The Choice of Materials in Architecture:
How ecology influences our cognitive and cultural schemas?

NATHALIE TORNAY [1 ET 2], FRÉDÉRIC BONNEAUD [2], LUC ADOLPHE [1]

[1] PRES Université de Toulouse – LMDC – Laboratoire Matériaux et Durabilité des Constructions, INSA – Institut National des Sciences Appliquées, Toulouse, France
[2] PRES Université de Toulouse – LRA – Laboratoire de Recherche en Architecture, ENSA – École Nationale Supérieure d'Architecture, Toulouse, France

ABSTRACT: *The access to the knowledge on the environmental quality of building materials and on their use is easier and easier. It increasingly influences the contemporary projects. It is of paramount importance for us to find relevant ways of linking these know-how with the modus operandi that are specific to design. Our research area lies in the cognitive sciences applied to design. Our working method consisted in using the contents of press articles on architecture dealing with the environmental quality. After collecting these articles and analysing their positioning in terms of materials, we characterized the ecological thinking modes that predominate each design. We synthesize these thinking modes according to four categories, each of them conveying a different definition of ecology. These four categories lead to a better understanding of how the notion of environment is integrated. In conclusion, our work illustrates how difficult it is to understand each other when dealing with the notion of environmental architecture. This notion is a catch-all notion. This clearly illustrates that, in the same cultural pool – which is represented in French architectural journals – knowledge sharing is not based on the same cognitive schemas, bringing about fundamental consequences on the whole design process.*
Keywords: materials, ecology, cognitive schemas, design process

CONTEXT

We have at our disposal an ever growing knowledge and know-how on the environmental quality of building materials and the way they are used. The environmental expertise of engineering on materials can be now clearly identified. It increasingly influences the contemporary and urban architectural production. Current researches are providing conceptors with pragmatic tools that are becoming more and more affordable by non-experts [1].
In the middle of this highly complex questioning, we are led to take a closer insight into the link between the conceptor's impressions - that is to say his emotions, his feelings, his affectivity... - and the environmental characteristics of the material. It is mainly about psychophysiological and holistic studies on perception, on mental process and on human behaviour with the aim of improving the conception process. Therefore, our research area lies in the cognitive sciences applied to architectural conception.

PROBLEMATICS

Dealing with the evolution of the environmental quality of materials, it is of prime concern for us to take a further insight into the connection between these know-how and the modus operandi which are specific to architectural conception. It basically consists in studying the relationship between the environmental know-how on materials and architects' aesthetic and socio-economic choices on the same materials. We do our best to bring to the fore the cognitive and cultural schemas revealed in these projects.

METHOD

Our study is based on a method that is used to apprehend the vision of ecology as it is defended - more or less consciously - by the designers [2]. This method will be explained further down in this article. Our contribution consisted in applying this method - initially used for energetic concern - to the specifications of materials.

We searched for information in architectural journals. Journals can be seen as mediators insofar as they convey experiences and make the reader share them. However, each magazine reveals a specific way of apprehending environmental architecture, as F. Raffaut comments about the magazine "Urbanisme": "The words are biaised and tinged so as to show a specific vision of the city. This situation contributes to what can be called a closing effect" [3]. As far as current issues are concerned, we have taken an inventory of the wide circulation journals published over the last two years, from January 2007 to December 2008.

At this stage of our progress that we are giving in this article, we've been spending the time, up to now, to identify the contents of the projects in four magazines aimed at both the widest public and the initiated and professionals. The journals are "Architectures à vivre" ; "Habitat naturel" ; "La Maison écologique" and "Systèmes solaires". Those magazines constitute an extensive corpus of texts and images that are particularly worth of interest. It is for this reason that we have only selected the articles that devoted at least two whole pages or more to a single project. In a first stage, each of the four selected magazines is placed in the contemporary context. Then, we have studied the selected project in each magazine. First, our work consists in doing a quick analysis by identifying and classifying the materials used for the external envelope (the walls and the roof) of each project. A second stage consists of a further analysis of the choice of materials. To reach this aim, we have used an evaluation method on the basis of energy efficiency and life cycle of materials. Our target is to try and define the way environment has been taken into account in the choice of materials. In the third stage, we provide a classification of the selected building projects according to all the criteria mentioned in the whole study. We try to bring to the fore different profiles revealed by the choice of materials when projects - which are referred to as "environmental" – are elaborated.

RESULTS 1: INVENTORY

We have selected four magazines which are more or less representative of the French press about architecture and ecology:

- "Architectures à vivre" is an architectural and design bimonthly created in July 2000 on the occasion of the day devoted to the contemporary house.

The environmental concern appears in "special files" in which a theme is very detailed, but also in "reports" about buildings. We have made a selection of nine projects in this magazine for our study. [4], [5], [6], [7], [8], [9], [10], [11], [12].

- "Habitat naturel" is a bimonthly magazine created in 2005 that is said to be the first approach to ecological construction and renewable energy. All the articles, files and reports deal with environmental concern. We have selected nine of them: [13], [14], [15], [16], [17], [18], [19], [20], [21].
- "La maison écologique" is a bimonthly magazine, which became independant in February 2001. It mainly deals with ecobuilding. All the tables of contents are linked with ecology. For our study, we have picked out all the projets – they are nine of them – from the file entitled "A la loupe" [22], [23], [24], [25], [26], [27], [28], [29], [30].
- "Systèmes solaires" has been a bimonthy magazine since 1985. It contains all the latest news about renewable energies: reports, files, production indicators, in France and abroad. As far as our work is concerned, we have chosen to study nine projects coming from a single issue [31] that contains the winners'projects of the palmares "habitat solaire, habitat d'aujourd'hui" (solar habitat, today habitat). This palmares selects, shows to a jury of experts and reward the most remarkable and innovative bioclimatic architectures, in Metropolitan and Overseas France. Organized every two years by the Observatory of Renewable Energies, the palmares also places emphasis on the valorization of the potential of solar energy in new construction and rehabilitation architecture. We have voluntarily selected journals that are aimed at a wide public as well as at the teams of conceptors. Consequently, the large proportion of the projects (80%) deals with individual housing. Since we have taken an environmentally sound approach, we have chosen to concentrate on the choice of materials only. Our ambition is not, in any case, to deal with the impact of these projects in terms of lasting development, especially as regards the imperious question of the occupants' daily transportation.

To start with, we have just repertoriated the materials the external envelope (walls and roof) of each project is made of by classifying them into three types:

- traditional materials : that is to say natural materials whose making and implementation come from ancient techniques (hemp wool, wood shaving...).
- contemporary materials, that is to say the ones that come from current building process (concrete, metal, hollow clay bricks "monomur", wood...)
- technological materials : they include materials called "active", that is to say coming from technological process (high-performance glazings, photovoltaic panels...).

Out of simplicity and efficiency, we will not take into account the influence of the cost of materials in the choice of the conceptors (this topic is not mentioned –or very briefly- in the articles). In the diagrams above, we can notice that most of the structural framework (the wall and the roof) is made of wood. In opposition, as far as isolation is concerned, we can note that a large number of articles do not mention the type of insulator used, we may suppose that it is mineral wool that is used here, otherwise, we assume that this would have been put forward. Besides, we note that roof coverings are well represented with the use of contemporary materials.

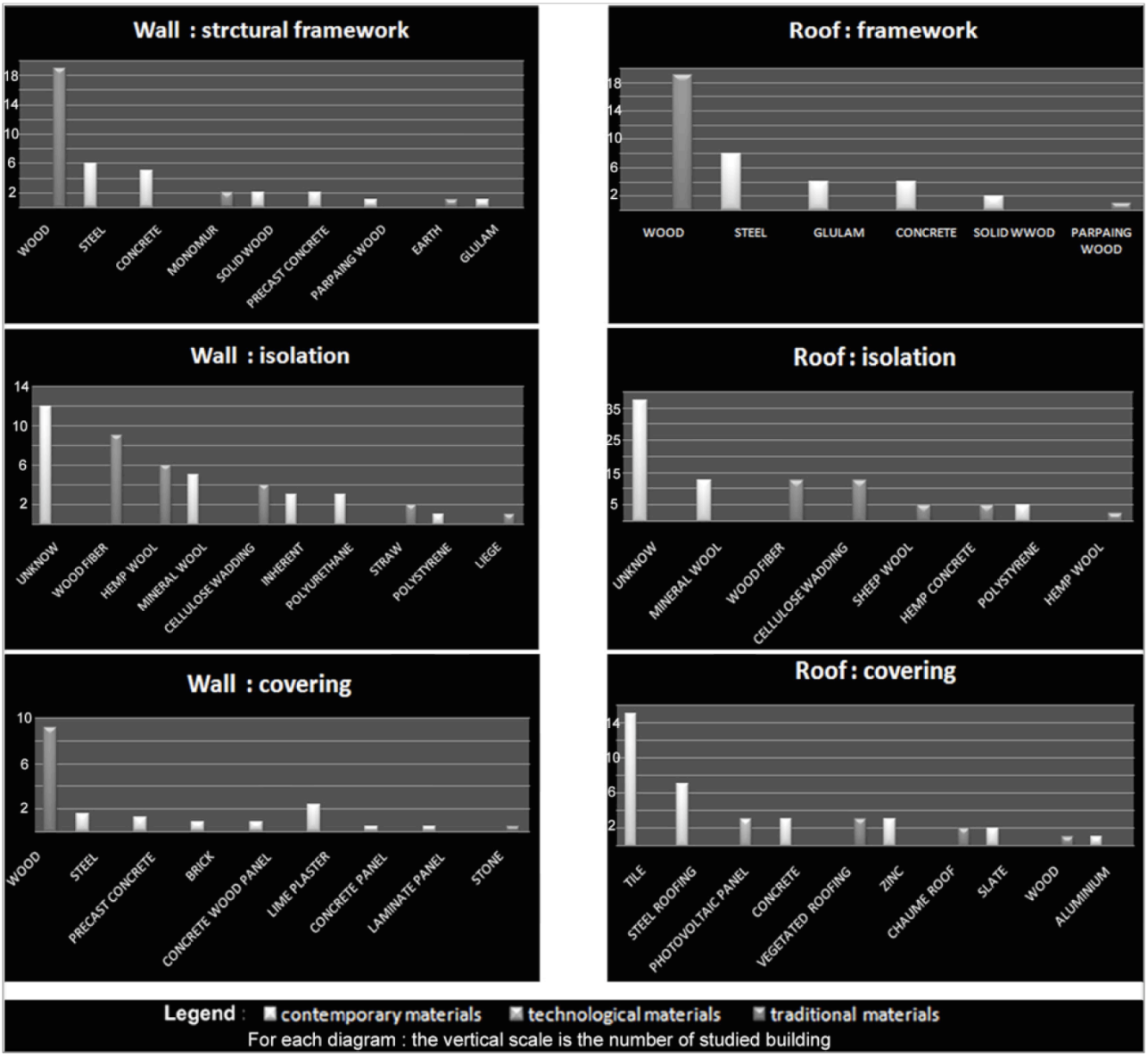

Figure 1: projects classified according to materials

We can conclude that natural materials do not generally predominate in all the so-called environmental productions. It is therefore necessary to go into each project more closely.

RESULTS 2: THE PROJECTS'ANALYSIS

Five criteria have been taken into account in order to analyse each project. The ones concerning the life cycle of material:

- The Ecobilan of buildings (grey energy), which is calculated with CO²CON sotfware, a customized spreadsheet elaborated by L. Floissac.
- The ecobilan of demolition (recycling)
- Impact on the site (dry die)

The criteria that evaluate the thermal efficiency are:

- The isolating value (thermal resistance)
- Summer comfort: that is a compilation of several parameters (thermal capacity, inertia, dephasing power, permeability).

We have used the CO²CON software in order to evaluate the thermal efficiency of each project. For each project, we have a diagram that allows us to see the priorities of the designer as regars to their choice of materials. We realize that the thermal efficiency varies between average and very good. On the contrary, we can notice two different attitudes to life cycles. As the following diagram shows, certain of the projects vary between average and very good on all criteria. The second half of projects oscillate between very bad and average in terms of ecobilan and varies between very bad and very good for the impact on the site. We have therefore chosen to

work out the average of the results obtained for the walls and roof coverings. As a matter of fact, we take for granted that these projects do have good thermal efficiency, so as to allow us to concentrate on the life cycle of materials.

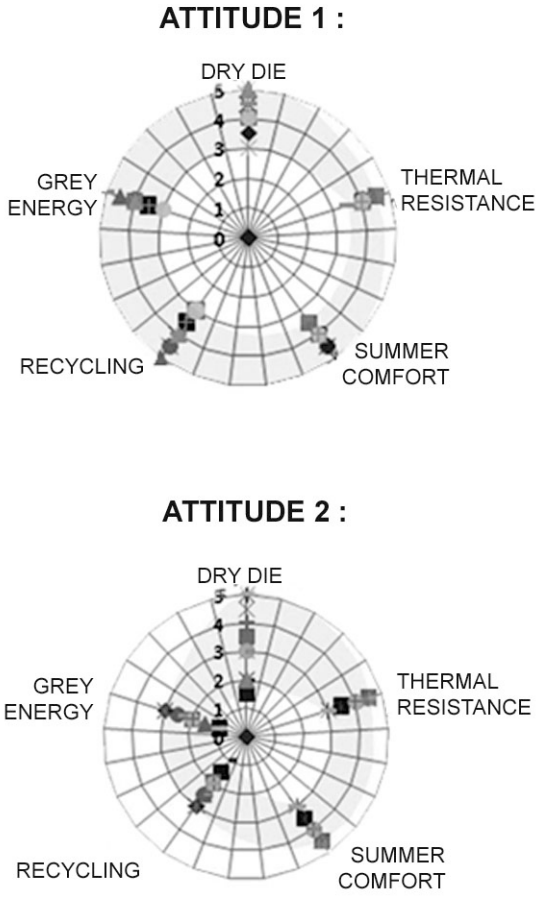

Figure 2 : two attitudes

From these data, we can already put into light two attitudes towards the choice of materials when projects, defined as being environmental, are elaborated. One of the two aims at a global performance, the other one aims at thermal efficiency, - which often appears as the main criterion to obtain certain ecological labels such as Passivhaus, Minergie or Effinergie – and, to some extent, the life cycle of materials.

RESULTS 3: CLASSIFICATION/CATEGORY

We cross-refer those results with those of the first stage that classifies the projects according to three material families (traditional, contemporary and technological). Then we obtain the following diagram: in the upper part we can see the projects aiming at a global performance and in the lower part, the ones that mainly target the thermal efficiency of the materials.

We notice the presence of two material families in the upper part: traditional materials and contemporary materials, while in the lower part, we find again contemporary materials and technological ones.

Therefore, four profiles can be distinguished:

- Profile 1: It is represented by the use of natural materials and the search for a global environmental performance. When examining those projects, we realize that they are well represented by green builders'projects that are illustrated by the following photographs. They take into account traditional architecture in its morphology as much as in its aesthetics. They particularly enjoy vernacular and even nostalgic architecture. Most of those articles consist of interviews in which green builders show their own approach. They constitute a community that emphasizes architectural and rural preferences since their aim is to economize on technical and financial means, and to lay the stress on local values which are seen as representative of a certain cultural authenticity of the place. This is a resigned acceptance of traditionalist solutions, for this reason we refer to it as "resignationist".

Figure 3: photograph of the projects corresponding to the resignationist profile.

When studying the ecological material family, two profiles can be seen:

- Profile 2: What matters for this profile is the global performance of the materials. They are buildings whose architectural and technical choices are known and recognized as being economical and tested for their use and implementation. The equivalent of this ecological approach in architecture must not be considered as architecture without boldness, as shown on the illustrations in the magazines. They can be projects whose concepts nourish contemporary discussion on architectural quality. These projects integrate environmental aspects in the service of architectural quality. For this reason we refer to this profile as "integrationist".

Figure 4: photograph of the projects corresponding to the integrationist profile.

• Profile 3: It refers to projects that use environmental materials associated with less efficient contemporary materials. These projects are often composed of two levels: the ground floor is generally built conventionally while the first floor only shows an environmental logic. The equivalent of this ecological approach in architecture corresponds to an architectural tendency, a specific style which appears to be little efficient from an environmental point of view. It is combined with an emergent and visible environmental logic. This approach shows a stong presence of images suggesting an aesthetic desire onto which the ecological value is superimposed rather than being integrated. We refer to it as superpositionist.

Figure 5: photograph of the projects corresponding to the superpositionist profile

• Profile 4: these projects use technological materials. They make up for their shortcomings in terms of life cycle with technical process that optimize the thermal aspects. These buildings reveal their environmental concern through specialized solutions, as regards to materials in particular. These solutions may not be reproduced easily, so much so that they can be considered as social, economical and physical doubtful experimentations. These projects are based on technological solutions to meet the ecological needs. For this reason we refer to them as technicist.

Figure 6: photography of the projects corresponding to the technicist profile

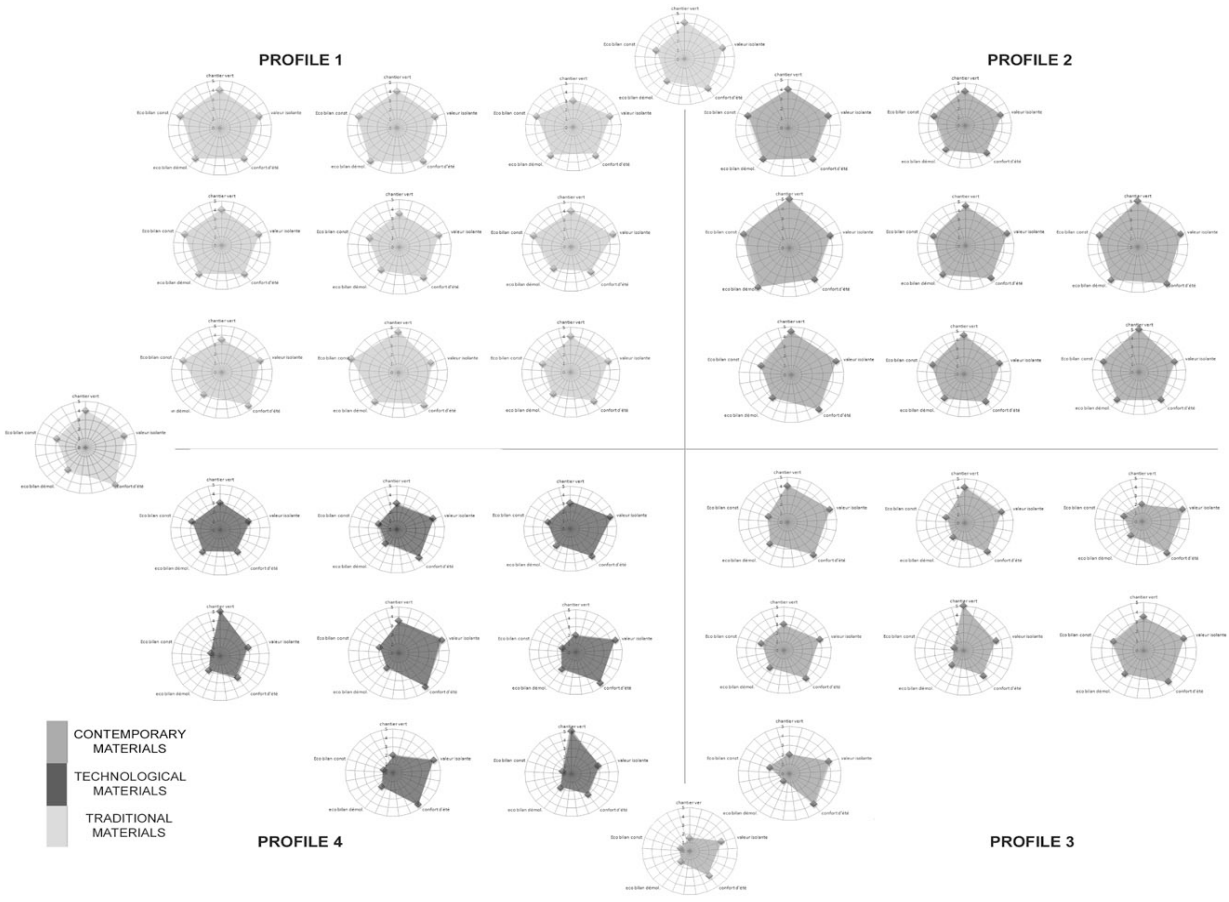

Figure 7: four profiles

CONCLUSION AND DEVELOPMENT

In conclusion, our work on the choice of materials and the way of using them in the current architectural production illustrates how difficult it is to understand each other when dealing with the notion of environmental architecture. From an architectural production to another, the study of the iconic and syntactic representations relayed by the architectural journals shows that today, the notion of environmental quality is a catch-all notion. It allows everyone to express his own vision of ecological architecture. This clearly illustrates that, in the same cultural pool – which is represented in French architectural journals – knowledge sharing is not based on the same cognitive schemas, bringing about fundamental consequences on the whole process of architectural conception. This study would gain by widening the panels of magazines. We are limited at this stage of our study, thirty-six projects submitted in only four journals. It is worth expanding this study with magazines aimed at construction professionals, such as "Le Moniteur du Bâtiment" and "Les cahiers techniques du Bâtiment" would allow to test and analyse more complex and important current projects (buildings, equipments, structures,...) that do have an impact on the scale of the district, city or territory. we will also take more distance from the editorial policy of each journal and the types of projects that are selected.

This research is part of a thesis in progress whose aim is to elaborate a tool that would help conception in the choice of materials. Our study does not understand the delicate question of the influence of architectural journals on their readerships. Our work focuses on the operational support tools for design. So this study allows us to identify four designers'profiles in environmental architecture. Our target is to integrate those four visions of ecology, whatever it is, so as to suggest know-how on the environmental quality of materials that would suit anyone's vision of ecology.

REFERENCES

1. Fernandez, L., (2008). Environmental quality of materials: software tools pertaining to architectural quality, *PLEA 2008*.
2. Bonneaud, F., La transpotition de connaissances techniques en architecture, mémoire en vue de l'HDR, 2009 (preprint).
3. Raffaud, F., (2003). L'urbain, l'environnement, et le développement durable en France: Essai d'analyse – Revue Urbanisme 1964-2000: p. 16.
4. Orth, S., (2007). Maison dans la garrigues nîmoise, *Architectures à vivre n°34:* p. VI.
5. Justman, E., (2007), performances énergétiques, *Architectures à vivre n°36:* p. V.
6. Justman, E., (2007), performances énergétiques, *Architectures à vivre n°36 :* p. VI.
7. Justman, E., (2007), la quiétude, *Architectures à vivre n°38:* p. 54-61.
8. Benoist, A., (2007), les ailes du désir, *Architectures à vivre n°38:* p. 126-133.
9. Leray, F., (2008), autonome, *Architectures à vivre n°40:* p. 124-133.
10. Repiquet, J., (2008), complice du terroir, *Architectures à vivre n°40:* p. 134-145.
11. Mathieu, C., (2008), hors champ, *Architectures à vivre n°40:* p. 146-157.
12. Repiquet, J., (2008), cité radieuse, *Architectures à vivre n°40:* p. 158-167
13. Doare, F., (2007), Crénihuel, *Habitat naturel n°12:* p. 64-67.
14. Leloy, C., (2007), Architecture organique, *Habitat naturel n°1 :* p. 30-36.
15. Auboiron, B., (2007), Si les parpaings étaient en bois, *Habitat naturel n°1 :* p. 44-48.
16. Leloy, C., (2007), José Bové, l'écoconstruction, *Habitat naturel n°1 :* p. 26-32.
17. Doare, G., (2008), Positive à tout prix, *Habitat naturel n°20:* p. 32-38.
18. Auboiron, B., (2008), Maison en paille, *Habitat naturel n°20:* p. 40-44.
19. Doare, G., (2008), Villa Minergie, *Habitat naturel n°21:* p. 26-32.
20. Peyrou, J., (2008), Louveraude entre chaux et chanvre, *Habitat naturel n°23*: p. 50-57.
21. Moliere, J., *(*2008), De bois en bois, *Habitat naturel n°23:* p. 29-32.
22. Moréteau, S., (2007), tentation vernaculaire, *La maison écologique n°38:* p. 12-15.
23. Moréteau, S., (2007), A la poursuite du soleil, *La maison écologique n°39:* p. 12-15.
24. Saint-jours, Y., (2007), la bonne maison, *La maison écologique n°40*: p. 12-15.
25. Moréteau, S., (2007), tendance passive, *La maison écologique n°41:* p. 12-15.
26. Boulanger, V., (2007), la paille version compressée, *La maison écologique n°43:* p. 12-15.
27. Boulanger, V., (2008), Une maison dans le Finistère en panneaux et bardeaux de bois, *La maison écologique n°45:* p. 12-15.
28. Boulanger, V., (2008), Le soleil perce le nord, *La maison écologique n°4 :* p. 12-15.
29. Greboval, P., (2008), la maison à quinze facettes *La maison écologique n°47* : p. 12-15.
30. Moréteau, S., (2008), rénovation patrimoniale, *La maison écologique n°48:* p. 12-15.
31. Ménard, JP., (2008), Le palmarès du concours Habitat Solaire Habitat d'Aujourd'hui, *Systèmes solaires n°187*.