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Co-design of products enhancing energy-responsible practices among users in proceeding of CO-CREATE 2013 conference, Helsinki 2013

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Abstract

How to design products that may influence users towards new and more sustainable behaviours? Beyond the eco-efficiency of domestic equipments, is it possible to think them so that they suggest to their users they should be used in a thirfty way? The paper presents a 6 months co-design session within ISEU (Integration of Standardisation, Ecodesign and Users in energy using products) research project funded by the Belgian Science Policy. It describes the collaboration with families, the tools and interactions used to ensure their involvement, the participative design sessions to define together with design teams, innovative design strategies and related sets of new domestic equipments. In particular, it focuses on computers, one of the four categories of appli-ances studied and explores possible redesign based on rethinking the default settings in order to induce more energy-responsible practices in households.

1 – Introduction. Designing practices

In the search for more sustainable consumption patterns, "behaviour change" has become a motto. A usual way to deal with this aim is the idea to change first attitudes of consumers, so that a behaviour change will follow. There is however more and more research showing that practices are not changing so easily, especially when consumption is inconspicuous as it is the case of household energy consumption (Shove 2003, Jackson 2005). From the point of view of design much of the political agenda is on ecodesign. According to the directive 2005/32/EC "establishing a framework for the setting of ecodesign requirements for energy-using products" (EuP), ecodesign means: the integration of environmental aspects into product design with the aim of improving the environmental performance of the EuP throughout its whole life cycle".
As our research has shown, the preparatory studies for implementing the 'ecodesign directive' are mainly based on technological considerations; uses and users are hardly considered (Wallenborn & al. 2009). Besides the necessary energy efficiency improvements, the question of sufficiency is never asked. Though efficiency and sufficiency are generally considered as opposite concepts and strategies, we think we have to make them complementary. Indeed we ought to combine acceptable additional efforts for the users (sufficiency) with improved usage process (efficiency) and explore how to 'do nearly the same with less'.

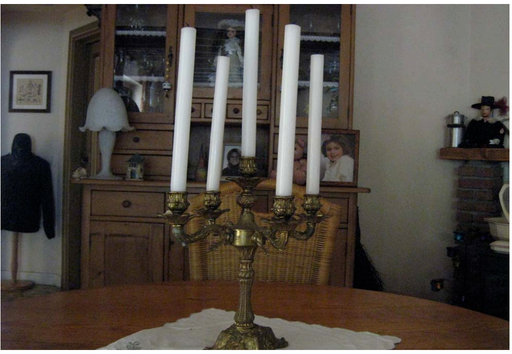
Manzini (2009) pleads for a design that would overcome the pitfalls of eco-efficiency and those of the individual choice as a sustainable solution. But how could design start from households' practices? How to design products that may influence users towards new and more sustainable practices? Beyond the eco-efficiency of domestic equipments, is it possible to think them so that they suggest to their users they should be used in a thrifty way? Design generally pushes consumption and tends to be part of the problem: how to use the same design skills to enable households to shift their practices

more in line with a sufficiency principle? How could new interfaces empower user rather than making them impotent?
What are they able to create as new device enhancing changes in user energy saving behaviour? This is the starting question of the present paper. We will present some results of the collaborative sessions with households, centred on 4 household appliance categories: lighting, heating regulation, washing machine, computer. These co-design sessions with users lasted 6 months and were conducted by Strategic Design Scenarios and Égérie Research, Belgium. Families were invited to collaborate and to participate to design sessions to define together with design teams, innovative design strategies and related sets of domestic appliances likely to induce energy-saving practices. The first part of the paper presents the collaborative work with the users, the tools and interactions used to ensure their involvement in the design process. The second part describes the results obtained at a methodological level proposing four design guidelines to engender energy-saving practices.

2 - Collaborative design with users

The co-design sessions with users has been developed during 6 months in four phases starting with online discussion with 16 families, discussing their energy consumption patterns, exchanging pictures of their living contexts and progressively building trust. This first phase aimed at selecting 'friendly users' which value is less in their testing capabilities and market representativeness than in their willingness to design a supportive environment toward new and more sustainable way of living (Snyder 2003, Sanders & Stapper 2008, Jégou 2009). The second phase of immersions at their homes, in households' life, allow empathy with the users (Evans, Burns and Barrett, 2002). The third phase has invited the families to work together with design teams at Strategic Design Scenarios offices and to co-design new product concepts. Finally the fourth phase consists in delivering to the families, mock-ups of the products they co-designed, makes them familiarise with these new equipments in their homes, and asks them to describe why they think these new appliances are likely to improve their energy-consumption practices in front of a video camera. The short video clips of users presenting their involvement in a design process, the results they obtained and the behaviours changes they expect will feed the following of the ISEU research project, in particular to stimulate qualitative discussions with larger samples of users as well as designers and producers of domestic appliance. Only the third and fourth steps of the co-design process will be presented here.







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3 - Playing design games

The third phase of the participative design with the families consists in proposing them to take part to some of the design projects they contribute to trigger in the previous phases. The proposed context is completely different: families were no more in their domestic environment. Two families were invited for an evening in a design consultancy at Strategic Design Scenarios offices. Learning from the previous steps is shared with them and 2 design exercises are proposed lasting about one hour each.
The lessons learn in the 2 previous phases tend to suggest that energy consumption issues of the computer doesn't seems to be an issue.
The trend shows clearly a multiplication of the computers per household and even per individuals (i.e. Mini-PC, TV-PC, tablets, etc.) with consequences in terms of energy. But compared to the other domestic equipment considered in the research, the computer consumes much less energy during usage and therefore is not perceived as a main problem in terms of energy consumption.

The computer is the most so to say intelligent equipment of the household and users tend to think that the self-management of the energy consumption by the computer itself would be more desirable than an implication of the users in this task. On top of that, computer-based activities in the household (gaming, browsing the Internet, writing, etc.) tends to be cognitively involving, therefore users are even less available to consider during these periods side questions such as energy management.

The issue of sparing the battery on portable devices is key enough on the market to pretend that competitors have maximised hardware and software parts to reduce the

◀ Figure 1. The first 2 phase of the co-design with users consist in building trust with them and ensuring their willingness to explore their own way of living and interact with the design team.

energy consumption. The diffusion of these solutions appears therefore likely to reduce the issue of energy consumption of any other computer-like domestic devices.

Based on these considerations emerging from the first steps of user study, the computer is perceived as both more and more intelligent and less and less material and tends to acquire a specific status for the users: the category of computer-like objects is expected to take care of it-self, to show a (partial) autonomy. Reduction of energy consumption should be therefore self-managed by the device. Beyond direct consumption management, users infer also a certain capability of computers to influence positively indirect consumption. Information and communication technologies-based objects are perceived as objects quasi-subjects (Manzini, 1989). Within sustainable development transition, they are expected to help users in daily tasks, to support them, to raise their awareness and to educate them.

Within this framework hypothesis, the research proposed to consider computers and computer-like objects in the domestic environment for what they could be energy eco-conscious objects: objects able to manage and reduce their own energy consumption and the consumption of other objects related to them or in their direct surroundings.
An anthropomorphic metaphor of this concept could be a group of kids where the older is given always the responsibility to watch the others. In the same intuitive way, in the population of domestic objects, it is expected that the more sophisticated take in change less elaborated ones with which it relates.

This hypothesis of research will be considered at two levels: first locally computer-like devices should manage their own consumption (i.e. processor, hard-disk management, etc.), the peripheral directly connected (i.e. on/off management, standby modes, etc.) and also help users to regulate their

practices (i.e. time of use, type of activities, etc.) and raise awareness of indirect consumptions (i.e. consumption due to the use of search engine and connection to remote servers).
At a second level computer-like devices and household ICT beyond their direct usage, may be involved and involve users in the management of energy consumption of interrelated systems they are connected to: a computer operating in the domestic environment involves in the rational use of energy in the house; intelligent domestic appliances support energy management in the kitchen, etc.

Computer managing energy consumption of peripheral devices

The first design exercise investigates the first level described above where the computer is promoting rational use of energy in all every tasks it supports. The computer would analyses permanently the different flux of energy in use, tracks wastes and suggests measures to be taken. But quasi-subject objects tend to interfere with users and sometimes tends to bother them in their usage (i.e. refrigerator ringing when the door is left open too long; car's sits alarm forcing users to put their belt on; software prompting tips each time they are launched, etc.).
Key-questions are then: when and how should the energy eco-conscious computer interact with users? Why these interactions will be perceived positively or disturbing? Under which conditions these interactions may induce shifts in users practices?
The first interaction exercise will therefore investigate these questions. The setting of the interaction proposed to the participating users is based on:
- The hypothesis of a computer connected with a series of peripheral devices: A4 printer; photo printer; scanner;

external hard-disk; loud speakers; etc. through a multiple socket controlled by the computer and allowing it to turn on and off the different devices;
- A series of computer screen-prints showing different situations where the computer proposes an interaction focusing energy management.

Three series of three screens are proposed focussing different topical moments of the usage of the computer and its peripherals:
- The moment of the initial installation and configuration of the peripheral to the computer chosen as a key moment to inform on the energy consumption as part of the different technical characteristics of the connected devices (i.e. which device is consuming what, when, etc.);
- When the users consciously ask for the use of a particular connected device and therefore dedicate some attention to this interaction (i.e. the printing command opens a window showing the different printer settings: paper size, quality, ink level and also costs of different colours options, number of pages printed monthly, average use comparisons, etc.);
- When the energy consumption is particularly high compared to the average and it is worth attracting users attention and disturb then in their practice (i.e. peripheral are on but have not been used for a moment and are not relating to the on-going task).

For each of these different emblematic situations of use three different patterns of interaction design are proposed on the screen-prints examples:
- An informative mode: the computer is an expert that gives information and teaches the users about energy consumption;
- A coercive mode: the computer is a policeman that obliges users to consider energy consumption issues;
- A suggestive mode: the computer is a friend that delivers an optional advice on energy consumption.

◀ Figure 2. Design exercise focussing different computer interaction modes to prompt user attention to energy management and shift of its own practices. Different screen prints picturing different moment on interaction with the computer and various postures/patterns of interaction design are presented to the group, reviewed, classified and a common strategy is agreed.

The interaction with the users is organized as an informal discussion (Figure 2) including presentation of the different proposition, spontaneous reactions of the group, review of opportunities and barriers, negotiation between the different participants to reach an agreement in term of interaction design of energy management.

The main learning from this exercise shows that the energy eco-conscious design concept seems to be pertinent for user and in particular materialising through an explicit multiple socket allowing the computer to control the set of devices it is connected to. This interest should be moderated by the fact already mentioned that ICT is not perceived as an issue in terms of energy consumption.
Some guidelines emerged in terms of user-computer interaction design:
- Eco-conscious objects should reduce cognitive saturation of users. The key moments for that are the initial installation of the devices and when users are explicitly requesting their use (spontaneous interruptions should be banned). Configuration of the connected devices is the right moment to set interaction rules including on energy consumption (i.e. predefined consumption targets; on-off management rules; etc.) so that the multiple devices can afterward work in a (more) autonomous way reducing the cognitive overload of the users;
- Eco-conscious objects should be highly customizable in particular in term of energy management to match what users retains as pertinent for them. A redundant choice between statistics, indicators, interactive displays, etc. should allow the family to build progressively its own most efficient but still socially acceptable levels of energy self-management by the computer, user capability to interfere in the process, social norm and mutual control within the family.

Computer managing energy interface of the household

The second design exercise relates to the second level of the research hypothesis where the energy eco-conscious computer goes beyond the devices directly connected to it in order to interact with the whole domestic environment. This enlarged hypothesis of research matches the broader problematic of smart metering and the gathering and analysis of energy consumption data and its potential to induce changes of user energy practices.
The key-questions to explore are then: what kind of interaction with an eco-conscious computer able to manage energy consumption of the house? How should data be aggregated and presented to attract interest of the family and induce long lasting practices changes?

A series of assumptions could be inferred from the two previous investigation steps of the research. In particular the technical infrastructure of energy distribution in the household is not the best model to make sense for the users and present them pertinent information on their consumption. Certain energy sources may be technically separated but perceived as aggregated in terms of user's benefit (i.e. read a book is based on both adequate heat and confortable lighting). On the contrary, the energy consumption may have very different significations in term of usage along the day (i.e. the same living room ICT may be work at certain moment and entertainment just after). Finally, the perceived benefit tends to be dissociated from the intensity of consumption (i.e. in the previous example of reading a book, lighting is perceived as important in terms of comfort as the heating even if the second is consuming much more energy than the first).

Three different aggregations of consumption data could be more significant for the users than consumption data of single

appliances :
Showing energy consumption per room of the living space (i.e. what does the small bathroom consume compared to the larger one?);
Showing the energy consumption organized according the different functions of the household (i.e. does preparing a meal for four people consume twice preparing it for two people?);
Showing the energy consumption of the different family members (i.e. does parents consume more than the children?).
This hypothesis of data aggregations may be completed with other ones and in particular with more pertinent mix (i.e. clothing care of the kids; thermal comfort in the bedrooms).

In parallel two phases appear distinctively in the interaction between the energy consumption data and the household:
The initial phase of installation and diagnosis of current consumption patterns. It's generally of moment of discovery of the family energy practices and of high interest of the family members for this news type of self-investigation. Shortly after these data are available the strengths and weaknesses of energy use practices emerge showing potential areas of economy in the household. In particular, easy changes appear either because they relate to technical issues (i.e; standby consumptions; low efficiency old appliances; etc.) or because they don't request important behaviour changes (i.e. misinformation on what consume more and less; old habits that were not revisited; easy substitutions with same perceived benefit; etc.).
After this starting phase characterized by self-diagnosis excitement and relative easy energy consumption reduction discovery, a second period opens not limited in time where initial interest for 'waste hunting' is passed. More challenging practices changes need to be faced in order to further optimize the household consumption either because technical improvements requires financial investments in new and more efficient appliances or because practices questioned are more

touchy in terms of behaviour changes for the family members. This period is characterized by efforts and good resolutions but also drawbacks and return to former practices. The household may try and blend strategies to reach practices changes such as setting self-challenges, focussing highest consumptions only or involving in user communities and more holistic lifestyles changes processes.

Practically these different options of data aggregation and periods of change were materialised in the second interaction with users (Figure 3). A series of cards featuring different screens of the household energy consumption data was made available asking participants to analyse it browsing through the different aggregations per rooms, functions and family members. Spontaneous use of the different cards was observed and participants were asked to voice their analysis process. After this first exercise reflecting the diagnosis phase, participants were ask to propose actions for further energy consumption reduction using the same cards plus three more series showing:

Different ways the energy metering system may display or prompt the data (i.e. detailed monthly bill; mails; sms; collective website; etc.);

Different possibilities to self-limit the energy consumption (i.e. by day; by function; per family members; etc.);

Different options to share experiences and exchange advices collectively (i.e. chat with peers; user communities; etc.).

A second round of discussion took place with the aim to generate agreement between the participants in terms of measure, actions the household could adopt to reduce its energy consumption and the how to best implement them.

Lessons learned from the second exercise on the energy metering data show a spontaneous interest and use in aggregation by function and places: participants used them and spotted relatively quickly in a first diagnosis where the over consumption were and used these information to elaborate strategies of changes in the family energy use practices. On the contrary they were very reluctant to use data aggregated per household members not so much because these aggregations were not pertinent but rather because they were likely to activate the already existing tensions in the family between single consumption patterns.

Unexpectedly if reluctant to compare within the family, participants showed a great interest in exchanging with peers. As far as these comparisons are pertinent (households that are effectively comparable) and transparent (data are reciprocally shared and open) dialogue with other families may help to better interpret proper data and orient changes. They ask for informal and vivid exchanges that may both give advices, tips and appeal to change. Beyond this interest and trust to peer-to-peer modes, the participants request the co-creation of a missing social norm that may help to provide references and regulate their own household practices.

As already noticed in the lessons learn from the first exercise, participants shoed a particular interest in forms of anticipation in the management of their consumption: cards proposing to set a consumption limits, challenges or objective to reach for a determinate period of time retain attention. The dialogue with the participants seems to show that this interest relate to the state of general overload and cognitive saturation in which families feel to be reinforced by this new option of managing energy consumption. In particular they seem to appreciate the interaction options that doesn't request constant attention but setting a target and adjusting according the results obtained and the possible efforts. Rather than rational behaviour, they acknowledge forms of bricolage between the possible and the desirable.

◀ Figure 3. Design exercise focussing the extension of an energy eco-conscious computer to the energy management of the entire household. Cards representing different aggregations of energy metering data per places, function and people feature the possible interface of the household energy metering system. Participants are prompter to use these data and interact to detect and agree strategies to reduce the energy consumption of the family.

Finally, participants tends to privilege usual communication canals. The screen of the computer or the interface of the energy metering device is suitable for the initial setting of the system and for the period of diagnosis and analysis of the first collection of data. Afterward, for daily use, situated cognition (i.e; the display of the energy metering data directly on the device the data relate to) and use of everyday ICT devices (i.e. rapid check zapping on the TV screen; SMS reminder for over-consumption warning) seem to be more accessible and integrated in the household daily practices.

4 - Sufficiency into design guidelines to engender new pratices

For each of the 4 categories of domestic appliances focused by the ISEU project an original interpretation of the current situation emerged from the early investigations with the families, showing why according to them the current appliances proposed on the market were not facilitating energy-saving practices or, worst, were favouring energy overconsumption. For each category of equipment, a new design attitude has been identified between the users and the design teams that brought, on the one hand, to a series of emblematic concepts of new products and, on the other hand, to four design guidelines to favour energy-saving behaviours with a general value going beyond the product category they emerged from. For each product category, the sufficiency principle has been translated into more concrete principles.

- **"Subtractive principle and lighting environment"** allows imagination of new light switches and light distribution in the living environment to minimise the number of lights on;

- **"Semi-manual interface principle and thermal regulation"** reduces user cognitive overload in the fine thermal regulation with systems set to peoples' habits at home while facilitating users manual regulation;

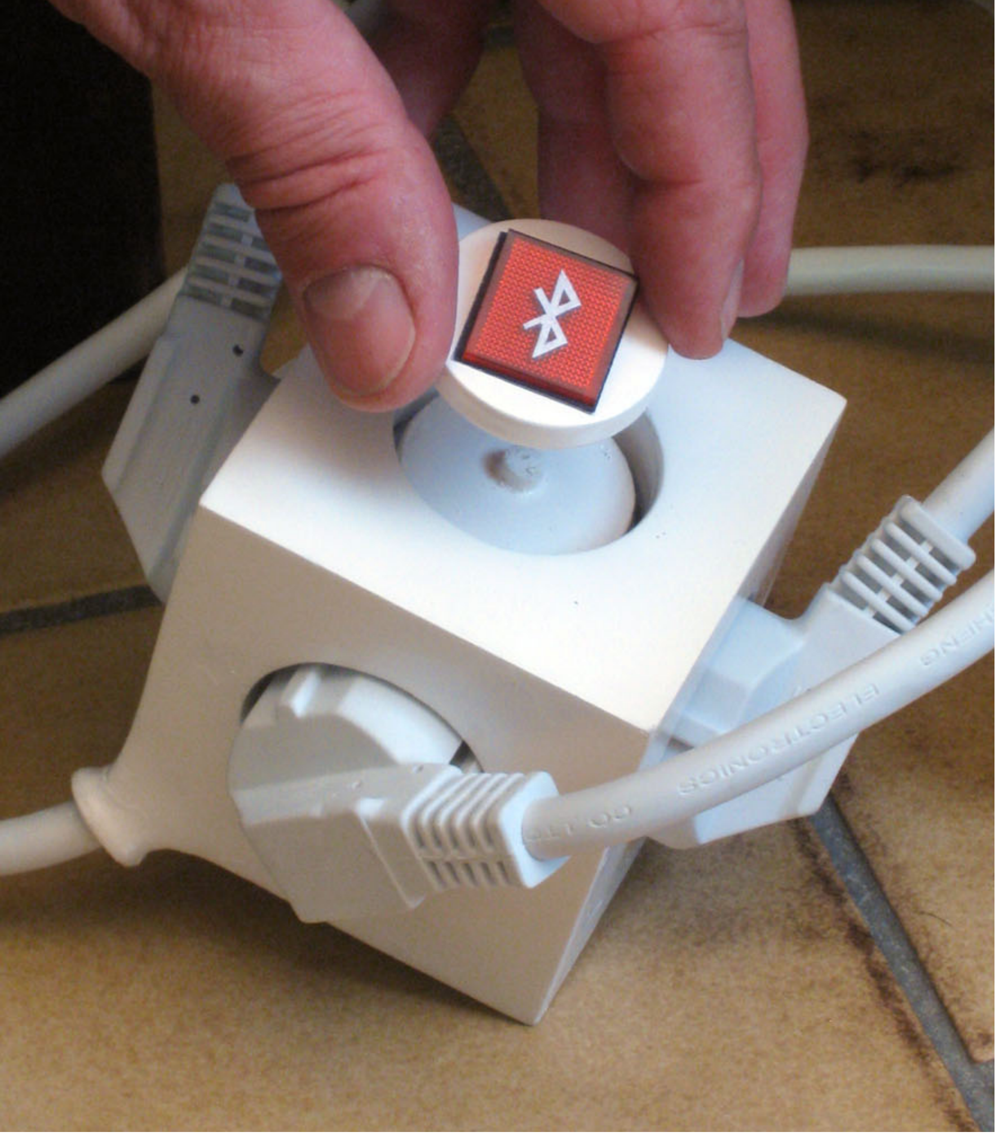
- **“Resetting default principle and clothing care”** allows to prompt low energy-intensive washing processes and to push evolution of users habits;

- **“Eco-conscious artefacts and energy smart meters”** facilitates interaction of users with energy metering enabling them to streamline household practices.

We will develop here more in depth the fourth principle and the resulting products going ahead with the case on computer and energy smart meters.

The issue of energy in the use of computers is not important to users. The device consumes relatively little in regard to the extent and perceived value of its benefits. It represents an 'intelligent' object par excellence and the user expects it manages autonomously its energy consumption. We consider thus the computer under the particular perspective of an appliance skilled with a sophisticated control system and capable not only to optimize its own use of energy but also to manage the other appliances connected to it, which are part of the same household sub-system.

An eco-conscious principle would allow designing systems that can autonomously optimize their use of energy, initially configured on the basis of an aggregation of consumption data in the form of indicators relevant to the user and easily adjustable daily by it.



USBpower to manage stand-by modes

The peripheral devices of the computer are more or less dependent and controlled by it as they are integrated or connected. Printers, scanners, speakers, external hard drives have their own power supply and requires management by the user of their power and their starting to limit their energy consumption. Instead of manually operating on their respective switches, these could be controlled directly by the computer (via USB or bluetooth), that would also measure their energy consumption. The set forms thus a 'cluster' of equipment complying with the eco-conscious principle. When installing the peripheral devices, a dedicated software allows to configure their consumption profiles and the printer, for example, will only be switched on at the request of a print or for the duration of computer use. Once configured, the energy-using devices behaviours will be managed in a manner transparent to the user able to analyse the consumption of each device and if necessary, to return to the configuration settings of the profiles consumption.

◀ Figure 4. Olivier H. and his wife are presenting the USBpower plug that allow the computer to control and turn on and off the range of peripheral devices connected powered with the plug.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SmartMeter Tags as situated change makers

The eco-conscious principle suggests in a system of interrelated objects, some (with higher control capabilities) maybe manage and optimize the energy consumption of the other elements of the system (with lower control capabilities). And if this may be true for the computer and its different peripheral as a sub-system of the domestic equipment, the eco-conscious principle maybe extended to the energy control of the whole domestic equipment and appliances. The home computer can be an interface for energy management of any household subject to the analysis of a smart meter. This principle assumes that energy metering enables households to change their behaviours. Despite the efforts of communication about energy consumption, the energy flux supplied to the home is not inherently motivating for users. It is part of the infrastructure of the habitat and, except to have to optimize a growing bill it is not of interest in itself. More precisely, the structure of gross consumption by appliances is fragmented and does not seem significant to a household that would analyze and change its practices: the heating and lighting are presented separately while they contribute to domestic comfort. To mean something to the users, it is necessary to develop indicators related to practices: according to housekeeping functions (maintenance of laundry, meal preparation, etc.) and to space (living room, bedrooms, bathroom, etc.), and reported to daily, weekly and monthly distribution average. Then users may think, compare and decide to act on the basis of an analysis of the perceived value of their consumption.
Beyond the static presentation, the interface can provide a dynamic mode to monitor and optimize its consumption. Again, management of energy consumption is more a management concern than a matter of spontaneous interest, and must be considered on the basis of an eco-conscious principle

◀ Figure 5. Stéphane X. and his daughter are presenting the SmartMeter Tags that display energy consumption of single devices, spaces or functions of the households and that can be placed directly on the device, in the space or in a place emblematic of a particular function of the household. The family can choose determinate consumptions to reduce and use the SmartMeters Tags to stimulate the effort of all family members during their usage time.

limiting the cognitive overload of users and facilitating their daily management. To do this, the interface should provide a dynamic management by objectives: households establish a threshold of consumption for some critical uses, which they want to monitor or control, and work then in adjusting their practices according to the margin of energy left.

5 - Conclusion. Users as experimenters

The conclusions of the specific co-design sessions within the ISEU research project gave rise to 2 levels of benefits:

- the user-centred approach starting from household activities generated very interesting results without any technological improvement of the eco-efficiency of the domestic appliances: only resetting usage patterns by a redesign of existing components 'from the shelf' shows promising propositions in streamlining energy consumption practices of households;
- the very process of the co-design sessions, the progressive training of the families, their involvement in the design of their own future environment brought the research team to consider all the interaction process and the material developed to be used during the sessions between users and designers as a sort of training toolkit to question people domestic practices, to take a distance from them and enable the families to re-invent progressively their daily ways of living.

Beyond concrete propositions for new energy-saving practices, our research has also shown interesting lessons we can learn from the interaction with households.

Our ethnographic approach has revealed that households are much more creative in the way they save energy than the usual representations conveyed by the "rational use of energy" flyers for instance. All the process, particularly the collaborative sessions, shows how much our interaction with computers is often fuzzy and conservative. When users are given the possibility to imagine other ways of interacting with the objects they use, following a sufficiency principle, they reveal that our houses have embodied standard appliances and systems that do not fit desirable practices anymore.

To observe the willingness of families to play and imagine new devices, we had however to move away from the idea of ready-made products. After the first interview it appeared indeed that the propositions presented as products or services led respondents to a hedonistic situation, like "Would I buy or not?" rather than a change of attitude motivated by a desire to save energy such as: "Is this a good research direction that I can apply?". If there is a reason functioning in this approach, it is not the one of the rational individual seeking to maximize its welfare within a given budget. The co-design sessions showed that participating families are much more in a playful and explorative situation than a pure economic calculation. Families who were ready to play the game, reveal the current system's constraints when asked to turn to energy-saving practices. Experimental situations are transitory, they always end up in final results, in “products”. But the process itself is as well interesting as the result. We think that transition towards a sustainable society will require much more transitory experimental situations.

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