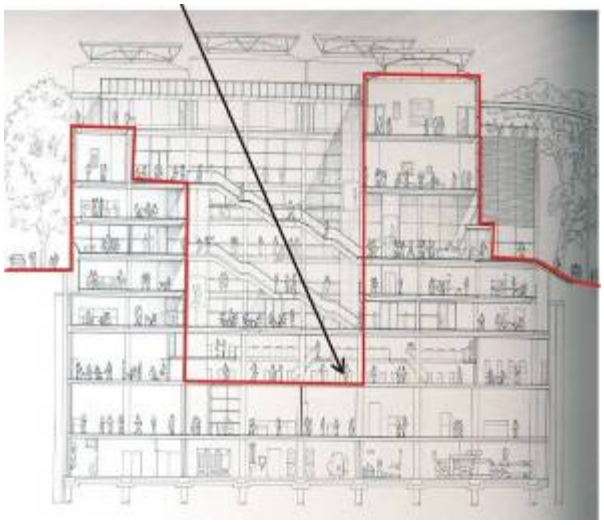


Figure 4-15- Cross section of Carré D'Art- France.

Therefore, Jestico points out that when the design concept is defined and consolidated it is very unlikely that the architect goes back and changes the concept completely. All the work is done to keep the main defined concept through the balance of the design strategies and the requirements of this concept;

> "Yes, if it is proved wrong. But …if you start in an early basis of the project, you might decide you want a glazed wall on one side of the building, which might be a very major decision and you won't like to change that completely. Once you decide you want a glazed wall in this side, then you are going to, certainly, refine and investigate what quality of glazing and what opportunities you can use, what are the problems, if you need solar shading, or if you could rely on the glass to guarantee the systems working with these solar gains, with these characteristics… So, once you have decided on the glazing wall, you will not like to come back and someone saying not use a glazed wall, use a solid wall." (Jestico's interview)

It is important to emphasise that, when the interviewees were asked about which climatic variables would be more influential on their design choices, their understanding was related to which design solutions have been generated in relation to the climate. When Spencer de Grey was asked about which climatic variables would have a stronger impact on the design choices, he immediately identified the design solution directly related to the considered variables. The solar position guides the orientation of space and openings, and the design shading devices are used to promote daylighting and to avoid excessive solar gains. The natural ventilation strategy is optimised through the identification of the prevailing winds; which also guides the orientation;

> "(…) temperature is very important, the sun path is very important, the orientation that leads the orientation of the building, yes there are a number of issues that are, that you need to now right from the beginning. It tremendously influences this building, you know, the orientation of this building, optimising the potential for using the wind, the prevailing wind, is part of the ventilation system, and the best orientation in terms of shading, and solar gain." (Spencer's interview)

It reassures the indication that the architect, in general, considers the information according to what he/she can do with it in terms of design (aesthetical/spatial) solutions (LAWSON, 1997)

So, considering the aesthetic character as the main guiding principle, they consider the architectural potential of the external conditions and systems to generate design solutions and the design concept itself. The materials, including glass materials, structure and environmental systems (passive or not) are first of all evaluated according to the aesthetic character of the project. For instance, the glass' aesthetic features and transparency that brings light for the space are the main stimulus for the use of glass in interviewees' projects. Spencer de Grey states that in order to explore their qualitative aspects it is fundamental to understand their technical aspects and technology;

> "And I think a lot of our buildings are strongly influenced by first of all, an understanding of materials, how you can explore them and use the best advantage of it and how you can develop new technologies in material work. So, again, the use of materials is a central part of our design." (Spencer's interview)

Therefore, Severiano Porto emphasizes that the architect must be aware of the heat gain that glazing solutions can promote. All of them criticized the glass boxes buildings, which according to Pamplona, "*do not give the chance to balance the design with the climate*."

All of them search for a balance when considering the use of glass, which for the Brazilians is mainly based on solar shading devices and orientation. In the case on the interviewees in Europe this balance is focused on the orientation and on the use of double skin systems. The architects practicing in England, Jestico, Prasad and Buzato, recognize that building regulations have been limiting the use of glass.

So, through interviewees' description of some of their design experiences, the consideration of the effect of external conditions on the architectural solutions was identified. It guided the adoption of strategies such as, double skin facades, evaporative cooling (Figure 4-17), cross ventilation and stack effect by difference of temperature (Figure 4-16) and solar shading strategies to allow the light and air flow at the desired moment and manner.

Figure 4-16- Meletitiki – cross section of Tombazis Office. Polydroso, Athens. Tombazis, 2002.

In Lele's case, the hospital's brief guides the consideration of natural ventilation as the main guiding principle to define the strategies, such as the orientation of openings, and the design concept itself through the adoption of sheds that define the aesthetic character of the whole building (Figure 4-17);

> "(…) The orientation of the galleries to wind direction, and sheds that would extract the wind, these were the first things I thought when I was designing the hospital." (Lelé's interview)

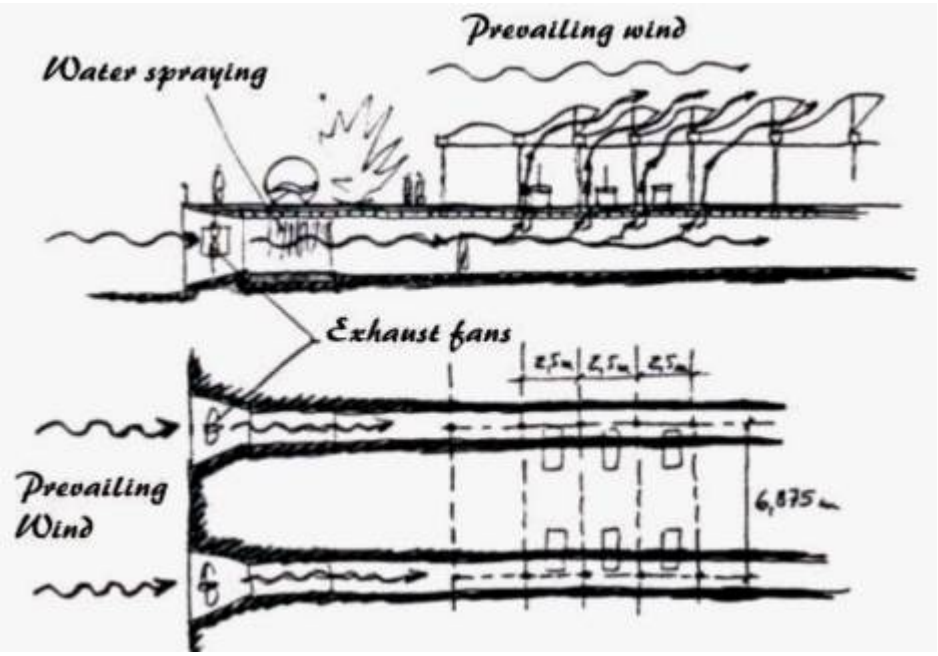


Figure 4-17 - Lele's sketches of the ventilation system of the hospital in Salvador. (LATORRACA, 2000)

The development of some design solutions based on the knowledge of building physics is noticed in Severiano's design solutions, such as the use of roof openings and

their orientation based on the understanding of air movement' processes by pressure and temperature differential;

> "For Example, Balbina is near Manaus but winds are completely different there. Then, it is an area near Manaus, but the wind is only East-West. So, it was completely different, (…) so this side has those little upper openings to extract hot air (…) (when he was talking about the project of the Centre of Environmental Protection of Balbina hydro-electric station in Amazon - Figure 4-18)" (Severiano's interview)

Figure 4-18- Environmental Protection Centre of Balbina.

Cucinella recognizes that the double skin solution applied in the project in Milan (see Figure 4-19) is a design solution directly related to the climate (solar radiation) that, then, was aesthetically explored in the design concept;

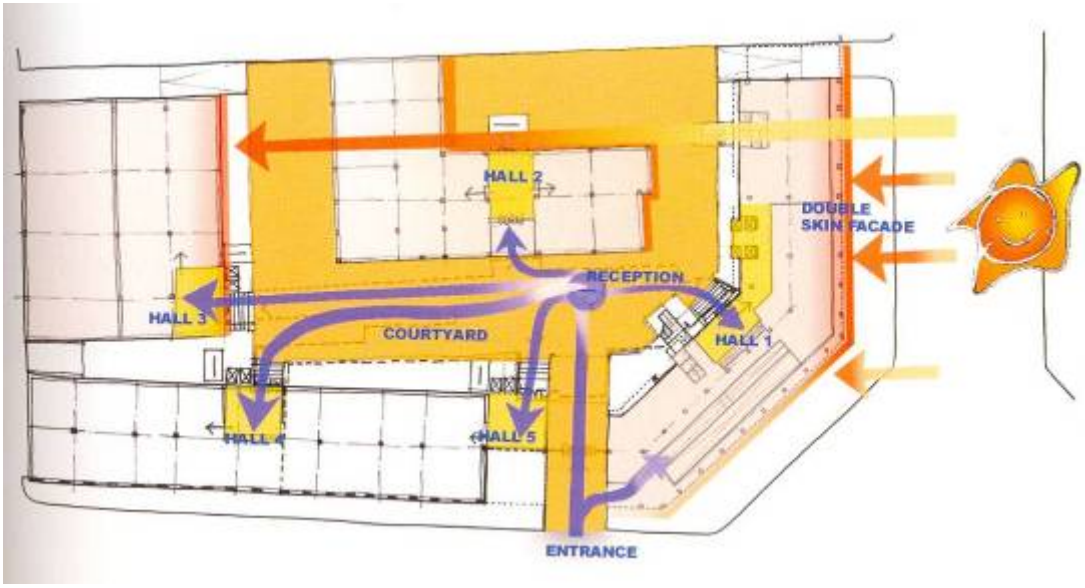


Figure 4-19- Schematic Plan of the Milan Project. Cucinella, 2004.

Extreme conditions of heating or cooling also involve the consideration of equipment and systems. In this case, Lele, Severiano and Spencer de Grey point out they search for the adoption of hybrid systems (part-time passive and part-time artificial), which have a fundamental effect on design concept. The project of Sarah Kubitschek Hospital in

Rio de Janeiro, shown in Figure 4-20 and Figure 4-21, illustrates the application of a cooling hybrid system.

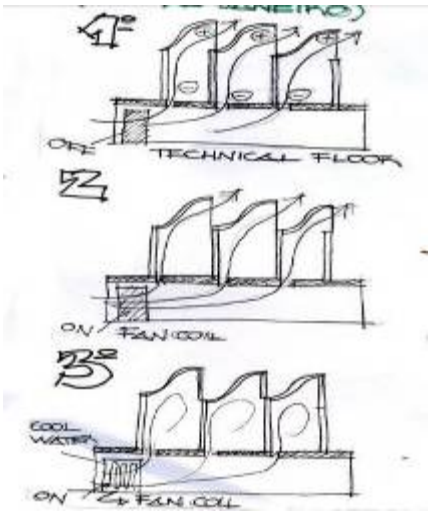


Figure 4-20- Sketches of the three different cooling systems in Rio de Janeiro's hospital.

Figure 4-21- Internal view of children's physiotherapy room. Daylight and natural ventilation with Sheds.

Spencer de Grey notices that the natural ventilation strategy was underestimated in the Commerzbank in Frankfurt. They expected it to be used 60% of the year and the air conditioning system 40%. But the natural ventilation has been actually used 80% of the year, which was a very good surprise for him.

4.4.3 Particular practices

All the interviewees present the practice of researching in parallel to design practice. The research is applied in general to improve their knowledge base and their confidence in the design decisions, making them able to define the right concept from the beginning.

In his practice, Jestico emphasizes the importance of stimulating the individual features of each architect. However, he identifies that there is a common approach to the problem, which is a cycle of analysing and testing the idea. But, he emphasizes that before, it is important to improve the knowledge to be able to proceed with this approach and to get the right answers. So, he stimulates research and promotes Continuing Professional Development (CPD) through workshops with experts of different technical fields of the building construction. In Cucinella's case, laboratory experiments and physical models are considered applicable tools in the beginning of the design process to support the understanding of natural phenomena on the building.

Another common practice among all the interviewees is the practice of going back to the building when it is already finished and occupied. In general, it is done informally by

visits to the occupied building and talks to the users. So, they base the analysis of the actual performance of their buildings on this kind of evaluation. Lele points out that the building performance cannot be based just on numbers because it includes an intuitive/psychological component, related to user's perception of the space, and it will depend on the quality of the space;

> "There will always be a subjective component that the architect will have to solve by sensibility, which he won't be able to solve in a mathematical way. (…) Of course it happens according to common sense (…) and it changes from person to person (…) if you take different architects each one will take into account different issues for the same project. (…) There are other factors of environmental comfort that are much more important than technical measurements to evaluate space's performance. They are subjective and psychological and they basically change this technical rigidity." (Lelé's interview)

HESCHONG (HESCHONG, 1999) points out that each sense not only gives us different information about the world but also has its own quality and affects one's perception of the world. She recognizes thermal sense cannot be easily isolated from overall experience, but it is intricately bound up with the experience of our bodies. "We continually sense the heat flow of our bodies, information that creates a general background for all other experience." Heschong makes the point that most of the processes of heat flow take place below our level of conscious sensation. But clues from other senses can make us more aware of thermal processes, enabling us to derive more enjoyment from them. Furthermore, the nervous system is much more attuned to noticing change in the environment than to noticing steady states. In spite of the extra physiological effort required to adjust to thermal stimuli, people definitely seem to enjoy a range of temperatures.

The coordination of a dynamic environmental strategy with other spatial, programmatic and social intentions ensure that architecture provides a series of appropriate and stimulating settings and sequences that vary over time and space (STEEMERS and STEANE, 2004). Hartog also states that what is considered pleasant is not a static concept but depends on the definition and interests of the people that will use the building (HARTOG, 2004). Environmental diversity is a design characteristic that is closely related to our experience of architecture (STEEMERS and STEANE, 2004). According to Lele's perception of the hospital designed in Salvador and his interactions with user's opinion, he comments;

> "Do you think this is an uncomfortable room? I: No (the interview was in his office in Salvador's hospital) Are you feeling the heat? I: No. Lelé: And today is a very hot day. And there is no air conditioning system here (…) So, it is possible. At the hospital here you will see that the temperature is surprising (…) You see, it is starting to get dark in here (17:30 in October, spring – south hemisphere- tour in Sarah's hospital in Salvador on the day of the interview) and people are not turning the lights on yet. It's already something cultural, the assimilation with the natural, daylighting

> (…) At the head office (at Sarah's hospital in Fortaleza) I thought it'd be better if I put an air conditioning system to avoid possible complains about temperature (…) do you believe that nobody has ever turned it on? It is always naturally ventilated." (Lelé's interview)

It can provide an answer to Marsh's question about how it is possible to show and appreciating the time and effort that goes into making a space works really well. It agrees with Spencer de Grey, Leonardo and Pamplona's beliefs that the opportunity to live a positive experience in passive design promotes the possibility of a cultural changing.

The practice of going back to the finished building shows their commitment with the quality of the final result and it is related to the concept of architecture that embraces the drawing to the construction. Cucinella recognizes that, in his practice, they prefer the projects in which they can also follow the building construction. Together to the opportunity of following the building construction, he considers this practice fundamental to understand the impact of his choices, creating a stronger commitment and ethical point of view.

This practice is also fundamental to make them able to recognize their own mistakes and learn with that. Lele, Jestico, Severiano and Pamplona believe their knowledge also comes from the experience and observation of their own mistakes. In Severiano's practice, the research is based on a search for references, on local context knowledge and on the dialogue with experts. He looks for an immersion into the problem, by visits to buildings of similar programs and the direct contact with the site and native people. He believes that with this kind of practice most of the information and learning is acquired observing the mistakes. It includes the learning with his own mistakes as well.

The collective work has also an effective impact on the understanding of the relation of the building to external conditions for the European interviewees and Lele, whose practices in general involve big design teams. Lele emphasizes that the complete development not only professional but also individual is achieved through the opportunity to work in a collective way;

> "Here we always work in team. I think the human being can only be completely happy when he acts collectively like this (…) the excess of individualism that this model of society is encouraging promotes isolation." (Lelé's interview)

Schoun recognizes that through the medium of a group, the student can immerse himself in the world of design studio, learning new habits of thought and action (SCHOUN, 1983). This interaction makes them to develop the procedural knowledge, or tacit knowledge (MCCOY, 2005), which is transmitted through personal experience, by observation or guided by an expert. This knowledge is embedded in a core of values, assumptions and beliefs. That is why Tombazis says a common design philosophy among

the members of his design team is naturally achieved along the development of the collective work.

Through Continued Professional Development (CPD), Jestico also stimulates the improvement and consolidation of propositional knowledge for the development of a common design philosophy in the approach to the project. Furthermore, this design philosophy is already stimulated in the recruitment of professionals in his practice. In his practice, the knowledge and vocabulary in environmental design is a strong criterion on the choice of a professional.

In the case of the other interviewed architects from Brazil, it is not common to work in big and multi-disciplinary design teams. But the small practices, the general lower budget of the projects and the awareness that a wider knowledge can guarantee the aesthetic choice, makes Severiano, Leonardo and Pamplona look forward to deal directly to technical aspects of the project.

The deep understanding makes them able to listen to the design team and experts and then, making better contributions. In Spencer de Grey's practice (Foster and Partners) he emphasizes the importance of the design team getting involved and responsible for the whole process. He recognizes it promotes a stronger knowledge and commitment with the project.

Therefore, the common practices identified here are indeed related to the construction of knowledge, mainly related to the materialization of the building, and the awareness of its importance to the quality of the project and its liveability conditions.

According to interviewees' description of their design experiences, the control of external conditions is done through orientation of the building and openings, shading devices, materials, shape and the constructive system (technology and structure), which are the design variables explored for the definition of the design concept. In this case, these variables are explored mainly to optimise the design strategies to promote daylighting and passive strategies for cooling and heating. Extreme conditions of heating or cooling also involve the consideration of equipment and systems. In this case Lele, Severiano and Spencer de Grey point out they search for the adoption of hybrid systems, which have a fundamental effect on the design concept.

Their building physics' knowledge makes the interviewees able to keep their aesthetic choice even when it is not bioclimatically favourable, because the design concept is based on the awareness of the thermal problem and therefore, it is balanced with alternative strategies. It is very important to the integration of environmental issues in the

definition of the design concept, considering that the architect, in general, does not use to go back when the design concept is already defined. The same is noticed in interviewees' descriptions, in which all the work in their practice is done to keep the main defined concept. Post occupancy evaluation, through informal visits to the occupied building and talks to the users, is another common practice among the interviewees. It shows their commitment with the final result and the relation with their concept of architecture that embraces the drawing to the construction.

4.5 AIDS AND INTERACTIONS IN THE DESIGN PROCESS

In the definition of the problem, the knowledge of the climatic context and its consequences for the building is the basis to identify the design strategies. In the climatic analysis, the Brazilians, Leonardo, Lele and Severiano Porto, present a clear picture of sun paths, its azimuths and altitudes, according to each latitude, through the use of solar charts. Leonardo states that a consolidate knowledge in solar geometry, based on his knowledge of the solar chart and his professional experience in Maceio, allows him to design solar shading devices without the use of the solar chart. However, he recognizes that he uses the tool when he wants to design more complex shading devices.

In Pamplona and Bonelli's case, they recognize that their knowledge of climatic conditions and sun paths is very intuitive, based only on observation and local experience. Pamplona is conscious that he could achieve better results in the design solution if he had a stronger knowledge basis. He identifies that not knowing how to use the solar chart limits the precision on the solar shading protections, such as the exact size of overhangs or vertical brise-soleils. In the case of Lele, he believes it is the knowledge of the solar chart that makes him to achieve better results. In Pamplona's case, he deals mostly with residential buildings, in closer contact with the client. In this situation, he can go back to the building and fix or improve these elements after built. However, he recognizes it is necessary to solve the gap in his knowledge to avoid these failures in the first place.

Tombazis also mention the solar chart as a tool to deal with solar geometry. However, all the European interviewees present the need of graphical visualization to better understand the phenomena. They mention visual renderings in basic CAD tools and physical models to make the visualization possible. In Cucinella's practice some daylighting studies are done with physical models in artificial sky (Figure 4-22).

Figure 4-22- Use of artificial sky to analyze daylight effect on physical model. Source: Cucinella, 2004

This kind of tool is considered easily applicable and it is used for the development of most of his projects, irrespective to the building type. On the other hand, computational simulations are used only when tests or refinement of the solutions are necessary, or to make a deeper analysis of some phenomena or engineering issue. Experts are involved to develop most of these simulations, which requires a bigger budget.

> "In the beginning, it is easier to make physical models because some you can do by yourself, and then you can go on stage and the deeper on the process you go, the more you need external support consultancy, because if you want to reach some certain level of solution, you need a specialist. But in the beginning you can do some analysis maybe in physical models and maybe understanding the phenomena. For the stage of preliminary design or sketch design, it is quite important and you are not going to call an engineer to do these things, you can do by yourself. Then, the more the process goes on in deep you can use the software for a specific point. (…) making a physical model, to make a lighting study doesn't cost more. It is only the way you work, not the cost. It is an extra cost if you want to go deeply in the analysis, and there must be a reason to do that. Normally it is a brief, because the brief ask you some details or in the case of residences there are maybe more engineering aspects that you want to investigate." (Cucinella's interview)

In Lele, Severiano and Leonardo's case, it seems that the knowledge of the solar chart provides a wider abstraction skill and satisfies their understanding of the phenomena without the use of software, even knowing and having access to CAD tools that provide 3D graphic visualization.

Besides that, in the climatic analysis all the interviewees considered essential visiting the site to understand local conditions of insolation, location and wind. The European interviewees acquire most of this data from meteorological stations and websites. The Brazilians also recognize local airports as data sources. But they did not

mention the use of any software or other tool to proceed with any kind of treatment or visualization of this data. In the case of all the interviewees, they did not know the existence of any particular software for that. Only Leonardo, because of his academic work, came across specific software such as Analysis Bio[8] and Phoenix to CFD analysis (Computational Fluid Dynamics). He identifies the appropriateness of the Analysis Bio software, which basically deals with the bioclimatic chart and the identification of passive strategies, for basic strategic studies for the concept definition (Figure 4-23). He considers it is more appropriate for the conceptual stage, because it just indicates possible strategies but leaves open options for the designer.

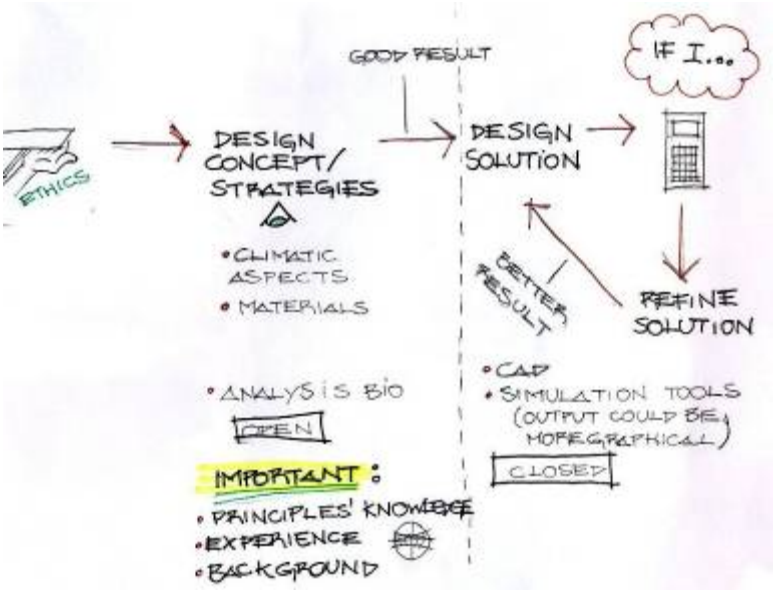


Figure 4-23- Schematic drawing of Leonardo's practices.

In the case of the interviewees working in big design teams, such as Jestico, Spencer de Grey, Tombazis, Sunand Prasad and Cucinella, the information to climatic analysis of the site is also provided by design team survey. They agree that, certainly, there is the application of software for that. But only Cucinella and Jestico could identify which software they were applying. Cucinella indicated the use of Ecotect software package in his practice and Jestico mentioned the use of the tool Sketch-up for shading visualization.

It shows that they, as the leaders of the design team, were more involved in the definition of the design concept based on the basic information provided. The early decisions, such as Marsh recognizes, are based on architect's fundamental understanding of what is happening on the site.

[8] http://www.labeee.ufsc.br/software/analysisBIO.html

Andrew Marsh points out that the difficulty, when you are dealing and discussing with the design team or with specialists or the client, is to communicate the idea and justify it. The communication and justification of the idea were his motivation and main purpose on the development of Ecotect software, which also helps on the detailing and precision of the defined strategies. Therefore, the architect should still need the previous knowledge base to define the idea and related strategies in first place.

Spencer de Grey says the advance in software made easier the development of strategic studies. According to his perception of the problem, it means studies of light and shadow, construction joints, basic analysis of the site and building. He believes it helps in terms of a sustainable agenda because it is easier to include it in the problem. However, Leonardo indicates that the knowledge basis is very important to get the right answers, even when using simple tools such as bioclimatic charts. Marsh also states that;

> "So, things tend to become intuitive. So, half of me argues that you don't need to be a physicist but just to play with it. The other side of me says that: yes, but half of the time there is these interesting little things that you really have to go deep in the technical issues to understand why it is actually happening, why do you see it? the computer will not discover it for you, it is just giving you a different view." (Marsh's interview)

According to interviewees' descriptions, the main idea and main strategies defined in the design concept are, then, in general translated first in free hand drawings. All the interviewees recognize that during the first design stage the CAD is a tool used in parallel to free hand drawings and it becomes dominant only when the design concept is already defined. Lele emphasizes that in his practice, it is applied only if complex geometric solutions are required. De Grey identifies that it is necessary to be careful with the role of computer on the design process and to be very critic to that (Figure 4-24). He states, free hand drawings help to preserve a direct response to the mental processing of information;

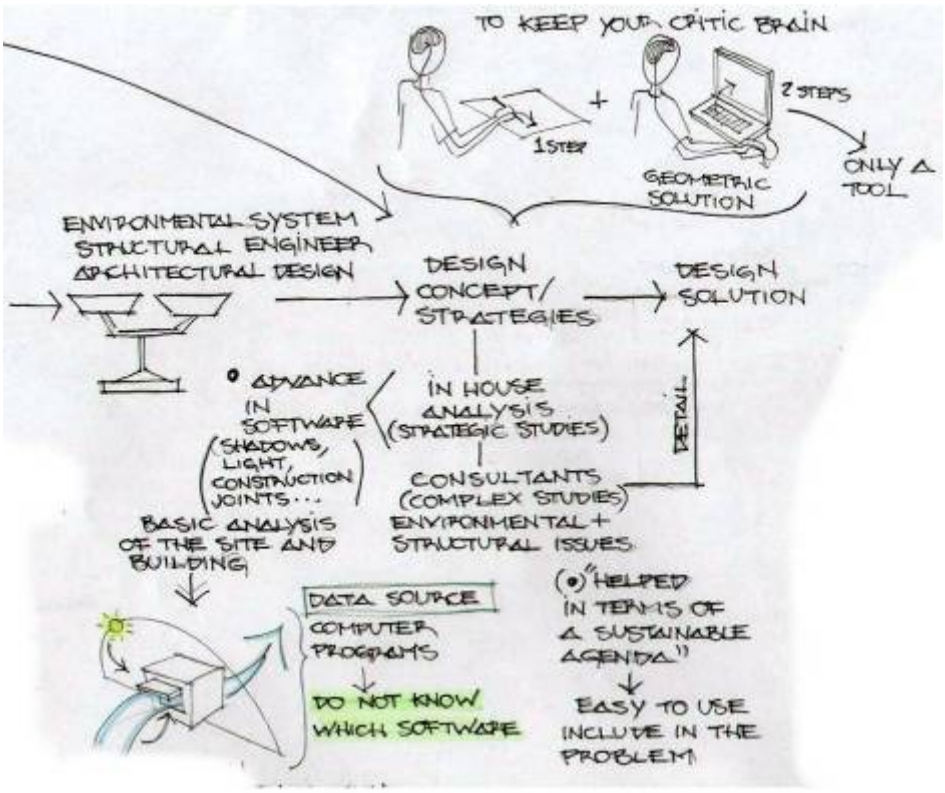


Figure 4-24- Schematic drawing of the practices in Spencer de Grey design process.

As noted by Haapasalo (HAAPASALO, 2000), CAD put into a pattern and facilitated the final result of the architectural design but the computer remains out of the sketch, which emphasizes the incompatibility of the available interfaces to design needs.

It is noticed that once they define the main idea in the design concept, they work to keep this idea. In the case of the interviewed architects, the applied tools are used then, basically for daylighting studies to guide the design choices from the beginning and to adjust the strategies to the concept. Part of the European interviewees also uses information from thermal simulation analysis. However, these computer simulations are developed by consultants and it depends on the budget, time and complexity of the specific project. It is done mostly to refine the solution, trying to keep the design concept. Tombazis holds that 95% of the environmental performance of the final solution depends on basic design decisions related to the knowledge of basic building physics;

> "I think it is very much an issue of new breed of specialists or the designers who are really more …, let's say, environmental consultancy or energy etc. So, we work with this people very much. And I think we do not do simulations and these things in the office ourselves. When we do, it is not always. Because it is also a matter of cost, and etc, and we know the basic, so it does not mean that what we are doing is 100% good, but for sure maybe it is the 90% or 95%, because it is the basic decision. I don't say this is not important, but it is not something that we necessarily always achieve." (Tombazis' interview)

Andrew Marsh also points out that, calculations become really important to the refinement of the solution although the early decision will play a fundamental impact on building performance and it does not require complex calculations;

> "I suspect that to make good early design decisions, and you think, right early in the design stage, you know, where you choose the orientation, that orientation is going to have an enormous impact. So, getting those early decisions right I don't actually think you need much deep technical background. Later on, when you are designing the detail of louver systems to get them right perfect on the walls, then maybe you need a little bit more, to look into the calculations to the thermal analysis, etc." (Marsh's interview)

Therefore, the consideration of bioclimatic issues in the early design decisions depends on architect's fundamental understanding of the relation of the building to local climatic conditions, which is basically related to insolation and wind conditions. According to interviewees' practice, at this point it does not require the involvement of a specialist. However, Andrew Marsh identifies that the architect in general lacks of confidence in that area because they believe a huge amount of technical knowledge is necessary to validate the design choice. Therefore, he points out the small practices in England and Australia, which associate the consideration of bioclimatic problems and passive strategies to big engineering companies, and these companies that in general require a bigger budget of the project;

> "most small firms would look at something like (…) and think, that's only possible because they pay Arup an absolutely big amount of money to give them all those feedback. And I think that put a lot of firms off. One is the client not asking for environmental efficient buildings and they, when they consider it and they look around all the processes, you know, all the pre existent exemplars they say: it is a wonderful picture by the designers and a wonderful technical picture by Arup associates. You know, I'm using it as an example, of big engineering companies. So, small architects get the idea that they can only attempt these design problems if you have the forward support of a massive engineering company. (…) And I don't think that is true, we can make a lot of these early decisions without any engineer involvement. But there are 2 problems with that, one is that architecture in general lacks a bit of confidence in that area only because, you know, it seems that you have to have a huge amount of technical knowledge to be able to validate a design." (Marsh's interview)

Although Jestico emphasizes there was not much advance in building technology, he recognizes that the advance in research and knowledge in environmental issues provided more information to refine the solutions and to guarantee a better performance. He describes a design experience of the poor performance of a strategy of natural ventilation based on stack effect, in one of his projects, when there wasn't a consolidated research on the field. The application of the strategy was based only on interviewee's intuition of the basic concept. In this case, it emphasizes the need for deeper calculations to improve the performance. Jestico comments;

> "Yes, I think we placed too much faith on stack ventilation. We did a building in Kensington, not far from here, in 1986, which has an atrium and we depended on heat rising up through the atrium to draw air from the outside. And there wasn't sufficient warm air to induce the stack effect. So, we

> learned from that. In 1986 the performance of atrium buildings was not as well developed as it is now." (Jestico's interview)

In case consultancy in environmental systems and thermal performance is required, Cucinella, Jestico and Spencer de Grey emphasize that they always try to involve consultants since the beginning to evaluate the consequences of the defined strategies. In this case, the work of the consultants is more in guiding advice on the way the defined strategy would perform better, but following the design concept defined by the architect. The involvement of the consultant since the beginning requires a bigger amount of work of the consultants because new evaluations have to be done every time the design concept is adjusted. However, it guarantees the analysis is integrated in the design solution because the architect develops his own solutions to the problem, based on consultant's explanation of the problem and not on suggestions to modify the design.

But, as Andrew Marsh points out, based on his experience as environmental consultant in Australia, in general architects require consultancy only when the design concept is already consolidated. Sometimes it is done just to solve problems related to requirements of building regulations, without any real dialogue. In this kind of situation there is not much effect on the design solution;

> "when I was in Australia, (…) they had no past local regulations or something, so it is being forced on them. In their case, they just wanted you to solve their problem, end of story. They said: we got a problem, we are paying you money, here is your problem, so you solve it for us. (…) for them it is just another jump, you know, another step that they can overcome to get their building into reality. So in those kinds of teams, it is hard, there isn't really a dialogue." (Marsh's interview)

All the interviewees also agree that a wider knowledge basis is fundamental in the dialogue with experts to preserve the design solution and its related aesthetic character. Sunand Prasad and Jestico emphasize that this knowledge allows them to challenge the engineer and then preserving their choices. Spencer points out that it is also fundamental to stimulate innovative solutions.

In the case of the Brazilian interviewees, there is only the involvement of professionals related to complementary projects of structure, hydraulic and electricity. However, even in this case, the dialogue just happens after the definition of the design concept. In the case of the interviewees, the difference is that their technical knowledge in complementary projects makes them to integrate and to solve previously the related problems. Pamplona emphasizes that the development of skills in timber structure in his first professional experience made him able to understand structure requirements. Therefore, even on projects with conventional structure of concrete, he defines the main structural solutions to keep his aesthetic choices. It also makes the dialogue with the

engineer easier. Pamplona considers that the structural limits are a challenge to integrate it in the architectural expression;

> "(…) I think that the limit the structure imposes is a challenge to use it as part of the architectural expression. I learned to do that in this school of timber structure." (Pamplona's interview)

The Brazilian interviewees don't require consultancy to thermal analysis or environmental systems because, in general, there is no budget for these issues. Just in Lele's case, because of his work with complex briefs of hospitals, sometimes consultancy to environmental systems is required. It is, most of the time, related to acoustic issues or the refinement of defined cooling systems. Lelé believes the performance of the hospital in Fortaleza is considered better - in terms of environmental comfort - than the performance of the hospital in Salvador because of the consultancy to refine the developed strategy of cooling. It is important to recognize that, firstly, the architect was able to define the design concept based on the understanding of basic physics principles of evaporative cooling and differential of air pressure.

> "In Fortaleza the solution was more technical; we had advisory of our expert. So it works better there than here. (…) the advisor participation was in the development stage (…) in order to create a system that makes air circulation possible through the entire hospital, sizing the pipes and connections. The galleries were already an industrialized system, for foundation and maintenance service." (Lelé's interview)

In Leonardo's case, if there is budget, his own knowledge allows him to assume the thermal and CFD simulation. But, it also happens just to refine the strategies already defined in the design concept. He points out that it requires a stronger quantitative knowledge.

All of them agree that technology is only a tool to explore the aesthetic potential of the control of environmental conditions. Tombazis believes that when technology is used without a reason, it does not contribute to the generation of appropriate design solutions, because there was no previous problem to justify its application.

Therefore, the consideration of bioclimatic issues in the early design decisions is not directly related to the use or improvement of design tools or software. It is first related to architects' philosophy and fundamental understanding of the relation of the building to local climatic conditions, which is basically related to the effect of insolation and wind on the building. However, the knowledge of some simple tools, such as the solar chart appears to stimulate the spatial perception and understanding of the problem.

In phenomenology it is established that perception leads us to generate empirical concepts of the world. The architect's view of the world, including the concept of architecture itself, is related to his/her experience and related perception. The particular

perception of each architect contributed to the consolidation of their design philosophy, which influenced their view of the problem of integrating of bioclimatic concepts. During their description of their background and design practice, the interviewees started to, spontaneously, identify the problems and possible solutions, not only regarding their own experience, but also the architectural practice in general. It agrees with Kvale and Freebody (KVALE, 1996; FREEBODY, 2003), who emphasized that, giving particular impressions to the approached problem provides to the interviewee new insights into his constructed social world. Those descriptions also provided the information to establish a relation between background and practice. Establishing this relationship, the related problems or effective examples on the consideration of bioclimatic concepts in design were recognized and synthesized in the following topics.

4.6 IDENTIFIED PROBLEMS

Tombazis, Cucinella, Spencer de Grey, Prasad, Lelé, Severiano Porto and Leornardo Bittencourt point out that the architect in general relates environmental issues directly to technical issues. Furthermore, technical issues are considered a limit to creativity and freedom in the design process. It agrees with Peter Carl's statements that techniques generally carry the value of necessity and aesthetics the value of freedom (CARL, 2004). Lelé recognizes there is a kind of prejudice for technical issues and also a belief that architect's skills are based on a kind of gift or artistic destiny.

> "I think that we architects very often are afraid of technical issues. We think that they are beyond our understanding, and we are afraid of constraints.(…) we don't like to address them, because we are afraid that we will loose our freedom and our creativity." (Tombazis´ interview)

Their perception of the problem can be related to their concept of architecture and the role of the architect, which must balance social, artistic and technical issues. They believe that environmental issues are a natural part of this balance. Therefore, they recognize that considering environmental issues optional or additional to the project is a negative approach, because they should be intrinsic to the process.

However, Buzato points out that many architects use this agreement that environmental issues are already part of architecture to justify that it is a knowledge already consolidated and therefore, there is no need to improve it. He notices that these architects use to repeat sentences they heard before without really knowing the physical principle and how that works.

Prasad also emphasizes;

> "sustainability in architecture is suffering from that because many times it is not possible to distinguish if it has been approached because it is fashionable or because it is logical." (Prasad's interview)

This statement points out the consideration of environmental issues as part of the logic of design, which was also recognized in Tombazis´ statements. Spencer de Grey states that ignoring issues of sustainability is ignoring the essence of the building.

Tombazis, Cucinella and Spencer de Grey emphasize the architect doesn't consider himself responsible for technical issues and the engineer is required to assume this responsibility. There is no integration, which is a problem to bring technical issues into the architectural expression (see Figure 4-25).

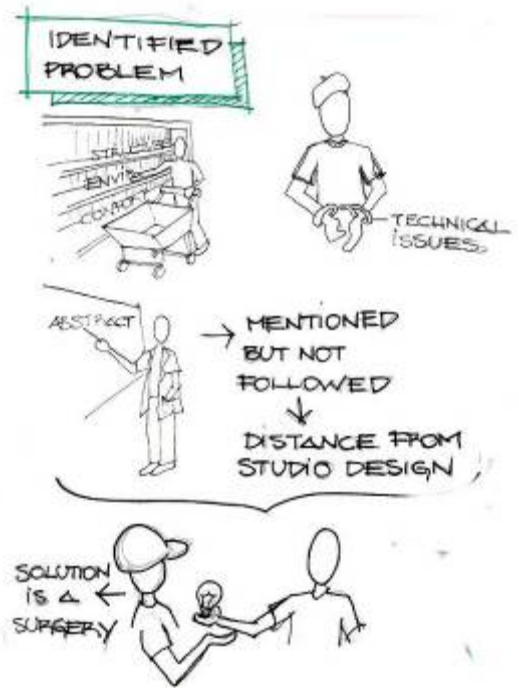


Figure 4-25- Schematic drawing of the problems related to environmental integration – Tombazis' interview.

Andrew Marsh notices that starting the interaction with the engineer only after the definition of the design concept does not allow an effective influence on the project. In this case, when the engineer doesn't work directly on the development of the design solution and he is limited to post recommendations and reports, it is very unlikely that something will be translated into design. In interviewees' description of their design experience, they recognize the importance of integrating the work of consultants since the beginning of the design process.

Such as Cucinella says, environmental issues are in general considered for verification and therefore, very late in the process, when the project and its main concept are already defined.

According to his experience, Spencer de Grey recognizes that the lack of integration between architecture and engineering fields is stronger in some countries than in others. He notices that countries such as the United States and France still make technical issues servant to the project (see Figure 4-26). In France, it can be related to the split between the "technical" schools and the "design" schools after various reforms in the methods and philosophy at the Ecole des Beaux Arts. Design and drafting were taught in independent studios, the Ecole itself did not provide practical instruction. The French school served as a prototype for architectural education in France and in the earliest

American Schools. By the third quarter of the 19th century, the Ecole des Beaux Arts became the most influential such institution in the world (BERGDOLL, 2000; MOFFET et al., 2003). De Grey notices that when the technical issues are servant to the project, they are always explored in a second stage of the design, therefore their potential of integration is not explored;

> "So, I think even in places such as France I think that relationship,… It is also partly due to the work in which the professions are set up, on the roles they pay on projects. So, in France the way they are building buildings is very different from here. And you feel that there the technical issues are also servant to the project, they are not an important part of the project, they are suppressed. In Germany particularly, I think it is much more similar to here."

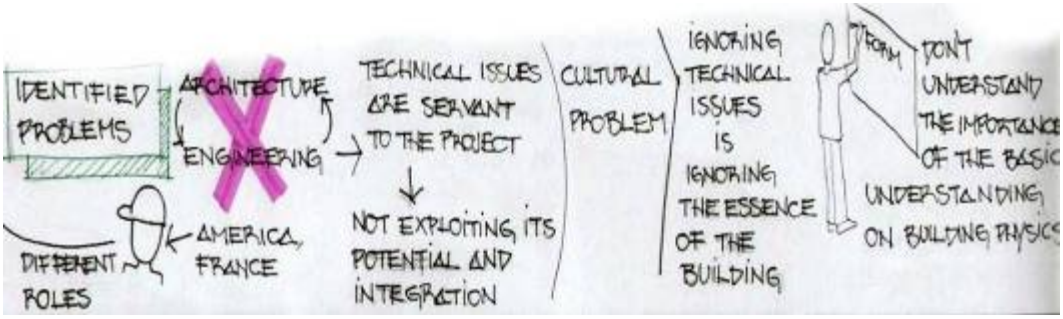


Figure 4-26- Schematic drawing of the problems related to environmental integration – Spencer de Grey's interview.

All the interviewed architects agree that nowadays the schools of architecture contribute to this dissociation between technical issues and design. They identify that one of the problems is the dissociation of environmental issues from studio activities and their optional condition to the process. So, even when these aspects are mentioned, they are not followed because they are not related to design practice.

Marsh, Pamplona and Bonelli emphasized in many occasions during their interview, their negative experience in school regarding environmental issues. The three of them recognize that the teaching of environmental comfort and related issues was very mechanical and focused only on the development of formulas and diagrams, which was considered torturous. Marsh notices that lately there has been a technical change in schools with the advance of environmental science and related software. However, he comments that there hasn't been a fundamental philosophical change.

Lelé and Cucinella emphasize that in general the schools of architecture are more focused on the formal/artistic aspect of the design, without a commitment to reality.

> "(…) but that is also an education problem, because the teachers make easier to explain architecture as an artistic facility. (…) the education takes in account only few of all these aspects, and the artistic view is the most predominant, because also it is the easy part of the work, it is the easier part. When you design a building it is easy if you do something that is impossible to build." (Cucinella´s interview- Figure 4-27)

The belief of the interviewed architects that the integration of these issues into design process stimulates creativity makes them to point out this dissociation as a limit to the creative process. Prasad emphasizes the student becomes less connected with the real issues of the material world. He notices the students want to abstract more, but according to his beliefs, the abstraction should not avoid the connection to the physical world. Tombazis states that;

> "And think too often the teachers do not care about these issues, and they care about abstract notions. (…) I'm not saying that these are not very important issues too, but they care about what they call composition, abstract idealization of building, and not about the whole and fantastic rewarding and rich issue, which is architecture. So, if the teachers do not care, I think that is very, very difficult to do something." (Tombazis' interview)

It agrees with Prasad, Spencer and Leonardo comments that the schools of architecture do not really understand the importance of the basic understanding of technical issues, including building physics. Cucinella and Severiano point out the dissociation to the reality of building construction. It makes more difficult to understand the requirements of the construction and their relation to design and context (see Figure 4-27).

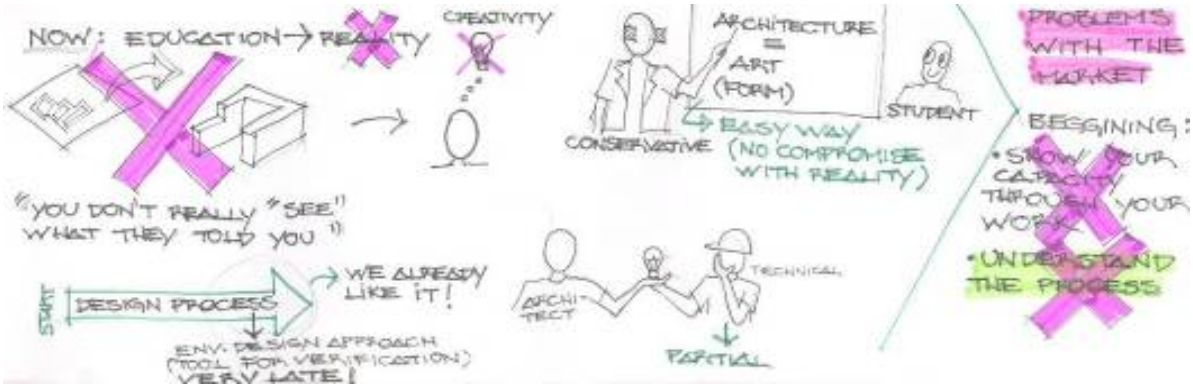


Figure 4-27- Schematic drawing of the problems related to environmental integration – Cucinella's interview.

Lelé, Cucinella, Severiano and Leonardo agree that, by being far from technical issues, the student loses his understanding of the working processes and the sense of detail, and consequently develops a lack of commitment to the impact of his choices;

> "I noticed that the student nowadays is working there, but he doesn't see, he doesn't feel that knowledge is important, and how to dominate this (…) He never goes to the building site, he never goes to places,(…)" (Severiano´s interview)

> "(…) the student doesn't have an idea of how it is the sound transference from one room to another, some things are so elementary and they don't know. The same thing happens with heat transfer, they don't know what materials they can use, and then they easily accept sellers' offers. And sellers are always interested in promote their product and not always they give a trustworthy technical information. (…)There is a difficulty to develop the practice, in building site, office (…) Doctors (…) work in emergency areas of hospitals developing a more general view of their profession. The architect doesn't do this kind of exercise (…)" (Lelé´s interview)

Such as Karl Popper (POPPER, 1979) argues, the influence of human knowledge expressed through the products of human mind is at least as strong as the world of direct experience. Considering the architectural design, not only the procedural knowledge to apply the design strategy, but also the knowledge of the concepts is fundamental to develop the knowledge basis, mainly on the development of innovative solutions.

However, Prasad and Marsh also point out there is a split between those who practice and those who teaches. They state the teachers became abstracters and do not deal directly with the physical world. Marsh notices that some schools try to put science and design together, however the teacher of environmental issues is usually very science oriented and does not understand the design approach or procedural knowledge in design. Prasad states that bridge is not complete.

According to Leonardo, Cucinella and Prasad, the main reason is that schools focus only on the quantitative issues of environmental comfort and do not show how to explore its architectural expression (Figure 4-28). Leonardo establishes a good comparison with the teaching of structure in architecture;

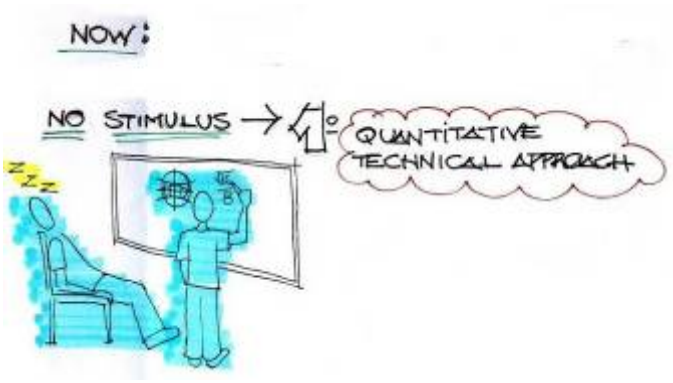


Figure 4-28- Schematic drawing of the problems in education – Leonardo's interview.

"The module of environmental comfort has an approach of calculation. The same happens in the teaching of structure. People like to calculate but they would like to know the structural possibilities of different structural systems, to take plastic and architectural advantage of that. (…) The architect doesn't go to the technique because the approach doesn't attract." (Leonardo's interview)

Based on his own experience, Bonelli also recognises that the school did not prepare the student to different social contexts, building typologies, materials and particular features of the site. Furthermore, the adaptation of the human being to local climatic conditions and its different comfort limits is not taken into account. Therefore, the design solutions are limited in restrict variations.

Marsh notices the student should already know some basic principles to make the integration of environmental issues into studio activities possible. He points out that teaching how to solve the problem of environmental integration would require a lot of time in studio, which is usually very time limited. It emphasizes the importance of a complementary module of environmental comfort, which should be related to design since the definition of the concept. Cucinella emphasizes that if it is considered only a tool for

verification, it is considered very late in the process when the design concept is already defined and enjoyed. So, it becomes very difficult to be changed.

According to Leonardo's perception of the problem, lately the student of architecture in Brazil has awakened the interest in environmental issues. However, he notices the student doesn't know what and where the right references are;

> "There is a search for environmental issues among the students that there wasn't before. I didn't imagine that this changing would be so fast. (…) The architect looks for references and architecture's media, in general, gives the wrong answers of how to integrate, how to use that. What the media offers is a wrong vision of what is efficient, of what is sustainable." (Leonardo's interview)

Marsh, Lelé, Leonardo, Severiano, Jestico and Cucinella agree that there is a cultural problem to the acceptance and dissemination of passive technologies related to the environmental integration of the building. Lelé (Figure 4-29) and Severiano (Figure 4-30) notice that the mentioned dissociation of these issues from design stimulates the individualism and a weak basis of technical knowledge.

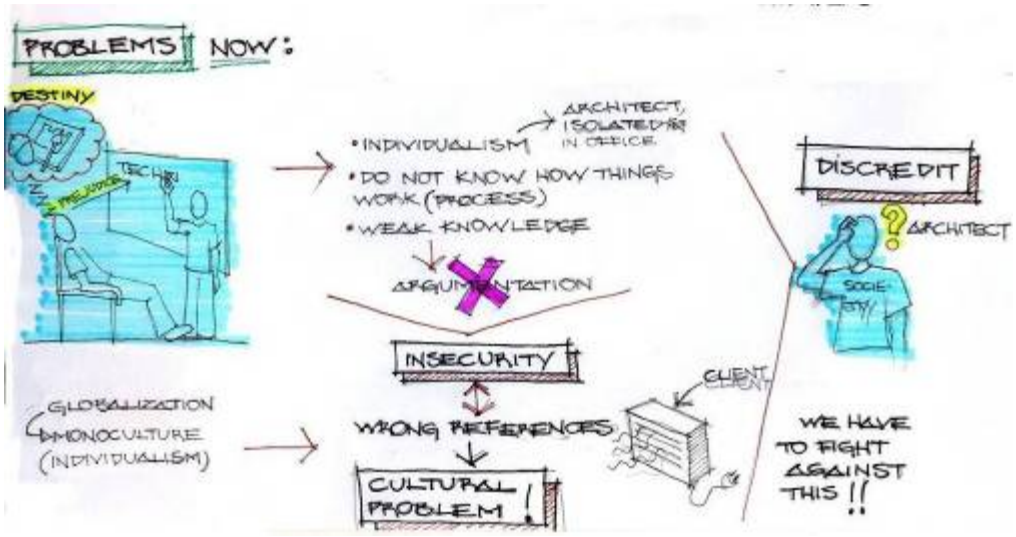


Figure 4-29- Schematic drawing of the problems related to environmental integration – Lele's interview.

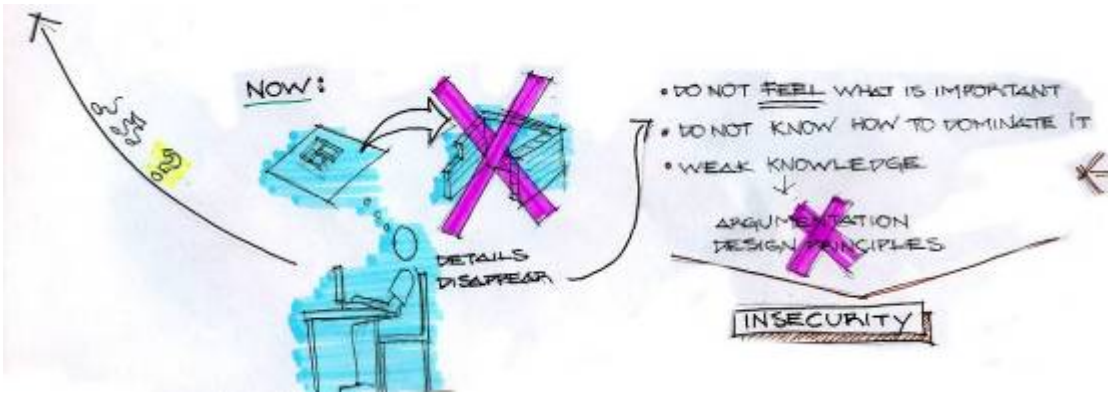


Figure 4-30- Schematic drawing of the problems related to environmental integration – Severiano's interview.

Consequently, the weak knowledge base does not support a consolidated design philosophy, which would help keeping ideas and principles above all the pressure and scepticism. Therefore, it also makes the future professional more vulnerable to wrong references, to clients and developer's requirements and also to the pressure of the market. Cucinella, Lelé and Severiano emphasize it results in a weak professional that faces many problems on the market, with problems to show his capacity through his work and his understanding of the process.

Considering the practice of searching for references in the design process (ROWE, 1987) and the fundamental role of referential procedures in the knowledge construction (ANDERSON, 2000), this vulnerability have a strong impact on the real integration of environmental issues into design. Marsh recognizes the student basically takes images out of books without really being able to judge and understand what is really important. In Jestico's case, the improvement of technical knowledge was proved important to make him able to understand the quality and the working process of observed design solutions.

All the interviewed architects point out the scepticism of the market to environmental issues. In the case of the architects who practice in Britain, developers are in charge of most building developments, including residential buildings (COX and HAMILTON, 1995; FOXELL, 2003). These developers base their opinion in agent's advice. According to Jestico's perception, these agents believe on previous and consolidated experiences, considered economically safer. And for them, the safer option is still the air conditioning building. On the other hand, Jestico points out that what he calls sustainable buildings represent a problem to developers because these buildings require more input from the occupiers. Furthermore, developers consider the performance of these buildings is not consolidated yet. Jestico notices that these buildings use passive technology but the occupier has to be much more active. It requires more education and commitment, which involves a cultural changing. Therefore, the building market does not see a reason to take the risk (Figure 4-31). Marsh and Tombazis agree, according to their experience, that sustainable buildings cannot be too active and require much input from the occupiers or it won't be accepted.

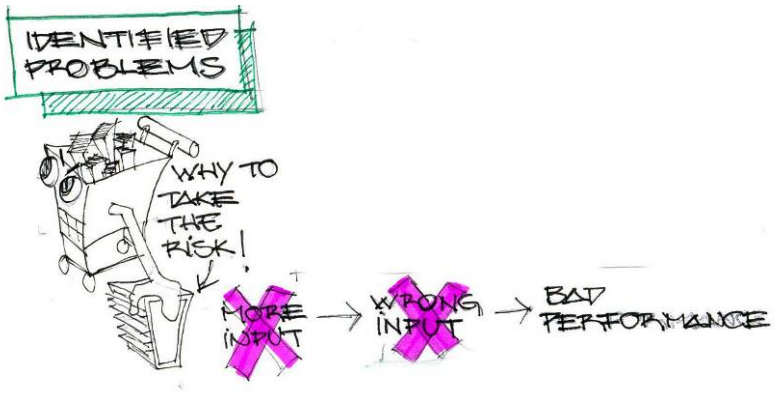


Figure 4-31- Schematic drawing of the problems of the market– Jestico's interview

Spencer de Grey also recognizes there is a cultural problem related to the role given to each field on the development of the project. Considering his previous statements, it varies from country to country, whether technical issues are servant or not to the project. Buzato and Marsh also point out that developers in UK are involved in the project just until the occupation of the building. Therefore, their priorities involve immediate savings.

Marsh states that this behaviour comes from ignorance, not of the problem, but of how to solve the problem. In terms of the uptake of privately cost effective energy efficiency improvements, the market failures also involve information failures and split benefits, because the incentives facing a builder sometimes diverge from the benefits facing the user (AG, 2005).

In this case, a strong knowledge base that makes the professional able to understand the process and to generate creative solutions is fundamental to promote a changing in this scene.

The introduction of energy efficiency requirements, mainly related to thermal transmittance of components and air infiltration (EC, 2003; ODPM, 2006), has promoted a gradual changing on developers' attitude and building quality, regarding materials and equipment. However, it doesn't present effective influence or relation to the definition of the design concept. The appeal to environmental issues directly based on numbers and savings is also considered a cultural problem that must be changed. Marsh, Leonardo and Cucinella emphasize the appeal must be based on the quality of the space and architectural expression. Marsh makes a comparison;

> "What is really interesting to me is that people scream about putting in insulation or double glazing or whatever, and that is the same people who spend 20,000 on a pool. A pool means constant maintenance, constantly checking of current levels, paper and leaves, all that stuff. So if they are prepared to spend that amount of time and energy on a pool, why…and the reason is that when we sell passive design we sell on savings; you save 500 pounds a year on your energy bill. What we need to do is to say… if you put, you know, this passive design system unit, you have this fantastic place

> on summer's morning to sit and have your coffee. Because that is what people want to buy. They don't want to buy a saving." (Marsh's interview)

Cucinella, Lelé, Severiano and Pamplona recognize the international style as a wrong reference to architecture professionals and the market. They point out the glazing towers as the icon of the international style. According to their perception of the problem, the international style is an example of the dissociation of architecture to the local context and climate. Cucinella classifies it as a primitive practice because it does not take into account the aesthetic and technical possibilities of the local context, which guides to standardized solutions. On the other hand, he also considers the reaction of some groups to the international style very primitive. The group he calls "eco-architects", or pre-industrial according to Hagan's classification (HAGAN, 2001), is considered very radical because it is also limited into extreme rules of sustainability and their view of local integration. Cucinella understands it also limits the creative process and the balance between this integration and the aesthetic choices (Figure 4-32);

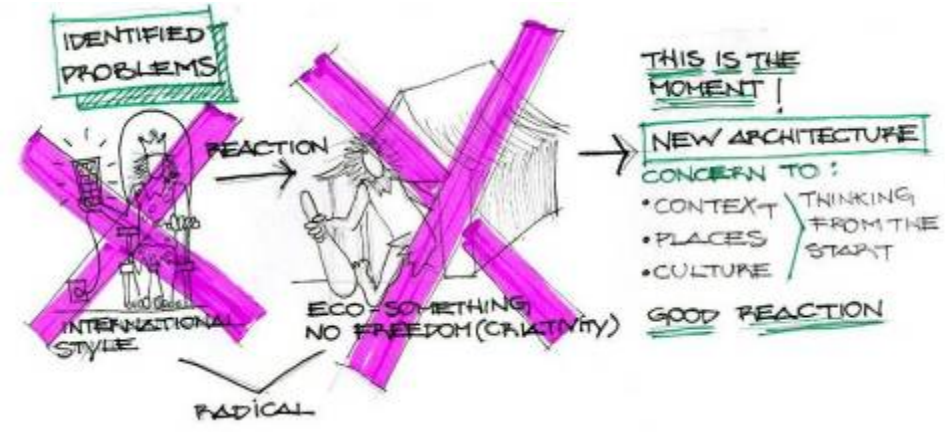


Figure 4-32- Schematic drawing of the problems of the International style– Cucinella's interview

Pamplona notices that, furthermore, the design solutions and systems to environmental integration are still very expensive, which limits the market to what he called "hippie chic". He also points out there is a kind of "thermal globalization", in which building users have limited their tolerance to temperature variations. He believes this globalization made the climate something disturbing and the air conditioning system a short solution;

> "The pattern of the society is the opposite of this (integration with nature). People are using more and more air conditioning systems, apart from the climate. The Americans from United States don't have any contact with the climate, the climate became something disturbing, but it is the reality, isn't it? You live there." (Pamplona's interview)

Such as HESCHONG (1999) points out, despite the benefit of experiencing a temperature change within the comfort zone to activate the sensation of the space, a steady-state thermal environment is still the prevailing approach for office buildings,

schools and homes across the United States. She states that the steady state approach to the thermal environment assumes that any degree of thermal stress is undesirable. A constant temperature is maintained in order to save people from the effort and the distraction of adjusting to different conditions.

Lelé considers the globalization process promoted the uniformity of design solutions, the professional isolation and individualism;

> "(…) this globalisation is something so violent. They are trying to create a monoculture and there isn't anything so stupid." (Lelé's interview)

According to his beliefs it is extremely negative because the team work is missed and also the consolidation of the knowledge and professional role. The lack of confidence of architects, related to technical issues, also makes them to believe that a specialized technical knowledge is necessary to validate a design. Lelé and Severiano notice that the lack of confidence among architecture professionals has contributed to a crisis in the profession, related to their discredit and disbelief in the Brazilian society.

> "(…) nowadays the sustainability of our profession is been discussed by architects. But I think that our profession can only be sustainable if it is useful for society (…) our profession is in a stage of decline, discredit (…) people don't know anymore the importance of the architect and what is his role in society (…) I think the architect can be there, isolated in his studio and while he stays in this wrong position we won't be able to get out of this unsustainable situation in what we live now." (Lele's interview)

Similarly, Simon Foxell, in the introdution of RIBA's book, "The professional Choice" (FOXELL, 2003) has identified that the profession in UK was living an identity crisis. Most of this crisis is due to new influences and references of power in professional and market relations. This crisis is also discussed as a "crisis of trust", since the trust of the client and society was a reflection of a unique knowledge, integrity and independence, in which the professions were traditionally based on. A stronger knowledge base is considered the tool to make professionals able to criticize and argue against the naiveté of certain methods of target setting by the market.

Prasad identified the inappropriateness of software and other tools for environmental analysis to the design process. He points out that, usually, they require too much information until you can get any answer. However, according to his statements, he understands the use of software, not to support the early decisions, but to help adjusting and justifying his choices. He recognizes the ideal tool should help predicting the exact impact of the bioclimatic design. Prasad, Marsh and Leonardo also state that no tool can substitute the importance of an engagement to the physical world to make the professional able to get the right answer from these tools. Lawson points out that, modern building science techniques have generally only provided methods of predicting the performance of

the solution but they give no help at all with synthesis (to define the design concept) (LAWSON, 1997; FORD, 2004).

Marsh also recognizes specialized software as tools to justify the design choices. He recognizes that tools such as tables and diagrams do not help on the discussion of the project because it does not support the visualization of the solution. The graphical image has a fundamental importance on the communication of the idea (GASPERINI, 1988). As MAVER & PETRIC appropriately defined, the architectural design is the creative working process of an abstract representation of the building concept that exists in architect's mind.

4.7 POSSIBLE SOLUTIONS

During the interview, the architects spontaneously identified the problems related to the integration of bioclimatic concepts into design, such as indicated in Topic 4.6. The insights raised with their statements provided a wider perception of the problem, in which they were able to suggest possible solutions.

Andrew Marsh raised many questions during the interview regarding the integration of bioclimatic concepts by the architects. He asks;

> "How does the client know that the architect he has engaged hasn't considered the sun and daylight? (…) where is the material benefit? Because if nobody ever knows, if it is so hard to appreciate, how should an architect bother?" (Marsh's interview)

However, while he approaches the problem from the perspective of his education and professional experience, he starts to identify answers to these questions. He identifies there are companies that are getting work due to the way they approach the environment in concern to the building. According to his perception, it is a positive stimulus to other architects. Considering Lelé's experience in the case of the hospital designed in Salvador, the material benefit is presented when the space does not require the users to switch the lights on. When I described this experience, Marsh pointed out;

> "So, it is not related to energy saving because these users are not paying the bills. So, they are very disconnected from the process. What is has induced to me, is hey, my designs don't require the people to switch the lights on, or the air conditioning system on. Do you know what I mean? That is the only tangible measurer of these spaces from other spaces. It doesn't seem to be any other way within the architectural profession to communicate that actually patients get better when they can respond to the day." (Marsh's interview)

The opportunity to live a positive experience in passive design is identified as a good possibility to promote cultural changing, such as Spencer de Grey, Leonardo and Pamplona also recognize. Cucinella points out the quality of the final result also influences the economy and behaviour of the users.

According to the understanding all the interviewed architects raised during the interview, environmental issues should be considered part of the process and not optional. The consideration of environmental issues starts to be spontaneous with the understanding of the process as one integrated problem. It raises the importance of the design philosophy of the professional and related concept of architecture to include the environmental comfort among the criteria of quality.

The interviewees consider extremely important the concept that the architectural design is a process that comprehends from drawing to construction. Cucinella and Severiano Porto emphasize it is fundamental to make the architect starting to understand the process and its implications, the reality of its dimensions and space, and the related consequences.

Lelé emphasizes that the architect must be able to solve issues related to design, systems, structure, comfort, energy saving, engineering, everything together. He states the concept of environmental integration is a fundamental practice and a commitment to architecture that should be recovered as part of the professional design philosophy. Tombazis, Leonardo, Lelé and Cucinella recognize the question of environmental comfort integration is, first of all, a question of ethics. In philosophy, ethics comprehends moral values, their origin and the motivation of ethical attitudes. Regarding ethics in the professions, it also studies the effect and implications of new technologies or projects on nature and society (BLACKBURN, 2005). The consideration of environmental issues among their ethical values is also related to their notion of aesthetics, once it is a criterion to qualify the space through its elements and the generated comfort (FOX, 2000).

Although, Tombazis, Leonardo and Cucinella agree that it is a question of ethics, they point out that it shouldn't be related to a duty or responsibility;

> "I think it is an ethical question, but I don't like to think about it like that, because I think if you try to convince people that it is their duty to think as responsible citizens, if you try to convince designers that it is their responsibility to respect the Earth, our planet, that it is their duty to inherit it to their children, (…) I think this is not the way to succeed. Because I think that, then you make things sound religious, or fanatical, or like an obligation. I believe that the way to convince is by showing two things, one is giving an example (…) referring more to teachers, and specially teachers who practice. And I think the other way is by showing that there is beauty in these issues and that, after all, if the space is nicely lighting and nicely ventilated and it is comfortable, and etc, etc, and the proportions of the space are not only a result of this, because I start to look at this with semi-closed eyes and say, oh this is beautiful, but it is…it is that too, but it is also because it serves a purpose, (…)" (Tombazis' interview)

Pamplona, Lelé and Prasad point out the cultural changing must promote not only the bioclimatic design, but also a bioclimatic behaviour, because a change of values is necessary to promote the respect and the priority to the human being and other "beings".

Therefore, it is necessary to understand the climatic cycles and, how we are integrated into them, which requires a stronger knowledge base.

Jestico, Marsh, Spencer de Grey and Pamplona recognize there should be a cultural change to make the building market to go into the direction of sustainable buildings. They suggest this changing will happen through the acceptance of more flexible internal environmental conditions and the increase of demand and energy cost, which would really make a difference for the market. In terms of incentives for the market, Marsh suggests that, first of all;

> "the society has to assign some sort of status to the people who are doing their part. And the second thing is the use of incentives. But in terms of green stamps and inventive skims, they are all (…) but they have to be done, in order to come up with the idea." (Marsh's interview)

According to Spencer de Grey, the local authorities should also give something tangible for the building market to stimulate the adoption of a green agenda. Therefore, developers would relate green issues to financial gains, in relation to the value of the building. It is considered a more intelligent approach to legislation and planning. Therefore, the adoption of these issues starts to be related to something positive and not only by the force of the law.

When he describes his experience on the project of the Commerzbank, Spencer de Grey emphasizes the positive approach of the local authorities in Frankfurt to stimulate the adoption of a green agenda;

> "It was wonderful work in Frankfurt, back to the beginning of the nineties, in the Commerzbank, they were able, when the city was run by the green party, it allowed them to build 30% more area of the site, of course the building was a green building. And so, the Commerzbank used this, because they suddenly saw a relationship between been green and financial gains, towards of the value of that building. And, you see, that was a very… I mean, everybody won, the city built the first of the major green high rise buildings, and the Commerzbank gained because they were able to build more area than before, so there it was a better investment for that. The people who work there gained because the environment of this building was much more pleasant than fully air conditioning buildings. So, everybody won, by an intelligent view of the legislation or, I don't know if it is even legislation, that is for planning, a planning environment. (…) because it was instead of saying if you don't build green you can't do this, what they were saying was, if you do build green than you can build more, it was a positive thing and not a negative thing. And I think too often, those guidelines have a negative feeling for them, if you don't achieve the guidelines than you can't do this, this and this. It is so much clever and psychologically better to say, if you do achieve the guidelines than you can have more." (Spencer de Grey's interview)

The development of viable design solutions to environmental integration and to the application of passive strategies, in terms of cost and technology, is also pointed out to avoid creating an elite market, according to Pamplona.

Furthermore, all the interviewed architects agree that, before the market and building regulations, the architect himself must believe on these issues, it must be part of

his design philosophy. Jestico emphasizes this statement with his comments (Figure 4-33);

> "I think you have to feel passion about it, you have to feel that it matters, and it is not an academic subject, it is something that comes from here (heart). You want to produce sustainable buildings because you fell that is the right thing to do. Unless you fell passion about it…I think it would be too easy to dismiss it, you know. It is something that we always have very close to our design philosophy, because we fell that it is necessary. That is not something that it is applied by regulation. So I just say that you must feel passion about environmental design (…)" (Jestico´s interview)

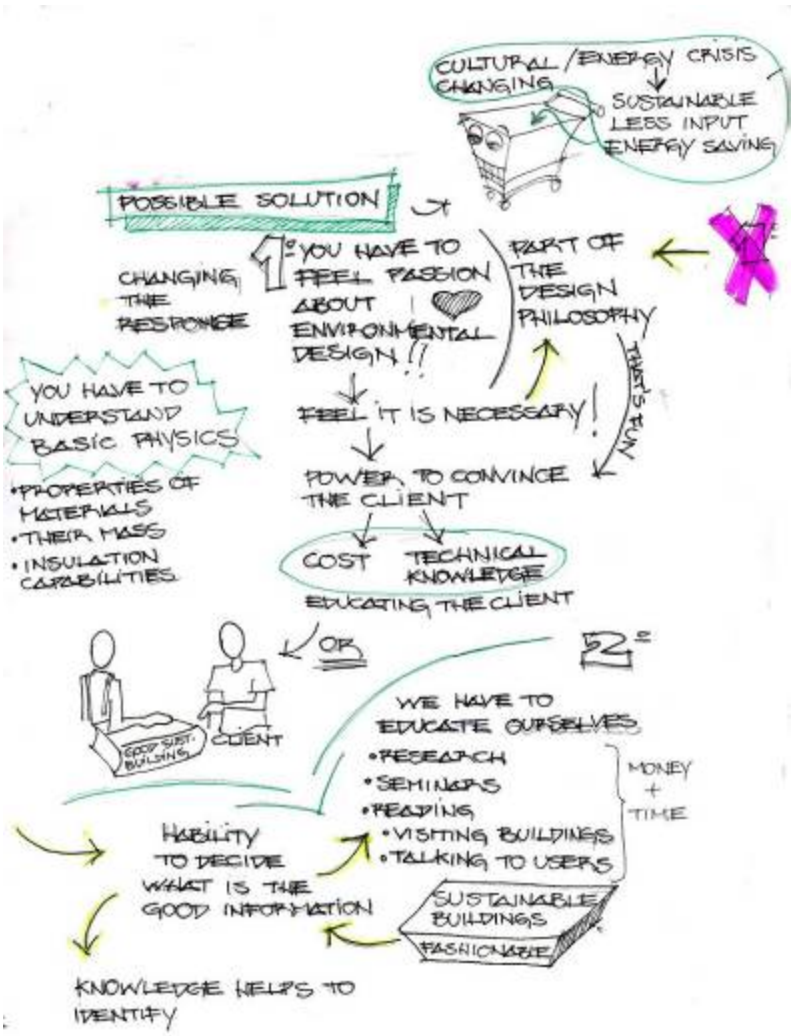


Figure 4-33- Schematic drawing of the raised possible solutions in Jestico's interview.

This passion is considered the main tool to convince the client. Once it is part of the design philosophy of the professional there is more confidence and stimulus to the defence of ideas and principles. Jestico emphasizes that sometimes it is necessary to educate the client in these issues. And then a strong technical knowledge is necessary to present the balance between cost and the benefits of the proposal.

However, the development of a consolidated track of good environmental design can be the first reason for the client to choose the architect, and there is no convincing

activity in that. Nevertheless, a well established technical knowledge is also necessary in order to develop a consolidated work in environmental design.

Tombazis, Jestico and Spencer de Grey believe the professional doesn't need to be necessarily an expert on environmental issues. First, they believe one needs to be at least sympathetic for these issues, integrating a basic understanding of the concepts. According to Spencer de Grey's perception, understanding the essence of the building means understanding the needs of how it stands up and how it operates environmentally. He emphasizes it is absolutely necessary to integrate bioclimatic ideas;

> "I don't think you can design a successful building if you don't understand and are sympathetic to the needs of how it stands up, and how it operates environmentally in terms of its sustainability. If you ignore those issues, you are ignoring a huge part of what the building actually is, (…), ignoring things that make it stand up and make it work, which are the structure and the environmental systems, maybe the essence of what the building is about. (…) This goes back to education. I think it should be very strong. I think you could only manipulate and in house a development of bioclimatic ideas and concepts if you have a sort of sympathy for the subject. I mean, you have to have some basic understanding. I'm not saying that everybody who works here has that, but I think people love that and work closely with environmental engineers. We do, I mean, a lot of high profusion things in terms of basic concepts, building physics concepts even not having it properly at school. I think architecture schools don't really understand the importance of that basic understanding." (Spencer de Grey's interview)

Buzato states the definition of the design concept is the most important part of the design process. According to interviewees' description of their design experience, once the design concept is defined it is very unlikely that the architect changes it radically. Therefore, Buzato recognizes that the architect must start the process being already informed of basic principles of building physics to promote environmental integration into design. Such as Marsh recognized, getting the early decisions right has a strong impact on final energy consume. According to GELLER, "with the establishment of measures to reduce energy consumption in existing buildings, the consumption can be reduced by 30%. In buildings designed regarding the energy efficiency, the economy can achieve up to 50%" (GELLER, 1994). According to interviewees' description of their design practice, most of the design strategies are defined in the design concept, which depends on basic design choices. Marsh also states that in the early design process the architect "plays" alone. It emphasizes the importance of a technical knowledge basis to guarantee the definition of the concept based on well established technical principles.

Therefore, the passion for environmental design must be supported by the development of technical knowledge. All the interviewed architects state that the development of technical knowledge is the basis of changing. Lelé comments that (Figure 4-34);

" (…) to define the sustainability of our profession it is necessary that clients and other people that use architect's services, believe in our professional work and (…) we are the ones who have to promote our credibility, based on our professional behaviour (…) and I would say that it is much more related to the technical side than to the artistic side (…) what the client expects from the architect is not only that he makes the project (design) but also that he solves all the issues related to the construction. From project features and environmental comfort to the engineering part of building construction." (Lelé's interview)

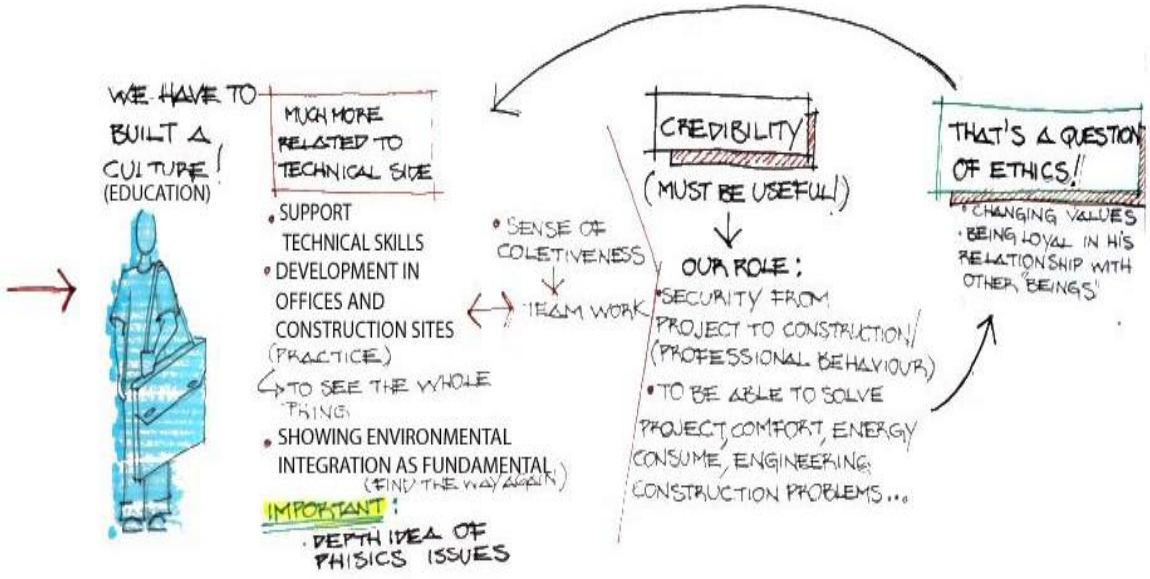


Figure 4-34- Schematic drawing of the raised possible solutions in Lele's interview.

Lelé and the European interviewees, who have a wider practice in big design teams, recognize the importance of involving the engineering work since the early design process. They believe the integration of technical knowledge makes one open to the dialogue with experts, understanding the essence of the building.

Therefore, it is necessary to build a new culture among architects based on the development of technical knowledge. Jestico suggests the architects have to educate themselves through research, seminars, specialized publications and also visiting buildings and talking to users. Although it takes time and money, it is also considered very important to develop the ability to identify the right information. Lelé points out that a deeper knowledge base in building physics also promotes a basis to confidence in profession. It increases the power of argumentation of the professional, consolidating his design philosophy, promoting professionals' credibility and their confidence to deal with the whole project, from design to construction.

Cucinella, Lelé and Severiano emphasize the importance of the contact with the building construction to promote technical understanding, making the architect to face the

problem of technology. It promotes the balance in the creative process of the style with the reality, based on the awareness of the impact of the design choices.

Leonardo states the consolidation of this knowledge and the ethics on the professional's role guarantee the necessary self-confidence to search for references and to develop the design solutions.

Therefore, such as Severiano emphasizes, the professional institutions can be also a very important tool to promote the updating of the professionals, considering the professional ethics. Bonelli suggests that specialized literature should be more accessible to architects in Brazil. According to his perception of the problem, this material should give priority to expose the architectural features of specific climatic conditions and not only presenting indices to arrive at complex calculations.

Regarding the use of computer models, Marsh suggests the use of IFCs (Industry Foundation Class files) to make all CAD models completely interchangeable. He believes this kind of format makes easier to engage the engineer in the process because he will be able to work on the same data base, and interchange the information. So, they would evolve into a process where they work together.

During the interview, Prasad recognizes some problems related to software or tools. Although he points out problems and possible solutions to improve or develop design tools, he, as well as the other interviewed architects, could not specify any available software or tool. Prasad exposed his needs regarding the use of tools or computer models in the design process, which should embrace the ability to predict the consequences of the solution. He states he would like a tool to integrate different issues, allowing the architect to balance different considerations and showing faster the true benefit of different orientations, for example.

According to the software review presented in Topic 2.2.1, part of these requirements is already considered in some software available in the market, such as the Ecotect (MARSH, 1997), the Design Builder (TINDALE, 2004) and the BDA (Building Design Advisor) developed by the LBNL (Lawrence Berkley National Laboratory). Therefore, there isn't a wide influence of these software on architects' practice yet, being restrict to consultancy work. These software present a friendly interface, which makes the modelling of the building easier. They also allow the evaluation of multiple models and the comparison of different alternatives, regarding energy consumption, cooling and heating. However, they still require a large amount and the accuracy of input data, which is not appropriate to the conceptual stage of the early design process.

The ECOTECT package allows an immediate visual response, facilitating the visualization of results that are difficult to undestand mathematically. Marsh states the design choices are easier when the architect can see the impact of these choices graphically. But he also points out that even showing the data graphically, the architect has to have some basic level of understanding building physics to make the given information meaningful;

> "Well, I'm not so sure about that. And they make a computer model, and they look at the solar insolation distributed over the surfaces, looking at the shadows and they get and see, well there is going to happen a bit of a problem there. The question is that with a tool that displays 650 W/m2 on the surface, actually it is giving no meaningful information. It is giving the data. But how meaningful it is, unless they understand that…? There is probably some level of basic physical understanding that people have to have." (Marsh's interview)

Furthermore, before the tools there must be a consolidated knowledge to allow the architect defining the design strategy to be evaluated. All the interviewed architects agree that education has an important role to improve this knowledge. The schools are considered responsible to introduce the technical issues. The Brazilians, Lelé, Leonardo, Severiano and Pamplona, and the Europeans, Tombazis, Cucinella and Spencer de Grey emphasize the school of architecture should present a commitment to the development of a professional ethics and to the construction of a basis of humanistic and technical issues. They believe the school should assume an ethical commitment to dissemination and integration of environmental issues.

Apart from their different social contexts and design experiences, Brazilian and European interviewees present very similar or complementary suggestions to the practical application of this commitment by the school.

All of them agree that bringing environmental comfort and building physics concepts to design practice is fundamental. It emphasizes their belief on the importance of feeling and living the problem. Pamplona, Lelé, Severiano and Cucinella emphasize the technical basis should be promoted through the development of conceptual skills and the direct contact with building construction sites and design practices. It agrees with Hertzberger statements (LAWSON, 1997) that "the more you have seen and experienced and absorbed, the more points of reference you will have to help you decide which direction to take; your frame of reference expands". According to Ford, architectural schools and the profession cannot be far from the other disciplines (construction related). The collaboration between institutions and the building industry is now often regarded as prerequisite for successful research bids to both UK and European Research agencies (FORD, 2004).

Severiano also emphasizes the importance of promoting the contact with the problems of the city through multidisciplinary programs and the stimulus to technical detailing drawings. They believe this contact promotes the understanding of the impact of design choices, and a commitment with the final result. Severiano points out it is fundamental to avoid the crisis in the profession. Lelé states the student also has the opportunity to develop the sense of community in the teamwork experience.

Tombazis believes that the teachers, who practice, mainly the design studio teachers, must be the responsible to introduce bioclimatic themes to the students. He also recognizes the teacher doesn't need to be an expert but he must promote the discussion in the project (Figure 4-35);

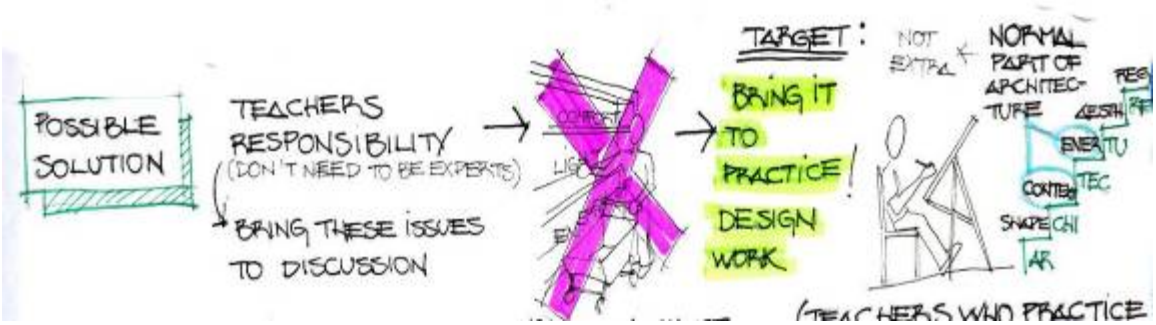


Figure 4-35- Schematic drawing of the raised possible solutions in Tombazis' interview

However, Cucinella comments that, there is no time to wait until all lecturers become aware of the environmental problem to introduce it to the students. According to his perception of the problem, it would be a very slow process, regarding the conservative character of most of the schools of architecture. Environmental integration should be a priority. So, he comments on the idea of the researcher Andre Mizel, who suggests that a faster revolution will happen if this process is inverted, and the student becomes the tool to disseminate this knowledge. Due to the easier and faster access to information through new media, such as the Internet, the student could easily raises a lot of information if the theme of sustainability and energy were required as a theme of work, for instance (Figure 4-36).

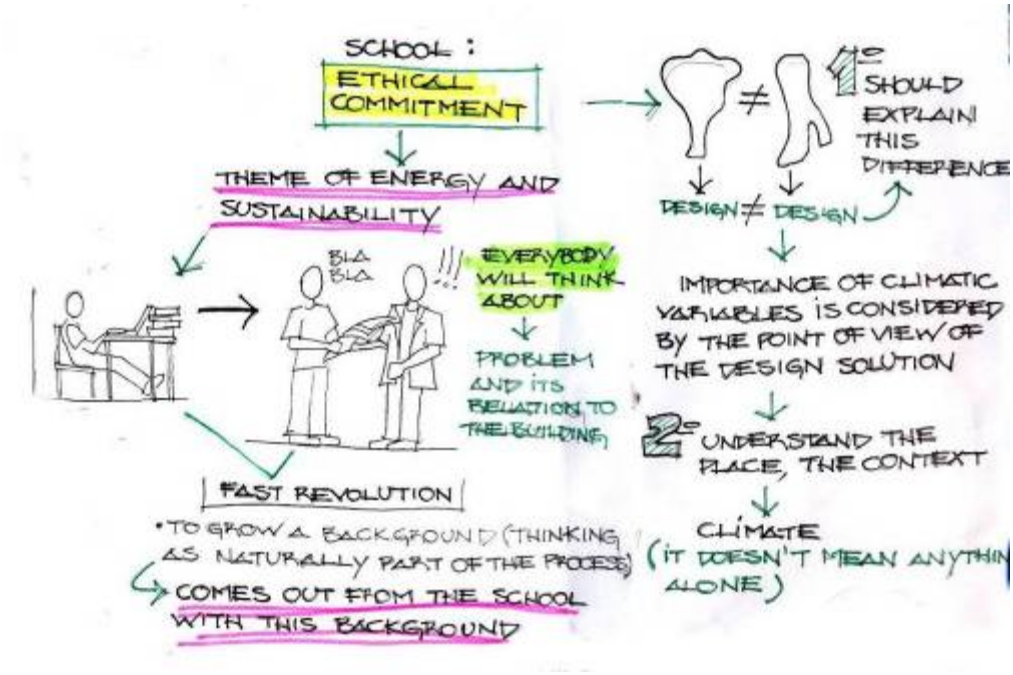


Figure 4-36- Schematic drawing of the role of the school to promote environmental integration- Cucinella's interview.

Cucinella describes the process whether the theme of CO_2 emission were required;

> "(…) if you ask the students to explore the problem of CO2 emission, a general view of the problem, they have to go back to the CO2 emission problem, how it relates to the building and why. And maybe you can make easier a sort of key connection to major themes like CO2, regulations, materials, and technology. And then everybody would investigate these main key questions and they can maybe find much more information than we know now, because they can now look through many other things. And then if you do that in the first year, when they don't know anything about architecture, they don't know anything of energy, they don't really know anything, it should be make them a…as a matter in his first year of design, because in the next year they will do an exercise and this theme will be already on their background. And we don't do this at schools, so it is something that needs to be done."

So, if the school - regarding its ethical commitment – introduced this theme to be followed by all years, the students would be raising this information very fast and bringing it to their teachers. And it would stimulate the discussion of the problem and its relation to the building. Then, the student would go from one year to the other with this problem already integrated into his background. Therefore, it would be developed and consolidated in parallel to the development of project/studio activities. The background related to environmental issues would grow as a natural part of the process and the student would finish the school and get into the market with this background.

The Brazilians, Lelé, Leonardo, Severiano and Pamplona, and the Europeans, Tombazis, Cucinella and Spencer de Grey also recognize that the first approach to environmental comfort and bioclimatic concepts should emphasize the architectural potential of environmental integration. Therefore, they recognize the attention of the

student should be first focused on the qualitative aspects of daylighting and materials, for example, as a first approach to energy efficiency. They agree it is a more efficient approach to stimulate environmental integration than relating it to the responsibility of energy saving or "planet saving". Tombazis emphasizes that this approach promotes the consideration of environmental concepts among the criteria to qualify the space, the architectural qualities beyond the visual;

> "the student starts to understand the hidden dimensions of the space." (Tombazis' interview)

When Spencer de Grey describes his experience in Cambridge, he emphasizes that bringing examples of design experience is an interesting approach to stimulate a creative and imaginative engineering because it is liberated from the traditional technical education. It means that he considers the traditional technical education very limited in terms of creativity, having no relation with design activities.

Leonardo and Tombazis also point out the importance of creating a repertoire/vocabulary of environmental design solutions to show the practical application of these solutions. According to their perception, it makes the comprehension of building physics easier because the connection to design starts to stimulate the interest to understand the quantitative aspects of environmental integration. Leonardo comments;

> "The architect or the student of architecture, first of all asks himself: what can I do with this information in terms of the design solution? He doesn't ask: How can I increase the energy saving with this information?" (Leonardo's interview)

The school should assume an approach that, firstly, called attention to the different design solutions related to different climates and, after this, awoke the interest in the climatic context and its technical implications. Such as Cucinella states, climatic data itself doesn't mean anything without this relation with the design solution (Figure 4-36);

> "And why these things are not taught in detail? It is not that there is a problem, but they must be part of the context, you know. So, the simple way to do that is just…you know, data is important, but data doesn't give you any information of how you design your building, you know. Hours of solar radiation, and millimetres of water doesn't really make any difference, but understanding the place means also understanding the radiation of the climate and the quality of life (…)" Cucinella's interview)

Therefore the school should stimulate a changing of paradigms, aiming at the production of a modern regional architecture through the commitment to the development of a professional ethics and the construction of a basis of humanistic and technical knowledge.

4.8 THE EFFECT OF BUILDING REGULATIONS

Regarding the different social and cultural contexts of the interviewed architects, the influence of specific regulation on building energy efficiency was also evaluated.

Such as emphasized in the Methodology chapter, through the interview the construction of knowledge is based on architect's own impressions of his work, experiences, values and influences of his social context. In the social/cultural context of the interviewed architects in Europe, they live the experience of dealing with specific requirements on energy efficiency, such as the part L of Building regulations in UK (ODPM, 2006) and the Directive of the European Parliament on the energy performance of Buildings (EC, 2003).

In Brazil, there is no standard method or building regulation regarding energy efficiency (CARLO et al., 2005; CARLO et al., 2006). However, in 2001, due to an internal energy crisis, the Brazilian government approved a law to improve the energy efficiency of equipment and buildings. It promoted the creation of a team of specialists to develop a standard of building energy efficiency, which is still in progress. Therefore, the interviewed architects who practice in Brazil do not have the experience of dealing directly with requirements or standards of building energy efficiency.

4.8.1 Positive perception

The experience of the European architects, regarding the application of building regulations, generated a more receptive perception of these regulations to stimulate the integration of bioclimatic issues. They point out building regulations as positive tools to stimulate the integration. They consider the influence of building regulations is increasing and also the sensibility of the market, design professionals and local authorities.

Spencer de Grey and Buzato emphasize building regulations are very advanced in UK. The Part L of the building regulations presents specific requirements on energy efficiency, mainly regarding the thermal transmittance (U-value) of building components, the maximum ratio of glazing area and air conditioning systems (Office of the Deputy Prime Minister, 2006). The part L has established a progressive increase in the U-value of building components, which Jestico and Spencer de Grey point out as a good approach to stimulate the acceptance of the market.

The European interviewed architects also considered the green labels important tools to promote the integration of bioclimatic issues into design, because they deal with buildings that are beyond the requirements of regulations. Therefore, the achieved

performance of these buildings can work as a reference to define requirements of regulations. The interviewed architects who practice mostly in Brazil didn't mention green labels as an approach to environmental integration and energy efficiency. In Brazil, there is no specific program of building certification yet, and therefore, these architects didn't experienced or had contact with requirements directly related to certification.

According to Cucinella, these labels can be used as environmental compensation to business corporations, to decrease the taxes or to attract the market. He states it has demonstrated an important influence on the development of environmentally integrated buildings;

> "Now a lot of companies, also for ethical problems, if they are certificate as eco buildings, as eco-companies, it is good for them in terms of market, and also if you have a label you are able to…in some countries if you have a label, green label, and then you certificate that your emission is low in relation to what the target is, you have some discount in terms of taxes, all these things, so it is interesting at the moment." (Cucinella's interview)

Sunand Prasad believes it can become a sailing point. Such as Marsh points out;

> "in corporations it is a different story. They want to stick on the stair symbol."

Prasad emphasizes the energy labelling is very positive and it should be extended to all buildings, not just to public buildings. However, the BREEAM (Environmental Assessment method of BRE- Building Research Establishment), which is UK's assessment to measure best practice in environmental design and management, can be applied also to private buildings, new and existing buildings. The EcoHomes is the home version of BREEAM, which also provide an authoritative rating for new, converted or renovated homes, and covers both houses and apartments (BREEAM, 2006).

Buzato, Prasad, Jestico and Cucinella believe these labels and also the regulations stimulate people to be more aware of the problem. In Italy, Cucinella recognizes there is no current regulation that requires an energy efficient design. The Italian law requires specifically from public administration to appoint energy managers, apply energy-efficient solutions and to evaluate energy saving potentials. However, the public administration has failed to translate the potential offered by the requirements into measurable energy savings (PROST, 2003). Cucinella believes that if there were a stronger obligation on environmental integration such as constraints of CO_2 emission, it would make professionals to think about it and the architect would have to learn (Figure 4-37);

> "And that is really the engine because, if the government makes rules, the rules are an obligation, then everybody needs to face all these problems. So, it is not only a sort of a game in which somebody likes to do something ecological or not. If it becomes a rule, under law, everybody needs to do that. And the architects may be obligated to learn, you know, it is also that process." (Cucinella's interview)

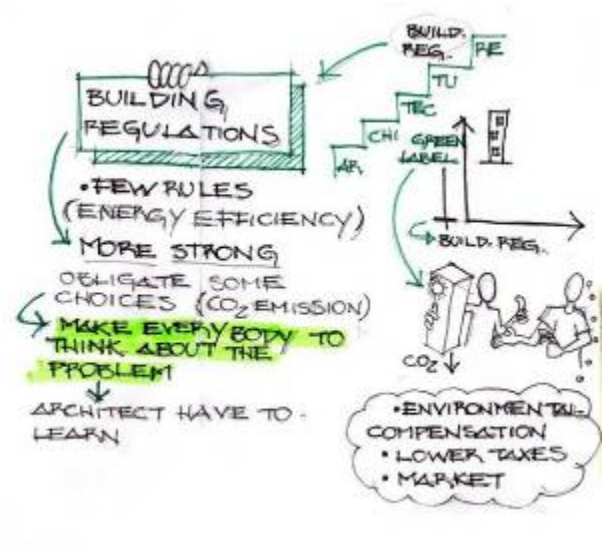


Figure 4-37- The effect of building regulations to environmental integration. Cucinella's interview.

If environmental integration principles are not part of the design philosophy of the professional, Jestico also emphasizes that the regulations can push the architects to act and to start thinking about it.

4.8.2 Negative perception

On the other hand, Spencer de Grey emphasizes that although building regulations are developing into the right direction, it is still based on measures that press for the adoption of these issues, which gains a negative approach. Although he considers the BREEAM system an interesting approach and not related to mandatory requirements, he identifies that "*there is no consistency about whether a building achieves gold, or silver or whatever these tags are*."

The BREEAM assesses the performance of buildings in management; energy use regarding operational energy and CO2 emission; indoor and external issues affecting health and well-being; air and water pollution issues; transport-related CO2; green field and brown field sites; environmental implication of building materials, including life-cycle impacts; ecological value conservation and enhancement of the site and in consumption and water efficiency. Credits are awarded in each area according to the performance, which relies on a green guide of specifications of environmental performance ranging from external walls, roofs and landscaping to internal elements such as partitioning, raised floors, insulation and doors. Each entry is ranked on a scale of A to C, regarding its impact. Therefore, the weighting of design solutions is limited into the guide options. A set of environmental weightings is defined to enable the credits to be added together to produce a single overall score. The building is then rated on a scale of PASS, GOOD, VERY GOOD or EXCELLENT (BREEAM, 2006).

An inquiry report of the Productivity Commission of the Government of Australia also points out that few programs in this area in Australia seem to have been rigorously evaluated, and there is an uncertainty about the estimated potential savings and the extent on energy consumption and emissions. There is an enthusiasm for tightening energy

efficiency regulations in the Building Code without having tested the effectiveness of existing regulations (AG, 2005). Therefore, it is still not clear if directly targeting energy efficiency is the best approach.

Marsh also criticizes the efficiency of green labels and their adoption by the general public. Although he recognizes it is an efficient approach to corporations, he does not believe it really influences buyers;

> "The fact that you can still walk around at Dixons store (UK household store) and see a 2 stars fridge means that people are still buying 2 stars fridges. And I think it is the same with these kind of stamps you can put in front of a house. Oh! 5 stars, 3 stars, I don't think it really influences buyers for no other reason that it is just a gimmick." (Marsh's interview)

Jestico and Marsh also recognize some specific problems in Part L of building regulations in UK. They point out the consequences of the glazing limits to daylighting and the performance of the building. Jestico states;

> "Well, the new building regulations make it very difficult now to incorporate a hundred percent glazing, on office buildings. (…) As result of that, buildings are getting thinner because you haven't gotten the amount of daylight you were getting through the wall, so they can't be as deep as they used to be. So, buildings tend to get thinner. Because they are getting thinner, the amount of external area of walls is increasing, because you are trying to build the same area in square meters with thinner buildings. So you are going to use more external materials, and the performance of external materials has got to increase to make that possible." (Jestico's interview)

These regulations are also not adjustable to the building type and its end-use. For instance, the requirements on the U-value do not take into account the weight that internal heat gains can have on the whole thermal problem;

> "Having said that, there are one or two things in the regulations which are craze (…). Well, when you design offices you have a cooling problem, because everyone has a pc at their desk, everyone is getting more heat, so actually you don't need any heat to the building, you need to get rid of it. Now, the thermal insulation requirements are all about heat loss, and the requirements for insulation are quite high, so you can't get rid of the heat, which is generated within the building, except by cooling it mechanically, and this is a non-sense. So in certain applications there should be a reduction in the U value, in order to the heat to dissipate through the fabric of the building. Then you would not need as much cooling. So, that is an example of the slightly craziness in the regulations." (Jestico's interview)

Marsh points out the example of Cardiff in Wales, where he was a research fellow at the University of Cardiff. The glazing limits have promoted a negative effect on the design of new buildings because of the application of the elemental method of the regulation;

> "Ok, part L has very specific criteria on the amount of glass. You look at them, and each window or each room has a boxy little window. In the mainland area, we've got four high windows, and the reason for that is that the part L says the maximum ratio of glazing area for the whole building is 1. And I think we can make glass work such as it is not a huge crime in energy. So, they go for the elemental method, it is easy to get the rules, you don't need so many calculations." (Marsh's interview)

The Government's latest proposed revisions to Part L of the Building Regulations introduced Window Energy Ratings (WERs). Window Energy Ratings (WERs) combine all the different aspects affecting the energy performance of a window into a single rating. These aspects are heat loss, solar gain and ventilation. Compliance for replacement windows will be achieved if the window achieves a Rating of -40 (which is band E) or better. The proposal requires the CO_2 emissions for the proposed building as a whole and to show that these meet the prescribed level. Therefore, the Elemental and Target U value methods will no longer be permissible. However, it is still possible to satisfy the requirement by the U value. For windows it is 2.2 W/m^2K (ODPM, 2006).

Leonardo believes that when the regulations are based on strict requirements it promotes their mechanical application and the distance to building reality. He states that the architect, in general, would look for the adjustment of solutions just to have the project approved;

> "What would happen would be that the architects would hire someone to arrange it to be approved, after the design had been finished. It would always come in a second time and it would not contribute to design concept." (Leonardo's interview)

Buzato also recognizes that according to the structure of the building regulations in UK the actions related to those requirements are, in general, only applied in the end. The mentioned problems on the integration of these requirements into the design process are related to Severiano's comments that there should be necessary to know if the architects would apply the regulations and also if they would know how to apply them.

These comments emphasize the importance of a previous and consolidated design philosophy and knowledge base to the integration of regulation requirements. It emphasises once more, that an effectively integrated design is also a question of ethics.

The previous awareness of the problem among their design and ethical considerations actually makes the interviewed architects to try to stay ahead of the regulations. Such as Tombazis emphasized, according to the design philosophy of his office, they try to foresee the requirements that are likely to be approached by the regulations.

Although Tombazis believes the building regulations can be an efficient tool to environmental integration, he recognizes that probably in Greece it would be difficult to guarantee their real application; because these regulations are not always followed and sometimes they are broken. It points out the influence of their lived experience and social context, including their relationship with regulations, on their beliefs or design philosophy, which agrees with the phenomenological approach.

The negative experience of the Brazilian interviewed architects, regarding the application of building regulations, made them to believe that these regulations would not be efficient to promote environmental integration. In Brazil, current building regulations and local codes do not consider energy efficiency requirements. Therefore, the Brazilian interviewees were asked about the hypothetic situation, in which parameters of energy efficiency were required. They criticize the bureaucratic structure of building regulations in Brazil. All the interviewed architects, who practice in Brazil, point out the problem of literal application of these regulations to any situation by the bureaucrats in the local councils. The narrow view of the problem is pointed out as a limit to the development of innovative solutions and research, regarding their belief that the project is a field of experimentation. These statements can be recognized in Lele' comments below, in which he also recognizes that the strict structure of building regulations makes them quickly obsolete (Figure 4-38);

> "(…) unfortunately they are developed by academic people that are distant from the problem (…) they are bureaucrats (people of the regulation institutions); they get the information in a wrong way and create codes that disturb research development. (…) the bad thing about regulations is that it is based on the assumption that the parameters that they establish can fit to every situation. And it is not true. Each project has a particular feature and condition (…) we learned how to blind the regulation, because it becomes quickly obsolete (…)" (Lelé's interview)

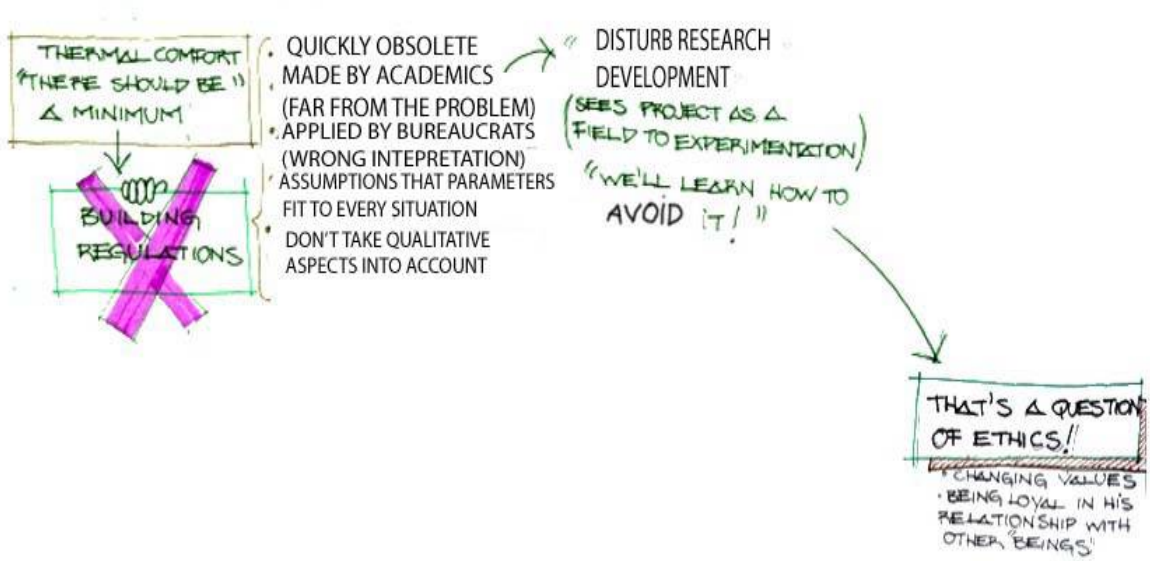


Figure 4-38- Schematic drawing of the problems of building regulations. Lelé's interview.

Lelé points out the importance of the procedural knowledge when he considers that the work of academics, who are not close to the problem, is a negative issue on the development of building regulations. Lelé and Bonelli point out that the mentioned narrow view of the problem by the bureaucrats in the government is an obstacle to the

consideration of the qualitative issues of the design solutions regarding thermal comfort. Bonelli comments;

> "(…) not because of the coherence of the material but because of the bureaucrat responsible to analyse the project. He doesn't care about your specific situation. Like if the law says the west facade must have X% of shading, but if there is a neighbour building of 20 stores already providing this shadow, the bureaucrat won't follow that. He will say you have to have this amount of shading and end of story." (Bonelli's interview)

This view of the problem, based on a hypothetic situation, is similar to the situation described in the lived experience of Jestico and Marsh, when they point out the strict application of the elemental method of Part L;

> "So, it is the total surface area of glass. Yes it has got some solar control but not for the right side, but you have as much glass as that particular regulation wants to the total exposed area." (Marsh's interview)

4.8.3 Suggestions

Leonardo and Bonelli emphasize the regulations should be more flexible to adjust to different building types and end-uses. It agrees with Jestico's comments that the U-value should be adjustable to each building type according to the internal heat gain.

Lelé and Bonelli believe that energy efficiency and thermal comfort requirements would work if they were used as recommendations or references rather than a law. In the inquiry report developed in Australia (AG, 2005), it suggests that minimum energy efficiency performance standards should include analysis of whether voluntary labels or standards would be a more cost effective policy. Bonelli suggests;

> "I think there should be a referential material. This kind of material should be provided in school, in which there should be a policy to make the architect aware of that, to use that, such as any other referential material. Like when you search for references of previous design solutions and nobody obliges you to use that form or the other, you make the choices based on common sense." (Bonelli's interview)

It highlights the importance of models and references in the design process, which promotes the construction of knowledge and a consolidated design philosophy to make those parameters part of the professional common sense. Pamplona is also in favour of the introduction of energy efficiency and thermal comfort requirements, such as cross ventilation requirements. However, he is not sure about the methods and their real influence. Leonardo believes that a more flexible adjustment to the requirements of the particular project would be achieved if the regulations were based on a performance approach. He states this approach would require a deeper knowledge in the quantitative issues of environmental comfort (Figure 4-39);

> "The idea that you can base your work on performance is very interesting, but at the same time, it requires more quantitative knowledge, a more solid approach. It will demand a more substantial basic knowledge from the architects. It goes against of what we were discussing. (…)But this approach

attracts me more than the other where they only give you something like "it has to have 1/5 of the area." (Leonardo's interview)

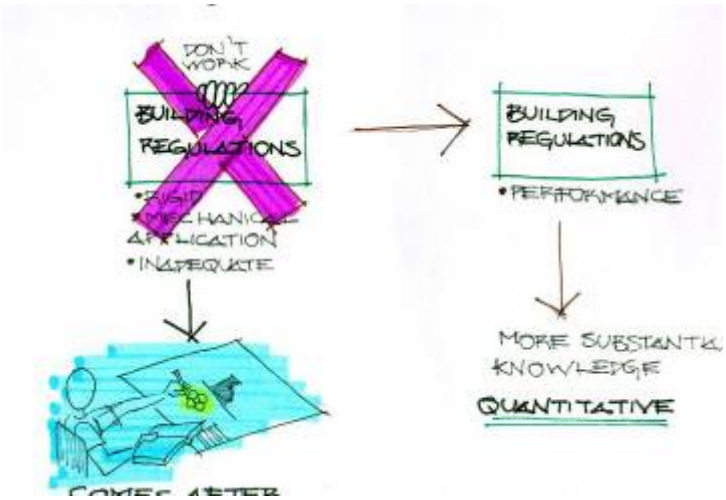


Figure 4-39- Effect of building regulations to environmental integration. Leonardo's interview.

All the European architects, who were interviewed in this research, also believe the regulations should be less prescriptive and based on performance criteria. It should be related to the performance of the whole building and not only to the properties of the components, to balance energy and the life time of the building.

> "It is certainly more and more influential (…) They are still codes, not on performance but more as, let's say, as a policy and forced measures. Like, we are allowed to do this, you are not allowed to that. And it is not yet the performance of the building, which is regulating it. But that is changing. (…) And you will have to prove that it is not only, let's say, losses but it is also a comparison of losses and gains, and how the building performs, and things like that. So, it seems, basically because of the European Union." (Tombazis' interview)

Jestico, Marsh and Spencer recognize this development is going into the right direction in UK because they are moving in parallel from the elemental method to the whole design approach. Jestico suggests the building could be classified according to its carbon points. Part L is already going into this direction because the new approved revision to Part L of UK's building regulations, published in 2006, establishes to all new buildings targets of CO2 emission. Therefore, the energy performance of buildings needs to be calculated. The aim of the Directive is to promote building energy performance improvement within the European Union. It lays down requirements for calculating energy performance according to a national standard (ODPM, 2006).

On the other hand, all the European architects also agree with Leonardo's comments that this approach will require a stronger technical knowledge, including more detailed calculations. Tombazis states that in the beginning this kind of approach will, certainly, bring more difficulty to the work of the architect. And he believes the technical issues related to this approach will be considered the biggest difficulty, more than the

additional cost and time (**Figure** 4-40). Jestico believes that is the reason for some architects not liking green labels.

Marsh comments that regulations in UK and Australia are now permiting developers or designers to approach the whole design to balance it with its energy performance. However, he recognizes it is harder and costs more money, so architects in general go for the elemental method. The building performance approach is based on the application of parametric analysis of energy consume. Even adopting this approach, the available tools of energy simulation can be manipulated to achieve the desired performance of the model. Marsh suggests the use of IFC files (Industry Foundation Class files) to avoid this manipulation of models. He also mentions the case of New Zealand, in which the designer is responsible for any building he designs;

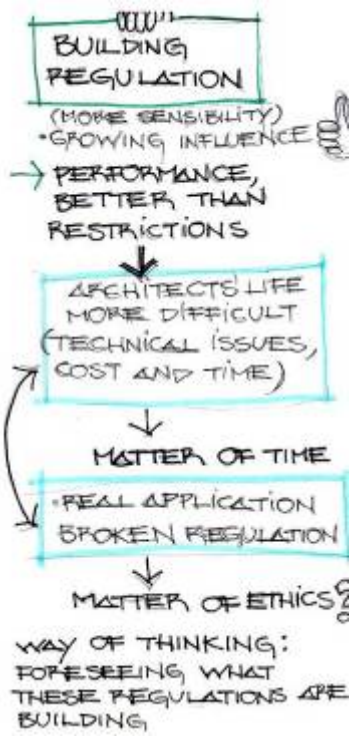


Figure 4-40- Schematic drawing of the raised considerations of building regulations. Tombazis' interview.

> "(…) that relation changes if people were more responsible for their buildings. And one example is New Zealand. Like, if you are a designer you are responsible for the building and at any stage if something goes wrong, you have to keep enough records to show what happened and how you did that. Because, you did that, you are responsible, end of story." (Marsh's interview)

It agrees with the belief of the interviewees that the architect should have a commitment with the final result of the project, including its construction and post occupancy. According to Gasparski a designer should be responsible for what he did or did not to prevent or at least limit the possibility of error (GASPARSKI, 2005).

The Brazilians, Leonardo, Lelé and Severiano, state that when the consideration of environmental issues is not part of the design philosophy of the professional, he just develops ways to avoid the regulation. Spencer, Marsh and Lelé point out the need of a cultural changing. Marsh recognizes that there won't be any change unless the energy bills start to rise and, it costs money or, there is a general felling it is a good thing to do. He states at the moment;

> "(…) the structure of the west society is; if you have a big fat car, a wonderful house, lots of lights on, air conditioning, that's your life status. If you drive status by being energy efficient, by not being wasteful, people will do it, end of story. People just want to be accepted." (Marsh's interview)

Spencer de Grey recognizes that local authorities are increasing the interest in bioclimatic issues to energy saving measures. However, it is still based on measures that press for the adoption of these issues, which gains a negative approach. Therefore, he states that it is necessary to stimulate a changing of culture to make it goes into the right direction, not only through legislation. It is necessary to make people "*positively embrace sustainability rather than being an attitude by law*." (Figure 4-41)

> "I think the culture of sustainability has still a very long way to go. I mean if it is more in the bloodstream, in the agenda, probably anywhere else in the world but here, I mean it is going in the right way but it is going also in a sort of pressing, because it is going in the right way through legislation and I think that, in a way, it gains a negative approach to it, not encouraging, you know. But it is a very interesting subject I think how do you change the culture, in such a way that people positively embrace sustainability rather than been an attitude by law." (Spencer de Grey's interview)

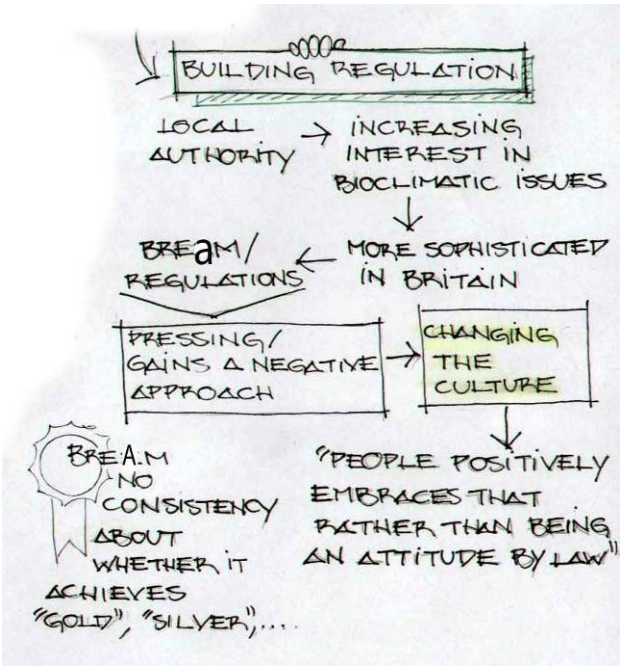


Figure 4-41- Schematic drawing of the raised considerations of building regulations. Spencer's interview.

De Grey emphasizes that there must be a combination of legislation and measures to stimulate the positive embracing of bioclimatic and environmental issues. The cultural changing is considered fundamental to their integration because most of the measures cost more money in terms of capital cost. It is related to the statements of Marsh, Lelé and Leonardo that environmental issues need to be part of the ethical point of view to make people keeping this choice.

Based on these evaluations it was possible to cross the information obtained through the lived experiences, the application of the acquired knowledge and perception of the problem of the interviewed architects. The main elements, regarding the application of bioclimatic concepts and their integration into the architectural design, are highlighted in the following chapter, of the Conclusions.

5 CONCLUSIONS

This chapter presents and discusses the main findings that provide answers to the research questions. Based on these findings, this chapter proposes actions to promote the integration of bioclimatic issues into architectural design and suggests future research themes following the findings of this research.

5.1 MAIN STIMULUS TO THE INTEGRATION OF BIOCLIMATIC CONCEPTS INTO ARCHITECTURAL DESIGN- "WHY INTEGRATE?"

5.1.1 Formal Education- Experience after the 1980s

In architecture the main focus is the building design and the final product is the built object. The construction of knowledge in architectural education is supposed to support the development of architects` skills to achieve a better design result. However, in the case of the interviewees graduated after the 1980s, the teaching of bioclimatic issues and related building physics was considered too technical and not related to design or studio activities. The perception of the interviewees included in this situation, is that this disconnection from design is a barrier to integrate these issues into design.

In these cases, and in the case of the interviewees that had no teaching at all of these issues (some interviewees graduated in the 1960s), there was already a previous awareness of the importance of bioclimatic issues, which was related to their ethical considerations. In epistemology, it is pointed out that one's beliefs will be determinant on the application of knowledge in the problem solving (BLACKBURN, 2005).

Therefore, their belief in the importance of these issues stimulated them to search to fulfil the gap left in their education, mainly regarding building physics, solar geometry and related passive strategies for cooling, heating and daylighting. In this case, consolidated references and sources of information are fundamental to support the construction of a technical knowledge basis.

5.1.2 Formal Education- Experience before the 1980s

On the other hand architectural education can have a strong role to awake the interest in bioclimatic issues and to make it part of the professional's design philosophy. It was made clear in the case of some interviewees graduated before the 1980s. In these cases, it is directly related to the integration of bioclimatic issues, such as building physics, climate and solar geometry analysis, into studio activities. This integration linked their

perception of the theme to design, which also made the understanding of the architectural potential of environmental integration easier.

The difference between the interviewees graduated before and after the 1980s can be related to the development of the specific field of environmental comfort and bioclimatic design started in the 1970s. The development of this research field stimulated specialization courses in related technical issues, which generated a separated branch on the curriculum of architectural education (STEEMERS and STEANE, 2004), not only in Europe but also in Brazil. Therefore, the student of architecture started to get in contact with bioclimatic issues in a separated class and studio teachers were not responsible for that knowledge anymore. It became a knowledge limited to specialists, without necessarily any practice in design. Therefore, the more specialized, the more separated from design. The previous holistic understanding of the building design, stimulated once in studio, was reduced to the formal and functional aspects of design.

5.1.3 Early professional experience and Social, political or economical facts

The early professional experience can also have a fundamental role on the consolidation of architects' knowledge and design philosophy.

Interviewees' work in big design studios or construction companies had in common the stimulus to get in contact with building site construction. In the case of the Brazilians Lele, Severiano Porto, Sergio Pamplona and Romulo Bonelli, this contact was stimulated also by architectural education, through the practice of visiting and working as trainees in construction companies. However, only Lelé and Severiano Porto consciously indicated this experience as a fundamental element in their construction of knowledge. For the European interviewees, individual references, represented by the architects who were leaders of the practices where they had this early experience, were more influential than their formal education. These architects are mentioned as strong references for their understanding of architecture itself. These experiences influence a common concept among all the interviewees that architecture is, first of all, seen as something which starts with the drawing but is only complete with the materialization/construction of the building.

This contact with the reality of the building site was fundamental to consolidate the procedural knowledge, or tacit knowledge (McCOY, 2003), of the interviewees on the application of the information, even having a propositional knowledge of technical aspects of architecture, such as building physics and structure.

Cucinella emphasizes several times that this contact with the building site was fundamental to the consolidation of his ethical view because it generates a commitment to the quality of the final result, which includes comfort and energy efficiency of the building.

Social, political or economical facts can also be very influential on the perception of a problem, mainly if these facts are related to or affect their professional viewpoint. And according to the interviews, the influence of these facts varies in different social contexts. For example, the oil crisis of the 1970's was a stronger influence on the Europeans interviewees to awake their interest in environmental integration and in improving their knowledge, because it had a much stronger impact on European than Brazilian economy.

Regarding Brazilian economy, Brazil has a hydraulic plant which generates more than 70% of the total electricity consumed in the country (EPE, 2006). Therefore the oil crisis did not have an important impact in this sector. Furthermore, this crisis actually stimulated the development of the sugar cane fuel technology and the starting of the federal program of sugar cane fuel production (Pró-Alcool) (BIODIESELBR, 2007). In fact, the 1970s (period of the military dictatorship) were the period of what is called Brazilian economic "miracle", with the growing of industry and energy consumption (GASPARI, 2002). It was only in 2001 that Brazil really had a major energy crisis, related to the low level of water in the hydroelectric reservoirs. This crisis forced a rationing program in the whole country to avoid blackouts. However, Brazilian interviewees did not mention this fact as a turning point in their perception of the design problem, mainly because they were already involved with issues of bioclimatic integration and energy conservation in their design practice.

5.1.4 Main interest in technical issues

The particular concept the architect has about architecture reinforces which are the issues considered most relevant and which choices should be taken. And all the interviewees have in common the particular perception that architecture is, first of all, something which embraces the drawing and the materialization/construction of the building. It highlights their interest in the technical issues of architecture, which was stimulated through their experience in architectural education or their past professional practice, references or specific facts. Their preferences for technical issues and awareness of the importance of their balance with the other design considerations agree with their concept that the architect, as the leader of the design team, must understand a little of everything, integrating engineer and architect's work.

The analysis of interviews also assured the importance of a stronger technical knowledge basis to the understanding of aspects of the design itself. The addition of information explicitly changed interviewees' perception of the design problem. Once they started to understand the concepts and principles of building physics, they improved their understanding of the quality and applicability of the design solution into the whole architectural expression of the building. It agrees with the sense in cognitive psychology and phenomenology that as we acquire new information our percept shifts (ANDERSON, 2000; MOSER, 2005).

The development of knowledge through the experience in their formal education or in their first professional experiences was very influential on their understanding of architecture itself and, consequently, on their understanding of their role as professionals. Nevertheless, it was influential on the principles and beliefs translated in their design philosophy, affecting their main considerations and approach to the design problem. The developed knowledge is directly related to technical issues of building physics and its relation to the context. And the interest for such issues was awake through direct experience in studio or in the contact with building site construction. A strong design philosophy, which embrace the commitment to building materialization, is then, presented as the key to promote a consolidate application of environmental issues into the design solution and to avoid the transformation of environmental design into a simple collection of iconographic elements.

5.2 MAIN DESIGN CONSIDERATIONS AND UNDERSTANDING OF CONCEPTS– "HOW TO INTEGRATE?"

Considering the definition of the design concept, Brazilian and European interviewees present very similar considerations. Apart from working in big design teams or in small practices, all the interviewees are in charge of the definition of the design concept, in which the design problem is first defined according to established conditions and guiding principles to help on the decision making and the creative process.

5.2.1 Design Philosophy

The main focus of their design philosophy is the balance between aesthetic/formal issues and technical issues. In this balance, every consideration is done having in concern its consequence to the aesthetic of the project. The aesthetic character is the dominant guiding principle. That is a key issue of their design philosophy for the effective integration of bioclimatic issues into their body of work, considering that their engagement to

environmental design is driven by the quality it can bring for the project and it is not necessarily ethical. HAGAN (2001) appropriately recognized, the ideological dimension of aesthetic in architecture on the persuasion of values has been systematically ignored by many of those engaged in environmental design.

The exploration of the architectural potential of technical issues, such as structural and environmental issues, is done through the understanding of the means to control them. Therefore, the main focus of their design philosophy can be clearly related to their concept of architecture, which involves the expressed balance between technical and aesthetic issues.

Some of the interviewees state that the knowledge in building physics allows the exploration of intuition (which plays an important role in the design problem solving) in a very confident and creative way. Lele emphasizes that confidence is fundamental to have environmental integration as a priority and to assume all the risks. It agrees with the definition that intuition is an unconscious form of knowledge and it is unconsciously affected by experience (ANDERSON, 2000; BLACKBURN, 2005). The exploration of the knowledge basis in building physics as a tool to promote the creative process is one of the biggest features identified, mainly among the interviewees graduated before the 1980s. The fact that this feature is clearer identified among the older interviewees can be related to their contact with building physics through studio in their formal education or to their longer experience on the materialization of the built object in practice. In mainstream architecture, the implications of the environment are still considered a strong limitation to creativity and established architects today are actually intimidated by, what Wines(2000) referred to as momentum of change, “fearing their stylistic commitments maybe under attack”.

The professional experience was also proved important on the consolidation of knowledge in different aspects of the problem and, therefore, it contributed to achieve a faster information process on the judgement of design alternatives. Considering Asimow’s model ((SMITHIES, 1981; ROWE, 1987; SZALAPAJ, 2005)), a more experienced architect would already start from an advanced point in the spiral of information processing. It is also in agreement with the cognitive psychology and phenomenological approach, regarding the influence of new information on one’s perception to the generation of empirical concepts.

Daylighting is also an influential guiding principle and it is fundamentally related to the integration of the building into the environment. The perception of the interviewees of

daylighting and passive strategies for cooling or heating is, first of all, related to the architectural quality these issues can bring to the space. This perception makes them looking for passive strategies and for understanding the technical aspects that allow their application. Energy efficiency is considered a secondary guiding principle in the process, seen as a natural consequence of building environmental integration.

5.2.2 The context, the climate and the building physics

The identified guiding principles also influence the way some conditions of the problem are taken into account.

In the definition of the problem, the understanding of the purposes of the project and the requirements beyond the brief are considered determining conditions. Some of the interviewees, Brazilian and European, also relate the process of development of innovative solutions to an attitude of challenging cost and time, putting these constraints apart from the problem in the beginning of the process.

All the interviewees point out the understanding of the context as a fundamental condition to define the problem. They recognize the importance of knowledge in building physics to understand the dynamic relationship of the building with external conditions and to integrate environmental issues, guaranteeing that the main design concept is based on the awareness of the thermal problem. It agrees with Gasparski's definition of the professional designer, in which part of his responsibility is related to the knowledge of the relationship between structural elements, which are dictated by laws of physics and logic (GASPARSKI, 2005).

The understanding of the context is mainly related to climate and site. Prevailing winds, solar geometry and maximum and minimum temperatures, in winter and summer seasons, define the climate in the initial definition of the problem to define the design concept. It is a common perception among all the interviewees.

The indication that the architect, in general, considers the information according to what he/she can do with it in terms of design (aesthetic/spatial) solutions (LAWSON, 1997), agrees with the interviewees' perception of climatic variables according to the related design solutions. Such as WINES (2000) recognizes, the fundamental aesthetic power derives from the sense that every architectural detail is an extension of context. For the definitions of the design concept, all the interviewees consider that knowledge in climatic context and its relation to building physics, is the basis to define the design strategies.

This knowledge is mainly in basic concepts of thermal properties and heat transfer, difference of air pressure and solar geometry, which are related to the effect of the sun on building's thermal gains and lighting, and the wind and its urban and internal flows. This kind of knowledge makes them to put targets to make the best use of these conditions. Therefore, it points out their level of understanding in bioclimatic concepts and building physics that makes them to consider these issues among the design considerations, and consequently it makes them aware of the consequences of their design choices in balance to the aesthetic character of the project.

Although the level of influence of environmental principles, such as on the use of passive strategies, can vary according to the specific project, all of them emphasize that these principles have to be at least part of the process and the conditions related to the requirements of the climatic context have to be part of the brief. Therefore, these principles can be identified as core principles that, according to Frank Lloyd Wright, are always changing their form but are also always recapitulating their deeper meanings (CRONON, 1994).

5.2.3 Cultural changing and the client

Their knowledge basis and design philosophy, regarding the integration of bioclimatic issues, also make a difference in the relation with the client. Some established and older interviewees point out there is no need to impose the approach to this theme, because they believe bioclimatic issues are a natural part of architecture and therefore, these issues become part of the logic of design and self evident in their work. The natural longer and wider body of work of the older interviewees justifies their perception that their own work can be used to attract client's attention. But it is their belief on the quality of their environmental design that makes them to believe on the power of attraction of their work, regarding bioclimatic themes. Even the younger interviewees agree that it is necessary to build a track of good environmental design to guarantee the attraction of the client for these reasons and, then, to guarantee a satisfactory result, not only for the client, but also for the architect. Their indication that guaranteeing the consideration of bioclimatic strategies is an important element to guarantee their satisfaction as professionals points out the importance of these issues to their own design philosophy and their understanding of their professional role. In all mentioned situations, the attraction of the client is fundamentally related to the awareness of the client to these issues and to his/her preferences.

But all the interviewees agree that there are situations in which their role in the dialog with the client is to show alternative ways to his/her demands. They understand that the relation with the client is an exchanging relationship, in which the client has preferences and demands and the architect presents the answers. But they understand that these answers can be direct or indirect. Thomas and Carroll (THOMAS and CARROLL, 1984) point out clients do not state all their goals explicitly, because they are probably not even aware of them before interacting with the designer. So, it agrees with interviewees' statements, in which all of them point out sometimes the client does not really know what he/she wants. In this case, the interviewees point out their clear understanding of the problem makes them able to show to the client better responses to the problem. It is in this point where their knowledge and design philosophy makes the difference to bioclimatic integration into design, because the consideration of bioclimatic issues is naturally included in these responses. It also agrees with the statements of the older interviewees that these issues are a natural part of architecture.

In the establishment of bioclimatic themes with the client, they emphasize the importance of technical knowledge to generate trust and confidence with the client, in the process of showing alternative ways. All the interviewees also agree that, in this process, the most efficient practice is showing a set of building solutions that demonstrate a balance between aesthetic and passive strategies, in which comfort and energy efficiency are natural consequences of this balance. So, they avoid introducing this theme in a frame of ethics. They believe that, first, the qualitative aspects related to comfort and energy efficiency have to be emphasized. Leonardo believes it helps to exemplify the intentions in practice, validating the discussion and also making the client to live a positive experience embracing comfort and the aesthetic solution. Spencer de Grey, Leonardo and Pamplona agree that the opportunity to live a positive experience in passive design promotes the possibility of a cultural changing. Therefore the cultural changing is not based or promoted through an ethical framework. It is motivated through the practice of stimulating the experience in an integrated built environment, which can change client's perception. It agrees with the phenomenological approach in which all that really exists is the perception itself that is based on the essence of what we experience.

5.2.4 Building regulations as a constraint in the design problem- European's perception

The European interviewee's, mostly the one's who practice in UK (Building regulations are more advanced in UK than Greece and Italy, regarding the consideration of

energy efficiency requirements), also consider building regulations a constraint condition on the design problem. For the Europeans, the material's properties were more relevant in their descriptions, mainly the transmittance of the component (U value). It is related to the stronger effect of heat losses to environmental comfort in European winter and the existence of specific requirements on U value in their building regulations. In UK, the interviewees recognize the introduction of energy efficiency requirements through building regulations has promoted a gradual changing on developers' attitude regarding materials and equipment. However, it does not present effective influence or relation to the definition of the design concept and strategies. Therefore, although there is a strong advance in building regulations in UK, for example, they is not a significant philosophical changing that consider the importance of the architectural concept itself in the whole building impact. In the case of UK's interviewees, materials, including glass, structure and environmental systems (passive or not) are still considered, first of all, according to the aesthetic character of the project and the regulations have been actually influencing the detailing stage of the project.

It is important to notice that the previous awareness of the problem among the design and ethical considerations of the interviewees makes them to try to always stay ahead of the regulations. These comments emphasize the importance of a previous and consolidated design philosophy and knowledge basis to an effectively integrated design.

Due to the fact that the Brazilian interviewees do not deal with energy efficiency requirements in their building regulations yet, these regulations are not mentioned as constraints on the design problem, regarding the integration of bioclimatic issues. Therefore, Brazilian interviewee's do not deal yet with constraints such as material's properties and components' transmittance, the so-called U-value. Besides the climatic conditions, it also explains the reason for the fact that Brazilian interviewees do not mention material's properties as a constraint to be considered in the design problem for the definition of the design concept. The Brazilians were more emphatic on the achievement of environmental comfort as a guiding principle to the adoption of passive strategies, basically related to daylighting, natural ventilation and shading. These strategies are mostly related to cooling strategies once the heat is a more common condition of the design problem in Tropical areas. It indicates the influence of the different social contexts of Brazilian and European interviewees on the main considerations to define the problem.

Therefore, the consideration of environmental issues among the main principles to define the design problem is identified among the interviewees. They are considered in relation to the quality they can bring to the space, regarding the architectural expression of the project. The search for the quality of the space makes them looking for passive strategies and for understanding the technical aspects to achieve their application. Regarding their main considerations to define the design concept, the interviewees consider simplified climatic variables and deal with simple concepts of building physics to control the considered aspects of the climate. It shows the influence of the design philosophy of the professional on the design choices, in which technical issues, such as environmental issues, have to be defined in balance to the architectural expression.

5.3 DESIGN PRACTICES AND AIDS TO ENVIRONMENTAL INTEGRATION– "HOW TO INTEGRATE?"

The particular features of interviewees' professional practice are fundamental to clarify the main influences on the adopted considerations and mechanisms from which they go from analysis to synthesis.

5.3.1 Particular and common design practices. The differences of size, age and social context.

According to interviewees' description of their design experiences, the control of external conditions is done through the orientation of the building and its openings, shading devices, materials, shape and the constructive system (technology and structure), which, in their case, are the design variables explored in the definition of the design concept.

All the interviewees search for a balance when considering the use of glass. For the Brazilian interviewees, this balance is mainly based on orientation and solar shading devices. In the case of the interviewees in Europe, this balance is focused on orientation and on the use of double skin systems. For all the interviewees, extreme conditions of heating or cooling also involve the consideration of equipment and systems, and it can involve the adoption of hybrid systems (passive and mechanical systems), which have a fundamental effect on the design concept.

Their building physics knowledge makes the interviewees able to keep their aesthetic choice even when it is not bioclimatically favourable, because the design concept is based on the awareness of the thermal problem and therefore, it is balanced with alternative strategies. It is very important to the integration of environmental issues into the

design concept definition, considering that the architect, in general, does not use to go back when the design concept is already defined (ROWE, 1987). The same is noticed in interviewees' descriptions, in which all the work in their practice is done to keep the main defined concept.

The practice of going back to the occupied building, through informal visits to the building and talks to the users, is another common practice among all the interviewees. Even the younger interviewee's mention this practice and point out the importance of learning also with the identified mistakes. In the case of all the interviewees, when they have the opportunity they also try to correct these identified mistakes. The difference is that this adjustment is empirical for the Brazilian interviewees and the European interviewees have the support of consultancy. It shows their commitment with the final result and the relation with their concept of architecture that embraces drawing and building construction. It can be also related to their previous experiences in building site construction that stimulated their commitment with the final result and materialization of the building. Lele emphasizes that besides quantitative measures of indoor conditions, user's opinion is very important to evaluate the performance of the space, because its quality is related to user's perception, and therefore, it includes an intuitive/psychological component.

It is important to notice that most of the interviewees consider the integration of the space into the dynamic of external conditions as criteria of quality for the architectural design. It agrees with HESCHONG (1999) statements that in spite of the extra physiological effort required to adjust to thermal stimuli, people definitely seem to enjoy a range of temperatures. Therefore, it agrees with their belief that living a positive experience can be the strategy to show and appreciating the time and effort that goes into making an effective environmental design.

For the interviewees in bigger practices, the collective work has also an effective impact on the understanding of the relation of the building and external conditions. This interaction promotes the development of procedural knowledge, which is embedded in a core of values, assumptions and beliefs. That is why Tombazis says a common design philosophy among the members of his design team is naturally achieved along the development of the collective work.

In the case of the interviewees in small practices, the general lower budget of the projects, and the awareness that a wider knowledge can guarantee the aesthetic choice, makes them looking forward to deal directly to the technical aspects of the project.

Therefore, the common practices identified here are indeed related to the construction of knowledge, mainly related to the materialization of the building, and the awareness of its importance to the quality of the project and its liveability conditions.

5.3.2 European and Brazilian's perception of tools and other design aids

In the climatic analysis, the European interviewees present the need of 3d graphic visualization, through visual renderings or physical models, to better understand the daylighting phenomena. In the case of the Brazilian interviewees who manipulate the solar chart as a design tool, it seems that the consolidated knowledge on the solar chart (provided in their formal education) provides a wider abstraction skill and satisfies their understanding of the phenomena. It is done without the use of any software, even knowing and having access to CAD tools that provide three-dimensional graphic visualization.

None of the interviewees mention the use of software to proceed with any kind of treatment or visualization of the obtained climatic data. Furthermore, for the definition of the design concept, most of the interviewees recognized they do not use or did not know the software applied to support strategic studies, unless the use of CAD tools for lighting and shading studies. It shows that the interviewees, as the leaders of the design team, were more involved in the definition of the design concept, based on architect's fundamental understanding of what is happening on the site.

The European interviewees also use information from thermal and daylighting simulation analysis. However, these computer simulations are developed by consultants and it depends on the budget, time and the complexity of the specific project. It is done mostly to refine the solution, but they try to involve the consultant since the beginning of the process to guarantee the adjustment of the design strategy in agreement with the defined design concept.

Brazilian and European interviewees state that most of the performance of the final solution depends on basic design decisions, which does not require complex calculations or the involvement of a consultant. However, they also recognize that the advance in research and knowledge in environmental issues provided more information to refine the solution and guarantee a better performance.

Therefore, the consideration of bioclimatic issues in the definition of the design concept is not directly related to the use or improvement of design tools or software. It is first related to architect's philosophy and fundamental understanding of the relation of the building to local climatic conditions, which is basically related to the effect of insolation and

wind on the building. However, the knowledge of some simple tools, such as the solar chart appears to stimulate the spatial perception and understanding of the problem.

5.4 MAIN BARRIERS TO BIOCLIMATIC INTEGRATION– "WHY NOT?"

The particular perception of each architect contributed to the consolidation of their design philosophy, which influenced their view of the problem of integration of bioclimatic concepts. Those descriptions also provided the information to establish a relation between the background and the practice. Establishing this relationship, the related problems and effective examples to stimulate the consideration of bioclimatic concepts in design were recognized and synthesized:

- **Limit to creativity.** All the interviewees recognize that mainstream architecture considers technical issues a limit to creativity and freedom in the design process and, in general, environmental issues are directly related to technical issues. In this case, the interviewees point out the architect does not consider himself responsible for technical issues. According to interviewee's perception, the lack of confidence related to technical issues makes the architect to believe that specialized technical knowledge is necessary to validate a design. Therefore, there is no relation to the architectural expression. Then, it is observed that when technical issues are servant to the project, they are usually explored in a second stage of the design, and therefore their potential and integration are not explored. Spencer de Grey recognizes that the lack of integration between architecture and engineering fields is stronger in some countries than in others. He notices that countries such as the United States and France still make technical issues servant to the project). In France it can be related to the split between the "technical" schools and the "design" schools after various reforms in the methods and philosophy at the Ecole des Beaux Arts. Design and drafting were taught in independent studios, the Ecole itself did not provide practical instruction. The French school served as a prototype for architectural education in France and in the earliest American Schools. By the third quarter of the 19th century, the Ecole des Beaux Arts became the most influential such institution in the world (BERGDOLL, 2000; MOFFET et al., 2003).

- **Schools of Architecture.** According to interviewee's perception of the present structure of most schools of architecture, they believe the schools contribute to the dissociation between technical/environmental issues and design when these issues are dissociated from studio activities and optional to the process. The observed structure follows the established structure of the mentioned Ecole des Beaux Arts, which shows its

still historical influence. The interviewees also notice that focusing only on the quantitative issues of environmental integration does not show how to explore their architectural potential. The belief of the interviewed architects that the integration of these issues into design process stimulates creativity makes them to point out this dissociation as a limit to the creative process. Most schools of architecture are indeed more focused on the formal aspect of design, without any commitment to the reality and impact of design choices. Therefore, there is no stimulus to the understanding of the working processes, to building physics and their relation to design and context.

- **Lack of confidence.** Some of the Brazilian and European interviewees identify there is a lack of confidence in architectural profession, related to a weak technical knowledge basis. They believe it has contributed to the vulnerability to wrong references and to the pressure of the market, and consequently, to a crisis in the profession. Considering the practice of searching for references in the design process (ROWE, 1987) and the fundamental role of referential procedures in the knowledge construction (ANDERSON, 2000), this vulnerability have a strong negative impact on the real integration of environmental issues into design. Some of the Brazilian interviewees recognize the lack of confidence among architecture professionals has contributed to a crisis in the profession, related to their discredit and disbelief in the society. It is very similar to Foxell's statements (FOXELL, 2003) on the situation of architecture profession in UK.

- **International Style.** Considering the fundamental role of referential procedures in architectural practice, all the interviewees point out the so called International style as a wrong reference. According to their perception of the problem, the international style, in which the icon is the glazed tower, is considered a wrong reference to architecture professionals and the market, because it is considered an example of the dissociation from local context and climate. Therefore, it guides to standardized solutions, which limits the creativity. Pamplona also points out the "thermal globalization", in which building users have limited their tolerance to temperature variations.

- **Wrong appeal.** All the interviewees also notice that the appeal to environmental issues, when it is directly based on numbers, target settings, savings and by the pressure of the law, does not contribute to an effective cultural changing. Therefore, the scepticism of the market and architecture professionals to passive technologies and strategies (still related to expensive measures) is related to a cultural problem.

- **Elemental method in building regulations.** Hagan (2001) points out that there are those who believe that only through "*draconian concentration of power at the top*" can the necessary environmental reform be effected, which is not part of interviewees' beliefs. Based on the experience of European interviewees, when building regulations use elemental methods that bring strict requirements of energy efficiency and thermal comfort, such as limits to specific parameters of building components and systems, it gains a negative approach, because its application becomes mechanical and does not influence the design concept. The view of the problem by the Brazilian interviewees, based on a hypothetic situation, is similar to the situation described in the lived experience of the interviewees in UK, regarding the elemental method of building regulations. The negative experience of the Brazilian interviewed architects, regarding the application of building regulations, made them to believe that these regulations would not have an effect on the consideration of bioclimatic issues into the design solution. The narrow view of the problem in the structure of building regulations is pointed out as a limit to the development of innovative solutions, research and to the consideration of qualitative issues of design solutions related to thermal comfort.

5.5 PROPOSED ACTIONS

The insights raised with the statements of the interviewees provided a wider perception of the problem. Therefore, some measures to promote effective cultural changing to the market and in professionals design philosophy are identified, regarding the perception and acceptance of bioclimatic issues.

5.5.1 From a policy making perspective

- Even the governments most advanced in legislation related to building energy efficiency and environmental impact, such as United Kingdom and Germany, do not put into question the model of economic development, which is still based on the growth of energy consume (WINES, 2000). Therefore, to be effective, any policy to promote bioclimatic integration has to consider the need to promote first a philosophical and cultural change that sees progress, also, in terms of ecological impact.
- Based on interviewees' experience the legislation needs to be combined with measures to stimulate the positive embracing of bioclimatic and environmental issues. The more receptive perception of European interviewees is related to their experience with Building regulations, which are effectively applied through trustful regulatory agencies. It points out the influence of their lived experience and social context,

including their relationship with regulations, on their beliefs, which agrees with the phenomenological approach in philosophy.

- According to interviewees' perception, requirements of building energy efficiency and thermal comfort in format of recommendations or references rather than a law are considered more influential and useful, considering the importance referential procedures in the design process. Therefore, design guidance in the form of guideline reports and rules of thumb can be a precedent and effective design tool on the consideration of bioclimatic issues in design.
- According to European interviewees' experience, the influence of Green labels are more effective in business corporations that can use them as environmental compensation or they can be used to decrease the taxes and to attract the market. Therefore, it becomes an indirect stimulus to the architect because of the potential new demand of the market. It has been already happening with certification systems such as the LEED (Leadership in Energy and Environmental Design) in United States and the BREEAM (BRE Environmental Assessment Method) in United Kingdom. However, the interviewees in UK are still very sceptic with those certification systems, regarding the method to define the applied classification. Spencer de Grey points out "*there is no consistency about whether a building achieves gold, or silver or whatever these tags are"*. In Brazil, a certification program for building energy efficiency is expected to start working as a voluntary program by the end of 2007. However, it is expected to become a law in 2012 (LAMBERTS ET AL, 2007). In the Brazilian case, the mentioned certification program is a governmental initiative and its development has been based on a wide discussion involving building industry, design professionals and research institutions, which gives confidence in the process. The performance of certified buildings can also work as a reference to define regulation requirements because they deal with buildings that are beyond the requirements of regulations.
- The adoption of the performance approach is considered the most efficient approach of Building Regulations to promote a more flexible adjustment to particular requirements of the project, which makes the balance between formal and bioclimatic issues easier. All the European interviewees point out the regulations should be related to the performance of the whole building and not only to the properties of the components, to balance energy and the life time of the building. Some existent building regulations are already migrating from the elemental method to performance approach. The new approved revision to Part L of UK's building regulations, published in 2006, establishes to

all new buildings targets of CO2 emission. Therefore, the energy performance of buildings needs to be calculated. The aim of the Directive is to promote building energy performance improvement within the European Union. It lays down requirements for calculating energy performance according to a national standard (ODPM, 2006).

- In this case, the interviewees are also aware that this approach requires a stronger technical knowledge because it includes more detailed calculations. Even in big practices, which is the case of European interviewees and Lelé, the adoption of the performance approach also depends on the budget and time of the project because it requires consultancy, which is focused on the adjustment of the design solution. Therefore, although the performance approach would be more efficient in respect to particular features of each project and innovative solutions, it would be more effective in the detailing stage of the project. Furthermore, even adopting the performance approach, the available tools of energy simulation can be manipulated to achieve the desired performance of the model. Therefore, according the interviewees belief the architect should have a commitment with the final result of the project, including its construction and post occupancy in order to apply any adopted approach of building regulations.
- Some measures can be done to avoid this manipulation of models, such as the use of IFC files (Industry Foundation Class files) and regulations that generate a commitment and technical responsibility of the designer with the built object. According to Gasparski a designer should be responsible for what he did or did not to prevent or at least limit the possibility of error (GASPARSKI, 2005). Andrew Marsh points out the case of New Zealand's regulations regarding designers' duties. According to New Zealand's building regulations, the building designer is responsible for the designed building at any stage of its life-time (Department of Building and Housing, 2007). In Brazil, if the performance approach is not followed by a policy that provides technical support, besides the use of IFC files, it won't be adopted because in general Brazilian architects work in small practices that rarely require consultancy. The mentioned guideline reports are then, the appropriate tool to promote the consideration of the environmental problem into the definition of the design concept.

5.5.2 Appeal to qualitative issues

- Based on interviewees' perception of their professional role and concept of architecture, before the market and building regulations, the belief on bioclimatic issues as part of the design philosophy is the main stimulus to defend ideas and principles. In this

defence of ideas, the appeal to environmental issues should not be firstly related to a duty or responsibility.

- The appeal can be based on the presentation of a track of consolidated environmental design as a positive strategy to attract the market and to stimulate other architects to adopt this approach. Hagan (2001) recognizes that within building industry, successful architects have high influence and their decisions can influence clients, contractors and fellow professionals alike.

- Promoting a lived experience in passive design through visitations to built examples, in the case they are accessible, also follows the strategy of awaking the interest in bioclimatic issues through the architectural quality it can bring for the space. A database of built examples of passive design would support the implementation of such action, mainly in the case of young architects, who do not have a wide body of work to present yet. There are already many websites that document buildings and leading architects, such as the gateway Greatbuildings.com, but few that focus on the documentation of built examples of passive design solutions. Most websites in this field, sponsored by governments, professional institutions and research organizations[9], focus on scientific research and detailing of strategies, but rarely bring built examples.

- It is also fundamental to stimulate the adoption of environmental issues as part of the status criteria of society. It can be achieve through their adoption in public buildings and by renowned architects, whose design solutions are approached in specialized and commercial media, showing the qualitative aspects of these issues on the space.

5.5.3 Development of technical knowledge

- The belief on environmental design must be supported by the development of technical knowledge, which is considered the basis of changing. The early design choices depend on basic building physics knowledge to promote its integration before the design concept is defined. The consolidation of technical knowledge, integrating a basic understanding of building physics concepts, guarantees the necessary self-confidence and credibility to search for references and to deal with the whole project, from drawing to construction. It stimulates the generation of creative solutions against the target setting of the market.

[9] Some examples: www.energy.gov/energyefficiency/buildings.htm ; www.architecture.com/go/architecture/debate/sustainability_2917.htm ; www.epa.gov/greenbuilding ; www.greenbuilder.com/sourcebook/passivesol.htm ; www.plea-arch.org ; www.lbl.gov

- The development of technical knowledge for the architect who is already in practice can be done through research, seminars, specialized publications and also visiting buildings and talking to users. The professional institutions can be also a very important tool to promote the updating of the professionals, considering the professional ethics. For the architects who practice mostly in Britain, the RIBA (Royal Institute of British Architecture) has had an important role in their construction of knowledge (propositional). This institute recognizes the impact of architecture on the environment and has taken actions to stimulate the production of what they call sustainable architecture. It is an important source of information and makes available trustful source of publications, researches and case studies, showing the application in practice of these issues. Furthermore, it supports and requires from its members annual CPD (Continuing Professional Development) with training, courses and seminars. It also provides specific CPD modules of sustainability. It is important to notice that the modules, which are available in RIBA regarding sustainability, are exclusively related to energy performance through efficient systems of lighting, cooling and heating and integrated passive strategies.
- Stimulating the contact with building construction to the consolidation of the concept that the architectural design comprehends from the drawing to the building construction. Therefore, it stimulates the understanding of the design process as one integrated problem, generating a commitment with the final result and the consolidation of the professional's ethical view. The integration of technical knowledge, through the understanding of architecture as only complete with the building construction, makes the dialogue with experts easier because they can understand the essence of the building related to the technical aspects of its materialization. The contact with building construction site can be provided in formal education and trainee programs (see 5.5.4).
- In the case of big projects that require engineering consultancy, according the European interviewee's perception, the most effective interaction with these professionals happens when they are involved since the first meetings of the design team to provide basic information that support the definition of the concept. It guarantees the analysis is integrated in the design solution because the architect takes his own solutions to the problem based on consultant's explanation of the problem and not on suggestions to modify design concept when it is already consolidated. To engage the engineer in the design process Marsh suggests the use of IFC files to make CAD models completely interchangeable.

- The use of computer models is suggested to help the architect to graphic visualization of the impact of design choices. However, a previous knowledge basis is necessary to define the design concept and the related design strategies to be analysed and to get the right information from the analysis tools.

5.5.4 Formal Education in Architecture

Architectural formal education has a fundamental role to improve architects' technical knowledge, in concern to environmental issues. Environmental issues should be an ethical commitment of the school, regarding their role to promote the development of professional ethics and in the construction of a basis of humanistic and technical knowledge. Apart from their different social contexts and design experiences, Brazilian and European interviewees present very similar or complementary suggestions for the practical application of this commitment by the school;

- Based on interviewees' experience, bringing environmental comfort and building physics concepts to studio is fundamental.
- The first approach to environmental comfort and bioclimatic concepts should emphasize the architectural potential of environmental integration to, then, attract the interest and approach technical aspects of environmental issues.
- In this process of approaching first the qualitative aspects of environmental integration, the development of a repertoire/vocabulary of environmental design solutions is fundamental to show the practical application of these solutions, regarding different climatic conditions and their technical implications. In this case, the mentioned database of built examples can be of fundamental help to support the development of this vocabulary.
- The technical basis should be also promoted through the development of conceptual skills in building physics, explored also through the direct contact with building construction sites and trainee work in registered and evaluated design practices. In most schools of architecture in Brazil, trainee work in design practices is already part of the curriculum. However, few schools also require trainee work in building construction sites, which is the case of the School of Architect at the University of Brasilia. This trainee work is required to third year students and the student can follow building constructions of any scale. This contact has promoted a differential on student's attitude to technology and professional field, mainly in the case of the students who worked in big scale constructions. In general, these students have developed a more confident relation to

engineers and have increased the interest in understanding the process related to building detailing and its materialization. The extension of their early professional work to deal with construction becomes more common than to students that did not have this contact during the course.

- In this process Cucinella suggests that the student can be the tool to disseminate the knowledge in bioclimatic concepts. The school would introduce the theme of environmental integration and comfort to be followed by all years. The students would raise this information and bring it to their teachers. It would stimulate the discussion of the problem and its relation to the building. Then, the student would go from one year to the other with this problem already being part of the discussion. Therefore, it would be developed and consolidated in parallel to the development of project/studio activities. The background related to environmental issues would grow as a natural part of the process, and the student would finish the school and get into the market with this background.

5.6 SUGGESTIONS FOR FUTURE RESEARCH

- Following the complete development of a project, from the design concept to detailing, in the practices of some of the interviewed architects, in Brazil and Europe.
- Evaluation of building regulations and certification programs, in Brazil and Europe, and the relation between the existence of requirements of energy efficiency and environmental comfort in local building regulations and the use of bioclimatic strategies in design.
- Evaluation of effective actions of professional institutions to support and promote the integration of environmental issues in the professional practice. Case study to evaluate the influence of the contact with the building construction on professional technical knowledge and environmental commitment. Evaluation of the curriculum at the schools of architecture in Brazil and European countries, such as England, Italy and Greece. Including a case study to evaluate students` perception in the schools of architecture where bioclimatic issues are part of studio activities and where they are not.

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