INFLUENCE OF THE PERFORMANCE AND BULDABILITY REQUIREMENTS ON THE BUILDING QUALITY: COMPARISON BETWEEN THE BRAZILIAN AND THE FRENCH RENOVATION DESIGN PROCESS

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Abstract
Design can be a useful tool to minimize building quality losses and unexpected expenses with construction and maintenance, if some requirements, such as performance and buildability are considered from the beginning of the design process, as strategic decisions. Thus, this article aims to demonstrate that building renovation in France has less problems concerning building quality, construction and maintenance costs, as compared with that in Brazil, owing, amongst others, to some requirements, such as performance and buildability, which are taken into account from the very beginning of the design process. This work was based on the comparative study between Brazilian and French renovation building processes (case studies) and on the analysis of Brazilian and French existing literature, standards and laws.
In Brazil, the beginning of the building renovation design process generally takes more into account the aesthetical and formal aspects. In France, the agents who work in the beginning of the building renovation design process consider esthetical and formal as well as performance and buildability aspects. In sum, both cases adopted technological solutions to support performance requirements. However, the French case, because the solutions were analyzed from the very beginning of the design process, was less costly concerning construction and maintenance than the Brazilian case.

Key-word: design process, performance, buildability, diagnostic phase, building renovation

INTRODUCTION

The amount and quality of the information contained in the design influences the building final quality. The worse the design quality, the greater the probability of problems to occur during the construction and the maintenance phases. Some national (Brazilian) and international researches show that approximately 40% of the buildings problems were caused by design imperfections (Qualiform, 1987; Souza, 1988; Bonin, 1988; Messeguer, 1991; Fiess et al, 2004). Design imperfections are the construction or maintenance operations that were misconducted due to omission of details or due to design mistakes, concerning materials, building techniques and production process.

These imperfections cause an increase in the buildings construction and/or maintenance costs,

which could be eliminated or reduced if such imperfections were detected during the design process (Hammarlund; Josephson, 1992).

Moreover, according to Castan (2005), the importance of the initial phases of the design is not considered. This author shows that 70 to 90% of the costs of a complex product are a consequence of the decisions taken in the initial phases of the design process. Therefore, strategic decisions must be considered in the initial phases of the design process (design conception phase).

A strategic decision, which culminates in a strategic solution, becomes more effective when taken at the beginning of the building process, because in this phase it is still possible to consider and acknowledge all interfaces. A strategic decision guides and influences all phases of the building process, such as design, construction and maintenance.

For example, to establish design premises that assure the building energy efficiency is a strategic decision. Such premises could be the building position study, the definition of ventilation areas and others. However, if these premises are not established at the beginning of the design process, to reach the same energy efficiency, it will be necessary to adopt technological solutions, such as insulated panels, usually more expensive.

Strategic decisions can influence the product and process designs specifications. To prioritize performance requirements such as durability and maintainability (easiness degree of a system, element or component to be kept, under specified conditions of use - adapted from ABNT NBR 15575-1:2008) is also a strategic decision that influences the whole building process and the operations and maintenance costs. The buildability (quality of something to be built under the design guidelines - adapted from Melhado, 1994) adopted as the design premise is also considered as a strategic decision, because it aims to make constructions operations easier, thus increasing construction productivity.

Therefore, design can be a useful tool to minimize building quality losses and unexpected expenses on construction and maintenance, if some requirements, such as performance and buildability are considered as strategic decisions from the beginning of the design process.

In Brazil, the beginning of the building renovation design process generally takes into account more the esthetical and formal aspects than the buildability and performance aspects. (Melhado, 2001; Aquino, 2006). Moreover, there are some cases in which the initial phases of the design process are ignored, resulting in the adoption of technological solutions instead of strategic ones, causing building quality damages and increase in construction and maintenance costs.

In France, the agents who work in the beginning of the building renovation design process consider esthetical and formal as well as performance and buildability aspects (MIQCP, 1997; Hutter, 2003). In addition, the initial phases of the building renovation process (diagnostic phase) are adequately considered because there are some rules which organize its execution. Besides, it is necessary to readjust the renewed building to current standards and laws, mostly concerning safety (structural and fire requirements) and habitability (MOP Law regulated as a Decree in 1993).

The purpose of this article is thus to demonstrate that the French building renovation presents less problems related to building quality, construction and maintenance costs, as compared to

that in Brazil, due to some requirements, among which performance and buildability, taken as strategic decisions from the very beginning of the design process.

This work was based on a comparative study between Brazilian and French renovation building processes (case studies) and on the analysis of Brazilian and French existing literature, standards and laws. The case studies were developed in three steps: interviews with design and construction process agents; documents analysis; and site visits.

CASE STUDIES

French renovation building (case A)
The building in this case study was built in 1972 in Lyon, France. Recently, this building was renewed and converted into a students' residence. Initially the "new" project owner had proposed the demolition and construction of an industrial building. However, this proposal was turned down by the local government because the building was considered a historic site of the twentieth century, according to the "*Patrimoine du XXème siècle en Rhône-Alpes, 2000*" (Twentieth century French buildings are protected by law as historic sites). Thus, neither its demolition nor the alteration of its original architectural characteristics was allowed.

The original building was designed for office use and its structure was made with steel components. Only one company rented this building for twenty years, but after the 1990s, this company left the building because of, among other things, the high maintenance cost. The building was empty for almost ten years and the renovation process started in 2004.

Firstly, in the diagnostic phase (first phase of the design process), the designers responsible for the renovation process were confronted with two questions, which would guide the design development or could make the project impracticable:

a) Which was the building conservation state, specially concerning structural and fire safety, besides thermal and acoustic performance, in order to match the current French standards and laws (*Code de la construction–article R111*)?

b) How to make the building renovation process considering the conversion from office into students' residence and, consequently, to adjust the building to the residential performance requirements, without changing the original façades architectural characteristics?

To answer these questions, the project owner decided to conduct detailed studies and analysis in the diagnostic phase. This decision was a strategic one, since it influenced the whole process. Moreover, it was also decided that the project would only continue if all technical problems identified in the diagnostic phase were solved and all standards and laws were obeyed.

Therefore, the performance requirements were taken into account since the beginning of the design process, in the diagnostic phase. The studies and the designs were developed by specialized offices (*bureaux d'études techniques* – BET) under the supervision of the design coordinator and the project owner.

The solutions and technical decisions were taken based on the result of the studies and the analysis of the diagnostic phase. As a result, when the first draft started to be developed, a

great part of the design decisions had already been taken.

During the construction process, there were some problems, specially related to interaction among the work teams. Yet, in general, the time schedule was kept and the final costs were not very different from those initially planned. A cost study was made at the beginning of the diagnostic phase and another at the end of the construction. Figures 1 and 2 show the façades of the building that was object of this case study.

Figure 1 – *Building general view*

Figure 2 – *Old panels and new panels: little difference between their aesthetical aspect*

Brazilian renovation building (case B)
The building in this case is situated in the São Paulo Metropolitan Region and it was built in the 1970s. This building was devaluated because the current aesthetic requirements are different from those of its construction time.

Thus, because of the need to improve this building technically and economically, and to increase its aesthetic qualities, an architecture office proposed a project to renew the façades, also including the introduction of a balcony for each apartment. Originally, the building, with concrete structure, did not have balconies and had granite revetment. After its renovation process, it incorporated balconies and received acrylic resin plate's revetment, whose final finishing is similar to that of granite. The construction started in 2000 and finished in 2003 and the apartment's price increased by more than 300%, motivated by the building renovation.

The project owners were the building owners themselves, who decided to do the renovation based on the price estimation, which was based on the preliminary designs. Generally, the project conception is made by specialists, but in this case the owners did it, although they did not have technical conditions for establishing a design requirement for the project.

The diagnostic phase, which was superficially carried through, considered safety requirements and some structural reinforcement. Then it was decided that the new façade should be designed with lightweight components fixed to the existing wall, aiming neither to produce construction demolition waste nor to change the building global stability. After that, the architectural design was made and it was approved by the competent agencies (government agencies) and the new façade components were selected. The design was not concerned about improving some performances, such as thermal, acoustic etc.

Therefore, all the design was carried through based on superficial information, because the

diagnostic phase was not adequately performed. Moreover, the definite design was not well defined, thus causing some buildability problems. For this reason, problems started to appear in the construction phase. One the most important problem was the impossibility to fix the new rendering (acrylic resin plates revetment) to the existing wall. This problem had interfaces with many design decisions. Thus the old rendering had to be removed, resulting in misalignment of all the windows.

Because of buildability problems, low productivity and the lack of uniformity of the façade components quality, the building renovation was delivered one year later than planned and the final cost almost doubled.

Despite the delay, the high costs and the quality problems, the owners' aims were achieved, increasing the aesthetic performance and increasing the building price.

Figure 3 - *Façade before and after the renovation process (photo from PROJETO DESIGN, ed. 286, Premio Asbea 2003, p. A47)*

INTEGRATION BETWEEN DESIGN AND PERFORMANCE REQUIREMENTS: A COMPARATIVE ANALYSIS BETWEEN FRANCE AND BRAZIL

The aim of this section is to analyze the differences between French and Brazilian building renovation design processes, based on the analysis of the case studies, the literature, and the performance laws and standards. Additionally, it aims to show how the performance laws are considered in these countries, and at which phase of the design process performance questions started to be considered.

Design and performance definitions in building renovation

There are usually four stages to renovate or construct a building: conception; design process; construction and building management. These stages are similar in almost all countries, but there are some differences, specially concerning interfaces among them and their activities. Figure 4 shows the stages and the phases of building renovation in France and in Brazil. Even

though the figure shows all the stages and phases of building production, in this article only the conception and design process stages will be discussed, particularly the diagnostic phase.

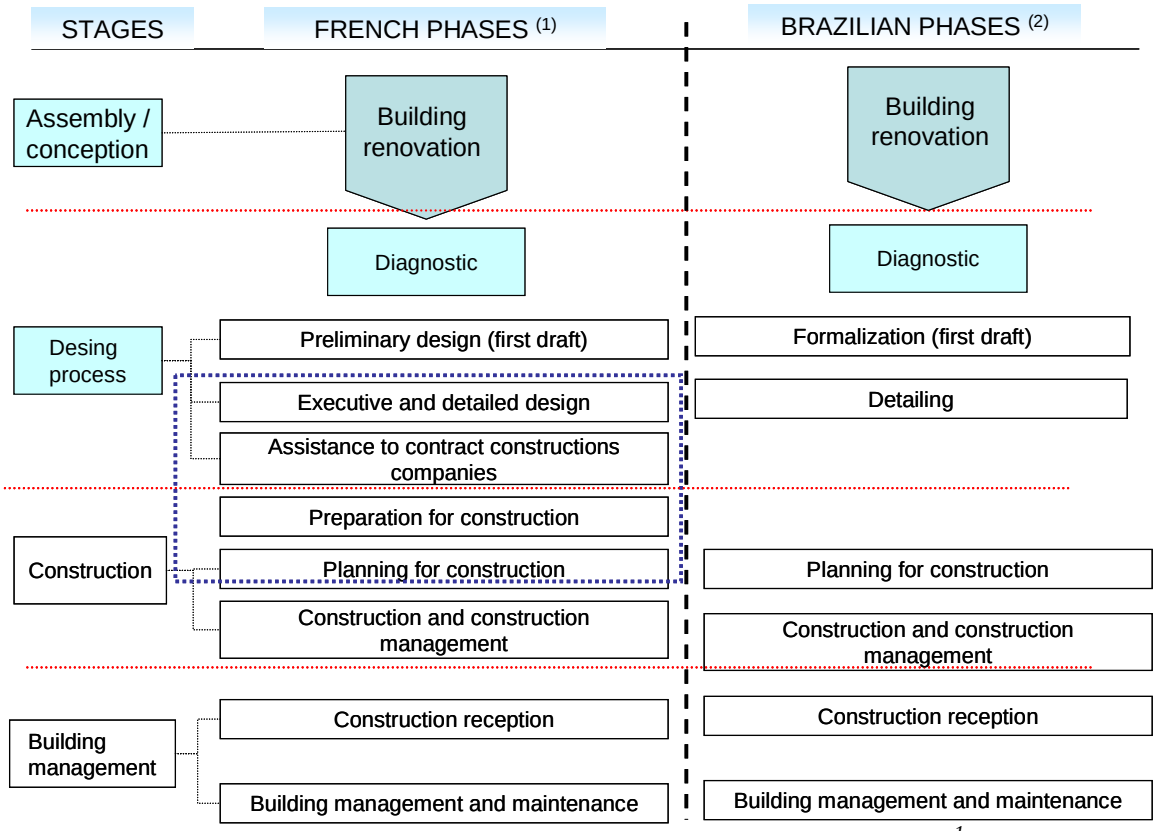

Figure 4- *Design process of building renovation in France and in Brazil; ((1) adapted from Hutter, 2003; (2) adapted from Melhado et. al, 2005)*

The first phase of the design process is the diagnostic and in France the targets of this phase are better defined than in Brazil. According to the MOP Law (1993) and Hutter (2003), these targets in France are:

- to diagnose the building conservation state under current laws and standards, especially those involving safety and habitability;

- to conduct a geometric and constructive investigation of the current building state;
- to study the building history and to assess its historic state. Also, to analyze the real possibilities for altering architectonic characteristics;

- to analyze the integration between the building (the old and the renovated one) and the local urban area;

- to analyze the technical and economic viability of the future project.

The diagnostic phase has an important role in the building renovation design process. Yet, if this phase is not adequately developed, the building production quality can be compromised (technical problems, delays, increase in costs, among others).

In France, the diagnostic phase is compulsory in the building renovation design process and its activities are defined by laws (*Loi* MOP) and standards, which contribute to its good

execution.

In the French building renovation design process, most of the agents participate in the diagnostic phase, aiming to analyze the technical viability of each solution. The possibility of attaining performance requirements is usually studied since this phase, which may result in strategic decisions. Buildability aspects are also considered as strategic decisions and they are also discussed in the diagnostic phases, or in the preliminary design phase.

In Brazil, the configuration of the building renovation design process is a little different from that in France. The greatest difference lies in the initial phases, specially the diagnostic phase. As shown in the case studies, this phase is not provided in legislations and standards and due to that, and others, this phase is not adequately conducted. The performance requirements are not always discussed. Maybe the reason for that lies in the designers' unfamiliarity and/or the lack of technical materials to guide the establishment of a building needs program.

Performance requirement laws and standards
In France, building performance requirements are in official texts, as decrees and *arrêtés* (administrative acts), because they are compulsory. The obligation of structural safety is provided in the Civil Code and in the Construction Code, when they express guarantees and responsibilities.

Fire safety is established by two laws: one for low buildings (*arrêté du 25 juin 1980*) and the other for high buildings (*arrêté du 18 octobre 1977*). High buildings are those that are more than 50.0 m in height (residential building) or h> 28.0 m (non residential building). Moreover, a high building can only be granted construction permission if its design meets all the regulatory requirements.

The acoustic requirement is provided by two other laws: the *arrêté* of 30th June, 1999 that establishes the acceptable noise inside a residential building; and the decree 95-20/22 of 9th June, 1995 which establishes the acceptable noise level in hospitals, schools and hotels. The acceptable noise level in office buildings depends on the project owner. These laws are valid for new buildings and for new building parts (Meisser, 2005; Venet, 2000).

Thermal performance and energy efficiency are provided by RT 2000 (Decree 2000-1153 of 29/11/2000), updated by RT 2005 (Decree nº2006-592 de 24/05/2006 and *Arrêté* of 24/05/2006) that establish the minimal thermal characteristics of façade elements and the maximum energy consumption of a reference building. These laws are valid for new constructions and for new building parts.

There is a recent law about energy efficiency concerning building renovation that establishes the thermal performance improvements, acting mainly on façade elements, on heating and ventilation systems and on renewable energy production (*Ministère de l'Ecologie, du Developpement et de l'Amenagement Durables - Décret nº2007-363 – du 19 mars 2007*).

In Brazil, there are some Codes dealing with the obligation of structural safety (Consumer defence Code - NB1-2003) and with habitability issues, particularly relative to salubrity[1]. There is also a national standard (ABNT NBR 14.432:2001) and a regional law (*Decreto Estadual S.P. 46076/2001*) providing about fire safety. However, both rules are aimed at

1 Set of favorable conditions for public health (Dicionário Priberam on line, accessible at <http://www.priberam.pt>)

buildings with more than 12 m in height or at buildings with areas over 750 m^2. Buildings with less than 750 m^2, or lower than 12 m, are practically neglected by fire safety rules.

Laws concerning, for example, acoustic façade requirements do not yet exist, except for residential buildings; but there is one standard concerning the acceptable noise inside a building (ABNT NBR 10.152:1987). Laws and standards concerning thermal performances and energy efficiency requirements there are few, such as PROCEL (2008), but they are very non-specific. Recently, a set of performance standard were established aimed the residential buildings elements and systems (ABNT NBR 15575:1-6:2008). This standard, despite being aimed at residential buildings with at most 12m in height, might be used as a reference document for the design of all buildings.

Briefly, in France all building performance requirements are provided in laws and standards, and they are always applied. However, in Brazil these questions are mostly provided by standards, which do not reach all construction sectors and they are not always compulsory or applied.

CONCLUSIONS

The results obtained from case studies and the literature analysis confirmed the differences in the building renovation design processes between France and Brazil. Many reasons can explain that, but mainly because of the fact that the construction sectors of these countries are structurally different.

In France, both the building design and construction phases are strongly regulated, thus assuring a minimum level of quality for the activities and products of the design process.

In Brazil, as the building construction sector is less structured, especially concerning performance requirements and design rules, the design process quality depends mostly on the agents experience and the recurrent construction practice. In addition, in building renovation, these practices are still being consolidated because this market, although great and in expansion, is still very new in the country.

After analyzing the case study, these differences are well demonstrated. Although both cases have adopted technological solutions to take care of buildability and performance requirements, the French design solutions were less onerous and more efficient, particularly in relation to thermal performance and to maintenance, once the solutions were analyzed from the very initial design phases. Conversely, the Brazilian case shows that part of the performance requirements started to be considered when the building was already under construction. Thus the cost was duplicated, among other reasons, because of imperfections in the development of the diagnostic phase.

Although some Brazilian performance requirements are not defined by laws, they could be, as they are in France, considered as strategic decisions from the initial design phases. However, these decisions would depend on agreements between customers, project owner and designers. Therefore, it would depend on the design briefing established for the building project, which is set in the early beginning of the design process (diagnostic phase).

Concluding, for Brazilian design to be an efficient tool to minimize damages to quality and costs, the initial design phases should be prioritized and, as in France, performance and

buildability issues should be considered as strategic decisions in the very early stages of a building design process.

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