# Integration of end-user needs into building design projects: use of boundary objects to overcome participatory design challenges

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## 1 INTRODUCTION

Taking into consideration end-user satisfaction is a key step in the design process of mass products. However, this approach still remains unusual in the construction industry (Kärnä *et al*., 2004), even though it has been described as crucial in the evaluation of the quality of a building by its inhabitants (Barrett 2000; Torbica and Stroh 2001). A lot of similarities exist between manufacturing and construction design processes and for user requirements integration (customization) into product design. In building industry, this would allow adapting participative approaches and practices (Sanvido and Medeiros, 1990; Kamara *et al.*, 2007). If the interest of participatory design is real, its complexity and its challenges need to be considered. Therefore, there is a need in identifying which actors are involved in the design phases, who leads the decision process, and what information are needed, exchanged and by whom. We propose to use the concept of *boundary objects* for answering some of the difficulties encountered along such a project could be a legitimate trail of investigation. This proposal will be illustrated in the context of a partnership with a French building company in charge of developing council houses. A participatory project allowing future occupiers (*i.e.* end-users) to join in decision taking about the design of both their own flat and communal areas of the building has been studied.

## 2 CONTEXT OF THE STUDY

Professionals of the construction industry share a short-lived relationship throughout the sequential process from the design phases to the construction of the building. Their relations are fragmented, especially in France. Indeed, responsibilities of stakeholders are clearly defined by the French legislation (Loi n° 85-704, 1985) that decrees the separation between the contracting owner, the project management (including the architect and its design team), and lastly the stakeholders from the construction companies. It aims at securing small companies at a local scale, in opposition to the development of big corporations in charge of all the stages of the building project (*i.e.* programming, design and construction) (Brousseau and Rallet, 1995). The stakeholders involved in a building project are architects, builders, ZZZZ, WWW. The final responsibility relies on QQQQ in the French legislation.
Another distinctive feature of the construction industry is its market: it is composed of heterogeneous one-off projects, which localized nature reduces necessarily the number of potential companies able to reply to a call for tender. As a consequence of both law and nature of the market, companies do not develop long term relationships and only cooperate punctually on some stages of the projects. Furthermore in French building projects, there is no project leader who would have competences and vision for having authority to take decision on all the stages of the project.
French legislation, characteristics of the market, specificities in collaboration and lack of leader have consequences on several aspects. According to literature, inefficient feedbacks capitalization sharing and frustrated process innovation are a result of this situation. Pemsel and Widén (2011) conclude that

"in the end, it affects the end-users and the services provided to them". At first sight, those characteristics differ from the usual characteristics of the manufacturing industry.

Nevertheless construction and manufacturing industry share some interesting similarities. Among others, Sanvido and Medeiros (1990) do consider that in both industries (i) products are designed to satisfy the user needs, (ii) design error or corrections due to last-minute changes are expensive, (iii) repeated processes are applied in the design and production of their products, and (iv) information management is often deficient. Kamara *et al.* (2007) insist on the fact that the parallel should not be done on the repeated product, but rather on the repeated design and production processes.

In this context, we were able to follow a French company that develops council house projects. Its objective is to increase the end-user satisfaction to expand its market share. Therefore, their strategy consists in developing end-users involvement by making them participate in the design process of their future apartment.

# 3 INVOLVING USERS IN A DESIGN PROCESS

Literature usually considers that the involvement of end-users in the design stages of a product has several benefits: (i) an improved quality of the system arising from more accurate user requirements, (ii) no costly system feature that users do not want or cannot use, and (iii) an improved level of acceptance of the system (Damodaran, 1996). Many authors confirm that the benefits of end-user involvement have a positive influence on their satisfaction (Kaya, 2004; Pemsel *et al.*, 2010). Therefore, the strategy adopted by the company that we dealt with seemed appropriate in order to increase end-user satisfaction; nonetheless some challenges require to be taken into account to warrant the outcome of a participatory project.

## 3.1 Interest of involvement

While manufacturing industry has studied the importance of end-user requirements for decades, Kaya (2004) highlights the "insufficiencies of the construction industry in the way that the client's needs are met". End-user satisfaction is a complex criterion to evaluate: it is a mix of technical and functional indicators (*i.e.* quantitative), and emotional and subjective appraisal (*i.e.* qualitative and highly dependent from one user to another). Several reasons can explain this timorous posture.

Firstly in the context of building design projects, the *end-users* are mainly (but not only) the future inhabitants. Caretakers, technical people in charge of such maintenance or any individual whose activity could be influenced by the building, could be involved in the design of communal areas. They all have a limited knowledge (Lai and Yik, 2007) and difficulties to project themselves into alternative spatial solutions (Dewulf and Van Meel, 2002). This situation is strengthened by the communication gap between end-users, designers and owners (Pemsel *et al.*, 2010), as well as some negative stereotypes from professional toward inhabitants (Loosemore and Tan Chin, 2000). This is why involving future end-users into the design of the building could appear as a risky endeavor.

On the contrary, ignoring them during design stages can be negative for their satisfaction because they are more reactive and critical about the final product (Kaya, 2004). If a user participates to the design phase, he shares a part of responsibility with the design team and cannot totally blame them for any design problem (Ammar *et al.*, 2013; Saleh, 2006). In other words, when users feel they have control over their surrounding environment, they are more prone to spatial appropriation, which increases their satisfaction (Leaman, 2002). According to Pemsel *et al.* (2010), "end-user satisfaction is contingent not only on the outcome but also on the way it is achieved". Lastly for Auchterlounie and Hinks (2001), user satisfaction is related to both the quality of the building (as an answer to his needs) and the relations with professionals.

Thus, end-users involvement is generally perceived as positive for the quality of the product and the satisfaction of end-users. Nonetheless it is crucial for companies to consider these conditions of involvement into the design stages of the building project as well as the challenges that ensue.

## 3.2 Degrees of involvement

### *3.2.1 In manufactured product design*

In product design, Damodaran (1996) considers four levels of user involvement: (i) none, (ii) informative, (iii) consultative, and (iv) participative.

Otherwise, Sanders (2002) describes the difference between *user-centered design* and *participatory design* as a shift of the designer attitude from *designing for users* to *designing with users*:

- In *user-centered design*, product is designed to meet the needs of users, which implies an important focus on the collection of user data. User involvement is materialized through qualitative and quantitative information and is interpreted by designers in the form of concepts that should benefit to users as a global entity. Kujala (2003) considers that "documents are insufficient as sources of information. […] Direct contact with users is crucial in order to understand the various context of use".
- In *participatory design*, users take an active role and express themselves "directly and proactively in the design development" (Sanders, 2002). They are present in design meetings and give their opinion on the product, in an iterative dialogue with designers.

To sum it up, in *user-centered design* user's input is rather passive and impersonal, whereas in *participatory design* their input is active and individual.

Lastly, "user involvement [in product design] is most efficient in the early stages of system development as the cost involved in making changes increases during system development" (Kujala, 2003).

### *3.2.2 In building design*

Wulz (1986) proposes seven degrees of user participation in a building design process, while Wandersman (1981) proposes five (Figure 1). Both of these proposals are consistent with Damodaran (1996) and Sanders (2002) considerations for a product design (cf. § 3.2.1). However in this last case, the *architectural design* phase seemed to be the better step to involve end-users; finding the right timing to introduce users into a building design project can rather be different.

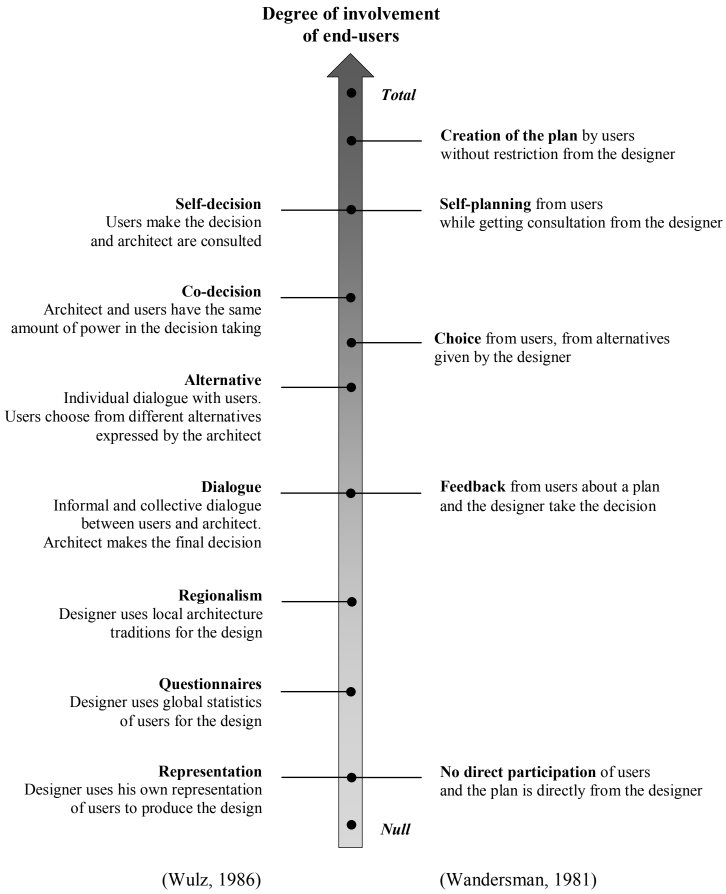



*Figure 1. Degrees of involvement of end-users compared in Wulz' (1986) and Wandersman's (1981) proposals*

As previously mentioned, user involvement is most efficient and influential in the early stages of a product development (Kujala, 2003). In the case of a building construction project, the first stages of development consist of the operation set-up, the definition of the real estate program, and lastly the design of the building *per se*.
The *operation set-up* is the first stage and consists in identifying a site, its commercial opportunities and its main characteristics (cost, surface, needs of levelling and connecting works).
Then, the *definition of the real-estate program* consists of the type of building, the number and type of flats as well as the forecast budget. In council housing projects, price and location are two main priorities in the site selection. Those are the results of an intense labor of site research and negotiation with both the owner of the land and the public decision makers that allocate grants to council house project developers. This time-consuming preliminary work requires experimented people as well as the knowledge of the local market. Therefore, it is difficult to ask a direct input from end-users in those preliminary stages even if it has a radical incidence on the future features of the project. Nonetheless those decisions are taken according to experts' knowledge of the local market; therefore it can be argued that participation of users in these stages is a mix of *representation*, *questionnaires*, and *regionalism*.
Even if a lot of decisions have already been taken when the design of the building *per se* begins, participatory design in building project is then comparable to participatory design for a manufactured product.

## 3.3 Challenges for involving users

### *3.3.1 In manufactured product design*

While the benefits from user involvement into the design process are numerous, some challenges have to be considered accordingly to the literature. First of all, in manufactured product design, the "cost-effectiveness of understanding user needs is difficult to evaluate" (Kujala, 2003). Similarly in user-centered design, time spent for collecting and analyzing huge quantities of raw data and its unclear impact on design (Blomberg *et al.*, 1996) can be important obstacles for designers. Beyond the time-demanding aspect of user involvement, other challenges can appear in participatory design: among others, difficulty to understand what is expected from users (Wilson et al, 1996), unusable input from users due to bad understanding of the design process, decrease of motivation from designers due to the modification of their tasks and responsibilities, etc.

### *3.3.2 In building design*

In architectural projects, Champy (1997) advises that user participation in the design should not erase architect role. He also warns about potential risks of user participation in architectural projects that are consistent with manufactured product design: increase of the amount of work and time for professionals, inexpediency of user decision on architectural issues, and finally demotivation of the design team. The introduction of non-professionals in the decision-taking process breaks traditional conventions of architectural projects. Indeed, tacit conventions do exist between professionals, both in the vocabulary and in the support of information (Lam, 2000; Senaratne, 2008), or in the tasks and responsibility definition (Pemsel *et al.*, 2010). "Routines and boundaries have a regulatory function on the activity, […] breaking these routines [with user participation] can jeopardize natural regulation mechanisms" (Champy, 1997). To limit the potential challenges of participatory design, Wilson *et al.* (1997) assert that all stakeholders should be motivated about user involvement, and that they should be aware of the design process. Gould (1988) advocates for the creation of a dedicated unit in the design team that would manage all usability concerns. Finally, Kujala (2003) explains that roles of users and architects (designers) should be carefully considered and defined, and that "designers should take an active role in user involvement".

# 4 CASE STUDY

## 4.1 A pilot project

The company that was investigated for the study assumes different roles during the building construction process: country planner, property developer and property manager. In most of its projects, the company is not only the owner, but also the project manager, the programmer, the accountant and the sale department. This position offers a wide vision of the process and allows having a deep knowledge of the market. It also allows the company to clearly formulate its requirements about both the design and the construction stages, while remaining clearly separated from architects and builders activities, in accordance with the public project contracting law (Loi n° 85-704, 1985).

In order to increase their market share, the company wants to propose new options to improve their customer satisfaction. One of the new options was to develop a participatory offer. So as to test it, the company decided to launch a pilot participatory project. As one of the objectives was to foresee the effects of participation in a building project, neither the level nor the condition of involvement of end-users (future inhabitants) was set up at the start of the project.

Due to the participatory nature of the project, a new stakeholder was proposed in the project team: the "*user manager*" (UM). His function is to be the intermediary (so as to find a consensus) and the translator (in order to explain technical aspects to users, or user demands to the architect) between the design team (architects and engineers) and the end-users. In this case, the UM was a former architect whose main role was (i) to settle meetings with end-users, (ii) to collect and compile their demands and (iii) to communicate them to the design team. However, the scope of action of the UM is fuzzy: neither the topics that would be discussed nor the means of communication that would be used were clearly defined at the launch of the project. Thus, we decided to investigate this initiative in order to compare it to a classical project (*i.e.* a non-participatory) with similar characteristics.

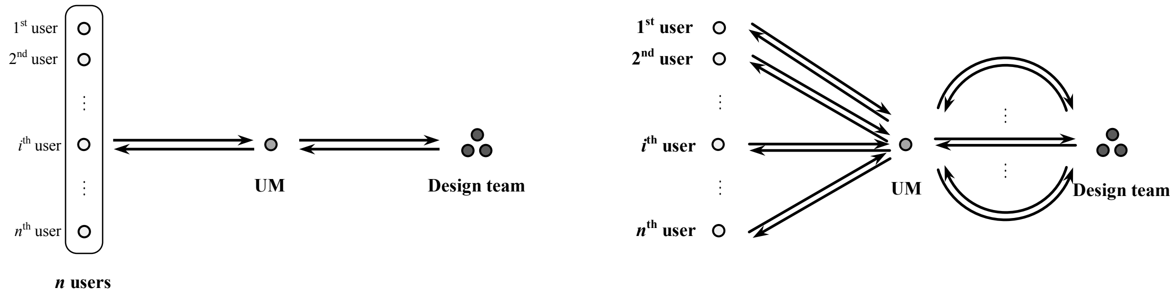
## 4.2 The participatory process

The participatory project was thought to follow five classical stages: the operation set-up, the real estate programming, the developed architectural design, the construction works and the delivery.

The *operation set-up* followed a traditional execution (cf. § 3.2.2). This stage required mobilizing a great number of decision takers in order to settle the legal and financial arrangements. As a result, a number of characteristics such as the location, the budget, and the number of flats in the building were defined. It was decided that 40 flats would be built and divided into two apartment blocks. The professionals in charge of the design and studies were also designated in this stage.

The second stage of the project consisted of the *real estate programming* and the first sketches of the building. This phase lasted eight months. Five meetings were held in order to find customers and register the project candidates.

Eight *collective design meetings* were held. At the first one, only 24 candidates were already registered for 40 planned flats. They consisted of collective exchanges between end-users and the UM in order to state their desires and needs. In Wulz' scale (Figure 1), these meeting could be categorized under a mix of *Dialogue* and *Alternative* categories: the discussions were collective and rather informal, and the decisions were taken in an iterative way by the majority of end-users (Figure 2a). As a decision support, *functional diagrams* were produced by the UM. Those diagrams only translated the number of floors, the approximate positioning of the buildings on the site but were not representative of the shape of the future blocks. According to the UM, a figurative representation would inhibit the end-user ability to think about alternative functional propositions because it would have focused their vision on aesthetic matters rather than usability topics. The professionals could express their opinion, but decisions were taken in a democratic way by the end-users while designers made sure that both the regulation and the budget were respected.




(a) (b)

*Figure 2. (a) Collective decision process on communal areas and (b) individual decision process on the design of flats*

Once the majority agreed on the *preliminary sketches* of the building, the *developed architectural design* started. Then, communal areas and individual flats were designed in parallel. For the first ones, design decisions were taken following the same mix of *Dialogue* and *Alternative* involvement as previously.

On the contrary, individual flats design followed a strict *Alternative* involvement of the users. Each end-user was asked by the UM to complete an *individual programming form* to express his desires about his flat (surface, number of rooms, usability features, etc.). Then, a first *individual flat design meeting* was organized between its future inhabitants and the UM. Each end-user could express anew his needs and uses that were finally translated by the UM into a *preliminary sketch*. (Figure 2b). All the sketches (one per flat) were communicated to the design team who later worked to comply with regulation and budget. Thereafter, architects communicated improved plans to the UM who delivered each one to end-users.

These exchanges recurred iteratively until the 24 end-users did not request more modifications and were all satisfied with their own flat design. Neither the procedure nor the format for the *modification requests* were previously set by any of the actors. As a matter of fact, the company did not anticipate the difficulty of the dialogue between end-users, the UM and the design team, which had a lot of consequences on the whole project.

### 4.3 Consequences of the participation of end-users

Consequences of the participation of end-users fell into the architectural design quality and the relations between stakeholders.

Firstly, according to the architect's point of view, some of the decisions taken by end-users on the communal areas, while totally democratic, were not optimal from both aesthetics and energy criteria.

Secondly, relationship between stakeholders was highly impacted by both the involvement of end-users and the introduction of a new actor: the user manager. The UM was supposed to help and facilitate the dialogue between end-users and the design team. It appeared that it was a satisfactory solution for collective design issues, but it was more of an impediment in individual ones. His position as an intermediary requires a high capacity of interpretation, and it appears that a more direct dialogue between designers and end-users should be preferable when designing flats. Design of communal spaces is the fruit of a democratic consensus between all end-users; the message is therefore much more explicit and shared than during the individual flat design sessions. Naturally, end-users are much more exigent in the design of theirs, and have high expectations that can be difficult to express in only one meeting. The role of the UM seems interesting and consistent with Gould's (1988) recommendations, but his task attributions should be rethought throughout the design of individual spaces. The high level of involvement of end-users is coherent with participatory design but has a high impact on the role of designers. While end-users have a lot of power in the decision taking, it appeared that designers were not aware of the limit of their own involvement: to what extent were they supposed to accept end-user decisions? If end-users are responsible for most of the non-technical design issues, are the architects only in charge of the technical? This radical redefinition of responsibilities in the decision taking appears to be one of the main issues in this pilot project and could be perceived as the main explanation of the delays observed in the project.

Note that to date, the building design stages are just finished. Therefore no data on the satisfaction of the end-users or professionals is available. Nonetheless, the time dedicated to the design stages were almost doubled compared to a non-participatory project with comparable features, by the same company. This is a real problem for the designer team as well as for the project schedule. From a profitability point of view, the margin of the company on this project was reduced by three points of the overall budget (which still represents a reduction of 40% margin).

Further research will allow making additional conclusions on the effect of participation on the satisfaction of both end-users and stakeholders of the project. Still, a number of actions would deserve to be taken to increase the performance of participatory building projects.

# 5 OVERCOMING PARTICIPATORY OBSTACLES

## 5.1 Roles and inputs definitions

The complexity of management is higher in a participatory project because the number of stakeholders increases. Moreover, non-professional actors take part in the design process, which impacts traditional relationship and distribution of roles and responsibilities between professionals. Each of the stakeholders should be aware of the consequences of the end-user participation. Therefore it is crucial to have informed stakeholders who get used to a participatory configuration. Champy (1997) insists on the necessity to clearly define the scope of end-user decision in the design process. Their introduction in decision making requires a preliminary work to prevent any negative impact on the tasks and responsibilities definition between professionals. Their input should also be the fruit of a collective thought: for users, becoming aware of the interest of their involvement and for professionals, being adaptive to the introduction of a “stranger” in their professional context. Thus, participatory design in building projects requires a framework that explicitly defines the objectives of end-user involvement, the tasks and the level of authority of each actor in each decision. It should follow as far as possible professionals’ usual conventions and be adaptable enough to suit the high diversity of building construction projects (Tric, 1999). Pemsel *et al.* (2011) insist on the need to clearly identify roles and activities, which bridge boundaries and allow a more productive collaboration between actors during building projects. They emphasize the strategic role of the building developer because he is, most of the time, the intermediary between designers and end-users, and has a higher understanding of the requirements and needs than all the actors involved in the project.

## 5.2 Boundaries objects as a tool to overcome collaboration issues

In this context of complex and informal coordination in multidisciplinary teams (Kubicki, 2006), every actor embodies a sum of conventions, standards and habits. Each one has its own expertise and language and pursues an individual goal. Those *boundaries* can be obstacles to knowledge communication in a context of inter-organizational collaboration (Pemsel *et al.*, 2010). Unfortunately, efficient knowledge and information exchange are crucial for collaboration. According to Senaratne and Sexton (2008) and Pemsel *et al.* (2010), project-based companies such as real estate companies, have low accumulation of knowledge because they are dominated by *tacit knowledge*, which causes difficulties in information exchanges. Moreover, experience capitalization is rarely generalized. This is an obstacle to the implementation of innovative solutions (Dubois and Gadde, 2002) and it consequently affects end-users. In a participatory project, a user can be considered as another stakeholder with his own boundaries that are not necessarily shared by others. If the communication between professionals in traditional building project is already difficult, some routines may have been developed to overcome these difficulties. The addition of a non-professional accentuates this problem because usual routines are not necessarily valid with unexperienced interlocutors.

In order to overcome these difficulties, literature insists on the usefulness of *boundary objects* to improve communication and translation between several organizations (Star and Griesemer, 1989; Fujimura, 1992; Pemsel and Widén, 2011). “Boundary objects both inhabit several intersecting worlds […] and satisfy the informational requirements of each of them. [They] are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation” (Star and Griesemer, 1989). For Vinck (2009), their goal is to maximize the autonomy of those social worlds and to improve communication between them. Lastly, Star and Griesemer (1989) differentiate four categories of boundary objects; they will be illustrated in building design:

- ***Repositories*** These are ordered piles of objects standardly indexed. Repositories are built to deal with problems of heterogeneity caused by differences in unit of analysis. For Kjølle and Gustafsson (2010), architectural knowledge as well as distributed and archived project documents is *repertories*. They are modular and can be used by every actor in a different way, without negotiation with other stakeholders.

- ***Ideal type*** This is an object that does not accurately describe the details of a thing. It is abstracted from all domains and may be fairly vague. It serves symbolically as a mean of communication and cooperation. It deletes local contingencies from the common object and has the advantage of adaptability. For Kjølle and Gustafsson (2010), *ideal types* can be a family of buildings or workplaces, diagrams, alternative plans that describe options. They can be used during meetings and enable discussion and negotiation.
- ***Coincident boundaries*** These are common objects with same boundaries but different internal contents. They arise in the presence of different means of aggregating data and when work is distributed. They aim at enhancing a common understanding. For Kjølle and Gustafsson (2010), informal knowledge sharing sessions and workshops with emotional tools are types of *coincident boundaries*. As an example, discussion and negotiation are facilitated by pictures of landscapes and buildings, as well as metaphorical illustrations that express expected moods and atmospheres of the different areas.
- ***Standardized forms*** They are devised and intended as methods of common communication across dispersed work groups. Those objects can be transported over a long distance and convey unaltered information. For Kjølle and Gustafsson (2010), those standardized forms are surveys about usage patterns, and can be presented in meetings and discussed during design briefings.

If these objects are interesting tools to overcome some issues of multidisciplinary collaboration in design, it seems that their use in building projects have not been studied in depth yet, nor generalized.

In the context of participatory design of workplaces, Kjølle and Gustafsson (2010) provide a concrete application of Star and Griesemer (1989) concepts. Unfortunately, the definitions and nuances between categories of boundary objects remain somewhat unclear. Still, the interest is real but some further work is necessary to define and develop a repeatable implementation in the context of participatory design of buildings.

Throughout the design stages of the project we followed, some objects were used: (i) *collective design meetings*, (ii) *functional diagrams*, (iii) *individual flat design meetings*, and (iv) *individual programming forms*. If we classify these objects into boundary objects categories, the first and the third could be categorized as *Coincident boundaries*. *Functional diagrams* could belong to *Ideal types*, and *individual programming forms* could be *Standardized forms*.

However the usefulness of these objects could be improved on two main aspects. The first one is that objects are neither shared nor accessible by all the actors in charge of the design process, which reduce their impact. A second axis of improvement is about the fact that none of these objects were consciously designed and used as an intended boundary object. As a result, their efficiency could be enhanced by adding some features or modifying their use.

Lastly, we assume that the *modification requests* stage could have been improved by using an appropriated boundary object that would facilitate exchanges between end-users, the UM and the design team.

## 6 CONCLUSIONS

We have stated the interest of user involvement in a building design process.

Some of the difficulties observed in the participatory process could be perceived as a caricatured illustration of other inherent difficulties in the building construction industry. Organizational boundaries are described by the literature as part of collaboration difficulties. Overcoming these boundaries allows improving communication and collaboration between actors from different backgrounds. Sharing tacit conventions between professionals overcomes partially these boundaries. Unfortunately, the integration of non-professional actors (such as end-users) complicates this sharing because they are not aware of conventions.

Building companies that desire to involve end-users in the design process firstly need to identify inherent boundaries in order to elaborate strategies to overcome them. This theoretically should optimize communication between professionals and end-users. In our case study, the role of the council house development company is crucial due to its wide vision of the process. An interesting strategy for the company should be to define collectively, at the beginning of the project, the inputs and roles of each actor in the decision-taking throughout the design process. Moreover, the company should pursue further research to define boundary objects that could improve communication between actors. New developments should help to define clearly how boundary objects should be used, and when they should be implemented in the participatory design process.

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