In the Heart of Intelligent Buildings
Occupants Practices Facing Automation

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Abstract: In a changing world, with more and more people living in urban areas and more and more energy needs, managing energy consumption becomes essential. This papers focuses on energy management in tertiary buildings, and more precisely on behaviour and daily practices from occupants of these buildings. It will firstly show what are the required uses, with dedicated areas, and the place of automation. It will then try to explain what are the real practices, in terms of space use, lighting use strategies and reactions towards automation. It will further show how involving people, with participatory design of services and systems for smart buildings, can motivate behaviour change. Lastly, the discussion will question the idea of collective identity and the balance between automation and human action.

1 INTRODUCTION

According to the world bank (http://www.worldbank.org/, 2014) urban population makes up for 53% of the total global population. By 2030, almost 60 per cent of the world's population will live in urban areas (http://www.un.org/en/sustainablefuture/cities.asp, 2014). Veron (2008) says that city dwellers will account for over 70% of the world's population in 2050. Presently, in France, the estimated ratio from the United Nations World Urbanization Prospects is 79% (http://www.worldbank.org/, 2013). In a perspective of durability, as shown by Guermond (2006), the phenomenon of human concentration raises the question of the density's management in territories. Finding good responses implies to think about the morphology of cities, their connexion to hinterland and the way to govern those large areas. (Di Meo, 2010; Jouve and Lefêvre, 1999). A unique solution doesn't exist (Féré, 2010; Laigle 2008) and the debate between the compacity defenders (Dantzig and Saaty, 1973; Newman and Kenworthy, 1989) and the keepers of peri-urbanity is rich (Bessy-Pietri, 2000; Castel, 2006; Charpentier, 2014; Chauvier, 2012; Hilal and Sencebe, 2002; Marry, 2009). The morphology is a mirror of the urban fabric which can be observed by satellite view (Demaze, 2010). This reflects human beings habits and the spatial relation with their environment. Human activity depends on growth of energetic resources despite the increase of their diminution and their cost (Ganguly and Anirban, 2009). The modification of the human energetic consumption is an important question. It's questioning the pertinence of the territorial response in a multilevel solution in the French case study as shown by Poinsot (2012). Pappalardo (2008) shows us that cities are the main places of energy consumption in the building sector, housing and tertiary. For the author, the building is in France the most energy intensive sector (23% of national emissions). Reducing the carbon footprint implies the reduction of C02 emission. The Report of the United Nations Conference on Sustainable Development (http://www.uncsd2012.org/ 2012) reaffirms the will to ensure the promotion of an economically, socially and environmentally sustainable future for our planet and for present and future generations. Reaching those goals implies the pursuit of urban planning measures imposed by the respect of norms and law (io : In France, Law No. 2010-788 of 12 July 2010 on the national commitment to the environment). Therefore the technological innovation research can contribute to reduce resource and energy consumption. Many projects have developed technical approaches to produce and keep energy in the city (Fenix, Rider, Reflexe), none of them has allowed a real-time energy monitoring

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of the entire production chain supply facilities at multiple scales (building and related areas such as districts). The objective of the program we participated in was to create a technical solution for energy management, by building a smart grid demonstrator. At the end, it should be extensible to an ecodistrict. This project involved important firms, leaders in the energy sector, as well as small enterprises and academic partners.

However, the way to monitor energy chain supply cannot be reduced to a technical approach. If Cities are artefacts, they live by the interaction of human beings (Ballas, 2013; Mahdavinejad et al., 2012; Raúl et al., 2014; Yanarella and Levine, 2011).

The project we worked in chose to take into account these aspects, and we were in charge of the work package concerning behaviours and daily practices of humans working in the buildings.

In this research program what particularly caught our attention was the role of human beings in the heart of that system. Our field study focused on two main sites: two French firms located in the West of Paris. We wondered how a community of actors contributes to the implementation of sustainable and virtuous practices in terms of low-carbon transition. How are roles distributed ? What rules govern the lives of these places? Who makes the rules ? What are the effects on the scale of the building and beyond (eco-district)? Is the emergence of good practices effective? Can it be transposed to other places ?

After a brief presentation of our theoretical frameworks and methodologies this paper will first show what are the required uses, with dedicated areas, and the place of automation. It will then try to explain what are real practices, in terms of space use, lighting use strategies and reactions towards automation. It will further show how involving people, with participatory design of services and systems for smart buildings, can motivate behaviour change. Lastly, this discussion will question the idea of collective identity and the balance automation/human action.

2 THEORETICAL FRAMEWORK: A COMPLEX APPROACH

Ethnology will allow us to create and analyse our observations of actors and his actions in live. This discipline is observation-based and has two dimensions. On the one hand, it is based on facts, details and specificity collection (Servier, 1993), and seeks to “rebuild their form and meaning” (Agier, 2004). On the other hand, it tries to “bring closer, generate dialogue, show what is common in this world of differences”. Authors as Agier (2004) enable us to establish our field study. Indeed he explains that “the ground is not a thing, it’s not a place, not a social category, an ethnic group or an institution. It is all of this, maybe, as appropriate, but it is firstly a set of personal relationships where “you learn something”. “Make fieldwork”, that means to establish personal relationships with people whom we do not know in advance, to whom we somewhat break-and-enter in their lives. So we must convince them of the validity of our presence, also that they have nothing to loose even if they have little to win, and most of all they have nothing to worry about. Relationships can be harmonious and friendly with some people, conflicting with others.” (Agier, 2004, p.35).

Our approach is also conforming to a "geo-cratic practice" (Bussi, 2001) which considers actors behaviours and their interaction as a social production. Through a political geography (and not only a geopolitical: Rosière, 2003) conflicts and cooperation are in the heart of the research. It considers the importance of the citizen point of view in a democratic perspective, where the researcher is engaged in the service of the power of democracy. Our objective is to question people’s power and capacity (Nussbaum, 2012) to produce norms and to reach a new kind of spatial justice. Our approach is also conform to the heritage of the French social geography relating and interrogated by Séchet, Veschambre (2006). This geography is a response to the social demand, focused on social inequalities, exclusion, human dramas and looks on the social relations of domination.

3 METHODOLOGICAL ASPECTS: CROSSED SOCIAL SCIENCES METHODOLOGIES

We studied these elements from a social sciences perspective, using methodologies of sociology, ethnography and social geography. We used semi-structured interviews, questionnaires and ethnographic observations to collect data.

This complex methodological approach allows getting data not only from a quantitative survey, but

also from a qualitative analysis of discourses. Observations give us a direct access to users practices on site. Thanks to this methodological tool, we can study how much discourses are far from real practices or not.

The surveys were conducted principally in two buildings which are the headquarters of big enterprises leaders in the energy field.

For the qualitative analysis, our corpus was made of twenty-three semi-structured interviews of buildings users. An interview guide was constructed, with questions about energy use, and behaviour in the building. Data collection begun with registered semi-structured interviews. Interviews were textually transcripted and analysed with a software for text analysis: Alceste. This methodology was completed by crossorting and a classic thematic content analysis.

Interviews were firstly "groomed", which means formatted to be analysable by our software for text analysis. We then began the analysis through an automated data processing with Alceste. This software cuts the text, making elementary context units (UCE), pieces of text selected and analysed by the software. These UCE are then spread within classes by detecting strong oppositions emerging from the text. Each speech class groups a number of words belonging to a lexical world distant from those of the other speech classes.

As Rouré and Reinert (1993) explain, while the speaker is delivering its speech, he goes through successive own worlds. These worlds, having their own objects, impose their own type of vocabulary. The statistical study of this vocabulary's distribution must allow us to track down the "mental environments" successively invested by the speaker. Authors precise we can then see in lexical worlds. Alceste software will help us find these lexical worlds.

To make the cross-sorting with which we analyze specific vocabulary of our corpus, we had to choose one element from this corpus, either one word or one variable. The software has a drop-down list of all the words of the corpus in alphabetical order. As such we can cross each word with the whole corpus. Alceste then gives us significant elements, with Khi-2, and with the repeat factor and the category to which the term belongs.

These category-specific keys are adjectives and adverbs, verbs (of action and movement in particular), the demonstrative …

Throughout these keys, we can get information about interviewed people's position (according to Achard, 1993). Three positions are possible (Achard, 1993; Reinert and Moulin, 2011): witness, actor or patient. These positions define people's way of living and acting. Alceste software spread the indicators of these positions into speech classes. Witness position is defined by an over-representation of adjectives, adverbs and nouns (sign of a descriptive discourse), and also descriptive elements, spatial elements and no markers of person like personal pronouns. Actor's position is defined on the contrary by an over-representation of verbs, indicating an action or a move in discourse, associated with markers of person. Finally, the patient's position is defined by discursive relation markers, which indicate argument and storytelling and logical and temporal elements.

These elements are our first guide through the analysis.

For the quantitative analysis, we constructed a questionnaire to be asked to all users of the two main buildings of the study. Since managers wanted to know exactly what we could ask to the building users, this step needed negotiation. Moreover, in the first building, the questionnaire was implemented by the communication service of the company, as they didn't want researchers to have access to their employees' email lists. We were only told that it had been sent to 825 persons. The questionnaire was available for one month on each site and we got 264 answers from users. These answers are the basis of our quantitative analysis. We used Modalisa software to help us analyse the data. Modalisa is a software dedicated to surveys quantitative analysis. It allows the finding of indicators such as type of behaviour or elements of freedom appearing from modalities of energy and space use.

Observations were a more complex process. In neither buildings did the higher hierarchy accept researchers to come and observe their employees. In fact we had to find ways to be there for others reasons. Interviews on site were one of our best pretexts. When several interviews were made on the same day, we had a good reason to move from one place to another inside the building. Sometimes we could spend lunchtime on site. This was also a moment for informal discussion, and sometimes people showed us one part of the building to underline what they had said. Another good pretext were technical visits. Since both buildings wanted to be a model of energy efficiency, we could visit each building several times with different guides, at the pretence of not having understood everything that had been explained to us, or we wanting to know more about one or other technical aspect. This was a very good way to visit and observe all sections of

the buildings and observe what people were doing at that time.

4 REQUIRED USES: DEDICATED AREAS, AUTOMATION

The first element we could clearly observed was space allocation. It appears that in the designers' mind, energy efficiency design in tertiary buildings begins by allocating a place to each occupant. Following this we first asked people what was their type of workplace. As shown by the figure below, most people work in an open plan configuration.

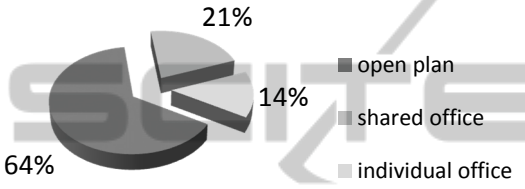

Figure 1: Workplace.

This means that a space where individual choices are restricted, because of automation and the need to negotiate light and heat uses with other occupants of the open plan. People are expected to stay in their workplace whether their job is adapted or not to that kind of place. Whenever they need to speak by phone or with someone else, they can use boxes or meeting rooms, some of which are not really close by and where light or heating cannot be regulated by the occupant.

In open plan workplaces, people are expected not to modify heating regulation, even if they can. And there is not too much communication about heating regulations, so that people don't touch it. Indeed, many people explained to us they didn't even know where thermostat for their workplace was. Interviewee N°6 explained to us "Some people are not used to touch. You know you have a thermostat for a whole open-plan. He doesn't speak to colleagues, he doesn't even know there is a thermostat." During our observations, someone showed us where the thermostat was for open plan places: in a corner where you clearly don't see it unless you know it is there. There are also established uses towards heating regulation, asking to let automation play and for human not to touch. During the interviews, one person explained that "we mustn't touch it because it will modify building's regulations, it is better not to touch" (N°2).

Intelligent planning of energy efficiency are generally thought as technological processes, with a high degree of automation. For example, a light cut is implemented every day at lunchtime, and another in the evening. There are also presence sensors in the cafeterias, in the toilets and in the corridors. But as observed, light in the corridors is always on due to the sensor's timer, and the fact that it takes one person alone cross a corridor for lights to turn on all the way long. Nevertheless, technical analysis shows that energy management systems allow for energy consumption reduction. Cutting off lights in the evening, which also turns off most of the screens like those in the hall and cafeterias seems to be particularly efficient. This automatic system replaces human action, because designers estimated it to be more efficient to ask an automatic system to do the job.

However, people are still asked to turn off the lights when they use meeting rooms, where they also have to turn off video projector.

5 REAL PRACTICES: SPACE USE, LIGHTING USE STRATEGIES AND REACTIONS TOWARDS AUTOMATION

Real practices are not necessary in adequacy with previsions of energy uses.

We can imagine that a configuration with many open plan areas can minimize energy use, which was probably what designers intended. However, as we can see on the next figure, this is not convincing.

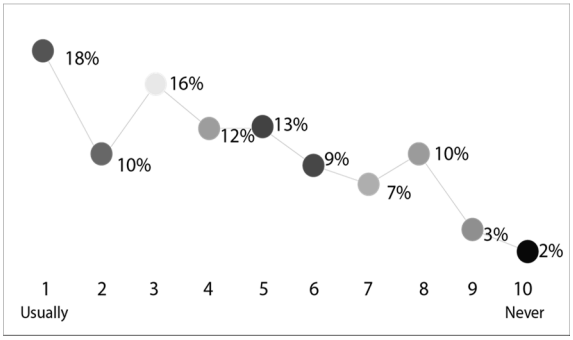

Figure 2: Light use frequency.

We notice that light is mostly on. In fact interviews show that as soon as one person needs light, it seems normal for everyone to turn the light on for the whole open plan. The only exception is

the open plan where the responsible for the energy saving program behavioural program sits.

We will now question this: Informing only does not suffice, but people need to be involved to maximize efficiency.

6 INVOLVING PEOPLE: PARTICIPATORY DESIGN OF SERVICES AND SYSTEMS FOR SMART BUILDINGS, MOTIVATING BEHAVIOUR CHANGE

Seeing the differences between required uses and real practices, we tried to understand users attitude towards energy efficiency. Were they interested? The first question we asked was whether they would accept to get information about energy in their professional environment. We can see the results in the next figure.

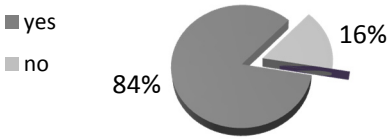

Figure 3: Willing of information about energy at work.

Once that was established, we needed to go further, and see what type of message people would get.

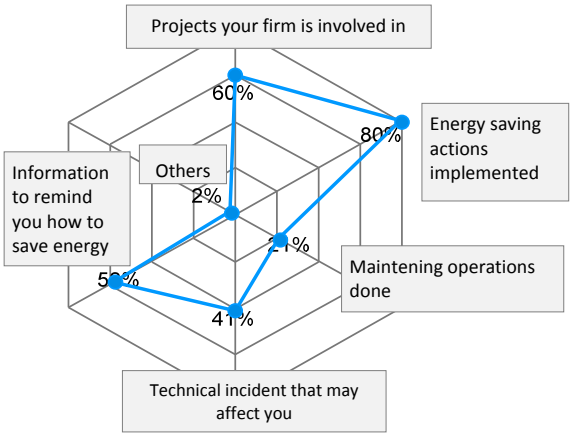

Figure 4: Type of message users would get.

We clearly see that not only people are interested in energy efficiency and want to be actors in the process (item how to save energy), but they also want to know what their firm does: 80% want to know more about energy saving actions implemented, and around 60% want to know projects the company is involved in. We can see here collective identity elements.

We also asked people what compensation would they require for their effort in contributing to energy savings. Once again we noticed that most employees are ready to make an effort without a need for compensation, as shown in the next figure.

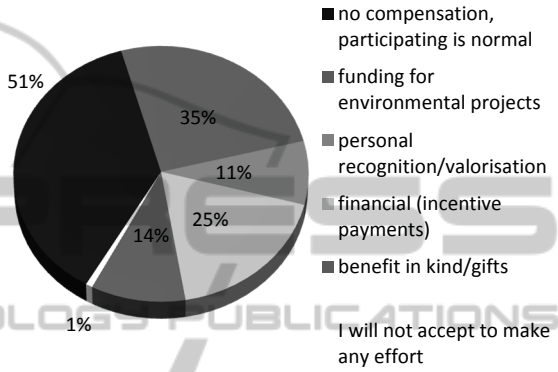

Figure 5: Compensations for energy savings.

The first compensation asked is funding for environmental projects. People are not individualistic, they want a better environment for everyone.

As it can be seen, for an efficient intelligent energy management system to be implemented, there is a real need to inform, co-construct and make users actors of energy efficiency programs and systems. It seems we must not forget that "*Actor doesn't exist out of system defining his freedom and the rationality he can use in his action. But the system only exists by actor who is the only one to build it, make it alive and possibly change it*" (Crozier and Friedberg, 1992, p.9).

7 DISCUSSION

Each practice has got a structural framework, as mentioned by Maresca and Dujin (2014). We must thus remind that this study couldn't be transposed to another context, although we can learn many lessons from it.

Several elements strongly modify occupants practices and behaviour towards energy use: type of workplace, situation from natural light and heating sources and degree of automation of technical devices and systems are the main ones.

Energy sources are still a geopolitical stake even on a building's scale. Among possible actions, lighting is especially important in occupant's discourses. Our quantitative data shows a strong use of lighting, so we can wonder if its use and will of saving really exists. But we must get in mind that 63,6% of respondent' s workplace is an open plan area, where lighting must be negotiated. And we saw that it maximized light use.

Who makes the rules? Collective pressure?

Groups generally adjust their practices to expressed needs. Therefore, as soon as an individual needs lighting, light is turned on in the whole open plan.

Nevertheless there are specific places exceptions, being collectively invested as exemplarity zones, as show by our interviews analysis. The following extract clearly states it:

"in fact I think we... we have felt over in… we try to much to reduce consumption and we never light up our open plan. Sometimes this is really annoying for me. Because I don't see anything, I can't see my screen. It is really tiring for me. Since we are in the [awareness program] cradle, we can't fight it, we must let the light off."

As recently shown by Vanolo (2014), this extract reveals how a person can accept practices which go against their comfort, but are conform to the mission they accepted to fulfil and the role they accepted or chose to play.

Consequently, valuating actions towards energy efficiency is a key factor for the success of energy management programs.

Is the emergence of good practices effective?

People's involvement toward energy efficiency seem to contribute to a more or less long-lasting perspective, as we saw that more than 50% respondents are interested in an history of consumption, for example. In order to get people involved, they need to appropriate this subject by anchoring it in their daily lives. To achieve this,, maybe they will need to bypass or hijack some elements planned for them, without them (de Certeau, 1990).

Who should regulate the system ? automation or reason ?

Strong differences appear when balancing awareness/automation. Most people believe in behavioural change efficiency for long term effect, but many also think that automation is better for short term outcomes. Others underline the weakening their responsibility brought about by automation, which "does all for me" (interview extract).

This question about the mode of action efficiency, either human or automation, is a key point for buildings energy efficiency understanding (de Brito, 2008).

What are the effects on the scale of the building and beyond (eco-district)?

This paper underlines how much human/machine interaction is a big stake to go through urban project in a multiscalar perspective. It is no longer only the point to know how organizing governance with stakeholders able to agree about a common objective. Neither it is to solve the equation of interpersonal contradictions to give meaning to the project.

From a philosophic point of view, it is deeply question of the acceptance and the use of the Reason notion. Can we entrust to independent technology (power of algorithm) the capacity to shape human being's behaviour inside the buildings and beyond (the ecodistricts, the cities)?

Should we preserve our control to trace our destiny based on controversy and imperfect choices?

Two essential questions catch our attention. Firstly, the increase in databases numbers and their exploitation, and the centralizing of individual data, create a colossal ecosystem to exploit. It's progressively invested due to spectacular augmentation of computer's power algorithmic capacities. NBIC convergence is unavoidable. (Broca, 2012; Larrieu 2014). Secondly, should we let the algorithm establish a standard for energetic buildings production? Should we let computers choose the best energetic needs of buildings, based on the exploitation of interconnected databases and composed by many local levels of data collection?

In which case, the occupant would not be an adjustable agent that could devote itself to the task for which it was employed by the company. This is no longer science fiction (Bostrom, 2014).

In an optimistic perspective, this action research raises the issue of the emergence of a sustainable and stable collective intelligence through space and time (Boisvert and Milette, 2009; Marek et al., 2013; Masselot and Galibert, 2014; Viera, 2014). In other words, to be an efficient pathway for change, information must be connected to people's involvement towards elements influencing their daily life at work.

Most people believe in ecodistrict concept's impact on the inhabitants' social relationships. This element is extremely interesting because it shows that a place can be, in people's mind, a source of social relationships change (Coutard and Levy, 2010; Emelianoff, 2010). A collective will of

expression appears, reminding that intelligent energy management must favour this belonging feeling (Dureau and Lévy, 2010).

This feeling of belonging to a collective identity (Castells, 1999) not yet constructed or reinforced is essential. Indeed it fixes the common base to involve buildings occupants in co-construction actions with site managers and other stakeholders. As such these actions will not only be accepted by occupants but also done with enthusiasm.

This element needs to be looked alongside the need of appropriation (Jouet, 2000) of programs and actions linked to energy efficiency. Occupants need to feel they are actors in their workplace, regardless of whether technical system acceptance and/or practices and behavioural changes are pertinent.

Aside from this researchers have shown that the appropriation of an idea, a program or a technical device permits deeper changes in behaviour and practices. Malhotra and Galetta (1999) explained: "*when social influences generate a feeling of internalization and identification on the part of the user, they have a positive influence on the attitude toward the acceptance and use of the new system. The findings also suggest that internalization of the induced behavior by the adopters of new information system plays a stronger role in shaping acceptance and usage behavior than perceived usefulness*"(Malhotra and Galletta, 1999). In a general way, many recent papers in human and social sciences show the need for people's support (Morel-Brochet and Ortar, 2014) in changing their environment. These papers are mainly addressing private housing or public space, but we see that our data about tertiary buildings and professional environment come aligns with these.

These questions feed an interesting debate. How to hybrid natural ecosystems and computing ecosystem to invent or reinvent the cities of the 21st century?

8 CONCLUSIONS

In this paper, we have shown what were required uses towards space and energy use, particularly lighting and heating, and the place of automation in the daily lives of users. We then saw that real practices were not necessary alongside required uses. Next, we showed how involving people, with participatory design of services and systems for smart buildings, can motivate behaviour change. Lastly, the discussion brought into the open the different elements at stake for occupants of intelligent buildings, such as the questions of appropriation of a program and the power of collective identity.

On future work, we will try to implement programs that enhance collective intelligence and collective identity in intelligent buildings.

We are convinced that individual capacities are ignored. We will explore that phenomenon at different scales to broaden our field of research. This energy potential based on the emergence of social links run could be in the long a real engine of a true ecological and sociological transition. We will both use social geography and computing. Our goal is to build interfaces. We want to understand the different forms of empowerment mechanisms created by citizen groups, before their political capture.

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