

Reconciliation of the objective and the subjective bioclimatic architectural parts; the contribution of schematization and CBR

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Abstract— During the process of architectural design, architects often face problems to which suitable solutions are required. To carry out this task a multitude of software programs were developed. Nevertheless, it has been noticed that an important number of architects do not use any bioclimatic device tools during the design process, at least in the present case. The inadequacy of these tools, to the professionals implied in the designing process especially the architects, is very probable. In this regard, the researchers aim to give the designer and the various actors a practical tool for help in order to understand and integrate the bioclimatic passive concepts as to the hot climate. The researchers tried to develop a bioclimatic sketching book based on decree n° 14-27 and case based reasoning method. This novel tool offers concrete illustrations to the actors, and assists the architects in the architectural bioclimatic design. It may contribute to the decisive insertion of building in its desert area during various stages of designing.

Keywords— Architectural design process, desert climate, integration, sketching book, schematisation

I. INTRODUCTION

Architectural projects sometimes are seen as a problem solving activity, and the result of a long complex multidisciplinary process of planning [1]. It is not only a non-linear procedure but also a dynamic one. The emergence of the conceptual solution is the result of various actions. It embraces different sorts of interactions between the actors and their subject-fields. [2]. Pierre Fernandez sees that the major character that renders the act of modeling the design process awkward is the diversity of the methods of project elaboration. This feature of diversity can be interpreted via several ways of conciliating both the objective (program, site, regulations...) and subjective (composition, reference...) parts during the process of design [3]. The architect has to get the maximum amount of information concerning the project, and call for his own experience in terms of knowledge and know-how [4].

Several approaches are suggested to integrate this established fact into an intelligent device which will help the architects to find solutions for the problems. This could be achieved by providing the machine with the necessary

knowledge that would enable it to find the most suitable solution.

The Case based reasoning (CBR) can be considered as the closest one to the human reasoning based satisfaction among all the various approaches related to artificial intelligence. Additionally, it is the most adopted in the activity of designing [5]. Indeed, it can help architects overcome the problem of the lack of information concerning bioclimatic field issues and find optimal solutions.

In its work on the reasoning base references Roger Schank proposes [6] that a problem resolution system based on the CBR must be guided by the experiment. The CBR is a form of reasoning by analogy. It consists in solving a new problem, called target problem, and by using a whole of already solved similar precedents [7], [8].

From this perspective, this paper concerns itself with:

- Gathering and conceiving a set of conceptual strategies related to earthquake resistance design.
- Trying to find a way to take them into account during the early stages of designing.
- Finally, developing a sort of tool based on the schematization and case based reasoning method to assist architects during the designing process.

II. THE ARCHITECTURAL BIOCLIMATIC DESIGN REQUIREMENTS

In Algeria and since 2000, the public authorities put the issue of the elaboration of legislative code for sustainable design as one of its priorities in order to take into account the natural and climatic variables. This is clearly stated in the various promulgated legislative decrees (laws: 01-20; 02-02; 02-08; 04-05; 04-09; 09-99; executive decree number 14-27) [9].

However, to interpret suitably the spirit of the code the designer's experience has to be up to the level, without this a contrary result might occur especially in the case of bad interpretations [10]. Moreover, the majority of the available

bioclimatic help tool devices are used as enhancers, they check the feasibility of the overall architectural forms and intervene at stages in which the architectural part is already done.

On the other hand, the architectural bioclimatic design requires a very close cooperation between both the technical and the architectural bioclimatic aspects as from the early stages of the designing process. By experiment this approach allows a great deal of reconciliation between the architectural aspect and the technical design of the architectural project.

Practically speaking, the implementation of such methods is the result of the interaction of extremely complex factors such as: the current regulation, the economic situation, the technical know-how, the aptitudes, and even the different actors' behavior.

Additionally, the majority of designers do not use a decision advice tool during the early stages of bioclimatic design process. This is mainly due to the inadequacy of these tools to the professionals implied in the design process, especially architects [11]. This absence can be explained on various levels as:

- They are not used until the last phases of the design process.
- Designers are heavily short of training in terms of using these tools.
- Their knowledge about bioclimatic designing concepts is quite poor.
- Architects consider that bioclimatic active strategies are in charge of treating the sustainable aspect of buildings.
- The fact of knowing the existence of an under state control subsidy for the residences energy consumption is compulsory make designing intervenors lazy in considering bioclimatic aspects during the early stages.
- The current software devices are beyond the mastery of architects because of their highly specialized character.
- They require relatively a long training period of time, which professionals can not actually afford.

The use of these support tools varies according to the mode of implication of the bioclimatic aspects in the architectural design process:

In case of post-implication, the support tools will assume the control, validation, or sanction mission. And hence, the amendments have to be limited with regard to the schedule and project budget. Indeed, great deal of rectifications during very advanced state of project design might imply revising a considerable work of design on various scales. On the other hand, in case of very early engagement, as of the draft stage, they will be involved as assistance in the bioclimatic design (see figure 01).

The current simulation tools of bioclimatic aspects of building available form part of the specialized codes, and they are not usually employed in architectural practice. During the early designing phases, architects do not need any validation

but rather an enriching and assistant tool ; as affirmed by the head of CLOA-Adrar (Local Council of the Architects Order), Mr. LAZRAG A. : «...when conceiving we always seek nutritive sources for the project and which stimulates the architectural creativity...»

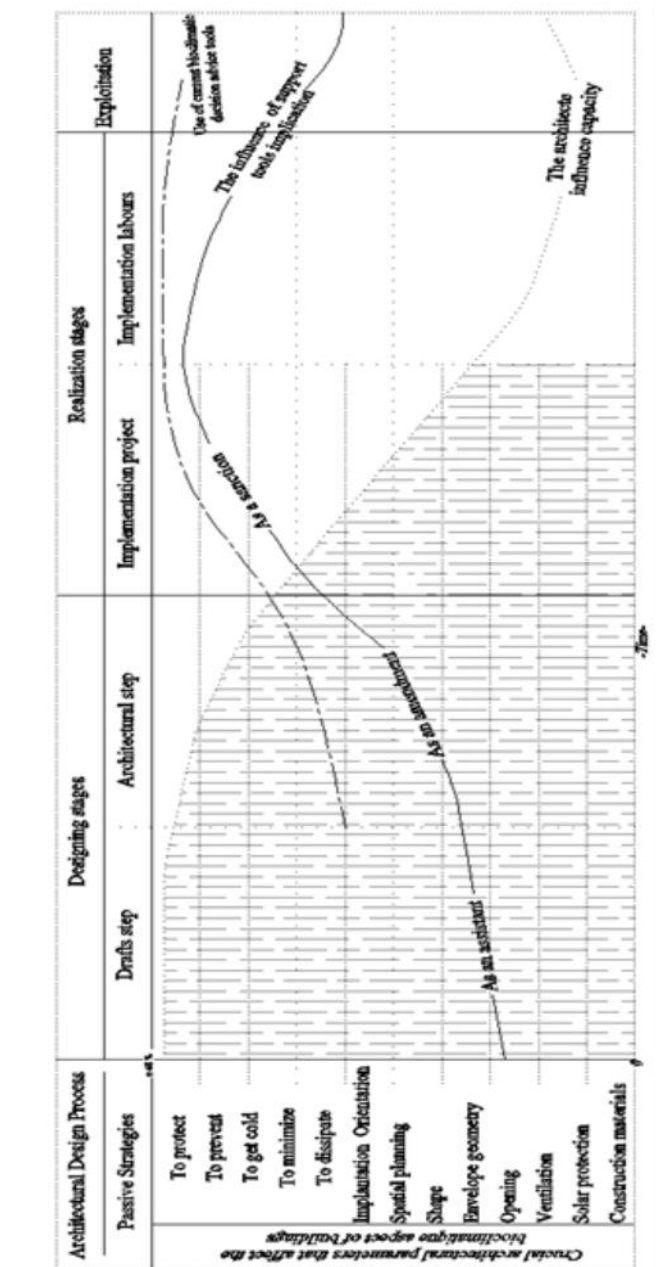


Fig. 1. Implication of current helper bioclimatic device tools in bioclimatic design process (Algerian case study)

Admittedly, the designing act is a rather complex activity; it is technical and sensitive labour at the same time. It often requests a search for ideas and information which can assist the designer in the development of his project. This idea was

developed by many researchers, such as Leplat (2002) [12]; Bignon (2004) [13]; [Kacher (2005) 14]; and other... They explain why during the architectural design process, the recourse to the images (diagrams, sketches, pictures, photographs... etc.) is essential. They consider also that the information transmitted by the image is easier to include/understand than that transmitted by the text. This probably results owing to the fact that the image requires fewer interpretations than the text. Moreover, the image presents information which can be directly integrated in the corpus of the ideas, the constraints or of the solutions of a project. The architectural design process is regarded as a chain made up of several couples of problem/solution formulations which each one called upon specific representations, see figure 02.

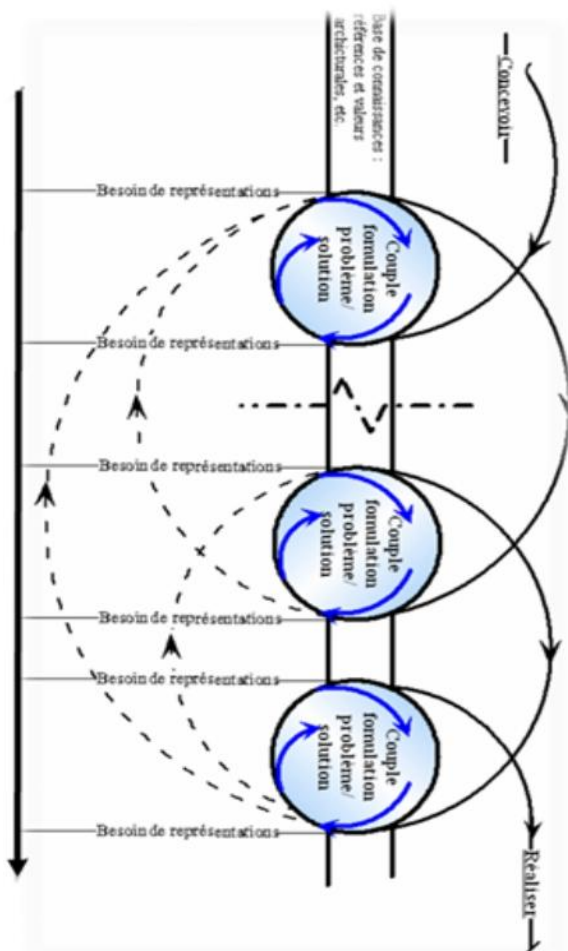


Fig. 2. The role of the couple problem formulation/solution in the advance of the architectural design process (Djafi 2005) [15].

The need for schematizations is a necessity which appears on the various level of the dynamic articulation of this couple. It gives the possibility of expressing the idea of the project which one wishes to carry out, and to communicate it. In architecture, the representation can be considered as a tool of studies making it possible to simulate the various assumptions, a means of anticipation, description, information, dialogue, decision-making aid, control and validation lasting the development process of the architectural project, and also a tool of communication towards a public not specialized.

III. EXPERIMENTAL THE PROPOSED DESIGN PROCEDURE

The designing act is a highly complex activity; it is technical and emotional at the same time. It often requests a search for ideas and information which can assist the designer in the development of his project. This idea has been developed by several researchers and designers, such as Bignon, Halin, and Kacher in his article « A method to index images in the wooden architecture domain » [13], and S. Kacher in her doctoral thesis [14] among others..., they explain that during the conceptual process the need to return back to visual illustration (images, pictures, drawings, etc.) is essential. They consider that the information transmitted by image is easy to understand if compared to written texts. This is due to the fact that the image has a limited number of interpretations. And it presents information which can be directly integrated into the corps of ideas, constraints or solutions for the project. In other terms, the image that supports the architectural creation before and after the design of the project in the conceptual, architectural and even economic order. It clarifies the various situations “analysis / development” of the designing process, and also simulates the comprehension of the bioclimatic architectural concepts. Moreover, it provides a clear illustration to the actors about how to include the formal relationships between the various attributes influencing the bioclimatic aspects of the building. [16].

In this piece of research, our aim is to suggest a tool that facilitates a sort of reconciliation between the objective and the subjective parts of the design. More precisely, enhance the communication between the different actors, and hence ensure a tight collaboration between them as it is the fundamental principle of any architectural design. The proposed tool is composed of two types of structures: a linear structure and in loop one (Figure 03).

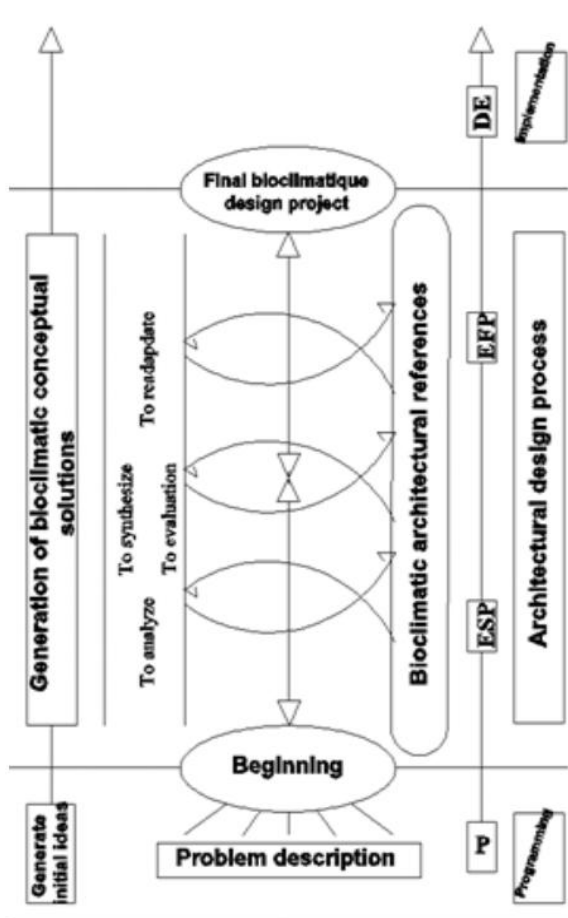


Fig. 3. The proposed design procedure

The linear structure is vertical and it defines the requirements, of the bioclimatic design concerned as well as the different developing phases of the project. The loop structure is concerned with generating alternative solutions and allowing the repetition of all the activities and phases of the linear structure in an iterative way. The loop structure divides the vertical linear into loops of five successive stages. The first one examines the project candidates. The second stage selects bioclimatic concepts from the given data.

Next, an analytic phase was carried out in order to suggest the various possible conceptual solutions. Then a synthetic step generates a potential solution through the exploration of various combinations of the primitive elements.

Finally, the results were evaluated, at times readjusted and reused. These phases were repeated until a satisfactory designing solution was obtained.

IV. THE BIOCLIMATIC SKETCHING BOOK

During the process of design, architects usually use their previous knowledge conceptualized in terms of references and schematized cases so that to feed their new artistic products. They do not have predetermined ways of resolution, but instead they know a certain number of technics and methods,

among which relying on similar projects or existing prototypes. However, it is necessary for designers to reinvent and recombine some strategies to elaborate an adequate solution each time.

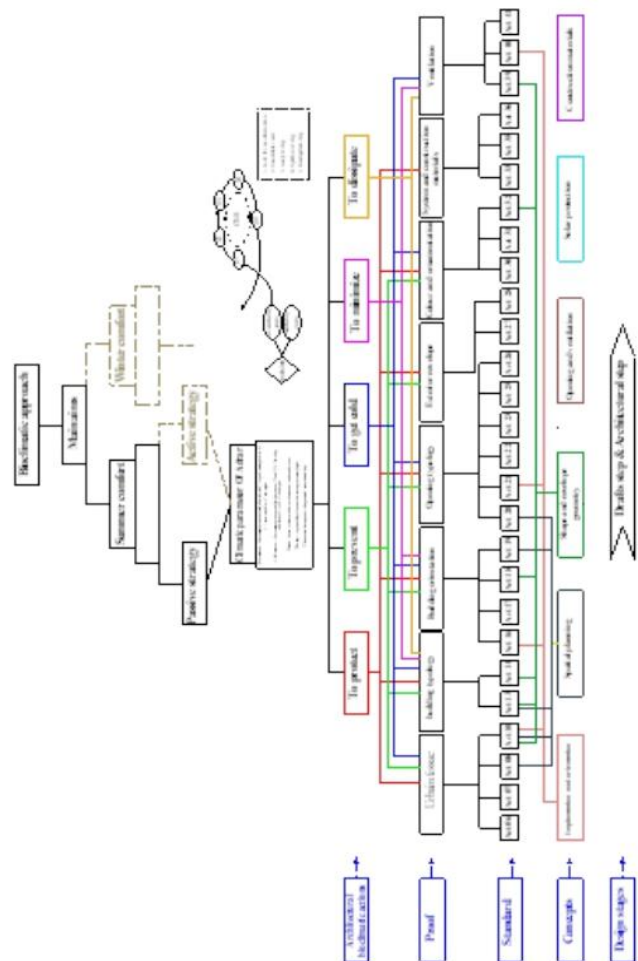


Fig. 4. Diagram of the bioclimatic sketching book

The need for rules related to bioclimatic designs proves to be essential as they offer the architect the conceptual bases for the architectural project. They enable also the guarantee, integration, and insertion of climatic variables as from the early phases of the design process. The reasoning based case is by far the most suitable resolution approach to the problems adopted in the act of designing. Indeed, it implies the use of artificial intelligence “AI” which helps the architect in the bioclimatic design and to find optimal solutions.

The diagram shown in figure 4 recapitulates the bioclimatic sketching book. This last is the result of the superposition of the obtained bioclimatic, urban, architectural, and functional indicators. It is also the outcome of analyzing the executive decree n^o 14-27 and the synthesis of

bibliographical study which fixes the various actions defining the bioclimatic cold passive strategy.

V. RESULTS AND DISCUSSION

The main aim of the present experiments is to contribute to the reflection by focusing on two essential points. The first one is to check the association concept-image which allows a correct interpretation and a performance appropriation of the bioclimatic concepts. The second one is to validate the practical, economic and creative benefits of a schematized navigation in standard referential of bioclimatic architecture of the Algerian southern provinces.

The results of the experiments are supported by 42 architects from CLOA-Adrar (Local Council of the Architects Order) who have received lessons in academic master in architecture at Adrar University in partnership with the University of Sciences and Technologies of Oran. Work proceeds in exercise form of design before and after the use of the developed sketching book. All the drawings and written traces produced during the experimentation are also reserved. The first step of designed tool is given in figure 5.


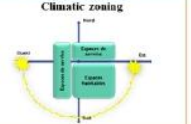

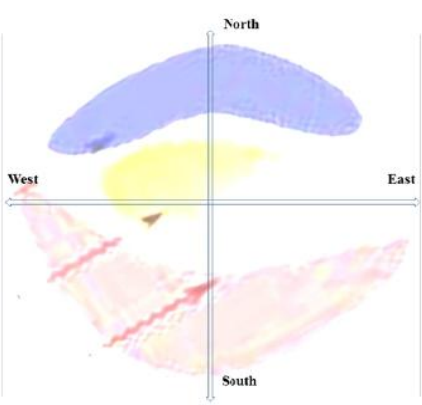



Sketch step	Architectural projet	Final projet	
Process	Implantation and orientation		
Main aims	To protect	To prevent	
	To get cold	To dissipate	
		To minimize	
Optimal orientation	Climatic zoning	Morphology	
			
Examination, Decree: 14-27	Art: 16, 17, 39, 18,19	Examination, Decree: 14-27	
	Art: 19, 13, 27, 40	Examination, Decree: 14-27	
		Art: 13, 14, 18, 27, 28, 30, 40	
La végétation			
			
Examination, Decree: 14-27			Art: 13, 17, 39, 30, 40
Protection provision			
			
Examination, Decree: 14-27	Art: 06, 07, 08, 14, 17, 39		
The joint ownership			
			
Examination, Decree: 14-27	Art: 27, 28, 31, 40, 13, 10, 14		
Recommendations			

Fig. 5. sketch step page of designed tool

Thanks to this experiment that we succeeded to improve our sketching book, determine architects' needs in terms of bioclimatic knowledge, and also define the main features of

the suggested approach. It enabled us to check our assumption concerning:

- The presence of several loops of feedback makes it possible to return back in order to take into account the new information generated during the designing process.
- The distinction between the various phases of the design processes especially the beginning and the end with loops between them implies the existence of objective criteria. This illustrates the fact that the objective and its properties guide the mechanism of assistance to generate bioclimatic forms as from the early phase.
- The reliance on the CBR concept and the graphic demonstrations at each level of the design situation enables the possibility to express the idea of the project that one wishes to carry out, or to communicate.

VI. CONCLUSION

The architectural form is remarkably the most significant element in the bioclimatic aspect of any building. The requirements of a bioclimatic design can appear during the first examination as an impoverishing constraint. In fact, in the professional space, we should seek shape of buildings adapted as much as possible with naturel variables, as well in architectural as of technical aspects. Many successful projects on the aesthetic level prove however that a bioclimatic architecture of quality is possible.

Thus, beyond the "thermomechanical behavior" aspect, we can integrate the bioclimatic concerns within the architectural intention, and it is possible to use the bioclimatic concept as an element of architectural expression.

The present model shows two sorts of information framing the representation and the progress of the architectural project; the first is meant to answers the question: « *what is to be done?* ». The answer could be considered as a source of bioclimatic conceptual ideas. And the second is an esthetic answer to the question: « *how it will look like?* ». Its role is to seek conceivable solution forms. The suggested tool can be conceived to be a tool of assistance and for decision-makers during early stages of the design process. Additionally, it can be used as a tool of communication with the common public.

REFERENCES

- [1] K. pal SANKAR, SIMON c.k.Shui, Foundation of soft case-based-reasoning, vol 2, 150, 2004.
- [2] R. Prost, "conception architecturale une investigation méthodologique," l'Harmattan (ed), French, 1992.
- [3] P. Fernandez, "stratégie d'intégration de composante énergétique dans la pédagogie du projet d'architecture," Ph.D. dissertation, école des mines de Paris, French, 1996.
- [4] M. Benabdelfattah, Y. Kehila, H. Khelafi, and N. Djarfour, "Integration du "RBC" à la prise de decision pour assister l'architecture parasismique; contribution méthodologique," *African Review of Science, Technology and Development*, vol. 3, no. 1, pp. 07-17, 2018.
- [5] S. Mazouz and M. S. Zeouala, "The integration of environmental variables in the process of architectural design; the contribution of

- expert systems," *Elsevier, J. Energy and Buildings*, vol. 33, pp. 699-710, 2001.
- [6] A. Bendeddouch, "Le processus d'élaboration d'un projet d'architecture," *L'Harmattan ed.* Montréal, French, 1998, p327.
- [7] C.K. Riesbeck, and R.C. Schank, (1989), "*Inside Case-Based Reasoning*," Lawrence Erlbaum Associates, Inc.: Hillsdale, New Jersey.
- [8] B. Fadi, "*Extraction de connaissances d'adaptation en raisonnement à partir de cas*," Thèse de doctorat : informatique, Ecole doctorale IAEM Lorraine UFR STMIA : Département de formation doctorale en informatique, 2009.
- [9] S. Hamrani, " L'insertion passive des bâtiments dans un climat désertique ; État de lieu et recommandations ; Cas de la wilaya d'Adrar – Algérie," M.D. dissertation, University of Sciences and Technologies, USTO, Oran Algeria, 2017.
- [10] M. BRET, " Image de synthèse : méthodes et algorithmes pour la réalisation d'images numériques," St-Jean/Richelieu, Dunod (ed), Bo-Pré, Paris, French, 1988.
- [11] Benabdelfattah M., Kehila Y., Makhoulfi A (2018) Meeting Paraseismic Knowledge Needs of Algerian Architects. In: Kallel A., Ksibi M., Ben Dhia H, Khélifi N. (eds) Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions. EMCEI 2017. Advances in Science, Technology & Innovation (IEREK Interdisciplinary Series for Sustainable Development). Springer, Cham.
- [12] Leplat, J., (2002), De l'étude de cas à l'analyse de l'activité, In : PISTES, perspectives interdisciplinaires sur le travail et la santé, 4(2), DOI : 10.4000/pistes.3658.
- [13] Halin G., Chaabouni S., et Bignon J-C. (2007), Recherche de références par l'image dédiée à l'assistance à la conception architecturale. In : SCAN'07, Séminaire de Conception Architecturale Numérique, 20 novembre 2007.
- [14] S. KACHER, " proposition d'une méthode de référencement d'images pour assister la conception architecturale : Application à la recherche d'ouvrages," Ph.D. dissertation, l'Institut National Polytechnique de Lorraine Discipline, Sciences de l'architecture, 2005.
- [15] Djafi, F., (2005), *L'apport du réalisme visuel à la représentation de l'image de synthèse dans un contexte de conception architecturale assistée par ordinateur (CAAO)*, Mémoire de maîtrise : Sciences de l'architecture, Université Laval QUÉBEC : Faculté des études supérieures.
- [1] L. Khelifi, " Contribution méthodologique à la conception bioclimatique en architecture; développement de modèles génériques," M.D. dissertation, Ecole polytechnique d'architecture et d'urbanisme, EPAU d'Alger-Algérie, 2006.