Commissioning Aid and Decision Making Assistance Tool 'Implementation & Assessment' – Cases Study

Ms N.Belkadi-Hannachi	Ms M.Jandon	Mr H.Vaezi Nejad	Mr F.Guéna	Mr Y.Diab
PHD student	Research engineer	Division manager	Professor	Professor
	CSTB		ARIAM-ENSAPLV	LGUEH-UMLV
	84 Avenue Jean Jaures,		144 avenue de Flandre	5 Bv Descartes
	77447 Marne la Vallée		75019 Paris,	77454 Marne la Vallée
	Cedex 02,France		France	Cedex 2, France

Abstract: The precedent paper, published in ICEBO 2005 presented the approach and methodology for information flow management in the commissioning of low energy buildings. Within this methodology, commissioning and decision making are included in the low energy building design process with taking care of the efficiency of information flow. This methodology aims at increasing the probability to meet the required needs by including, in the entire building life cycle (design, construction, occupancy and maintenance), a quality control process such as commissioning.

This paper presents two aspects. The first part describes the specifications of a tool box for commissioning and decision making aid that we are developing. This tool box applies our methodology in order to guarantee the efficiency of the design process. The seconde part shows how was the approach used to capitalise a reabilitation and construction of low energy buildings in Paris, France and Saint Pierre, Reunion, to validate our hypothesis, to develop and Assess our tool.

Key words: assistance tool, design process, low energy building, commissioning, decision making, information flow, case study.

1.INTRODUCTION

The building sector represents in France an important part of greenhouse gas emission. A lot of researches are carried out to reduce building consumption. Low energy building seems to be a solution but in many cases the results do not achieve the expected performances. The problems are from information loss during data transfer between the different actors and between the design process phases and the lack of systematic evaluation of designer new choices. A way to increase the probability to meet the required needs is to include, in the entire building life cycle (design, construction, occupancy and maintenance), a quality control process such as commissioning.

The paper presented in ICEBO 2005 [1] describes the methodology we developed to reduce the difficulties that different building actors meet during low energy design process. It introduces the commissioning during all the design stages, and has three purposes. First, it permits to evaluate all the decisions made and linked to energy performance, secondly, it permits to control the flow information circulation, and third, it permits to manage the unexpected events by proposing an evolutionary commissioning.

The objective of this study is to develop a prototype of tool that can be used by commissioning actors. In this order we study reel cases of low energy buildings: a rehabilitation of social housing in Fontenay Sous Bois (France), and a realization of new building in the University of La Reunion (France). These experiences help us to justify the hypothesis of evolutionary commissioning and to create the commissioning toolbox.

To set in application this methodology a specifications of tool was defined.

2.TOOL BOX SPECIFICATIONS

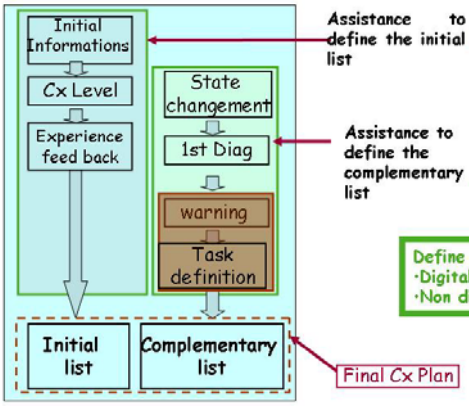

Fig 1. Representation of the steps for the definition of Commissioning Plan

The objective of the developed toolbox is to assist the commissioning committee to define all the necessary tasks along building life cycle (commissioning plan). This toolbox is composed of three tools: a preliminary check list, simple indicators and a complementary check list. We can also add a tool for decision-making orientation as a forth part. The figure 1 illustrates the main steps to define the commissioning plan.

Preliminary checklist. For the preliminary check list, this study inspired from some works done during annex 40 of AIE [2, 3], from international standards as "PassivHaus" in Germany [4] and "Minergie" in Swiss [5] and from low energy buildings experimental project feed-back. This preliminary checklist takes into account three factors (see figure 4). The first element is the preliminary information of the project (the program, the norm, the standard, the regulation, the constraint of the site etc.) The second factor corresponds to the definition of the commissioning level that depends on the building type (risk level) and the company strategy [2, 3]; the last one is the feed back experience capitalization. After we detect the difficulties the building actors meet during the building project realization of experimental cases, we are able to define the commissioning tasks they could do during design process and at which moment to avoid this difficulties.

A generic check list is defined. It will be adapted to the project according to the detail level (depending of the budget and the company strategy), to the commissioning level (low, medium and important), to the performance level (efficient, very efficient, BEPOS[1]) [6] and to the field domain (global, system, component).

In addition to this preliminary checklist, a list of simple indicators is defined. These indicators can be used in the first steps of the design process to evaluate the taken choices and help in the decision-making (for instance, the possibility of building orientation, neighbourhood shadow etc.)

Complementary checklist. The complementary list has several objectives: it anticipates the drifts due to a difficult communication between actors (knowledge, experience etc.), it manages the unexpected events (bad diagnostic etc.), it permits to take into account the detail phases, and it permits to guaranty that all informations are considered.

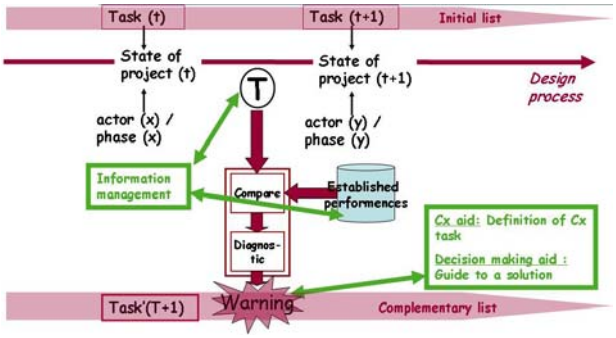

Fig. 2. Complementary check-list specifications

The figure 5 illustrates how the complementary list is created. This list is defined by analyzing, and comparing the states changes of the project with the established performance and preliminary information. This comparison allows detecting the change that can influence the performance and put in front a warning. Each warning represents the commissioning task that must be realized in order to verify the real impact of this change.

To avoid a systematic and irrelevant warning, this study makes the choice of realizing a quick

[1] BEPOS : Bâtiment à Energie POSitive

diagnostic of the project (based on incomplete information) by comparing the change state with the performance required by the owner.

This tool will relate the causes and their effects to define the commissioning tasks. Inversely it will be possible to locate which project characteristics have to be modified to reach the performance. That represent the part called "orientation to the decision-making". It's important to specify that this tool is not predestined to a decision-making aid tool, but it will be interesting to capitalize the information without forgetting that we cannot be judge and jury in the same time (see figure 2).

After the definition the specification of the commissioning toolbox, the next section of this paper presents the manner to drive profit from real cases.

3.CASES STUDY DESCRIPTION

This study is based on the observation of two cases. This observation aims to validate the hypothesis of evolutive commissioning and to develop a tool box. These cases are: a housing renovation and the design of the "University of La Reunion" extension.

3.1 Fontenay Sous Bois

3.1.1 Building

Fontenay Sous Bois project realised the renovation and the modernization of social dwelling. It is classified as a project of low energy buildings. The partners whose are doing this project are pioneers in term of social dwelling renovation: Logirep, BASF, and CSTB.

The objective of this project is to use innovative solutions to decrease the building consumption and the greenhouse gaz emission. These objectives are totally accordable with the respect of the architectural design of this building and with the economical and social aspects.

Logirep represents one of the most important social housing companies in "Ile De France". This company is engaged in the sustainable approach, which is used in the realization of all its new constructions. This company has the "Habitat et Environment"[2] certification delivered by Cerqual[3].

BASF, number one of the chemical industry in the world has participated in collaboration with Buildings Company in the realization of low energy buildings called "3L Housing". Those building's consumption don't exceed 3 Litre fuel per square meter per year comparing on the 20Liter in the past.

CSTB has registered this project in the BEPOS[4] research project in order to divide the energy consumption of buildings by four until 2050. This operation anticipates the projects of PREBAT (Research Programme of the Energy in Buildings). The CSTB roll is to verify all along the building project if we reach the performance by the commissioning of the construction process, the evaluation of the innovative materials, the evaluation of the reel performance obtained and the establishment of a social diagnostic.

Before renovation After renovation

Fig. 3. Picture and model of the project

3.1.2 Quick Historic

This rehabilitation project began in October 2002. In first time, its objective was to realise a project certified Qualitel. The objective of the project changed with the BASF intervention. It became allow energy building and aim at 5L of fuel consumption per year.

[2] "Habitat et Environnement" : House and environnement

[3] Cerqual: is in charge of a "Qualitel" certification.

[4] BEPos : Energy POSitive Buildings

Logirep took charge of the mission and choices an architectural office to realize the plans. This one obtained the construction permit in 2003 and he realise the first DCE [5]. After that the architectural office leaved the project.

The project was interrupted until March 2004. The owner decides to boost the operation before the surpassing of the construction permit. A quickly review of the project was done. An economist office was put in charge with project. After that they open bidden.

3.1.3 Performance Objectives

The three partners aim at realising a "Generation E" building concept, E like: Environment, Energy, Economy and Equilibrium. This building corresponds to building factor 8. That means that the energy consumption (heating & ventilation) will be dividing by 8 and pass from 400 Kwh/m².year to 50 Kwh/m².year. Why?

- to control the operation cost
- to guarantee the global comfort
- to guarantee the security
- to protect the planet

This project is submitted to four constraints: an important level of performance, a technical complexity, a protected Architecture submits to the approbation of the architect of "Bâtiments de France" and the fact that it is an experimental project. To reach the performance and to avoid the constraints, different technical solutions were used.

3.1.4 Technical Solutions

Technically, this operation is characterized by the association of innovative solutions with traditional materials and methods.

- Innovative envelop, with 20cm of external thermal insulation. "Neopor" for the facades and "Styrobur" for the floors.
- Phase change material for the internal divisions.
- « Blocs Baie » inside the windows to avoid thermal bridges.
- Internal insulation for framework using « Fibratop Silver » box.
- Balanced ventilation system with air handler unit.
- Floor low temperature heating system using high efficiency gaz boiler with hot domestic water production.
- Efficient domestic appliances.

3.2 University of La Reunion

3.2.1Building

Fig 4. 3D view of the building

The "University of La Reunion" set from the last 5 years an energetic political of Control of Energy (MDE)[6] and a development of sustainable energy. Their actions have concerned new and existing buildings. We present in this paper the methodology used to realise a new building. This project is composed by four parallel small buildings. The orientation of their principals facades are North / South (Figure 4) [7].

The space typologies are: offices, practical area, computer area and other.

3.2.2 Performances Objectives

This project is inscribed in Bepos research study. It wants to reduce the energy consumption by dividing it by four.

[5] DCE: "Dossier de Consultation des Enterprises" This file represents french regulations respective to contractual documents required to close design steps.

[6] MDE : « Maîtrise De l'Energie »

The first objective of the methodology used to realise this project is to arrive to the thermal and visual comfort by passive solutions. The cooling and the artificial lighting have to be used very little. To reach this objective some quality criteria's were defined:

- Environment around the building
- Thermal and aerolique design
- Systems and technical equipment
- Control and measurement of energy

These criteria's were specified in a control of energy report (MDE). The MDE is integrated in a program and permit to define clearly and some principle of the Energy control. The building design has to respect the PEREN[7] prescriptions too [8].

3.2.3 Technical Solutions

To reach the thermal comfort and favourites passive solutions, PEREN propose simple and low cost solutions [8] to avoid some recurrent design problems. These solutions are classified in three main sections:

1. The location on site (to plant vegetation around the buildings in order to avoid air-overheating)
2. Thermal design of the envelop (solar protection of the building)
3. Aerolic design (Air renewal: natural or mechanical ventilation)

In addition, PEREN imposed to realise dynamic simulation which will define the different cooling period (natural, or mechanical).

After reducing the energy needs of the building, efficient systems to produce and to manage energy were defined: chilled water production (with EUROVENT certification) in addition to individual air conditioner when there are problems of distance; efficient domestic hot water production; natural lighting in addition to efficient lighting systems (time-switch, low consumption light …); sustainable energy, BEMS ... All this solutions were described in the MDE document.

3.3 Experience Feedback

The interest of these two studies is that they propose different solutions to reach the performance (Passive solutions as an efficient envelop for the first case and bioclimatic solutions for the second one). For different levels of the constraint we have different solutions. In Fontenay Sous Bois, there is an important level of constraint which is the state of the building and the fact that it is a protected patrimony, in addition to the classical constraints present in the two cases (climate, regulations, cost ...).

A second interest is that the two cases are not in the same state of the project. In Fontenay Sous Bois, we assist to the construction phase. We assist at meetings and we realised some interview with the project actors in order to reconstitute the design process presented in the figure 5. In the University of La Reunion case the project is at the end of the design phase.

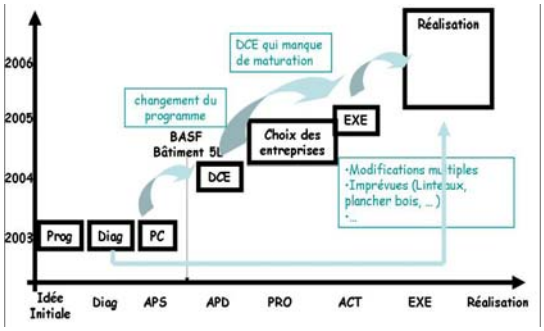

Fig. 5. Illustration of Fontenay Sous Bois evolution project

These cases permit us to compare the way that the two projects were boarded. They give us the opportunity to pass from a real experimentation to a project elaboration. They permit us to validate the hypothesis of the Evolutive commissioning that we proposed in the global methodology [1], and to

[7] PEREN: Energetic Performance of building: a research project to set up a standard for design of low energy building in DOM (for tertiary).

illustrate the needs for commissioning during design and construction phases (Figure 6).

In fact, the observation of the rehabilitation case permits to confirm the frequency of the unexpected events in the architectural project realisation. The figure 5 illustrates the change of the program during the design process, (in addition to the change of actors), the multiplication of approximation during all the design phases and the different unexpected events during the construction phase (change of the position of the air handler unit, the substitution of the wood roof etc.).

The main lakes and difficulties that we observed are:

- Approximate diagnostic
- Approximation files
- Lack of detail for the singular point
- Incomplete evaluation of the new choices
- Actor change
- Lack of coordination between actors
- Lack on the specification of each actor mission

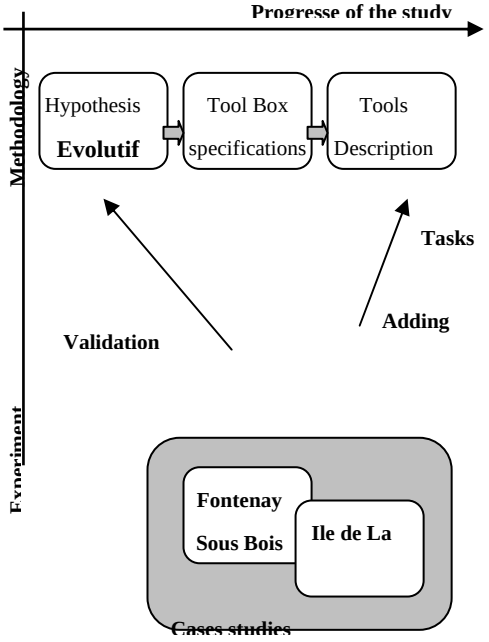

Fig. 6. Illustration of cases studies contribution

The result is that during the construction phases it was difficult to respect the delay, the budget and the performance established by the owner. After all, it's impossible of the owner to stop the yard in order to fix all this problems (unless in case of disaster when he can introduce his insurance). So, to manage all this complexity we need flexible commissioning process.

The confrontation to this project permits us also to validate some commissioning tacks that we implement and to add some others in order to minimise the lacks and difficulties that we observed. For instance:

- Verify the rigour of the diagnostic
- Verify that all singular points are treated
- Verify that all the impacts of all the changes done in construction step are validated
- Verify that there are good actors on good places

The particularity of the second case is that the owner adds to the program a MDE report where he presents all the performance specifications of the project and design role's obligation. This report names all the documents (graphic, reports …), the technical studies (thermal ...), the financial studies and all informations that the designer team have to produce for each step.

This approach has two aspects. In one hand, it facilitates the commissioning mission by defining a major part of the specification that we are waiting for. In this case we can imagine that the commissioning will be less evolutive and that we can avoid a lot of unexpected events and limit drifts in design process. On the other hand, the MDE report could represent an important constraint to the designer team.

In this stage of the project we can not say if this approach will be a success. In fact, there are less lacks then in the first case in term of files and informations, but we don't know yet the result in the construction phase. That's why we are not able to say if we can apply this approach in larger.

In our opinion, a light version in term of obligations of a similar report is necessary but not sufficient in the design process and the commissioning process of low energy buildings.

4. CONCLUSION

In this article, we have tried to present the approach that we used to define specifications of a toolbox in order to apply a quality control procedure (commissioning) to the low energy building design process. The specifications of toolbox were defined in order to apply the global methodology we developed.

This toolbox is composed of two parts. The first part is static. It is composed of generic preliminary checklist and simple indicators. This check list can be adapted to the project depending of the commissioning level, the detail level, the performance level and the application field. The simple indicators have to be easy to manipulate especially at the beginning of the project where the informations are poor, but also all along the other project's steps.

The second part of the tool box is dynamic. It is composed of a complementary checklist and an "orientation to solution tool". The complementary checklist aims at complete the preliminary one by taking into account the unexpected events, the anticipation of the drifts, the details phases, and the efficiency of information flow. In this part, a quick evaluation based on the comparison of incomplete project information (digital and non digital) and preliminary information (program, regulation, site...) is realized to identify the commissioning tasks. This evaluation will be based on a quick diagnostic tool. With a good capitalization of the information used for the diagnostic, it will be possible to know the point which pose problem and to give the orientation toward the solutions.

Then we present two deferent case studies situated in France. The first one is a social housing renovation in Fontenay Sous Bois and the second one is the design of the extension for the "University of Ile de La Reunion".

This study allows to recognize the importance of commissioning to reach the performance, to validate our hypothesis of evaluative commissioning, and to extract the necessary informations to develop a prototype of tool that will be adapted to the reality.

In fact, the analysis, the evaluation and the comparison of these projects permit us to notice the lacks (performance report …), the drifts and their causes (choices, actor exchanges …) and to know how to anticipate them by defining commissioning tasks. In the same time, the confrontation of this tool with the realities gives us the opportunity to validate it.

REFERENCES

[1] Hannachi, N.K, JANDON, M., Vaezi Nejad, H., 2005, "Methodology for information Flow Management in the Commissioning of low energy buildings", 5th International Conference for Enhanced Building Operations, ICEBO 2005, Pittsburgh, USA.

[2] Annex 40 reports, 2004, Commissioning tools for improved energy performance, Results of IEA ECBCS Annex 40.

[3] Annex 47, http://www.commissioning-hvac.org/newannex.aspx

[4] Passivhause, consulted on 2005/2006, http://www.passiv.de/.

[5] Minergie, consulted on 2005/2006, http://www.minergie.ch/fr/.

[6] Chlela, F., Fleury, E., François, C., Quenard, D., Weckstein, M., 2006, « Bâtiments à faible consommation » : << Facteur 4 >>, Tome 1 : « Approche exemplaire des projets et des acteurs », realised in Sustainable departement in CSTB.

[7] Garde, F., Bastide, A., Bentaleb, D., Fakra, A., Pothin, E., Ferjani, N., Mai 2006, «Rèalisation d'un bâtiment à energie positive à l'Ile de La Reunion. Présentation d'une nouvelle approche de la conception en phase étude», Esim 2006 Conference, Toronto, Canada.

[8] Garde, F., David, M., Adelard, L., Ottenwelter, E., "Elaboration of thermal standards for French tropical Islands: presentation of yhe PERENE project.", Clima 2005 conference à Naples, Italia.