

WatchOUT! A System to Investigate Ethical and Behavioural Transformation through Annoying Feedback and Social Translucence

Gabriele Barzilai

Department of Industrial Design
Eindhoven University of Technology
The Netherlands
g.barzilai@student.tue.nl

ABSTRACT

This paper illustrates a six-months research project conducted on ethical and behavioural transformation through the interaction with intelligent systems. In particular, the study addressed the question of how to design interactive artefacts able to elicit ethical reflection on the issue of energy consumption. Reflection that may eventually lead to a transformation/change of the users' mindset and behaviour with respect to the everyday energy consumption in the home environment. In this respect, a theoretical framework was developed and employed to generate a relevant design concept: *WatchOUT!*, a lamp to share energy with other people based on the concepts of annoying feedback and social translucence. The lamp aimed at promoting ethical reflection on energy consumption through social interaction and annoying feedback. The concept was implemented through the construction of an entirely working prototype. Finally, the prototype was used to conduct a user-test in the field. The research provided with significant elements of knowledge regarding how to design intelligent artefacts able to elicit ethical reflection on the issue of energy consumption. The general aim of this research was to understand how to design interactive systems that can transform ethics and behaviour of users, empowering the user's role in the process of change.

Author Keywords

Ethical change; transformation; awareness; energy consumption; meaningful annoyance; social interaction; interaction design; intelligent systems.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): User Interfaces – *theory and methods, input devices and strategies, interaction styles*.

INTRODUCTION

Addressing social change through technology has become an established research strand in the fields of both HCI and Industrial Design, over the last twenty years (e.g., [12][43]). A diversity of academic studies investigate how intelligent artefacts/systems influence the related users, focusing on either behaviour change or social transformation depending

on the specific research purposes as well as the underlying visions [7][43][29]. In spite of the great difference in the approaches to (design) research, what bonds together the above mentioned studies is the aim of changing the final users of the artefacts in question. Whether the focus is on ethics, individual behaviour or social practices, a recurrent aspect can be observed: the development of a design strategy to make products or research artefacts "enablers of change". In this regard, a crucial component is the responsiveness of the artefacts, made possible by the use of advanced technology. Such a responsiveness, namely a dynamic change in the features of the artefact/system in response to the user's way of using it, gives rise to a complex relation between users and systems where meanings, emotions and actions bundle in a dense network. This network may be defined as the user's experience, as some relevant research on the matter seems to suggest [50][26]. All things considered, steering the complexity of human-computer interaction towards people's transformation is a common goal amongst researchers committed to designing for users' change. Most importantly, aesthetics and materiality are the primary means by which the user's experience is "shaped".

The stabilisation of different lines of research is an unquestionable achievement for it enriches the understanding of the impact of design on users, with respect to transformation. However, most of these niches fail to embrace a thorough conception of design for transformation, either limiting the user's role in the process of change through the use of persuasive strategies or reducing the research to the realisation of provocative artefacts, in fact making the user's experience an ephemeral event. As a result, the role of the intelligent artefacts/systems as enablers of users' transformation remains under-explored.

A thorough approach to the research on design for transformation combines together critical stance, field observation and user's engagement. As suggested by Lascke et al. [32], users need to be engaged in a process of meaning-making through which gaining awareness regarding the message conveyed by the artefacts. This engagement fosters a change that is profound as it entails an active role of the

people involved. People who, thus, become directly responsible for the process of change as well as its direction. In a scenario where users play an active role in the process of change, the critical character of the message conveyed through the artefact holds the value of feeding people's reasoning. The outcome of such a "*dialectic between the user and the product*" [32] is, however, in the hands of the users and only partly follows the intentions of the designer/researcher. Therefore, the ethical reflection crossing the process of change is sprang from what Verbeek calls "*hybrid intentionality*" [57], namely intentions that derives from the relationship between human and artefacts and that are never attributable to one of the two alone. In other words, transformation (or change) as an active and intentional process of the people involved, is always mediated by technology (e.g., artefacts) and so is for the ethical decision-making at the heart of the change itself. In the light of this co-shaping the process of decision-making, the field research allows the designer/researcher to gain an understanding of the specific mediations that the devised artefact gives rise to and the possible unexpected directions that the user's change takes.

This study aimed at investigating **how to design intelligent artefacts able to elicit ethical reflection on the issue of energy consumption**. Reflection that may eventually lead to a transformation/change of the users' mindset and behaviour with respect to the everyday energy consumption in the home environment. The underlying questions were the following:

- 1) What are the specific characteristics (functional and aesthetic) that the artefact needs to have in order to elicit ethical reflection about energy consumption in the users involved?
- 2) What theoretical principles the artefact needs to be based on in order to elicit such ethical reflection?
- 3) What kind of ethical reflection regarding energy consumption is elicited by a specially designed interactive artefact?
- 4) What is the user's ethical and behavioural change related to the issue energy consumption that the interaction/experience with a specially designed artefact gives rise to?

The research provided with the following contributions: 1) design of an instrumental framework to support the concept phase; 2) design and realisation of an interactive prototype based on two macro-themes: a) social translucence concept applied to the user's daily energy consumption (home environment); b) soft annoyance employed as a critical means to generate awareness; 3) field trial over a two-weeks period in the home environment with a single participant daily interacting with the designed artefact; 4) data collection and analysis conducted by employing qualitative research methods; 5) discussion on the outcome of the study; 6) reflection on strengths and weaknesses of the methodolo-

logy employed and on the relevance of the outcomes for the research field.

RELATED WORK

Critical design

Twenty years ago, the work of Dunne and Raby established a new research line called Critical Design, openly inspired by the Radical Design movement spread in Italy in the early seventies [13]. Although not specifically committed to social or behavioural transformation, the development of a critical approach to the everyday use of technology and to the design of electronic objects created a space of debate, addressing the changes in the way society relates with technological artefacts. With the essay *Hertzian Tales* [12], the authors extensively elaborated on the implications of a critical approach to the design of electronic objects with respect to the everydayness. This effort to bring conceptual and critical design in the everyday life, out of the art galleries, marked a significant step towards a user-oriented type of research, making Critical Design more relevant to the actual transformation taking place in the society. In this regard, the research here illustrated endorses the vision expressed by Dunne and Raby to the extent that one of the priority of the study was to credibly integrate the research artefact in the ordinary life of the user. The reason behind this choice is, in Dunne's words, "*to provide conditions where users can be provoked to reflect on their everyday experience of electronic objects, it is necessary to go beyond forms of estrangement grounded in the visual and instead explore the aesthetics of use grounded in functionality, turning to a form of strangeness that lends the object a purposefulness*" [12].

However, the lack of a systematic research method aimed at gathering and analysing data, weakens the approach promoted by Dunne and Raby. Therefore, adopting a rigorous approach to research is the breaking point where the present study leaves the critical-design path. The implementation of a scientific method to produce knowledge is a valid opportunity to further develop the precious insights provided by the work of Dunne and Raby.

Persuasive design and behaviour change

Persuasive design has gained popularity in the area of behaviour change since J.B. Fogg published his first book on how computer influence human behaviour [16]. This approach to behaviour change, named Captology, focuses on the application of persuasive strategies to the design of computing technology. The main purpose of this research line is to induce a desired change in the behaviour of the users interacting with intelligent artefacts. Over the years, theoretical frameworks such as the *Functional Triad Model* [18] and the *Fogg Behavior Model* [19], have been developed to support the design of persuasive technology, largely drawing on psychology. These frameworks offer tools to outline and predict the emotional as well as psychological response of the user, allowing researchers/designers to target a specific change in the user's behaviour. The

transformation sought is, therefore, pre-defined and driven by designers, where the closer to the envisioned behaviour-change, the more successful the design.

Despite the accuracy in targeting specific aspects of the behaviour, this approach to transformation limits the user's role in the process of change, seeking a change "whatever the cost". Moreover, the ethical domain is addressed only as far as the choices made by the designers are concerned, leaving out the process of value-change of the users involved. In other words, the user's awareness and active role in the process of change are overshadowed by a heavily driven design, which leaves no room for unexpected mediations between technology and users. Therefore, the theoretical principles identified by Fogg such as *ability*, *motivation* and *behaviour triggers* [17] were only partly considered in the present study, giving priority to the user's awareness regarding both ethical and behavioural change.

Designing for transformative qualities

The ubiquity of computing technology in the contemporary society makes urgent for designers/researchers to address the complexity of interactive systems, focusing not only on usability and efficiency, but also on the psychological, social and ethical implications of the interaction between human and computer [7]. This new technical-social paradigm characterises recent studies in the field of design for social transformation [7][45][29][10][12], distinguishing them from those operating in the past. In this regard, the establishment of specific research fields, supported by academic communities, follows the rise of complexity and the related need for multidisciplinary studies. However, the research communities committed to designing for social transformation seem to have difficulties in offering a proposal accessible, both in terms of language intelligibility and in terms of practical viability (e.g. [29]). This sheltering behind academia often entails the risk to be caught into abstraction, limiting the potential for realisation.

Regarding the concept of *transformation*, it is worth summarising what links the present research with the above mentioned studies, particularly with [7]. The main points of agreement are the following: 1) role of design and scope of transformation; 2) methodological approach to designing; 3) focus on ethics.

Role of design and scope of transformation

As "*the elementary role of design is to design artefacts embodying value propositions*" [7], a deep change in people's behaviour and mindset can only be achieved by dealing with the complexity of the interaction between people and artefacts ("space") within a specific system of relationships ("context"). This complexity lies in the proliferation of phenomena occurring simultaneously in the relation human-environment. Acknowledging the multidimensional nature of such phenomena means dealing with both material and abstract aspects, in the attempt of unravelling the multiple knots that tie them together and to understand the dynamics of their connections. In short, the scope of transformation

can only be multidimensional, involving practice and theory, perception and intellect, feelings and thoughts.

Assessment of the design process

The development of the design process influences the way it is assessed. Therefore, the process can only be assessed through its unfolding and never in advance. As "*the way we design and the way we assess our designs are dynamically interrelated*" [7], the criteria for the evaluation need to be flexible and related to the specific design process. In this respect, the creative potential of design is expanded by acknowledging the unpredictability of the outcomes of the research being conducted. All in all, a suitable approach to the complexity of designing for transformation is that of allowing the process to suggest designers/researchers how to change the criteria of the assessment, favouring "*reflection in and on action*".

Focus on ethics

Claiming the need to "*incorporate ethics and its values as a deliberate focus in the design process*" [7], the researchers aim at expanding the scope of design (research) towards existential and profound matters. The relevance of this claim lies in the complex nature of the relation human-computer, where emotion and ethics are bundled. Ethics plays a crucial role being at the heart of responsible decision-making. In short, ethics is seen as fundamental part of the phenomenology of awareness and, more in general, the drive of change/transformation.

Transformational things and frictional feedback

The work of Laschke et al. on the concept of *frictional feedback* [33][32] deserves specific mention as most relevant to the present study. This type of feedback is designed to softly annoy users, so disrupting their routines and making them reflect upon their own behaviour. The researchers developed this concept with the aim of eliciting reflection and inspiring a process of meaning-making in the user regarding possible actions to be performed. These actions are suggested by the aesthetics of the artefact, which is meaningful with respect to the message being conveyed (e.g., consuming less electricity). In this scenario, the frictional feedback is a strategic means to achieve situated action instead of purely abstract intentions. When the user's routine is interrupted, he/she has to think, take decisions and, finally, take action. In this respect, the user's change has more chances to occur, being driven by the "*dialectic between the product and the user*" [32]. The concept of frictional feedback is part of a wider idea that envisions objects as "*transformational products*" or "*pleasurable troublemakers*" [34]. Instead of solving problems, these designs try to "cause" them. Creating problems is meant as raising attention on societal issues in the everyday life of users, with the aim of making people responsible for their own change. This approach to design for social transformation is built upon the criticism of purely informational design interventions such as *Static!* [2] and the *Erratic appliances* [15] developed at the Interactive Institute Swedish

(ICT). The above mentioned projects operate aesthetically only at the informational level by displaying the user's energy consumption. They, therefore, foster abstract intentions without providing the user with the opportunity to take action. Moreover, as they express no criticism regarding behaviour, the user may have "no reason" to change. All this considered, the Laschke et al.'s approach is consistent with a concept of profound transformation through design and relevant to the present study.

The main points of agreement with the Laschke et al.'s research are the following: 1) dialectic between the artefact and the user aimed at eliciting a process of meaning-making; 2) slightly annoying feedback that makes the user reflect and take action by disrupting his/her own ordinary behaviour; 3) aesthetics of the artefact meaningful with respect to the message conveyed, which is expressed through the use of the artefact rather than only through its appearance.

The only remark to be made about the research on transformational products is the lack of a theoretical framework in support of the concept development. The principles behind the research on frictional feedback may be translated in a framework and used to address specific design cases in a systematic and structured way.

WORLD ENERGY CONSUMPTION

A multifaceted issue

Production and consumption of energy are capital for human existence itself, especially in the light of the exponential economic and demographic growth which has characterised the last two centuries [39]. As a consequence, the issue world energy consumption and the related sub-topics such as energy development, waste management, pollution, economic warfare, etc., have become primary in the international affairs of most of the countries around the world. An extensive literature summarising data and forecasts about the world energy consumption (since now on e.c.) is published every year by several associations (e.g. EIA, IEA [60][61]) and statistical bodies. The technical challenges to reduce the world e.c. are at the heart of the scientific debate, plunged into difficulty by the growth of the energy demand in the developing countries. In this debate, main concerns are the estimation of growth and how its patterns will vary in the next upcoming years [58]. Therefore, portraying a general overview of the social and economic processes related to the issue world e.c. is beyond the possibilities and the intents of the present paper. However, a major difference can be drawn between public and private scope. The categories private and public are not conceived rigidly and their definition serves the identification of the scope of intervention described in the following sub-chapter.

The role of values in domestic energy consumption

In the private scope design mainly focuses on the domestic e.c. This also includes the relationship between technology and users in the home environment (lifestyle, habits,

behaviour) [51]. Therefore, the home environment was deemed as the most relevant context where to conduct research on ethical and behavioural transformation related to e.c. People attribute a sentimental value to their own home and the objects that belong to it, establishing a relationship that goes beyond functionality. A relationship that implies emotion, affect and social ties. The way some of such objects are used, thus the people's behaviour and the related values, directly affects the level of domestic energy consumption [30][20][46]. Although hard to define, the relationship between values and household energy use can be investigated pondering the role of behaviour on energy consumption (e.g., [48]). Moreover, an interesting and relatively unexplored investigation over the unconscious character of the habits related to the use of technology [24] may further unveil the dynamics of the relationship between values and behaviour in energy use. The above mentioned studies highlight how the ethical dimension of individuals is crucial in shaping their attitude towards societal issues they are involved in. Such an insight makes worth reviewing some examples of design intervention within the home environment, specifically aimed at enhancing users/people's awareness about the issue e.c.

Energy consumption, behaviour and design

A major difference can be drawn between engineering design and industrial design with respect to the way the issue e.c. is addressed. In the first case, the focus is on increasing the performance of the most energy-demanding appliances (e.g. fridges and freezers) [23]. In the second, the research focuses on how to design new products and services to induce a sustainable behaviour in users [5]. The engineering design research is technology-driven, prioritising the efficiency of the systems integrated in the home devices [1]. Conversely, in the industrial design field, the research is mainly user-centred and devoted to change the user's behaviour. In this research area, a further distinction can be drawn between researchers who favour an analytical approach, focusing on the development of frameworks and methodologies [56][36], and researchers who accomplish the investigation by means of refined prototypes, focusing on aesthetics and interaction [2][27]. Relevant examples of the latter type of research are projects such as *Power cord* [27], *Keymoment* [33], *The shower calendar* [35] and *The hungry caterpillar* [34]. They all address the user's awareness of energy consumption building upon the legacy of *Critical Design*. Moreover, they employ a research-through-design approach, based on iterative and non-linear design process, where the prototype is the "*embodiment of theory*" [59]. However, a significant difference needs to be highlighted between purely informational interventions (e.g., *Power cord*) and artefacts that engage the user in action-based experiences (e.g., *Keymoment*). As previously emphasised, the artefacts that focus on user's situated action and meaning-making process are better examples of how to design for transformation, addressing the multidimensional complexity of the human experience.

DESIGNING FOR TRANSFORMATION

Ethics and artefacts

Ethics plays a crucial role in people's transformation as the individual dimension of values shapes behaviour, guiding choices and actions. In this respect, the concept of *transformational products* [34] seems to deem ethics as a fully-fledged component of the experience between user and artefacts. The underlying vision of this approach is consistent with the idea that technology or technological artefacts "*mediate human actions and experiences*" [57]. They are a "*material form of intentionality*", not only shaping behaviour but also contributing to the user's decision-making process. In other words, the nature of the change induced by the interaction with artefacts is multidimensional (physical and mental, emotional and cognitive, cultural and psychological, etc.) as the material dimension contributes substantially to the engagement of people in the everyday activities, making the experience a rich and complex phenomenon [50]. In this regard, is worth emphasising the co-responsibility of both artefact and user in the shaping of intentions and related actions. Unlike what the persuasive design approach suggests, intentionality is not entirely driven by designers through the artefact, rather is "*co-shaped*" in the relationship between user and artefact through what Verbeek calls the "*technological mediation*" [57]. This technological mediation entails space for interpretation (*hermeneutic mediation*), beside the prescription operated by the artefact (*pragmatic mediation*). The resulting bi-directional dynamics is what allows the user to take decision and action beyond the expectations or plans of the designer. Proof of this are the unexpected ways of interpreting the meaning of artefacts and related experience by the users. Such unexpected *mediations* take place both when the artefacts are used as intended and when they are employed in contexts different from those envisioned by their designer. Therefore, this active role of the user in the process of meaning-making is crucial, allowing the transformation to be effective as well as self-managed by the user.

In summary, unexpected outcomes of the interaction with the artefacts are fruitful with respect to user's transformation rather than being flaws of the design strategy. This openness towards unexpected results is what distinguishes the present research from that concerned with strategies of persuasion through the design of intelligent artefacts. Failing to fully orient the user towards specific goals is not necessarily a negative outcome as it can open new paths of change where users gain more responsibility and awareness. In this respect, the field research approach and the methods applied in the area of User Experience Design (UXD) are precious means for investigation and, most importantly, for the assessment of the unexpected *mediations* emerging from the actual users' experience.

In conclusion, by deliberately "playing" with the connections between artefacts and people/users at multiple levels simultaneously (emotional, functional, symbolic, etc.), it is

deemed possible to elicit ethical reflection(s) upon societal issues and make people responsible for their own transformative process.

Ethics, emotion and design

Emotion and meaning in interaction have gained great interest since the establishment of the research on user experience [26]. As a result, researchers in the field of interaction design have started to employ theories of emotions and concepts of cognitive psychology in the design of interactive artefacts since the early stages of the design process [55]. This type of research is highly user-driven and draws upon the principles of human-centred-design (HCD). A related line of research, called Empathic Design, specifically addresses emotion in design, seeking to the fulfilment of the user's needs beyond the notion of usability and performance (e.g. [41][44]). Overall, user studies have expanded the domain of design towards more complex matters of human experience and, moreover, they have introduced the field-research approach as a means of investigation. Undoubtedly, this change of paradigm in they way of conducting research is an advancement, having significantly enriched the breadth of design intervention. However, UXD approach is hard to reconcile with design for transformation, especially as far as the general research aim is concerned. Most of user-driven studies focus on identifying the user's needs, shaping the design proposal accordingly. Researchers seek to be informed by the understanding of the user's experience in order to formulate a relevant design concept. In short, the closer the concept to the needs identified, the more successful the design. Conversely, design for transformation aims to suggest thoughts and ways of behaving that not necessarily fulfil the desire of the users involved. In particular, the notion of need is not that of something holy and defined once for all, only because emerging "directly" from users. Neither is a judgement-proof kind of statement. In the design-for-transformation view users are considered social beings involved in a constant learning process where what is right or wrong (so what is needed) is subjected to change and, most importantly, needs to be related to the social debate going on. In this regard, it is not surprising that rare are the cases of UXD employed to steer users/people towards a behavioural and ethical transformation (e.g. see [54]).

In spite of the divergence of approaches, UXD and design for transformation may share a point: an essentially qualitative type of research with particular propensity for a field-research approach. From a design-for-transformation perspective (as intended in this study), the field-research approach is a valid means to both assess and understand the qualitative transformation being sought. To this extent, the research methods developed by the UXD approach are relevant to the study here illustrated.

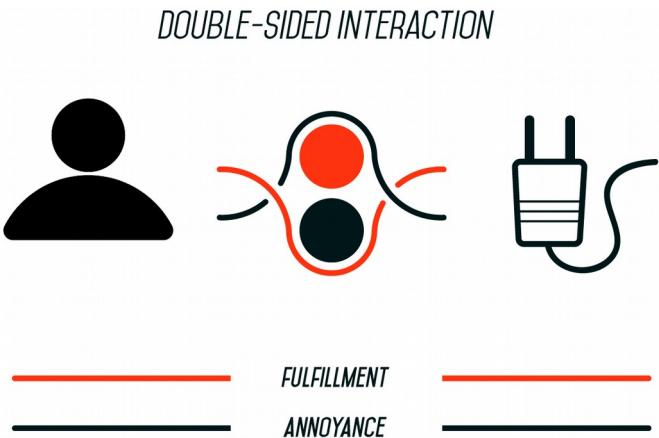


Figure 1. Double sided interaction: annoyance and fulfillment

The need for social criticism

Researchers committed to design for transformation are often accused to impose a particular vision to users through a top-down approach to design. In fact, as shown by Laschke et al.'s research [32], a bottom-up type of approach can be applied when designing for transformation, introducing disruptive feedback and opening opportunities for reflection and action. In this scenario, the user is co-responsible for the process of meaning-making together with the designer, who conveys his/her message through the artefact. As a result, although influenced, the user takes lead of the decision-making process and, most importantly, of the action. In this light, the direction of the change is only suggested, finally remaining under the responsibility of the user involved. Such independence in the lead of the change may be considered as the actual transformation aimed by this study. The user's awareness lies in this capability more than in merely knowing (or understanding) the nature of the problem being addressed. In other words, becoming aware means being able to lead one's own transformation at both cognitive and practical level. Simultaneously, this transformation takes place in a given value system, that is, the cultural and social context the user lives in. This value system also concerns the message conveyed by the designer. Therefore, the user will be making choices in accordance or against this value system, depending on the direction he/she will be taking and according to the awareness achieved.

In brief, as needs are strictly related to the values individuals have and values are dynamically changing depending on the social, economic and cultural context, valuing natural resources – whose limited character is the main issue in the debate on energy consumption – does not pre-exist in people's mind, rather, must be learnt. However, whether or not the user will adopt the change sought by the designer is not the main concern of the present study. Conversely, the main concern is the awareness users gain with respect to the possibility they have to take action, changing their own behaviour.

Annoyance and fulfillment in interaction

Drawing on both the concept of *frictional feedback* [32] and the project *Static!* [2], the present study developed a conceptual strategy to address design for transformation, based on the combination of annoyance and fulfillment. **Fig.1** represents this type of interaction where the user experiences both feeling when interacting with an artefact. The concept of annoying/fulfilling feedback is similar to that of frictional feedback, aiming the user's awareness of the issue energy consumption. The annoyance interrupts the course of the ordinary, making the user reflect ethically upon energy consumption and take action accordingly. However, the disruptive feedback here proposed is intended as combined with fulfilling elements (e.g., pleasurable feedback) in order to foster a desire of experience in the user. Projects such as *Power cord* and *The flower lamp* [2] are relevant examples of how beauty can be meaningful with respect to the specific use of the artefact, leveraging the user's satisfaction. Therefore, fulfillment is a crucial "ingredient" to achieve users' engagement. On the other hand, in *Static!*, the component of a pleasurable, unexpected and beautiful aesthetic experience overshadows the constructive purpose of the artefact: making the user reflect and, most importantly, to act for changing. This generates a paradox when, in the case of the *The Heat-Sensitive Lamp* [2], users may be even pushed to use the artefact for longer, thus increasing the consumption of electricity.

In conclusion, a balance between disruptive and pleasurable characteristics of the interactive experience was deemed as strategic in order to trigger the user's reflection while keeping him/her engaged in the interaction.

Understanding the phenomenology of awareness

The process of becoming aware is a complex phenomenon, concerning a variety of factors such as cognitive thinking, emotional state, environmental and external events. Entirely understanding the nature of such phenomenon goes far beyond the scope of this paper. However, to address the concept phase was necessary to outline an hypothesis of

ANNOYANCE/FULFILLMENT MIXED INTERACTION

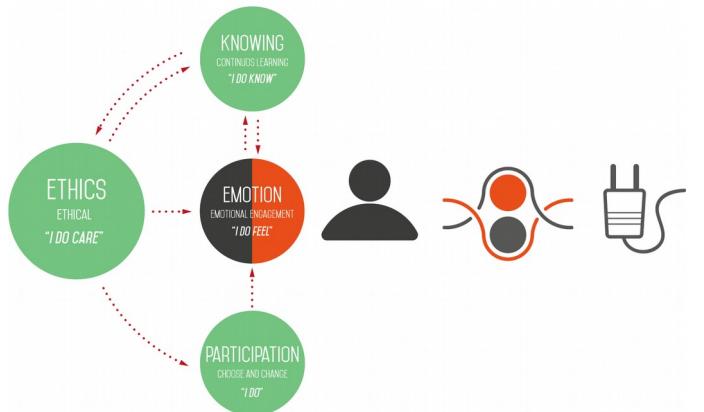


Figure 2. Awareness process in the double sided interaction

how awareness happens with respect to interactive experiences. In particular, the focus was on disruptive interaction. **Fig.2** depicts, conceptually, the happening of awareness in the context of a user's interaction with an intelligent system. The diagram is an attempt of identifying the main phenomenological characteristics of this process and by no means claims to be a definitive explanation of the phenomenon. **Fig.3** gives a more detailed account of this process as far as the interaction with the artefact is concerned. As shown in the latter figure, the design (artefact) triggers a particular emotional state (e.g., fear-sadness) and a reflection about values (ethical judgement). Determining whether the valuing process comes before or after the emotional state is not crucial. What it matters is their relating with each other. In this dynamics, the room for ethical reflection, that is, the opportunity for the user to value what is happening, is created by the disruptive feedback. An interruption of the routines that aims at eliciting a controversial set of emotions (e.g., negative and positive emotions together). Moreover, the disruptive feedback corresponds to a temporary and slight malfunctioning of the system. This malfunctioning induces the user to take action to restore the normal conditions of the system and, therefore, opens space for decision-making.

In Appendix-1 an extensive version of the diagram depicts the whole awareness-elicitation process through the interaction. The diagram is a conceptual and hypothetical representation of how the process of awareness happens in what was called *double sided interaction* (combination of annoyance and fulfillment). Albeit hypothetical, this abstract model was critical for addressing the complexity of the phenomenon and finding a starting point for the design process.

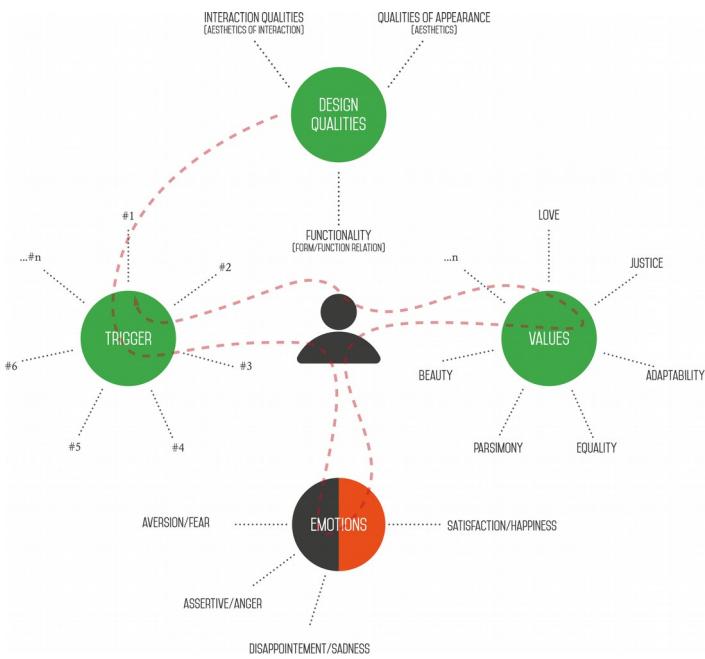


Figure 3. Dialectic user-artefact in annoying interaction

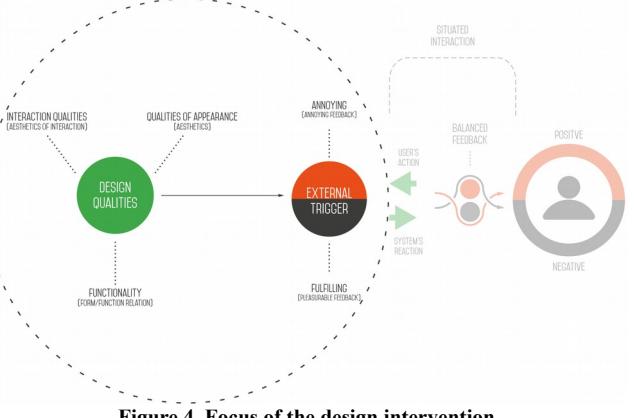


Figure 4. Focus of the design intervention

Fig. 4 shows the focus of the design intervention. The most relevant part of the intervention was the design of the type of feedback and its qualities. This understanding suggested the need to develop a framework in support of the concept-design phase.

Design for annoyance and fulfillment: a framework

A framework consisting of four main categories was designed to support the concept development phase (**Fig. 5**).

The first category groups the set of aesthetic qualities to be attributed to both the artefact and the interaction. As emphasised in the previous section of this paper, aesthetics plays a crucial role in the attribution of meaning to the experience from the part of the user. Therefore, it was essential to identify the aesthetic qualities to be included in the design of the artefact. This identification built upon literature, resulting in a collection of aesthetic properties [25] and aesthetic qualities in interaction [37][38][37]. Referring to the aesthetic qualities in interaction helped the researcher work towards a meaningful aesthetics in action, going beyond the aesthetics of appearance and the mere informational intervention.

The second category is the mechanism for changing the features of the artefact. A disruptive feedback entails a sudden, rapid and reversible status change of the system. The latter needs, thus, to be designed through a mechanism that permits the transition from correct functioning to malfunctioning and vice-versa. Shape-change was deemed as an optimal means to achieve reversible status changes of the artefact, while attributing the aesthetic qualities previously identified. In particular, the eight types of shape-change proposed by Rasmussen [49] were employed to have a systematic reference. In this scenario, the different types of shape-change can be reproduced and tested individually, assessing the different user's responses.

The third category groups three parameters (time, material, space) to attribute the aesthetic qualities to the artefact and adjust the intensity of the feedback. By modifying the three parameters, a diversity of aesthetic qualities can be attributed to the system (e.g., using wood rather than metal).

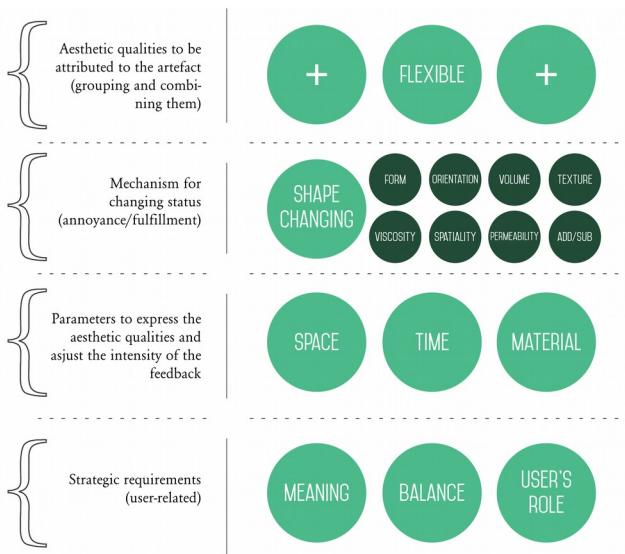


Figure 5. Framework to support the concept development

Moreover, by emphasising one of the three, the feedback can result as more or less annoying (e.g., increasing the duration of the feedback).

Finally, the fourth category groups the general requirements deemed as strategic for the success of the design proposal. Three strategic requirements were identified: 1) meaningfulness of the experience; 2) balance between pleasurable and annoying feedback; 3) user's empowerment (leading role in the interaction). According to the first requirement the design needs to be meaningful with respect to the message conveyed (e.g., consume less energy). The message takes shape through both the apparent aesthetics and the aesthetics of use. Thus, the meaningfulness regards the process of meaning-making that the user is engaged in when facing specific interactive (e.g., aesthetic) qualities. The second requirement regards the balance between fulfillment and annoyance in the interaction. The balance is vital to prevent the user from becoming biased against the system and its underlying purpose. A purely annoying feedback would elicit a purely negative reaction in the user, resulting as meaningless. The third requirement is: making the user take the lead of the interaction. The user needs to have the power to stop the annoying feedback and, in case, to adjust its intensity. In other words, the user has to be in control of the system and never feel to be subdued to it.

The framework here illustrated was designed to support the concept development and by no means is intended as a definitive or universal tool to be employed in the design-for-transformation based projects.

From individual to social experience

One of the key points this research began with was that of making world energy consumption an issue related to the everyday life of users. By relating the topic to an actual

daily practice, the whole matter becomes concrete and relevant to personal values and practices of the users involved. This relation with the everydayness was the rationale behind working on the energy consumption in the home environment. However, one may argue that there is no direct link between the private issue of domestic energy consumption and the broader societal implications the latter entails. In other words, users may still be aware of private energy consumption while neglecting the value of saving energy in the interest of the whole society. In this scenario, the individual behaviour may be driven by values such as efficiency and money saving, rather than care for the collective interests. Making users link these two values was a crucial step of the process of transformation sought by the present study (**Fig.6**). A strategy employed to achieve this linkage was that of including social interaction amongst the general requirements listed in the framework. **Fig. 7** shows a relevant conceptual model. In practical terms, this requirement is translated in connecting two or more artefacts together (e.g., via the internet) and let multiple users interact with each other. The interaction becomes, thus, social and the experience more significant with respect to the societal issue. To a certain extent, making the interaction a social experience means scaling the issue of world energy consumption to a home-sized environment.

With respect to scaling the issue world e.c. to the home environment, this study drew on the concept of *social translucence applied* to digital systems. The aim of the approach based on this concept is “*to design digital systems that support coherent behavior by making participants and their activities visible to one another*” [14]. In short, the concept seeks to the intelligibility of action and thought amongst users interacting with the same system(s). Three main principles characterise this concept: 1) visibility; 2) awareness; 3) accountability. The first principle is related to the influence on one’s behaviour derived from knowing what others do. In other words, knowing what others do makes one change accordingly. Therefore, by making this social information visible, one’s choices and behaviour can be changed. The second principle regards the awareness one gains through this acquiring socially relevant information. This kind of awareness has to do with the social rules that lead one’s own behaviour: what one does (or does not do) since he/she is aware of the consequences of his/her own behaviour for others.

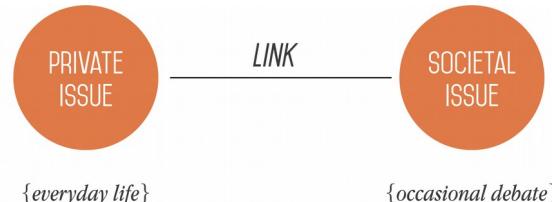


Figure 6. Link between private energy consumption and world energy consumption

The third principle is about the effect of knowing to be seen on one's behaviour and choices. Knowing to be seen generates awareness of the possible actions one can be deemed responsible for. This social accountability (or awareness to be accountable for actions one performs in social contexts) influences one's own behaviour regardless of the level of care one has for others.

Although initially developed through intuition, the design concept was based on the principles of social translucence (see design concept section). These principles were strategic to expand the scope of intervention beyond the individual interaction. Moreover, they were employed to make the association between the private issue and the societal issue stronger for the user.

METHODOLOGY

Process

The aim of this study was to explore the design of intelligent artefacts able to elicit ethical reflection on the issue of energy consumption. Reflection that may eventually lead to a transformation/change of the users' mindset and behaviour with respect to the everyday energy consumption in the home environment. The research consisted of the following steps.

- 1) Design of an instrumental framework to support the concept development phase. The framework consisted of four main categories: 1) aesthetic qualities; 2) mechanism for status-change; 3) parameters for the intensity of the feedback; 4) strategic requirements (focus on user). Each category grouped a specific set of abstract characteristics to be translated into tangible features of an artefact/system. Part of the abstract characteristics were specifically related to the aim of designing for user's transformation.
- 2) Development of a design concept and realisation of a refined model of the system. The system was designed to allow multiple users to share energy at a distance, being constantly aware of their own energy consumption and of that of the others. Moreover, the users were meant to receive a slightly annoying feedback when the quota of consumption they set for themselves was overcome. The artefact consisted of a lamp and two separate tangible interfaces.
- 3) Realisation of an entirely working prototype. This step consisted in implementing the tangible artefact and the related interaction devised in the concept phase. Several changes were made on the basis of both technical constraints and test requirements.
- 4) Twelve days field test in the home environment with a single user. Data were collected through three different means: 1) diary; 2) questionnaire; 3) final interview. The focus was on the user's experience, with particular regard to the ethics and behaviour.
- 5) Coding of the data gathered according to the grounded theory method. The video interview was divided in three

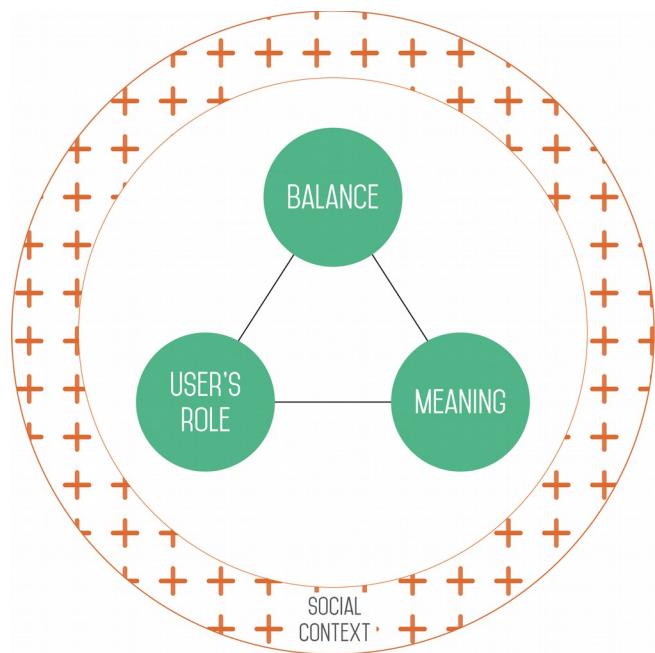


Figure 7. Social interaction as a strategic requirement

chunks and entirely transcribed. The lines of the transcript were coded resulting in 53 codes.

- 6) Clustering of the codes into categories. The code were grouped into 10 categories and 14 related sub-categories.
- 7) Creating themes/concepts from the categories. Four main themes emerged from the analysis of the content of the categories.
- 8) Bridging towards an interpretation. Definition of each single theme in detail to proceed towards an overall synthesis.
- 9) Synthesis of the emergent themes and development of a theoretical construct. The construct as an interpretation of the phenomenon being studied.
- 10) Illustration of the results (answer to the research question).

Ethical conduct

All the relevant information about the study, was included in a designated area of the form provided to the participant. The information sheet provided the participant with the following specifications regarding the study: 1) the right to refuse to take part in the survey; 2) the name of the researcher and related academic institution; 3) the data collected through diary, questionnaire and interview would be only used for research purposes and their copyright belonged to the participant; 4) what the research was about; 5) what the survey consisted of; 5) the diary, questionnaire and interview would be anonymous and all the personal information gathered (e.g., participant's thoughts) would be treated on compliance with confidentiality rules.

Field-research approach

This study was conducted employing a field-research approach. This approach to (design) research is particularly suitable for studies whose aim is to gain a deep understanding of the phenomena being investigated [9]. In this regard, a relevant research that inspired the present study was that of Brown et al. [6]. The researchers explored the concept of location in interaction by addressing values of several families interacting with a specially designed system. They conducted a field trial in the home environment aimed at gathering qualitative data. A similar research setup was arranged in the study here illustrated.

Wizard of oz method

Part of the test conducted in this project addressed the user's experience with respect to social interaction. In order to minimise time and effort while maximising results, the test was conducted involving one participant only (see Field trial section). The participant was made believe to be interacting with a second participant unknown to her. With the aim of preserving this arrangement, the interface of the system dedicated to the social interaction was programmed to behave autonomously. In particular, a twelve-days program was designed on the basis of two different personae (see Field trial section). Each day the "other-participant's interface" would provide with a light feedback that corresponded to an actual use of the system. The participant was, therefore, able to interact as if there were someone actually interacting with her remotely. The fictitious social interaction was designed drawing on the *wizard of oz method* [31]. This method is largely employed in the field of HCI to test the user's response to a new system/prototype still in an embryonic stage of development.

Data collection method

The following means were employed to collect data: 1) questionnaire between the first and the second week [3] ; 2) diary throughout the test (Appendix-2); 3) final interview (Appendix – 3).

1) The questionnaire aimed at capturing relevant data regarding the first week of user's experience. A prevalence of open-ended questions emphasised the qualitative character of the investigation. Two main macro-themes were addressed in the questionnaire: 1) annoying feedback; 2) social interaction. In turn, the macro-themes were addressed in relation to a twofold aspect of the experience: emotional state and ethical reflection. For the to assessment of emotions and ethical reflection it was referred to [21].

2) A paper diary was designed and employed to gather daily thoughts of the user regarding her experience. The diary included all information needed for its proper use (see Appendix-3). Diary methods are largely used in Psychology research [28], providing an important source of qualitative data. In this research case, using the diary allowed the user to freely express and carefully record the dynamics of the (ethical) reflection and emotion elicitations. Such an intimate and private relationship with the recording tool, fostered

the authenticity of the thoughts expressed, making the measurement more qualitatively significant. Moreover, having the opportunity to instantly record/assess the user's own experience (Ecological Momentary Assessment – ECM), aimed at preventing (or reducing) the phenomenon known in Psychology as *memory bias* [53]. To properly design the diary, it was referred to [28][11].

3) The interview was the final stage of the data collection. The data were gathered through a video recording. In accordance to [9], the final interview was semi-structured, following the trend of the conversation and the user's narrative.

Sampling method

The sampling strategy employed was purposeful, following an established practice in the field of qualitative research [47]. In particular, the *criterion sampling* technique was used to recruit the participant: the selection was based on predetermined criteria the participant needed to meet. This type of technique was employed to reveal major weaknesses of the system being studied while gaining an in depth understanding of the phenomenon of awareness (in annoying/fulfilling interaction). Overall, this technique allows researchers to gain in-depth information regarding the subject of study and was, therefore, deemed suitable for this study.

The following criteria were used for the recruitment of the participant: 1) older than 18 years old; 2) being available to be connected with unknown people at a distance; 3) being acquainted with simple interactive devices (to the extent to be able to interact with the system without major difficulties and hindrances).

1) The first criterion aimed at excluding children and elderly people. Children are part of a social category with an incomplete independence of thought, a crucial requirement for the success of the test. As ethics is a dominant topic in this research, only people who have reached their adulthood were deemed as suitable for the study (although it is not meant to state here that maturity comes necessarily with the age of consent).

2) The second criterion was led by the need to raise awareness through social interaction, a crucial point of this study. To be eligible, the participant needed to be willing to be connected to a second user. Moreover, the participant needed to accept to be interacting with an unknown person. This requirement was a stratagem devised to maintain the participant unaware of the fictitious character of the social interaction, securing the execution of the test.

3) The participant needed to be familiar with basic interactive devices such as smartphone and PC. This minimum level of acquaintance with interactive system was necessary to avoid major hindrances to the conduction of the test.

In addition to the above mentioned criteria, sample size and context of recruitment deserve a mention. The size of the



Figure 8. Concept developed through the framework

sample had a twofold rationale. On the one hand, a small sample lends itself to an in-depth enquiry, typical of qualitative research aimed at understanding the phenomenon being studied. On the other hand, a small sample facilitates the overall conduction of the test. In this regard, the sampling strategy employed in this study may be considered as of convenience. Is worth mentioning that the sampling strategy was of convenience also as far as the recruitment of the participant was concerned, namely the choice of the social contexts from which the participant was selected. In fact, the participant was recruited performing the most viable option, given the researcher's means and possibilities.

Analysis method

The approach to data analysis draws on *Grounded Theory* (GT) [52], a systematic method for the interpretation of qualitative data gathered in the field. In particular, the method is employed with a *constructivist* slant, acknowledging a greater role for the interpreter [42]. The method has been developed to address epistemological and ontological research questions, gaining considerable weight in the field of social sciences over more than thirty years [22]. In this study, the analysis of the data concluded with the development of a theoretical construction. In this respect, the present research addressed an exploratory research question aimed at understanding a phenomenon (e.g., ethical reflection on and awareness through interaction).

CONCEPT DEVELOPMENT

A “social lamp”

A first concept (Fig. 8) was developed with the support of the above mentioned framework. Fig. 9 shows a “physical sketch” of the concept: a lamp for sharing energy amongst members of a community (e.g., neighbourhood or friends). The choice of a lamp was driven by the need to simplify the functional scope in order to focus on the social, ethical and aesthetic aspects of the interaction. The system was devised focusing on two macro-themes: 1) slightly annoying feedback; 2) social character of the interaction.

The design of the feedback was developed through the framework. In this regard, the concept embodies the aes-

thetic quality *flexible*, employs *orientation* as a type of shape-change and focuses on the parameter of *time*, with particular regard to speed. In material terms, the structure of the lamp is flexible and changes its orientation to give feedback when a certain threshold of energy consumption is overcome. The velocity of the change in the orientation of the structure can be employed as a parameter to adjust the intensity of the annoying feedback. A considerably fast movement may be perceived as a sign of impetuosity and therefore associated with a negative feeling by the user. Conversely, a slow movement may be experienced as funny. As previously mentioned, the fulfillment of the experience was meant to be achieved through a pleasurable aesthetics of the artefact. Nevertheless, by adjusting the intensity of the feedback (e.g., speed), a diversity of emotional responses of the user can be targeted.

Towards social interaction

By envisioning two or more systems connected together, the interaction became social and so the experience. This type of interaction entailed being able to visualise the other members' consumption and warn the sharers in case their consumption is deemed as excessive. As shown in Fig. 9, the system consisted of two parts: a lamp and an additional interface. At the base of the lamp a knob-slider allowed the user to set his/her own expectation of daily energy consumption.

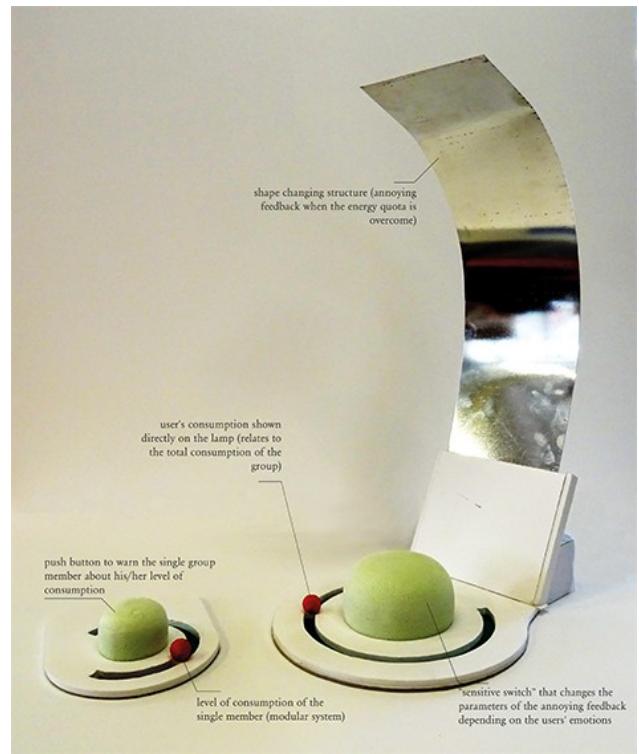


Figure 9. Physical sketch of the new concept (with social interaction)



Figure 10. Refined model of the system (devoid of functionality)

In terms of perception, the consumption was expressed in time elapsed. As a consequence of the setting, an LED ring indicated the progressive dwindling of the amount of energy set by the user. Visually, the user would see the LEDs progressively turning off as time passed. The flow of interaction just described would be shown in the additional interface (the small object in Fig. 9) to the other members remotely connected. Therefore, each user (e.g., member) would see the others' consumption and, simultaneously, would show his/her own consumption to the other users. The additional interface was meant to be modular so to allow the user to enlarge his/her own community over time.

Assessing and refining the design

A refined model of the system was built in order to assess the relevance as well as the quality of the concept (**Fig.10**). The set of objects was devoid of functional components and employed only to simulate the final interaction. The realisation process itself clarified the consistency of the elements of the system with respect to the interaction envisioned. In this process, a new interface was added with the aim of making each user aware of the total consumption of the community. **Fig.11** shows the setting of the total consumption and the visualisation of the other members' settings in real time. With this new component, the users involved not only were made able to relate their own individual consumption to that of the other members, but also they were given the opportunity to be aware of how different behaviours affected the general consumption. In addition to awareness, the new interface allowed the users to collectively set the amount of energy to be shared. This setting had the aim of enabling social interaction and ethical reflection as the amount of energy to be shared needed to be negotiated amongst the members.

To summarise, the system consisted of (1) a lamp, (2) an interface showing the other members' consumption, (3) an interface to set and visualise the total consumption of the community.

1) The lamp would change the shape when either the individual or the total energy quota previously set would expire, giving the users a slightly annoying feedback. The intensity of the feedback would depend on the emotional state of the single users, measured by sensing the force exerted on the soft push-button at the base of the lamp. Should the user's emotional state be negative, the intensity of the feedback would be lowered by the system in order to achieve a balance.

2) The interface connected to the other members would show in real time the settings as well as the dwindling of the amount of energy of each member. In other words, any member would see in real time how each of the other members was setting the lamp and how much energy each of them was consuming. A soft push-button at the centre of the interface would allow the users to warn each member in case their consumption was deemed as excessive. When the push-button would be pressed, the member's lamp associated with that interface would shake. Lastly, a small screen would allow the users to personalise the interface, including images for the identification of the members the single interfaces would refer to.

3) The interface of the general consumption would allow to set the total amount of energy to be shared amongst the members. Moreover, the interface would show the dwindling of the energy in real time. The amount of energy was meant to last for a week and once had been set no changes could be made until it expired. Once the collective *quota* (e.g., energy shared) had expired, a new negotiation started amongst the users. It is worth mentioning that the amount of energy consumed was expressed in time elapsed.

PROTOTYPING PHASE

Implementation

Based on the model above described, an entirely working prototype was realised (**Fig.12**). For an extensive and detailed account of the prototyping phase, it can be referred to the following project report [4].



Figure 11. Setting of the total energy consumption quota



Figure 12. Entirely working prototype (whole system)

Because of both technical constraints and test requirements, the final design of the system differed from the original concept. It is worth mentioning the main changes made to both physical prototype and design of the interaction throughout the prototyping phase. Details of the changes made and their rationale follow.

Physical prototype

The implementation of the system devised in the concept phase would have required a highly complex design in terms of both hardware and software. As the test was prioritised, the design was simplified and so the related interaction. This simplification of the system made possible to conduct a field trial in the time available, testing the main aspects of the interaction (e.g., (1) disruptive feedback; (2) social interaction).

The main change made was to discard the detection of the user's emotional state through a pressure sensor integrated in the soft push-button at the base of the lamp. The reason that led this change was manifold. Firstly, the assessment of the user's emotion would have been partial as the ontology of emotions is complex and cannot be reduced to sensing single and small details of the user's behaviour. Secondly, the design of the software would have been made overly complex, prolonging the prototyping phase. However, a future re-design of the system may take into consideration a further development of this aspect of the interaction. Regardless, look and materials of the push-button were left as in the original concept: soft push-button made in foam and upholstered with Lycra.

A further change made was the implementation of the physical interface to set the energy consumption. Both, user's individual consumption and total consumption of the community were re-thought to be set by means of a physical knob-slider provided with augmented feedback (e.g., LED strips). In both interfaces, a tactile switch was included to allow the user to confirm the setting. In particular, in the case of the individual energy consumption interface, the

tactile switch was integrated in the knob-slider (**Fig.13**). This change in the design of the two interfaces was driven by the need to secure the functioning of the prototype during the user test. In this regard, mechanical components were deemed as more reliable than sensors. Moreover, the physical slider was considered as an affordance to facilitate the use of the interface.

Lastly, the interface representing the other members' energy consumption was also simplified. The little screen originally envisioned was not implemented in the final design as deemed not critical for the conduction of the test. As indicated in the dedicated section, the final test was performed involving one user alone. The user was told to be connected to an unknown person (see Field trial section). Therefore, there was no need to identify other members. A future re-design of the system may include a different solution to allow the user to identify other members, customising the related interfaces.

Except for the above mentioned changes, the interface was implemented according to the original concept.

Design of the interaction

The interaction with the system was conceptually divided in two parts: 1) individual interaction; 2) social interaction.

1) The individual interaction occurred when the user would set the expected individual use of energy – moving the slider placed at the base of the lamp – and would visualise her own consumption in real time (**Fig.14**). In fact, the consumption was steadily related to time and, therefore, what was being set was the duration of use of the lamp. This maximum time available was represented by 23 LEDs, each one counting approximately ten minutes. Therefore, the maximum time available was 3.5 hours. Once the time had elapsed, the user would receive the slightly annoying feedback (shape-change of the structure) and would be able to set a new energy quota.

The user could pause the tally by pressing the soft orange push-button and re-start the tally by pressing the tactile switch in the knob-slider (**Fig.14**). A change in the colour of the LEDs served as an augmented feedback. When the LEDs were red the bulb lamp was off and the tally was interrupted.



Figure 13. Knob-slider with tactile switch to adjust individual e.c.



Figure 14. Pausing and re-starting the tally

Conversely, when the LEDs were green the bulb lamp was on and the count was running. In order to simplify the dynamics of the interaction and its implementation, the intensity of the feedback was made regular. Therefore, the speed of the shape-change would not vary as the interactions followed. The intensity established was deemed as medium (approximately five seconds from the initial position to the final position).

2) The social interaction occurred in two separate phases: setting of the total consumption quota; visualisation of other member's consumption and the related possibility to give a warning.

The user was made responsible for defining the total consumption quota, as a single participant in the study. The interface to set this quota worked as the one used at the base of the lamp for the individual consumption. However, once the total consumption quota was set, it could not be paused until its depletion (Fig.15). The maximum time available was 18 hours, approximately 2.5 hours per LED.

With respect to the visualisation and warning of the other members, the user interacted with a fictitious second user. The behaviour of this fictitious user in terms of feedback was designed on the basis of a persona made ad hoc for the test (see Field trial section). Thus, the user visualised a pre-established set of behaviours, as if there were someone actually interacting with the same lamp at a distance (Fig.16). Two personae-based behaviours were employed over approximately two weeks of testing. In this scenario, the user would see the light changing throughout the day, believing



Figure 15. Setting of the total energy quota

that a second user was remotely connected. Moreover, the user could press the dedicated push-button, believing to be warning his/her energy sharer.

Time thresholds, energy consumption and feedback

As the bulb lamp employed was neither replaceable, nor had a dimmer, the energy consumption could be steadily referred to time. Overall, the LEDs employed for the bulb lamp had a rate of energy of 1.8 watt-hour. This rate is rather low, ultimately not causing a significant impact in terms of world energy consumption. However, it is worth clarifying that the priority of the research was the understanding of the user's experience, with particular regard to behaviour and ethics. Therefore, the emphasis was not on the actual amount of energy saved, rather, on the user's awareness. All things said, the interaction was designed considering the variable of time only. In this respect, the maximum time available, thus, the maximum quota of energy the user could set each time was established on the basis of assumptions of use. In particular, the closer to the actual time of use of the lamp, the better. This choice was made to avoid excessively high thresholds for the triggering of the feedback. Conversely, using the actual energy consumption as criterion for the establishment of the threshold may have caused the feedback to be never experienced by the user, so compromising the outcome of the research (the threshold would have been excessively high).



Figure 16. Other person's consumption interface in use

FIELD TRIAL

Test setup

A field trial in the home environment was conducted involving one participant alone over a period of 12 days. The interaction to be tested consisted of two main parts: 1) individual interaction; 2) social interaction.

1) Regarding the individual interaction, the system provided with full functionality, allowing the participant to set and visualise her energy consumption. Moreover, the participant received a shape-change based feedback whenever the energy consumption quota was overcome (Fig.17).

2) With respect to the social interaction, the participant visualised the other participant's patterns of energy consumption in real time. In fact, the second participant was fictitious and the light feedback shown in the interface was driven by a code. Thus, the participant was made believe to be actually connected to a second user. In particular, the participant was told that other two participants would alternate one after the other, over a two-weeks period.



Figure 17. Shape-change based feedback

In this regard, the patterns of use represented by the light feedback were based on two hypothetical users (e.g., personae) and related behaviours. The first persona's pattern of use was executed for 7 days, while the second persona's pattern was executed for 5 days overall. These two personae were carefully designed to represent different attitudes towards energy consumption (see the Personae section).

Participant and context

The participant was a clerk, woman, about seventy-years old. She was given an information sheet and made aware of the general aim of the study. Moreover, she was asked to sign a consent form. Regarding the interaction with the system, the participant was told that she would be interacting with two different users remotely over a two-weeks period. She was told that the other two participants needed to remain anonymous in view of the test requirements. Thus, the participant ignored that the social interaction was fictitious.

The test was conducted in the user's home environment. In particular, the prototype was placed in the living room (**Fig.18**). Because of the specific period of the year (May/June) and the related natural conditions of light, the artefact was used mainly in the evening (Appendix – 3).

Personae

Two personae were created (Appendix – 4) to design the autonomous behaviour of the other participant's interface, making it as close as possible to the behaviour of actual people. **Fig. 19** shows a card summarising the characteristics of the personae devised. To create the personae it was referred to [8][38].

This compliance with a real person's behaviour made sure the participant believed to be connected to an actual second user rather than to a software. Moreover, employing a realistic pattern of behaviours entailed the possibility of em-

bodying specific values related to the use of the lamp and, therefore, to energy consumption (Appendix – 5 and 6). In this respect, the two personae embodied opposite values with respect to energy consumption.

The first persona, Martijn, embodied the values of greediness and egoism. His being an avid reader, so attached to his habits made him be reluctant to reduce his consumption to comply with the collective interests of the sharing. Conversely, Alexandra, the second persona, embodied the values of compliance and fearful respect. With her obsessive sense of duty she was ready to adapt her behaviour to the needs of the community she was made part of.

Values and behaviours of the personae created resulted in a diverse set of light feedback shown in the dedicated interface throughout the test. Such a diversity made it possible to observe how the participant experienced and reacted to different patterns of values and behaviours.

It is worth mentioning that the two personae were created mixing both negative and positive aspects. In this regard, none of them were devised as ideal model of ethics and behaviour. Such a twofold nature of the personalities reflected human character and was deliberately targeted. Therefore, the relevance that these personalities had to the test mostly lies in their giving rise to two different ways of interacting with the lamp.

ANALYSIS

Diary

The participant was asked to take note of her thoughts regarding her experience with the artefact, throughout the test. A dedicated diary was designed, printed and given to the participant to encourage her to write her reflection. However, the participant returned the diary with no text, saying that she had no thoughts to record. Therefore, the diary could not be employed as source of data.

Questionnaire

The participant was asked to complete a questionnaire after the seventh day of testing. The questionnaire was on-line and consisted of 66 questions [3], most of which open-ended.



Figure 18. Prototype in the participant's living room

MARTIJN VAN BEEK

PROFILE	Avid reader
GENDER	Male
AGE	60
LOCATION	Eindhoven, NL
OCCUPATION	Accountant

DESCRIPTION

Martijn is employed in a computer company and he deals with the accountability. He has a rather ordinary life and is a creature of habit. He is not married and has no children. Every day, from Monday to Friday, he gets away from work at 6 pm, has dinner at 7.30 and goes to bed around midnight. During the weekend, he goes grocery shopping, then he goes out for a walk in the park and reads one or two books.

Martijn loves reading and has a passion for crime novels. As he spends many hours in front of the computer at work, dealing with numbers and figures, he takes comfort in narrative. Every evening and during the weekend, he enjoys reading and, sometimes, even writing short stories. In this regard, Martijn hardly renounces to his evening readings, often staying awake until late. As a consequence, he makes a large use of his desk lamp. Martijn is strongly attached to his habit and not enthusiastic about the idea to change them.



Figure 19. Card summarising the persona (Martijn)

The aim was to gain information relevant to the participant's experience with the lamp, pinpointing its major aspects. This information was used as a reference to design the final interview.

The questionnaire addressed two main themes: 1) annoying feedback; 2) social interaction. Each theme was investigated by assessing the related emotions and thoughts of the participant. In particular, it was assessed whether or not an emotional response occurred and, in case it did occur, whether the emotional response triggered thoughts related to the issue energy consumption.

Annoying feedback

As emerged from the answers to the questionnaire, the participant experienced no emotional response in connection with the annoying feedback. In fact, the feedback was not deemed as annoying at all. Moreover, the participant had no thoughts related to the feedback other than that related to its functional purpose (informing about the time elapsed). In synthesis, the participant reported no thoughts triggered by emotions and no emotions triggered by thoughts, as far as the feedback was concerned. As explained later in the interview, the satisfaction that the participant felt regarding the feedback (Appendix – 7) was due its functional value and not to its capability of eliciting particular emotions or thoughts.

Social interaction

As far as the social interaction was concerned, the answers to the questionnaire showed that the social experience raised neither emotions nor thoughts of ethical nature related to the issue energy consumption. The participant clearly stated to have experienced no emotional response with respect to the observation of the other's consumption, nor she reported to have had thoughts of a particular kind. In this regard, the only thought she reported is that related to noticing the other person's presence (in her words: "*not much. Only that I saw when the other person turned on the lamp*"). However, the participant showed the wish to be in contact with the other person and her disappointment for not having received a reaction when trying to communicate to him/her. In the participant's words: "*Was eager to know*

if I would [sic] get a reaction when pushing the orange knob. However, never saw a reaction".

Ethical reflection

It is worth mentioning that the participant did not associate the other person's behaviour (Martijn) to that of a person who consumes much energy and is reluctant to sharing (as the construction of the persona aimed for). In fact the participant deemed the other person's behaviour as "*normal*". Moreover, she thought the other person's level of awareness regarding energy consumption was high enough and that the person should not have behaved differently. Nevertheless, with respect to this last question, the participant clarified that "*I did say 'no' but my answer is that I did not expect anything from the other user only to sometimes react. However, I never saw this*". Therefore, the participant's judgement upon the other person's behaviour was rather limited as she felt scarcely interested in that, having no expectations in its regard.

As better explained later in the interview, the participant's difficulty in expressing a clear judgement upon the other person's behaviour was due to both a sense of extraneousness (partly caused by the lack of a reaction of the other person to her "*warnings*") and a lack of reference to translate a quantitative value into a qualitative one (needed to formulate an ethical judgement).

Behaviour change

With respect to the individual consumption is worth noticing that the participant's choice was influenced, albeit "*rarely*", by the interface of the total quota shared (Appendix – 8). In this regard, the participant was influenced by knowing the amount of energy left. However, in the questionnaire she explained that her choice was driven by the wish to quantify the quota of energy shared and made "*for experimentally [reasons]*". In fact, as emerged later from the interview, the participant wanted to consume the quota of energy shared as soon as possible in order to be able to operate the knob-slider of the related interface. This desire of transgression originated by the participant's need to be in control of the system and by her curiosity (the wish to discover something unknown to her). Interestingly, to a certain extent this phenomenon encouraged the participant to consume more energy rather than less.

Unlike the total quota shared, the visualisation of the other person's consumption had no influence on the participant's choice (Appendix – 9). This confirmed what the participant had previously stated in the questionnaire regarding the scarce sense of social connection with the other person.

Overall, the participant's choice regarding the changes in the individual consumption settings was driven by her own usage of the lamp only. In this respect she reported that her thought was: "*the time is too short*".

Self-assessment

In the last part of the questionnaire the participant was asked to assess her own degree of awareness regarding en-

ergy consumption. The participant deemed herself as highly aware, providing with the following reason: “*Before I turned the button I thought about the hours I would need the lamp*”. As confirmed also in the interview, this thinking over action applying a moral principle (e.g., I should consume no more than I need) was the basis of the participant’s ethical judgement on her own behaviour. Judgement that, it needs to be said, only occurred after the test and during the interview.

Overall, the participant felt that no change occurred because of the experience with the lamp. Her motivation was the following: “*Nothing. I am used to arrange less energy consumption during the years*”. This judgement was expressed again and steadily claimed throughout the interview.

Significance of the data

Albeit the participant’s answers to the questionnaire suggested that the system proved ineffective with respect to the capability of eliciting ethical reflection on the issue of energy consumption, the data gathered were of great significance for the understanding of the phenomenon being investigated. In particular, the information gained through the questionnaire played a decisive role in the preparation of the final interview. The interview became, therefore, the opportunity to understand whether the artefact had proven actually ineffective and, if that were the case, what the reason was.

Interview

Location

The interview was semi-structured, favouring the conversation between the participant and the researcher aimed at gaining a deep understanding of the participant’s experience. The conversation was video-recorded under the participant’s consent. The interview took place on 6th June 2017 at the participant’s house after 11 days of testing and lasted approximately 45 minutes (Appendix – 10).

The interview mainly focused on the themes of social interaction and ethical reflection on energy consumption, with particular regard to the participant’s value system and behaviour related to sharing energy with other people.

Analysis process

The analysis of the data collected was entirely executed by means of NVivo 11 Pro (free demo version), a professional CAQDA (Computer Assisted Qualitative Data Analysis Software). The process consisted of the following steps:

- 1) Division of the raw data (video-recorded interview) into three manageable chunks of approximately 15 minutes;
- 2) Transcription of the entire conversation (e.g., Appendix – 11). Thanks to the functionality of the data analysis software, each group of lines of conversation was divided and automatically associated with the relevant excerpt of video. This allowed the researcher to watch separately each single excerpt and to be able to take notes rapidly.

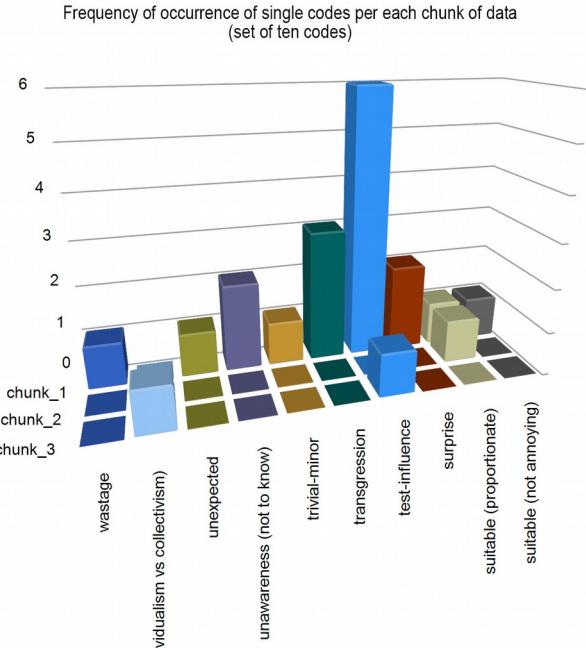


Figure 20. Frequency of occurrence of ten codes in the data sources

3) Coding of the chunks of the transcript following the relevant established practice in the grounded theory method [52]. The codes were created and assigned to the transcription text, resulting in 53 units.

4) Re-coding of the entire text through annotations. Each line of text previously coded was accurately inspected and commented with a side annotation. The annotations served as a first degree of interpretation of the text, giving rise to the creation of new codes or the relocation of those already created. This step was crucial in determining the relevance of each single code to the associated line of text in terms of meaning.

5) Categorising the codes by grouping them in clusters. After several iterations, 14 categories were created (see the section Categories). It is worth mentioning that clustering the codes allowed the researcher to better identify their meaning, moving from a particular and yet superficial understanding to a more abstract and profound one.

6) Clustering the categories in themes. This phase entailed a first actual interpretation of the participant’s experience. In this respect, the themes aimed at grasping subtle and implied meanings while trying to explain the related aspects of the phenomenon (so constructing meaning). Four main themes were created (see relevant section).

7) Bridging towards the construction of a theory. An extensive comment/explanation of each theme served as an intermediate step towards the theoretical construct. This step prevented the dispersion of concepts and meanings condensed in each theme. Moreover, this phase ensured that the

theory was actually relevant to the themes and that sprang from their interpretation.

8) Theory construction as synthesis of the concepts emerged from the themes. This crucial step aimed at formulating an abstract concept able to explain the reason for the occurrence of the phenomenon as it was observed. This concept was the final part of the interpretation, crucial for answering to the research question.

Coding

The entire text (transcript of the interview) was coded and re-coded with the addition of explanatory annotations (Appendix – 12). Appendix 13-14 show the list of codes created. In addition, the data analysis software allowed to create an interactive file where to visualise the annotations and link them to the associated line of transcript (e.g., Appendix – 15). This function helped the process of re-coding and clustering. Lastly, the frequency of occurrence of each single code per chunk of data was analysed (Appendix – 16).

The codes were divided in five sets of approximately ten units each and visualised in charts (Appendix – 17). **Fig.20** shows the frequency of occurrence of a set of ten codes in each of the three chunks of data. This visualisation allowed to rapidly identify the most significant codes and related topics. It is worth mentioning the codes that occurred more often throughout the transcript analysis: *non-relatedness* (10 times); *bias-belief (liberalism)* (8 times); *pragmatism* (7 times); *test-influence* (6 times). Once identified these main codes, it was possible to link back to the associated annotations and lines of transcript to further evaluate them.

A brief description of these main codes can give the reader an account of the participant's experience.

Non-relatedness, the most frequent code used to label the transcript related to the lack of social interaction that the participant reported. The participant words clarify this: “*But...there was no interaction*” or “*No...[shakes her head again]. I didn't...because I didn't...because I didn't realise about the energy, you know? The connection*”. Although aware of the functioning of the system, the participant said that she “did not realise” about the connection. In other words she felt as if there were no connection at all. One of the reasons for this was the lack of reaction when she pressed the “warning push-button” placed on the other person's consumption interface. However, other factors played a role as e.g. the anonymous character of the social connection (*anonymity* is a related code that emerged). Overall, the participant showed to have not established a relationship with the connected person. Moreover, she was not able to relate her own consumption with her sharer. As a result, she considered the total energy quota visualisation only in relation to her own individual consumption.

Bias-belief (liberalism) related to all those ethical judgements expressed by the participant regarding one's own individual freedom. These concepts (e.g.: “*Yes but, because I cannot be responsible for all the others [...] J*”) were used by the participant to explain her reluctance to judge others' behaviour and to be judged by others. This explanation sounded as a justification as if the participant felt to be accountable for not wanting to express a value judgement. In this regard, two principles seemed to clash against each other during the conversation (individualism vs. collectivism).

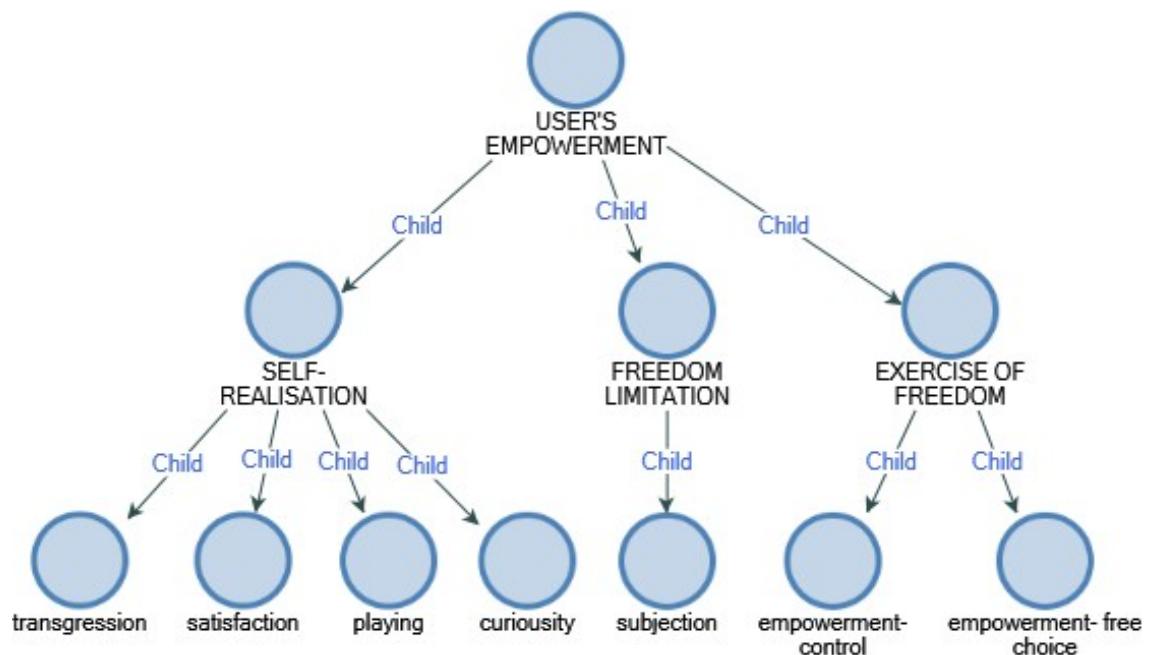


Figure 21. Diagram of one category, its sub-categories and related codes

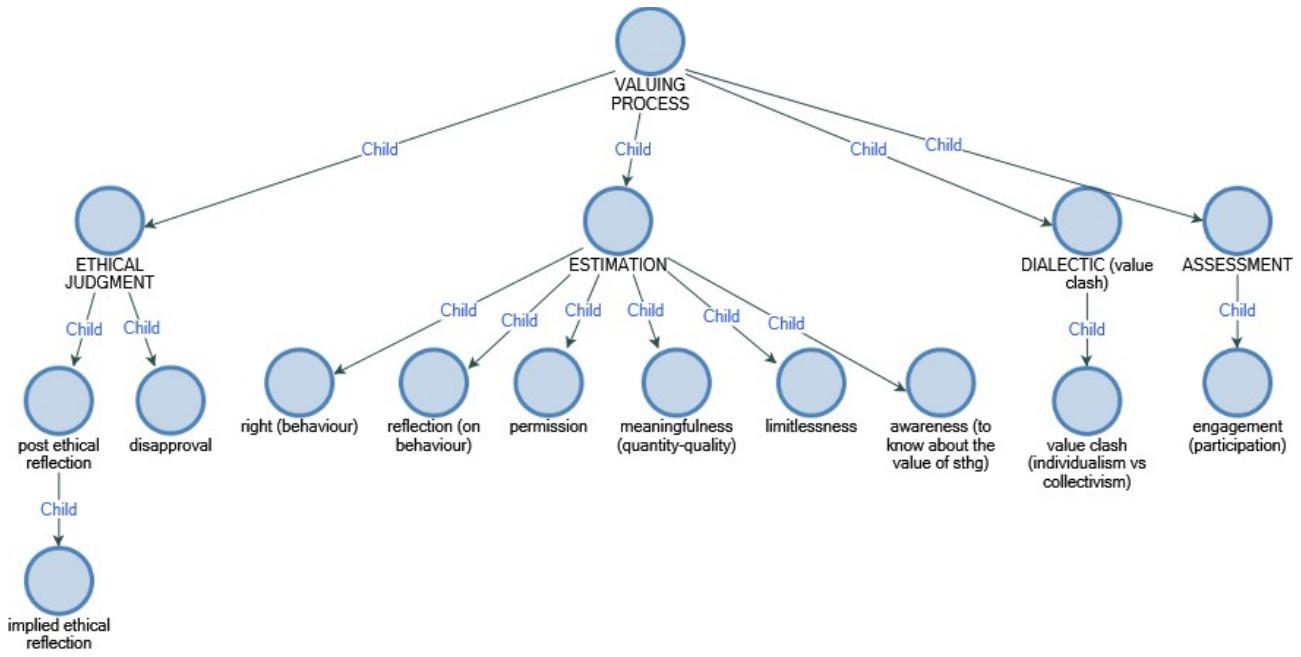


Figure 22. Category *Valuing process*

The participant's belief regarding individual freedom proved primary with respect to the principle of sharing a common resource. Although she acknowledged her right to intervene in case of an abuse of a common resource perpetrated by other people (e.g., the other people's wastage of common water) as well as the rightness to do so, she deemed she was not allowed to intervene in virtue of individual freedom. This strong bias from the part of the participant heavily influenced her behaviour and mindset throughout the test. It is worth mentioning that the code *bias-belief (liberalism)* was strongly related to others such as *social pressure (culture)*; *individualism*; *value-clash (individualism vs. collectivism)*. Overall, the participant's value system played an essential role in the way she experienced the design and the way she related to it.

The code *Pragmatism* related to the participant's inclination to value the practical aspects of the interaction with the system. A quotation from the interview can give a clear account of this slant: "...*I don't have so much emotion with something I use*". In this part of the interview the conversation addressed the emotional response to the shape-change based feedback. For the participant, the meaningfulness of the experience was limited to the practical value of the feedback, with no space for emotions of any sort. In this respect, the following participant's words were illuminating: "*Yes OK, it was meaningful because I could use it but that was it, I don't have anything else to say anymore*". This pragmatic attitude was related to both the participant's cultural background and her personal character (related codes were: *rational*; *non-emotionality*; *non-relatedness*). All in all, the participant's pragmatic inclination was the main

reason for not experiencing any emotional response to the feedback.

The code *test-influence* deserves to be mentioned for its significance with respect to the participant's valuing process. This code was used to label the participant's reluctance to experience the interaction as "real". In fact, despite her being able to interact with a tangible and entirely working artefact in her own everyday environment, she thought and behaved as if the interaction were fake. In other words, the participant was resistant to "perceiving" the experience as part of the ordinary life. She deemed the experience with the lamp as fictitious or artificial. In this respect the code *extraordinary* better grasps the meaning of this phenomenon. Although real, the participant deemed the interaction as extraordinary and, therefore, to be valued as less serious (or important). This extraordinary character of the experience is linked to the fact that the participant felt to be involved to help someone else (e.g., the researcher who asked her to participate), rather than feeling engaged firsthand. Proof of this were the following words from the interview: "*Yeah but...I didn't know I had to think about that. I was...no...no, you didn't tell me and...that I had to think about that*". The participant's disengagement was due to considering the experience as something impersonal, not belonging to her. All things considered, knowing to be part of an experiment made the participant underestimate the value of all the aspects related to the experience, from the energy consumption awareness to the social interaction and related ethical implications.

Categorising

The codes were grouped into 10 main categories and 14 related sub-categories (Appendix – 18 to 22). Fig.21 shows

the conceptual map of one category and its connections. In the maps the capital letters distinguish categories and sub-categories from the codes (small letters). By identifying clusters of categories the codes started to acquire meaning with respect to the actual context they referred to (Appendix – 23 and 24). For the sake of conciseness, only three categories are here mentioned: 1) *Valuing process*; 2) *Sense of non-relatedness*; 3) *Yardstick (means for judging)*.

Valuing process

The category *valuing process* grouped all those codes related to the participant's process of attributing values to something both tangible and abstract. Four sub-categories were identified: *ethical judgement*; *estimation*; *assessment*; *dialectic (value-clash)*. These sub-categories allowed the researcher to reduce the ambiguity of some codes such as *disapproval* and *permission* (Fig.22), so making sense of what the participant meant when expressing a particular thought/concept.

A significant aspect of the participant's valuing process was the tendency to make estimations in order to attribute value to something. The category *estimation* (loosely meant as estimate or calculation) grouped the codes relevant in this respect. A relevant example is the participant's thought regarding the estimation of her consumption in relation to that of others. She clearly expressed the need for estimating specific needs in specific situations to be able to value the appropriateness of a certain consumption of energy. In other words, she needed to quantify in order to qualify. Her words about this point were: "It's...well it depends I mean, I live alone here and if I have other persons who live alone, then it would make sense. But if it's a family then you cannot compare". This specific thought shared a relationship with the category *yardstick (means for judging)*. This need for estimating also played a role in "negative" as the participant showed to have had difficulties in quantifying the total energy quota and therefore in valuing its character as, e.g., precious. In this respect, the participant's estimate was based merely on the awareness of being free to "re-fill" the total energy quota once the latter was depleted. Therefore, her estimate of the amount energy available (e.g., time) was that of a limitless resource. As a result, the lack of parsimony in the energy use was not deemed as wrong or an issue at all. Rather, for the participant there was no need to worry about the depletion of energy. In this regard the participant said: "No I wasn't, I thought OK, if it's out [depleted] then [she mimics moving up the knob as saying that she would have filled it up again] [...] As I said I could just turn it on again". This last thought also related to the category *need for guidance* and, in particular, the sub-category *sense of limit*.

Sense of non-relatedness

The detachment experienced and then expressed in the interview by the participant had different forms. In particular, three sub-categories grouped such forms: *non-relating with a value system*; *out of ordinary (unreal)*; *lack of social rela-*

tion. The first form of non-relatedness regarded the participant's difficulty in relating with a message that challenged her self-confidence. She considered herself aware of energy consumption and totally unrelated to a process of transformation that the experience with the artefact was meant to give rise to. An excerpt from the interview clarified this aspect (G is the interviewer and A is the interviewee):

"G: do you feel changed because of this [because of the experience with the lamp]

A: No, I don't feel changed

G: why do you think this didn't change you?

A: My behaviour?

G: your behaviour; your mind, whatever. Any kind of change.

A: [shakes her head]

G: why do you think wasn't that effective?

A: Why should it?"

The participant felt no relation whatsoever with the underlying ethics of the design. This reluctance was partly due to the participant's personal beliefs (in this regard, another relevant category is *individual value system*).

A second form of non-relatedness was the participant's perception of being *out of the ordinary*. Albeit in her own everyday environment, interacting with a fully working system, the participant perceived the experience as fictitious or artificial. The following words were repeated several times during the interview: "[...] yeah I mean, this is a user test. That's the way I talk about it". The participant behaved as if the experience did not regard herself, as if it were impersonal. As a result, in the conversation she tried to justify herself mentioning the fact that she had not been instructed properly regarding what to do and what to pay attention to (e.g., "I didn't know that I had to be worried about it" or "Yeah but...I didn't know I had to think about that. I was...no...no, you didn't tell me and...that I had to think about that"). In short, she experienced the interaction as a sort of rehearsal to be performed in view of her commitment with the researcher.

The third form of non-relatedness derived from a lack of reaction from the part of the other people the participant believed to be connected to. As previously mentioned, the participant was disappointed by this lack of a tangible sign of connectedness. It needs to be said that this failure in the participant's feeling of being connected was partly due to the scarce responsiveness of the system as far as the social interaction was concerned. Despite the personae and wizard of oz method be effective tools for testing in that specific scenario, the program of the interaction designed (coding and system's behaviour) proved not entirely appropriate in this respect. However, such failure made possible to observe a significant aspect of the participant's behaviour. The participant showed to be curious and expected a reaction from the other side. Moreover, as already mentioned, she felt disappointed when such reaction failed to occur. All

these feelings suggested two important aspects: 1) an underlying interest in being connected socially; 2) the need for tangible signs of such connectedness, where continuity and reciprocity are essential components.

Yardstick (means for judging)

The participant repeatedly reported a lack of reference to formulate a judgement about the energy consumption. Regarding the total energy quota the participant said: “*and if it was really necessary then I would have...yeah well if they say: 'you have that time (she mimics with her hands a portion), that's what you get... 'then you use it differently”*. This thought also sheds light on how this lack of reference influenced the participant’s valuing process, that is, assessing whether or not the her own consumption was excessive and, in turn, whether her own behaviour was right. In this respect the participant expressed the need to have clear bearings: “*but it's different if you told me you've that certain [she mimics a portion with her hands] amount of time, you've to do with it”*”. This thought is also related to the category *need for guidance*. Moreover, this need for clearer references is confirmed by what the participant said regarding the overview of consumption she regularly receives from the energy provider: “*I already get it, I already now get a...you can compare at the energy site [website = the website of the electricity company]*”. The participant’s awareness of her average consumption also worked as a yardstick in her own experience with the lamp. Overall, having a yardstick to assess the quantity of energy consumption was for the participant directly influencing her valuing process (so the implicit ethical judgement upon her own behaviour).

Emerging themes

Four themes were created, moving towards the final interpretation of the data analysis (**Fig.23**). The themes were the result of an interpretative process, where the main objective was to grasp the underlying meaning of each cluster of categories to which a single theme was deemed to be related (Appendix – 25 for a larger view of the diagrams).

Theme 1

The influence of cultural background and available means for judgement, in the valuing process and related (user’s) behaviour. This theme is a concept that emerged from the following categories: *Valuing Process*; *Yardstick*; *Individual value system*.

Theme 2

The role of personal attitude in change resistance. This theme resulted from the following categories: *Personal attitude*; *Change*.

Theme 3

In search of meaningfulness: lack of guidance and clear bearings as main cause of social disconnectedness. This theme emerged from the following categories: *Sense of extraneousness*; *Need for guidance*.

Theme 4

Self-empowerment, exploration and freedom as prerequisites for change. This theme emerged from the categories: *User’s empowerment*; *Need for balance*; *Realising (getting to know)*.

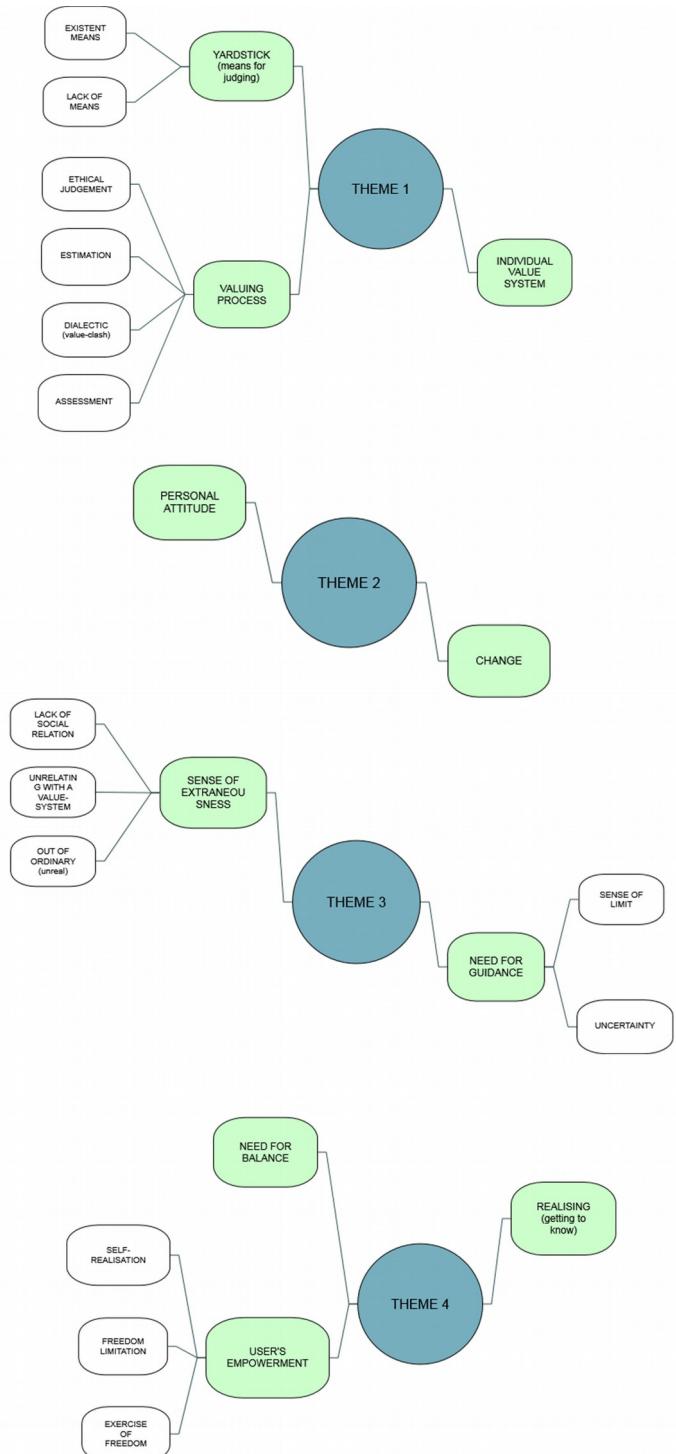


Figure 23. Themes emerging from the categories

Bridging (towards an interpretation)

The key-concepts contained by each theme were summarised to both avoid dispersion of meaning and facilitate the process of interpretation (e.g. Appendix – 26). The summaries were then merged together. This synthesis resulted in a theoretical construct aimed at explaining the phenomenon being investigated (ethical reflection about energy consumption sprung from the interaction with an intelligent system).

Theoretical construct

In users' behaviour a set of values and beliefs is crystallised, partly originating from the specific cultural context the people in question live in. Although not explicit, these values are expressed through the users' behaviour and, most importantly, through their choices. This means that the process of value attribution and, therefore, the ethical judgement that justifies certain actions (e.g., saving electricity) is often tacit and not reasoned upon. It can be said that the ethical reasoning behind a certain behaviour remains covered by the "blanket" of habits and taken for granted most of the times. In this character of "subconsciousness", the cultural background of a person, that is, the value system structured and adopted by him/her through the years because of the social context he/she has been living in (see the case of liberalism in the analysis) plays a crucial role in driving the person's choices and behaviour (e.g., in relation to whether or not being open to sharing). Beside the value system (e.g., social pressure), the means available for estimating (references for quantification) are essential for the person's capability of forming a value-reference that guides his/her own behaviour. Whether this value is explicitly expressed in the form of an ethical judgement (mentally or verbally) seems not to be crucial as it may be implicit in the person's action. In other words, the person needs to quantify in order to qualify and this may happen without an explicit ethical reflection of the person. In this regard, the person involved is constantly in search of meaningfulness, that is, the opportunity to move from quantification to qualification in a constant and tacit loop. A loop that seems to manifest itself more in the person's action than in his/her own thoughts. In order to be able to perform this "loop", the person needs a guidance that gives him/her not only a relevant reference, but also a sense of certainty. However, the specific values the person adopts or tacitly expresses through his/her own behaviour can clash against those expressed by the design he/she is experiencing (and therefore against those values the designer is trying to convey). This clash against values can result in the person not being ready or available to change (see clash between individualism and collectivism in the analysis). In relation to the specific test conducted, as the sharing experience and the transformation process entailed the adoption of certain values (e.g., being responsible for each other), an opposite value system from the part of the participant (e.g., being responsible for one's own) produced a value-clash. This phenomenon showed as biases may eventually make the user involved change-

proof. The person's resistance to change may also originate from his/her own specific personality, which can prove more or less open to change. In this regard, an enduring value-clash seems to be destined to heavily hamper the opportunity for social interaction and, more in general, social connectedness. In turn, a social disconnectedness limits the potential for individual transformation (e.g., the person remains attached to his/her own habits regardless of others). Finally, the need to be in control of the situation remains a vital requirement for the acceptability of transformative experiences. In this respect, during the test the participant expressed a desire to transgress rules that she was not in the position to change. This desire brought about a more profound need for empowerment. Empowerment to be accomplished through the person's possibility to know and act freely.

RESULTS

Main understanding

- 1) The user's cultural background and personality can hamper the transformation process to the extent that the related values clash against those implied in the interactive experience (e.g., values conveyed by the design/artefact).

With particular regard to the study here illustrated, a clash was observed between two opposite values: individualism and collectivism. The related ethical stances can be summarised as *everyone is responsible for his/her own* (individualism) and *all are responsible for each other* (collectivism). Despite this simplification, the dialectic between opposite values made the phenomenon investigated be of political character. In this respect, the celebration of individual freedom to the detriment of common interest is part of the tradition of liberalism. Conversely, the ethics based on the principle of an interdependence amongst individuals in society mostly belongs to socialism. Therefore, beside the understanding that users' personal beliefs can make the latter change-resistant, in the specific context of this study, a particular value system proved incompatible to the idea of transformation promoted by the artefact. In other words, the value-system ascribable to liberalism can hamper the user's transformation process towards a higher awareness of energy consumption to the extent that this awareness means accepting the ethical value of social interdependence.

- 2) The user's personal inclination (e.g., personality) can neutralise the strategies employed by the designer and embodied in the design to foster social transformation.

In this study, the participant's pragmatic personality made the strategy of the aesthetics of annoyance ineffective with respect to a perspective of transformation. The emotional aspects of the interaction with the artefact played a marginal role in the participant's experience. Such marginal role of emotions was also observed in the social part of the interaction. This also sheds light on the limitations of the concept of social translucence when applied to a real context. Overall, this phenomenon suggests that the design can fail to

achieve the user's transformation to the extent that does not properly take into consideration the subjective character of the user experience.

3) A lack of a reference to make comparisons is reflected on the users' incapability of assessing and, therefore, expressing a value judgement. As a consequence, the meaningfulness of the experience is lost and so the social relatedness related to it.

In the present research it was observed that the participant had not enough references to express a relevant value judgement regarding the energy consumption of both herself and the other people connected to her. Although she could constantly visualise her own consumption and that of the other person currently connected, she had no references to quantify and express a value judgement. It is worth mentioning that the participant was in search of meaningful references to compare her own habit with that of others. In this regard, to be meaningful a reference needs to be related to a certain practice or use (e.g., leaving the light on in the bedroom for the whole night). Therefore, the social interaction becomes meaningful when the user has the opportunity to make comparisons that are contextualised. In other words, the user's conceptual representation of energy use needs to be linked to actual everyday practices, where the use of energy translates in the way objects/systems are used. In this respect, for the user it is crucial to know how and why these objects/systems (designed world) are used by others and then being able to make comparisons. A lack of meaningfulness of the kind above described results in a loss of social relatedness and the impossibility for the user to express value judgements.

4) The opportunity for the user to take control in the interaction is a prerequisite for his/her availability to change. The user's empowerment fulfils an inclination to decision-making and exploration, making the experience relevant personally.

In this study, a desire for transgression and a will to access to a denied source of knowledge were observed. This phenomenon was partly due to the impossibility for the participant to have full control over the interaction. The participant showed a curiosity that led her to a "playful subversions" of the rules. In other words, transgressing the rules became a game, a game to exercise the denied power (full control over the interaction). Therefore, the user's empowerment is a pre-condition to avoid the user to "work against transformation".

5) The values underlying users' choices and action are often tacit and not reasoned upon. Therefore, users can express certain beliefs through their everyday practices without claiming them verbally or pondering on them. This suggests that user's change occurs through practice (e.g., behaviour) and in the absence of deep ethical reflection.

In the study it was observed that users' values were tacit and implied in her behaviour. This sheds light on the fact that the user's dynamics of value-change occurs through practice, being bonded to it. Therefore, transformation can happen without deep pondering about ethics and values. However, the lack of ethical reflection may leave room for manipulation and unaware persuasion. In synthesis, ethical reflection is necessary in the light of a change that is entirely driven by the user (deeper awareness).

Answering the research question

This study can be considered as a first step towards the understanding of **how to design intelligent artefacts able to elicit ethical reflection on the issue of energy consumption**. Although this query cannot be entirely answered, the study provided with significant elements of knowledge that can address future research on the same matter.

Following the main understanding gained through this research, four main points can be identified in relation to the research question:

1) In order to achieve the user's transformation (through ethical reflection), the design needs to take into account the user's value system, that is, her/his own cultural background and personal life experience.

This entails that in the case of a contradiction between the values expressed by the designer (through the artefact) and those expressed by the users (through practice), the design should be able to adapt and change its strategic characteristics, working on mediation and compromises.

2) The interaction, both social and individual, needs to be meaningful with respect to the user's everyday practices, allowing the user to express and attribute values.

In this respect, the design should make the user able to relate the abstract notion of energy consumption to contextualised practices through which energy is used.

3) The first role of the user in the interaction needs to be guaranteed to avoid the user to "subvert" the principles underlying the design.

The design should leave room for the user's decision-making and action, even when this means leaving the user the possibility to neutralise the transformational character of the interaction (e.g., disabling the annoying feedback). However, the user's tendency to transgress the rules established by the functioning of the design may be used in favour of a certain kind of transformation. In other words, the "game of transgression" may be used as a leverage to make the user question specific values and practices.

4) The design should give the user the opportunity to make explicit the values that are implicit in her/his own everyday practices. Therefore, the interaction should enable a "visualisation" of one's own values in relation to practice.

In this respect, beside fostering ethical reflection, the design should provide the user with means for “visualising” his/her own values (either tangibly or abstractly) in relation to his/her own everyday practices and those of others.

DISCUSSION

About the method

In the study here illustrated, the iterative character of the design process was reduced to the minimum in order to guarantee a high quality prototype while meeting the project deadlines. The refined artefact finally met the requirements envisioned in the concept phase, proving consistent with the desired characteristics. On the other hand, the opportunities to gain significant insights from users were limited to the very final stage of the research. In this respect, having performed multiple user-tests with small prototypes would have led to a more rapid understanding of strengths and weaknesses of the concept. Nonetheless, maintaining the unity of the artefact gave the researcher the opportunity to test a higher level of complexity of the system. Such a complexity gave rise to a deeper investigation in terms of meaning and understanding of the user’s experience (see the interview).

In synthesis, the research method proved fruitful with respect to the aim of understanding the phenomenon being studied. However, future research may consider a more iterative process based on larger user studies. In this regard, a diversified set of data collection methods may better respond to the specific needs this line of research revealed to have. E.g., the study found that the user’s cultural background plays a crucial role in determining his/her availability to change. Therefore, an ethnographic approach to the research may prove suitable to understand the role of culture in the design for ethical and behavioural transformation.

Limitations

Beside the implications of adopting one research method instead of another, the technical limitations influenced the outcome of this research. The following constraints are part of a non-thorough list of issues to be addressed in future research.

1) The amount of hours of daylight available influenced the participant’s use of the artefact, limiting the interaction to the evening time. Therefore, seasonal weather conditions should be taken into account when conducting research on the topic of energy consumption. In particular, conducting the research and the related user-tests in winter time would provide with more data than conducting the study in other periods of the year.

2) In this study, the social interaction sought failed to occur because of a variety of issues. One of these issues was the lack of a real connection between multiple participants. This connection was replaced by the autonomous character of the interface that in the system was meant to enable social interaction. It needs to be said that a higher responsive-

ness of the interface, that is, a more complex code able to respond to the participant’s action, might have proved more effective with respect to the capability of enabling social interaction. However, future research on this topic should involve a minimum of two people in order to truly test the effects of social interaction in ethical and behavioural change.

3) As far as the information regarding the participant’s behaviour was concerned, the present research only relied on what the participant stated in the final interview. In future studies of this kind, keeping track of the actual flow of interaction may be useful with respect to the understanding of the user’s behaviour and choices. From a technical point of view, this tracking system can be achieved rather easily (e.g., an SD card and dedicated shield on the microcontroller). Such implementation would prevent bias memory as well as deliberate omission of information from the part of the user.

CONCLUSION

The research provided with significant elements of knowledge regarding how to design intelligent artefacts able to elicit ethical reflection on the issue of energy consumption. In fact, the artefact employed in this study proved ineffective with respect to the capability of eliciting the user’s ethical reflection on energy consumption. Both annoying feedback and social interaction were fruitless in this respect. However, the analysis of the user experience allowed the researcher to gain a deeper understanding of the phenomenology of awareness in interaction. By analysing the reasons for a lack of change and ethical reflection in the participant’s experience, it was possible to identify some theoretical principles relevant to the research on design for transformation.

In particular, four main points were identified:

1) *Need for a design artefact that is tailored into the user’s context.* The design needs to be flexible in its strategies for promoting transformation. This means that annoyance/fulfilment and the concept of social translucence may be replaced by other strategies based on mediation and compromise if the user’s value system is likely to clash against the values underlying annoyance/fulfilment and social translucence.

2) *Clear reference between the abstract notion of energy consumption and the user’s everyday practices through which energy is used.* The design needs to provide the user with the opportunity of linking energy consumption with his/her own practices and those of others. In this respect, the possibility to make comparisons is essential for attributing meaning to the interaction as well as to the overall experience.

3) *User’s empowerment through a full control over the interaction.* The design should make the user lead the interaction. However, the design can also use the limitation of the user’s control as a leverage to promote specific actions.

4) *Making explicit the values underlying the user's everyday practices.* The design should provide the opportunity to "visualise" user's values that are tacit and taken for granted as bonded in practice (e.g., the values underlying the behaviour related to energy consumption).

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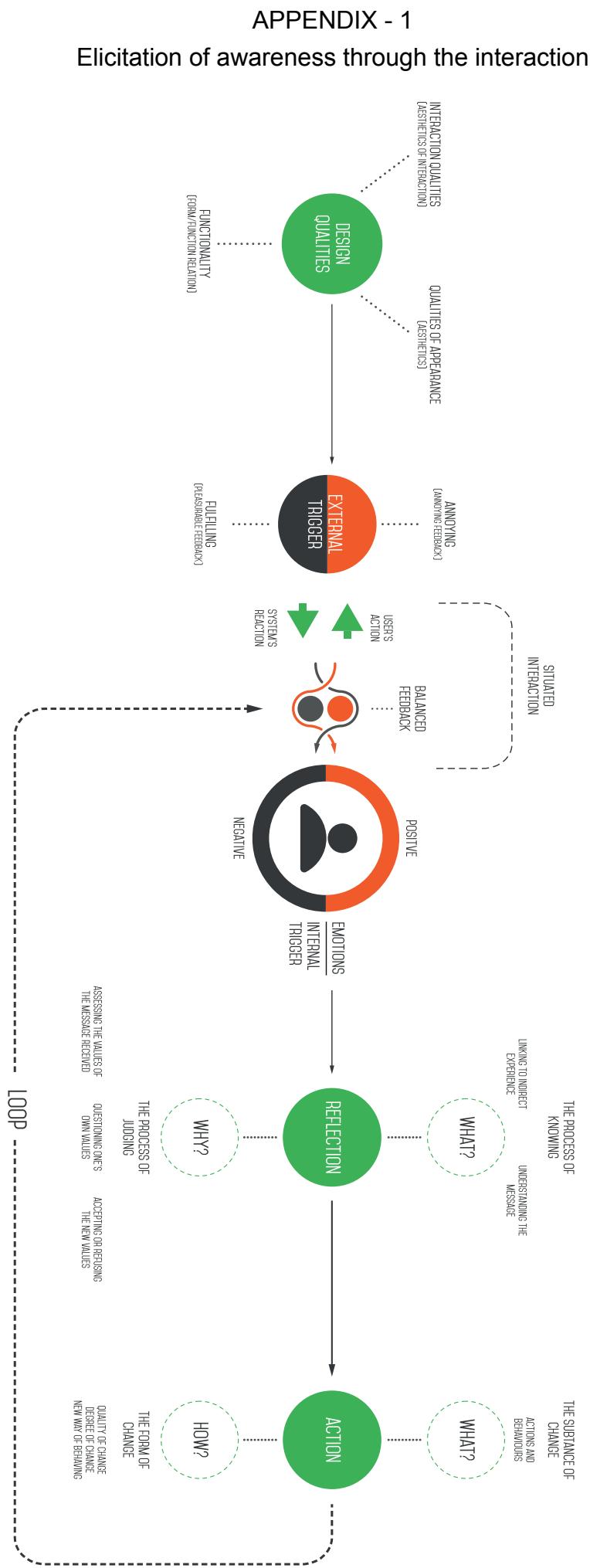
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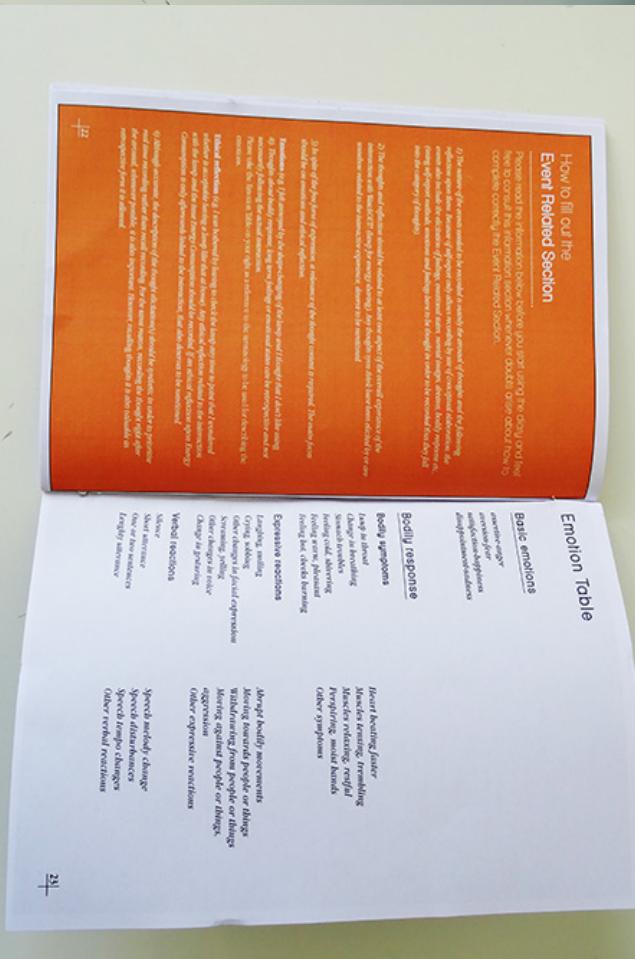
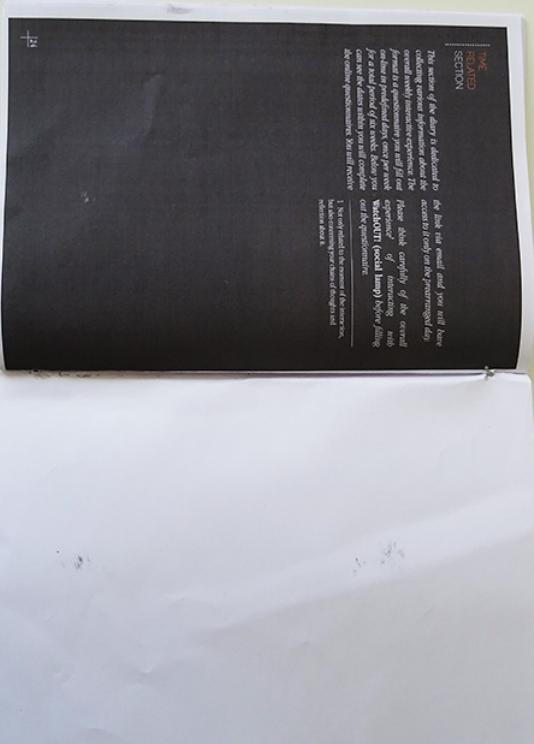
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DOUBLE-SIDED INTERACTION DYNAMICS



APPENDIX - 2

Diary



APPENDIX - 3
Prototype in the field

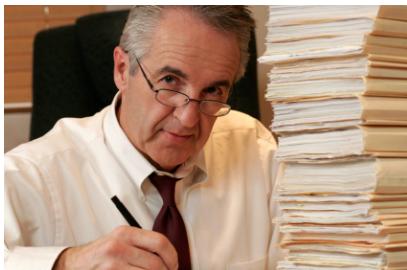


APPENDIX - 4

Cards summarising the personae

MARTIJN VAN BEEK

PROFILE	Avid reader
GENDER	Male
AGE	60
LOCATION	Eindhoven, NL
OCCUPATION	Accountant



DESCRIPTION

Martijn is employed in a computer company and he deals with the accountability. He has a rather ordinary life and is a creature of habit. He is not married and has no children. Every day, from Monday to Friday, he gets away from work at 6 pm, has dinner at 7.30 and goes to bed around midnight. During the weekend, he goes grocery shopping, then he goes out for a walk in the park and reads one or two books.

Martijn loves reading and has a passion for crime novels. As he spends many hours in front of the computer at work, dealing with numbers and figures, he takes comfort in narrative. Every evening and during the weekend, he enjoys reading and, sometimes, even writing short stories. In this regard, Martijn hardly renounces to his evening readings, often staying awake until late. As a consequence, he makes a large use of his desk lamp. Martijn is strongly attached to his habit and not enthusiastic about the idea to change them.

ALEXANDRA ANASTOS

PROFILE	Dutiful person
GENDER	Female
AGE	28
LOCATION	Amsterdam, NL
OCCUPATION	Cashier



DESCRIPTION

Alexandra is employed in a large store of home appliances as a salesperson. She is very dedicated and dutiful in her job as in her life. This sense of duty often goes beyond what is expected from her or what is asked her, giving rise to intransigence towards whom does not follow the rules. Such a rigidity is exacerbated by her constant attempt of adapting to the Dutch society (she moved to Netherlands a couple of years ago from Greece).

Alexandra has a regular life: she works every day from 9 am to 5 pm and on Saturday morning from 9 am to 14 pm. She likes walking and doing sport. Beside, she likes watching films and reading novels. However, her readings are usually light and rather short ones. She mostly prefer to watch the TV. Alexandra does not make much use of her desk lamp as she reads occasionally. Moreover, because of her high sense of duty, she is ready to change her habits if new rules impose her to do so.

APPENDIX - 5

Time table for the autonomous behaviour of the other user's consumption interface (Martijn)

Based on the proto-persona Martijn, the time table was used to write the code (in Arduino software) to be uploaded to the other user's consumption interface. Using a DS1307RTC module for Arduino it was possible to trigger specific events in different days/times of the week.

Program for a week:

Day	Sequence	Duration
1	a. Switch on till ¾ of the ring (red LED) simulating a scrolling to set the indiv. Consumption. b. switch to green and then counting down.	From 20.15 to depletion. (Trigger at 20.15 hrs else OFF. After depletion OFF).
2	a. Switch on till ¾ of the ring (red LED) simulating a scrolling to set the indiv. Consumption. b. switch to green and then count down. c. pause (LED currently on for one hour) d. switch to green and count till zero.	From 20.30 to 22.30 then pause of one hour and from 23.30 to depletion. (Trigger at 20.30hrs else OFF. After depletion OFF).
3	a. Switch on till 90% of the ring (red LED) simulating the scrolling. b. switch to green and count down	From 21 to depletion. (Trigger at 21hrs else OFF. After depletion OFF).
4	a. Switch on till 100% of the ring (red LED) simulating the scrolling. b. switch to green and count down	From 21 to depletion. (Trigger at 21hrs else OFF. After depletion OFF).
5	a. Switch on till 80% of the ring (red LED) simulating the scrolling. b. switch to green and count down c. switch on till 100% again e. count down	From 19.30 to depletion. Start again (whatever the time is) and go to depletion (trigger at 19.30 else OFF. After the second depletion OFF).
6	a. Switch on till 65% of the ring (red LED) simulating the scrolling. b. switch to green and count down c. pause (LED currently on for three hours) d. switch to green and count till zero.	From 20.00 to 21.00. Pause of two hours. From 23.00 to depletion. (trigger at 20.00 else OFF. After depletion OFF).
7	a. Switch on till 100% of the ring (red LED) simulating the scrolling. b. switch to green and count down c. switch on till 100% again e. count down	From 19.30 to depletion. Start again (whatever the time is) and go to depletion (trigger at 19.30 else OFF. After the second depletion OFF).

APPENDIX - 6

Time table for the autonomous behaviour of the other user's consumption interface (Alexandra)

Based on the proto-persona Alexandra, the time table was used to write the code (in Arduino software) to be uploaded to the other user's consumption interface. Using a DS1307RTC module for Arduino it was possible to trigger specific events in different days/times of the week.

Program for a week:

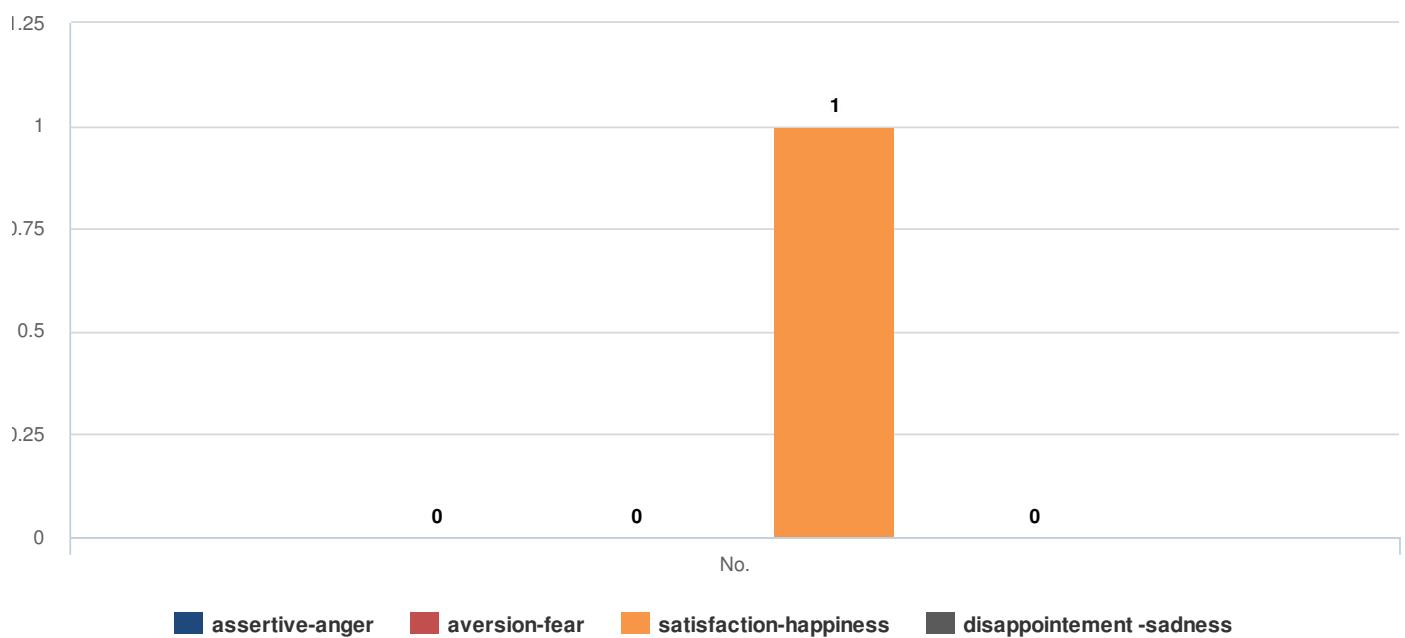
Day	Sequence	Duration
1 (2 nd June)	a. Switch on till 1/3 of the ring (red LED) simulating a scrolling to set the indiv. Consumption. b. switch to green and then counting down.	From 20.15 to depletion. (Trigger at 20.15 hrs else OFF. After depletion OFF).
2 (3 rd June)	a. Switch on till 1/3 of the ring (red LED) simulating a scrolling to set the indiv. Consumption. b. switch to green and then count down. c. pause (LED currently on for one hour) d. switch to green and count till zero.	From 20.30 to 22.30 then pause of one hour and from 23.30 to depletion. (Trigger at 20.30hrs else OFF. After depletion OFF).
3 (4 th June)	OFF	OFF
4 (5 th June)	a. Switch on till 3/4 of the ring (red LED) simulating the scrolling. b. switch to green and count down	From 19 to depletion. (Trigger at 21hrs else OFF. After depletion OFF).
5 (6 th June)	a. Switch on till 1/2 of the ring (red LED) simulating the scrolling. b. switch to green and count down c. switch on till 1/2 again e. count down	From 19.30 to depletion. Start again (whatever the time is) and go to depletion (trigger at 19.30 else OFF. After the second depletion OFF).

APPENDIX - 7

Excerpt from the questionnaire report

What emotional state did you experience when receiving the shape-change feedback?

#	Question	No.	%
3	What emotional state did you experience when receiving the shape-change feedback?	1	100%
	assertive-anger	0	0%
	aversion-fear	0	0%
	satisfaction-happiness	1	100%
	disappointment -sadness	0	0%

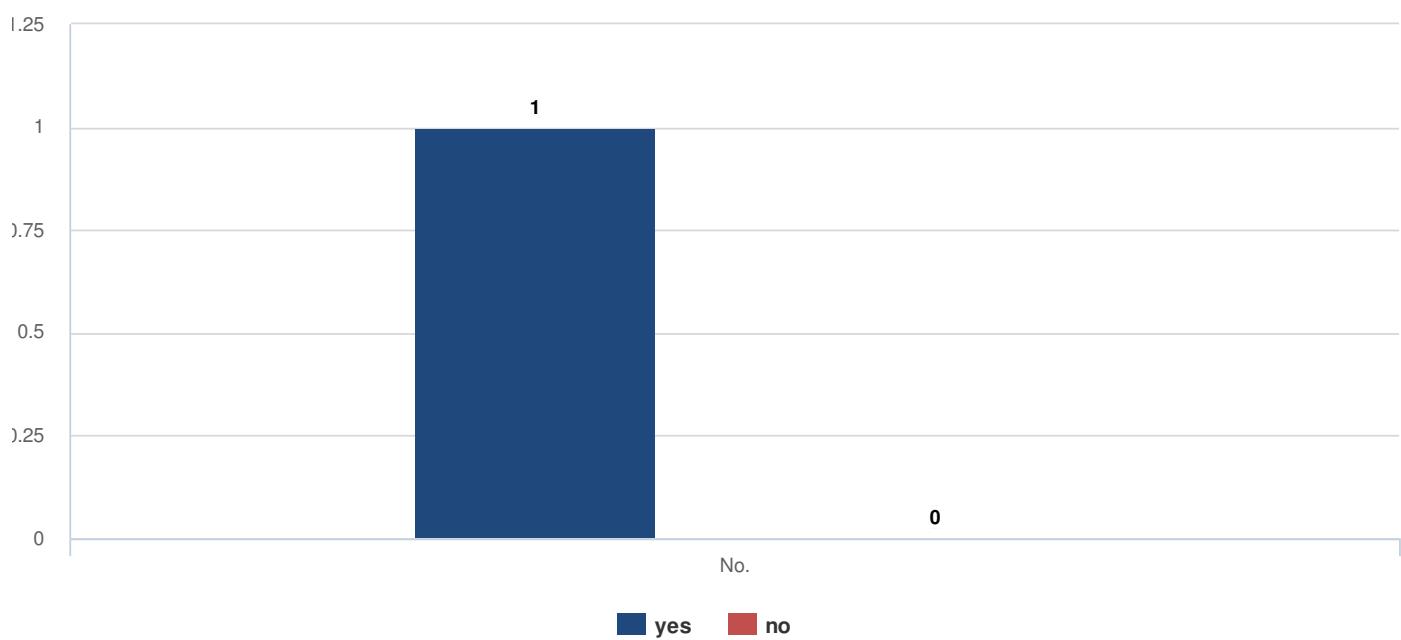


APPENDIX - 8

Excerpt from the questionnaire report

Have you ever adjusted your own (estimation of) consumption on the basis of the energy left (the total consumption LED strip)?

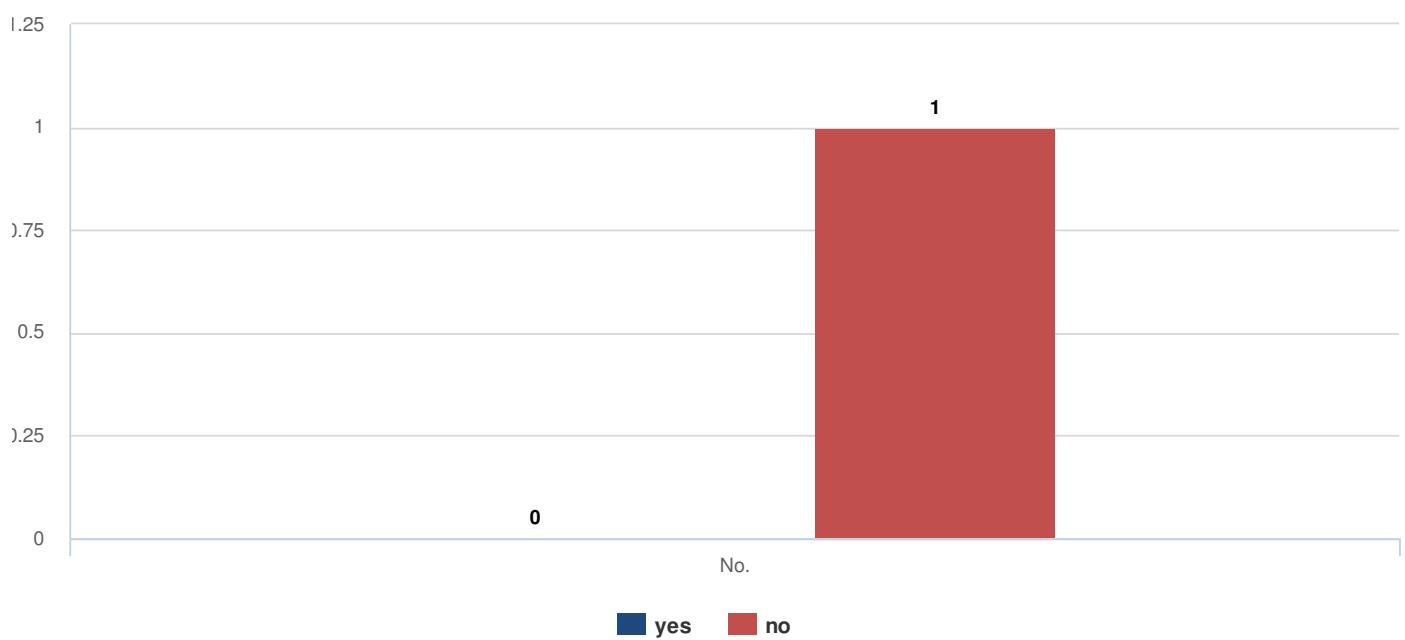
#	Question	No.	%
43	Have you ever adjusted your own (estimation of) consumption on the basis of the energy left (the total consumption LED strip)?	1	100%
	yes	1	100%
	no	0	0%



APPENDIX - 9
Excerpt from the questionnaire report

Have you ever adjusted your own (estimation of) consumption on the basis of your sharer's consumption?

#	Question	No.	%
47	Have you ever adjusted your own (estimation of) consumption on the basis of your sharer's consumption?	1	100%
	yes	0	0%
	no	1	100%



APPENDIX - 10
Excerpt from the video-recorded interview



APPENDIX - 11

Transcription of the interview

Display Playback Selection Import

Sources

Look for Search In Find Now Clear Advanced Find

Display

footage_1

Name / Nodes Rows

first fo 0

0:00.0 1:40.0 3:20.0 5:00.0 6:40.0 8:20.0 10:00.0 11:40.0 13:20.0 15:00.0 16:40.0 18:20.0 20:00.0 21:40.0 23:20.0

first footage

Timespan ▲ ↴ Content ↴

27 7:13.0 - 7:35.1 G: What did you think of when you had this feedback? Except for that you'd run out of energy, of course.

28 7:35.1 - 7:48.5 G: Did you have any other kind of thoughts, related to the fact that you used...

29 7:48.4 - 7:59.6 A: No...(she shakes her head and laughs) G: So it was only functional
A: Yeah, it was functional

30 7:59.5 - 8:12.6 G: You said (in the questionnaire) " yeah but I was already aware"

31 8:12.5 - ... A: That was because I estimated how long I would sit here and that also how was indicated it. And I know (sic = knew) I can (sic= could) turn it off. But I just wanted to try out

Sources

Nodes Classifications Collections Queries Reports Maps Folders

In Nodes Code At Enter node name (CTRL+Q)

● GB 1 item Nodes: 0 References: 0 Editable Unfiltered 8:29:9/23/23:6

APPENDIX - 12

Coding of the transcript

interview analysis.nvp - NVivo Pro

The screenshot shows the NVivo Pro software interface. The top menu bar includes FILE, HOME, CREATE, DATA, ANALYZE, QUERY, EXPLORE, LAYOUT, and VIEW. The left sidebar has sections for Nodes, Cases, Relationships, Node Matrices, Sources, and Nodes. The main area displays a table of search results for nodes like 'awareness (to know)', 'bias-belief (liberalism)', and 'post ethical reflection'. Below the table is a transcript view with a timeline from 0:00:00 to 15:00:00. A red box highlights a segment of the transcript where G (Interviewer) discusses energy supply and environmental impact.

Name	Sources	References
awareness (to know)	2	3
behaviour-change	1	1
bias-belief (liberalism)	1	8
carelessness		
clear bearings	2	4
curiosity	1	4
disappointment	1	2
disapproval	1	1
disengagement	1	2
engagement (partici	1	1
excessive freedom	1	2
individualism	2	4
inurement	1	1
lack of reference	3	4
limitlessness	1	2
meaningfulness (qua	1	1
permission	1	1
personal belief	1	1

15 13:45.3 - 14:42.1 G: What would you improve of this thing (the lamp)? What would you change?

A: If you have two bottles of water and the person is using that much then I would say something...no I think it's different, I also (in that case) wouldn't say that.. I mean, if the neighbour is using a lot of water I can't say anything, no.

G: You'd then behave in the same way?

APPENDIX - 13

List of codes

Coding of the interview transcript

Codes

Name	Description	Sources	References
anonymity		1	2
awareness (get to know)			4
awareness (to know about the value of sthg)			3
behaviour-change		1	1
bias-belief (liberalism)		1	8
carelessness		1	4
clear bearings			4
curiosity		1	4
disappointment		1	2
disapproval		1	1
disengagement		1	2
empowerment- free choice			2
empowerment-control		1	1
engagement (participation)		1	1
excessive freedom		1	4
extraordinary		1	2

Name	Description	Sources	References
individualism			1
habituation		1	1
lack of reference		3	4
limitlessness		1	
meaningfulness (quantity-quality)		1	1
need for guidance (2)		1	1
permission		1	1
personal belief		1	1
plan-changing		1	1
playing		1	
post ethical reflection		1	4
implied ethical reflection		1	4
pragmatism			8
pre-existent awareness		1	
privacy		1	3
proportion		1	1
rational		1	
reference-comparison		1	
reflection (on behaviour)			3

APPENDIX - 14

List of codes

Name	Description	Sources	References
right (behaviour)		1	1
satisfaction		1	
scepticism			1
social pressure (culture)		1	4
soft judgement		1	1
subjection		1	1
suitable (not annoying)		1	1
suitable (proportionate)			
surprise		1	
test-influence			\$
transgression		1	3
trivial-minor		1	1
unawareness (not to know)		1	
non-emotionality		1	3
unexpected		1	1
non-relatedness			11
value clash (individualism vs collectivism)		1	1
wastage		1	1

APPENDIX - 15

Link between annotations and transcript (screenshot of the html interactive file)

Annotations		
NO.	TIME SPAN	CONTENT
1	11:42,4 - 11:45,5	<p>G: but one of the functions was that of change the way you conceive energy</p> <p>A: No, because I already paid attention to energy</p> <p>G: and the social experience wasn't strong enough let's say</p> <p>A: No, yeah [she confirms it wasn't strong enough] 12</p>
2		<p>She contradicts herself: first she says that she didn't pay attention and then she says that the other person's consumption wasn't that much (statement that implies that she did pay attention). Without counting that previously she said that she didn't know how much the other person consumed. I think that this apparent contradiction depends on the fact that now she's judging on the basis of how much it took for the general bar to go down (rather than the actual other person's consumption). This is understandable and even legitimate to be thought as the general consumption bar is supposed to be the reference to judge whether or not one needs to be parsimonious with the use of energy/ (so of the lamp). But the single usage of the other person remained kind of meaningless (as said before she couldn't say exactly that ring what it stand for).</p> <p>as a matter of fact here it's clear that she couldn't perceive the other person's wastage (regardless of whether it was or not; she just wasn't able to evaluate/assess that).</p>
3		<p>Here she's saying that she thought that the consumption wasn't that much (but again, it seems an afterthought as in fact she didn't evaluate that during her experience).</p>

Links

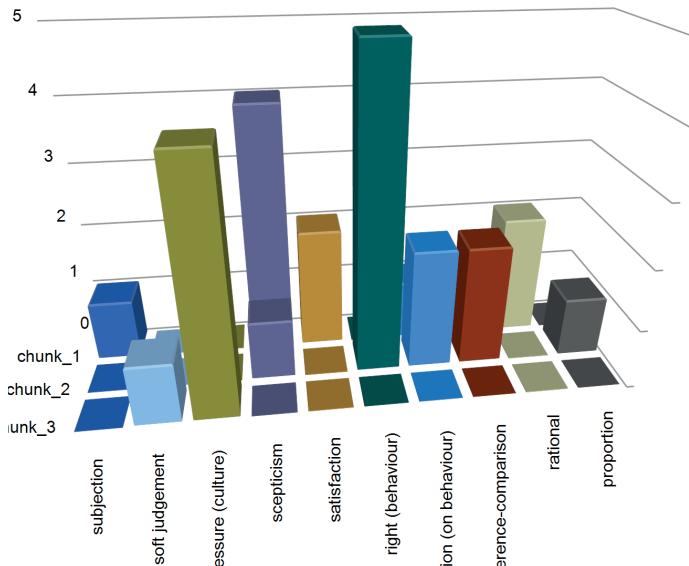
APPENDIX - 16
Frequency of occurrence of the codes in the data sources
(full list)

	First chunk	Second chunk	Third chunk
1 : wastage	1	0	0
2 : value clash (individualism vs. collectivism)	0	0	1
3 : unexpected	1	0	0
4 : unawareness (not to know)	2	0	0
5 : trivial-minor	1	0	0
6 : transgression	3	0	0
7 : test-influence	6	0	1
8 : surprise	2	0	0
9 : suitable (proportionate)	1	1	0
10 : suitable (not annoying)	1	0	0
11 : subjection	1	0	0
12 : soft judgement	0	0	1
13 : social pressure (culture)	0	0	4
14 : scepticism	4	1	0
15 : satisfaction	2	0	0
16 : right (behaviour)	0	5	0
17 : reflection (on behaviour)	1	2	0
18 : reference-comparison	0	2	0
19 : rational	2	0	0
20 : proportion	0	1	0
21 : privacy	0	0	3
22 : pre-existent awareness	0	2	0
23 : pragmatism	7	1	0
24 : post ethical reflection	0	0	4
25 : implied ethical reflection	0	0	4
26 : playing	2	0	0
27 : plan-changing	1	0	0
28 : personal belief	0	0	1
29 : permission	1	0	0
30 : non-relatedness	10	1	0
31 : non-emotionality	3	0	0
32 : need for guidance	1	0	0
33 : meaningfulness (quantity-quality)	0	1	0
34 : limitlessness	2	0	0
35 : lack of reference	1	2	1
36 : individualism	2	0	3
37 : habituation	1	0	0
38 : extraordinary	2	0	0
39 : excessive freedom	4	0	0
40 : engagement (participation)	0	1	0
41 : empowerment-control	1	0	0
42 : empowerment- free choice	1	0	1
43 : disengagement	0	2	0
44 : disapproval	0	0	1
45 : disappointment	2	0	0
46 : curiosity	4	0	0
47 : clear bearings	1	3	0
48 : carelessness	4	0	0
49 : bias-belief (liberalism)	0	0	8
50 : behaviour-change	1	0	0
51 : awareness (to know about t)	0	1	2
52 : awareness (get to know)	3	1	0
53 : anonymity	2	0	0

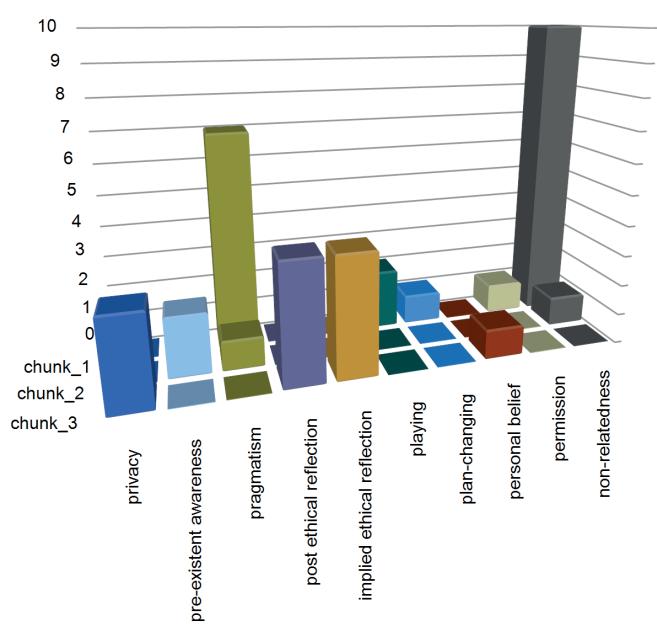
APPENDIX - 17

Charts representing the frequency of occurrence of the codes in the data sources (approximately ten codes per chart)

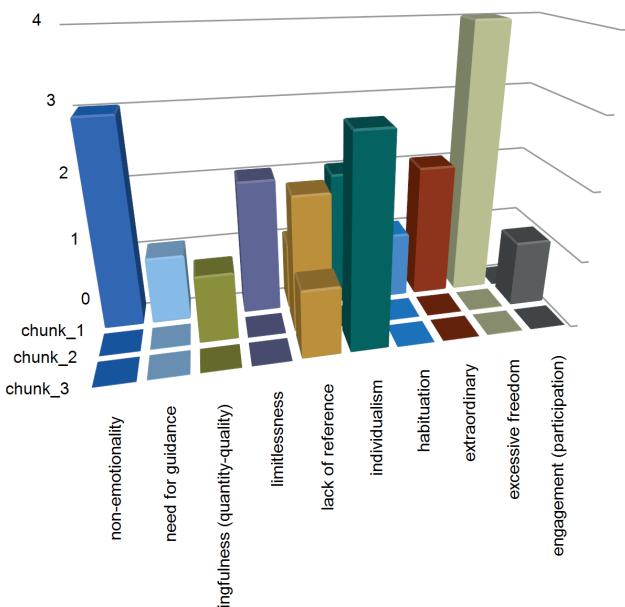
Frequency of occurrence per single code (second set of ten codes)



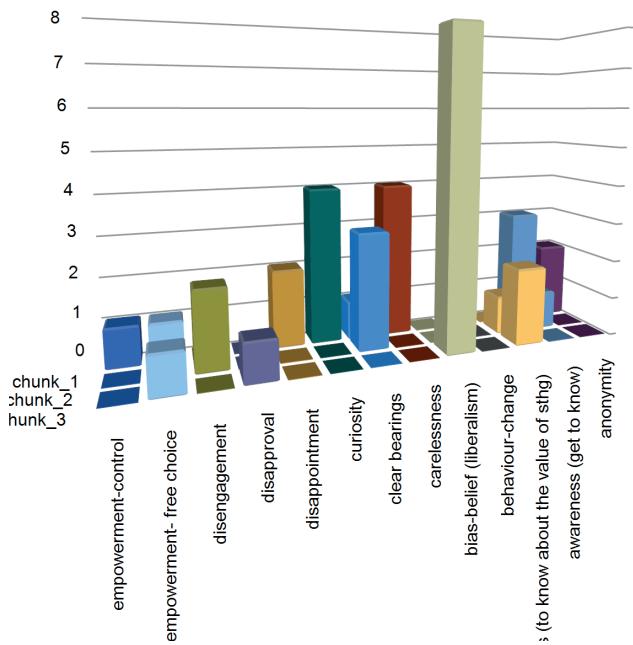
Frequency of cooccurrence (third set of ten codes)



Frequency of occurrence (fourth set of ten codes)



Frequency of occurrence per single code (last set of codes:13 codes)



Categories and sub-categories

Codes

Appendix - 18

List of categories, sub-categories and related codes

Name	Description	Sources	References
CHANGE		0	0
behaviour-change		1	1
habituation		1	1
plan-changing		1	1
INDIVIDUAL VALUE SYSTEM		2	22
bias-belief (liberalism)		1	8
individualism		2	5
personal belief		1	1
privacy		1	3
social pressure (culture)		1	4
soft judgement		1	1
NEED FOR BALANCE		0	0
proportion		1	1
suitable (not annoying)		1	1
suitable (proportionate)		2	2
NEED FOR GUIDANCE		0	0

Appendix - 19

List of categories, sub-categories and related codes

Name	Description	Sources	References
SENSE OF LIMIT (bearings)		0	0
excessive freedom		1	4
wastage		1	1
UNCERTAINTY		0	0
need for guidance		1	1
unawareness (not to know)		1	2
PERSONAL ATTITUDE		0	0
pragmatism		2	8
rational		1	2
Non-emotionality		1	3
REALISING (getting to know)		0	0
awareness (get to know)		2	4
surprise		1	2
unexpected		1	1
SENSE OF NON-RELATEDNESS		0	0
LACK OF SOCIAL RELATION		0	0
anonymity		1	2
carelessness		1	4
disappointment		1	2

Appendix - 20

List of categories, sub-categories and related codes

Name	Description	Sources	References
Non-relatedness		2	11
OUT OF ORDINARY (unreal)		0	0
extraordinary		1	2
scepticism		2	5
test-influence		2	7
trivial-minor		1	1
NON-RELATING WITH A VALUE SYSTEM		0	0
disengagement		1	2
USER'S EMPOWERMENT		0	0
EXERCISE OF FREEDOM		0	0
empowerment- free choice		2	2
empowerment-control		1	1
FREEDOM LIMITATION		0	0
subjection		1	1
SELF-REALISATION		0	0
curiosity		1	4
playing		1	2
satisfaction		1	2
transgression		1	3

Appendix - 21

List of categories, sub-categories and related codes

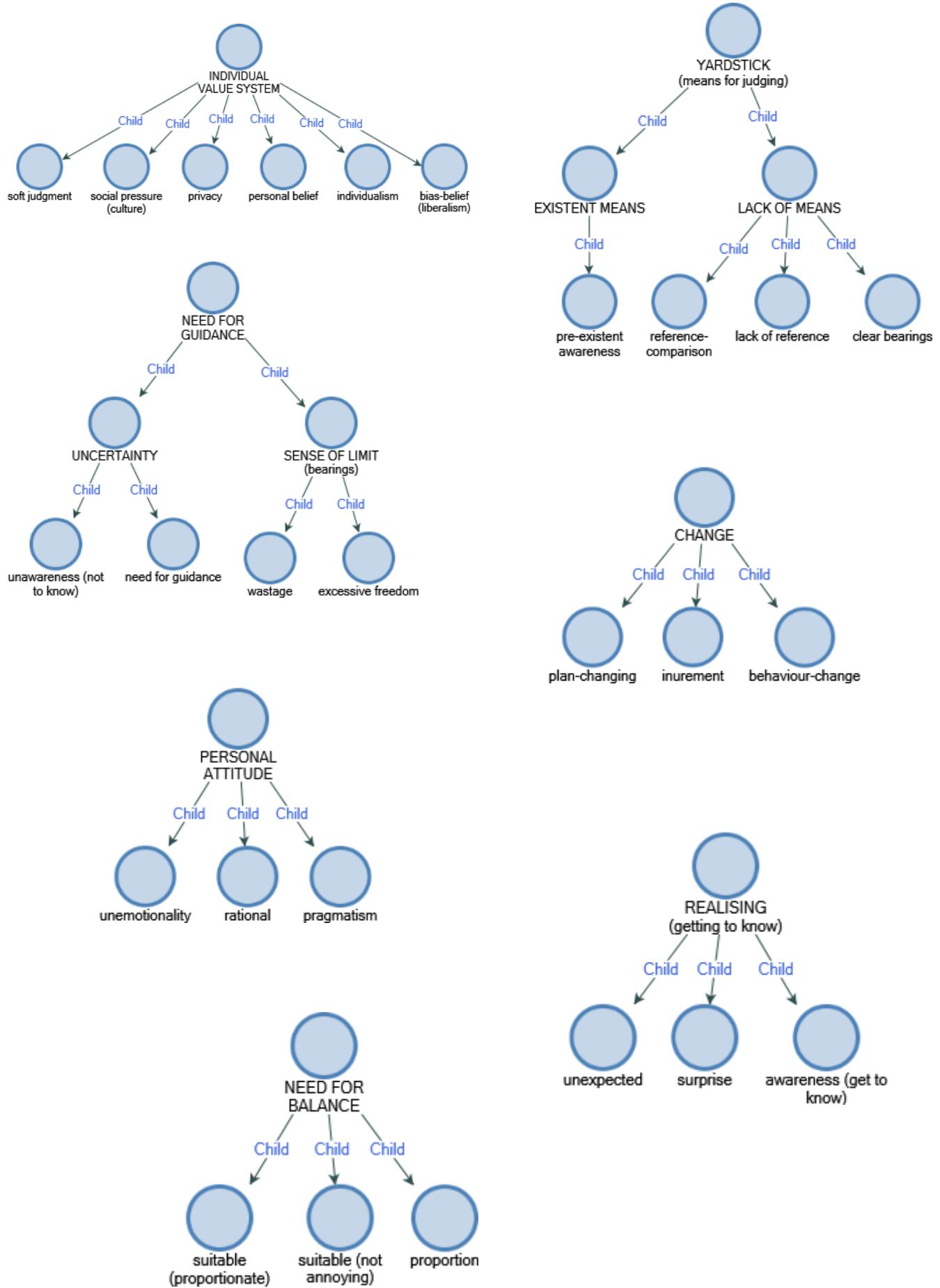
Name	Description	Sources	References
VALUING PROCESS		0	0
ASSESSMENT		0	0
engagement (participation)		1	1
DIALECTIC (value clash)		0	0
	value clash (individualism vs collectivism)	1	1
ESTIMATION		0	0
	awareness (to know about the value of sthg)	2	3
	limitlessness	1	2
	meaningfulness (quantity-quality)	1	1
	permission	1	1
	reflection (on behaviour)	2	3
	right (behaviour)	1	5
ETHICAL JUDGEMENT		0	0
	disapproval	1	1
	post ethical reflection	1	4
	implied ethical reflection	1	4
YARDSTICK (means for judging)	This category groups those codes related to the need for reference as requirement to be able to express a judgement on one's behaviour or mindset.	0	0

Appendix - 22

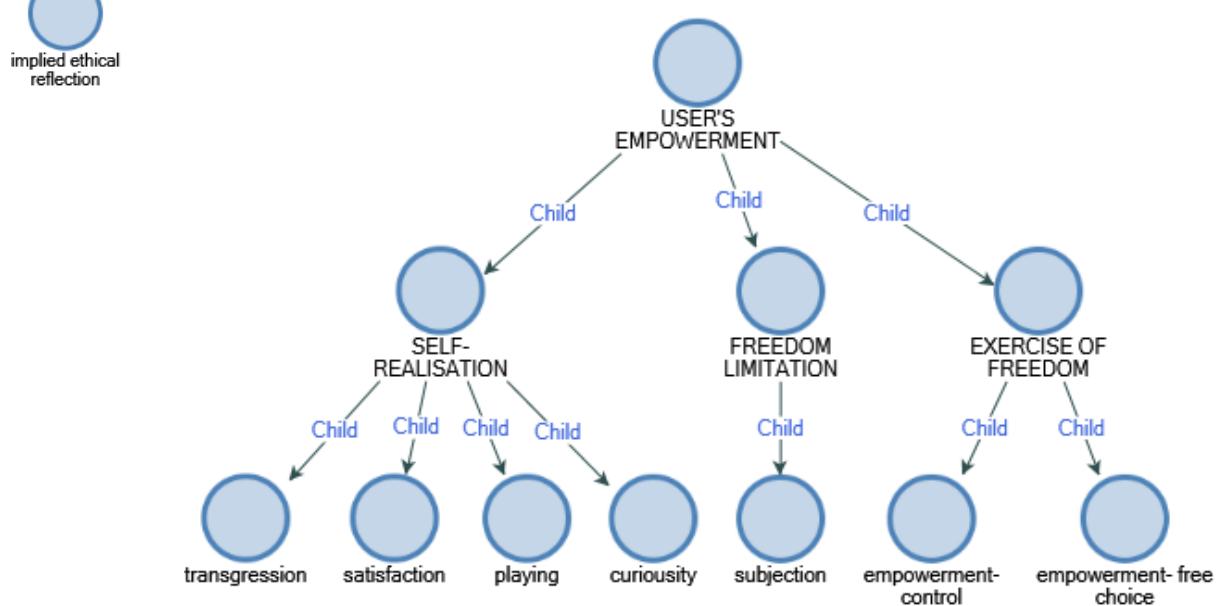
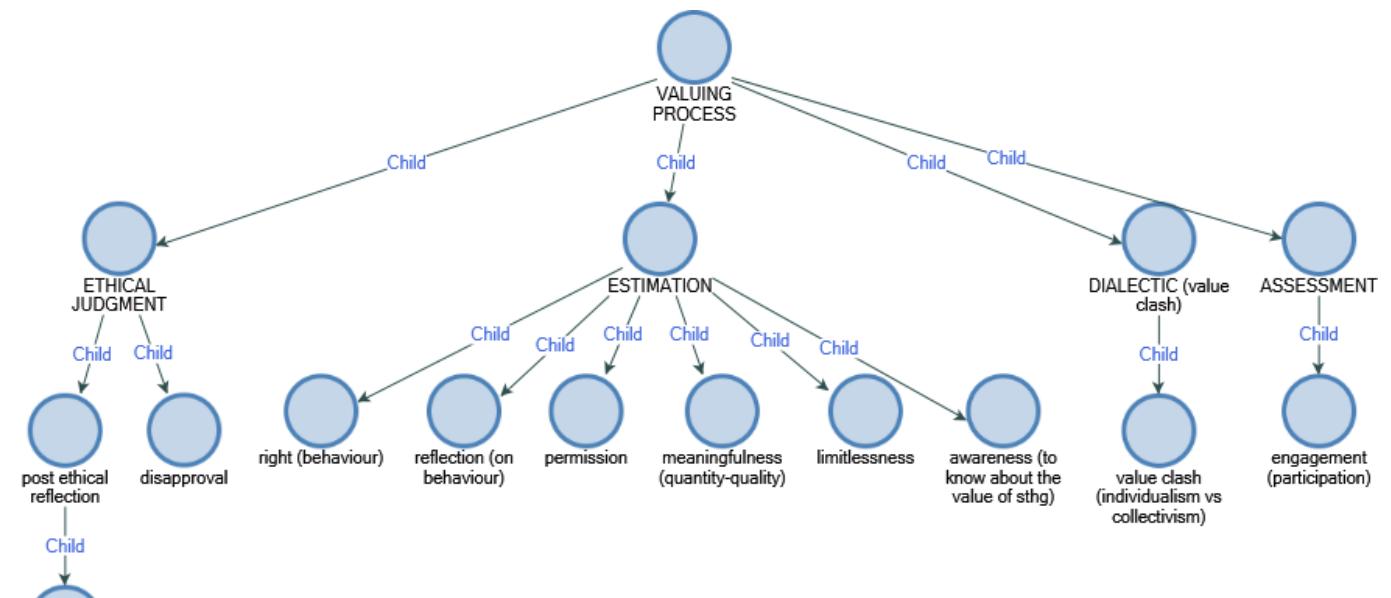
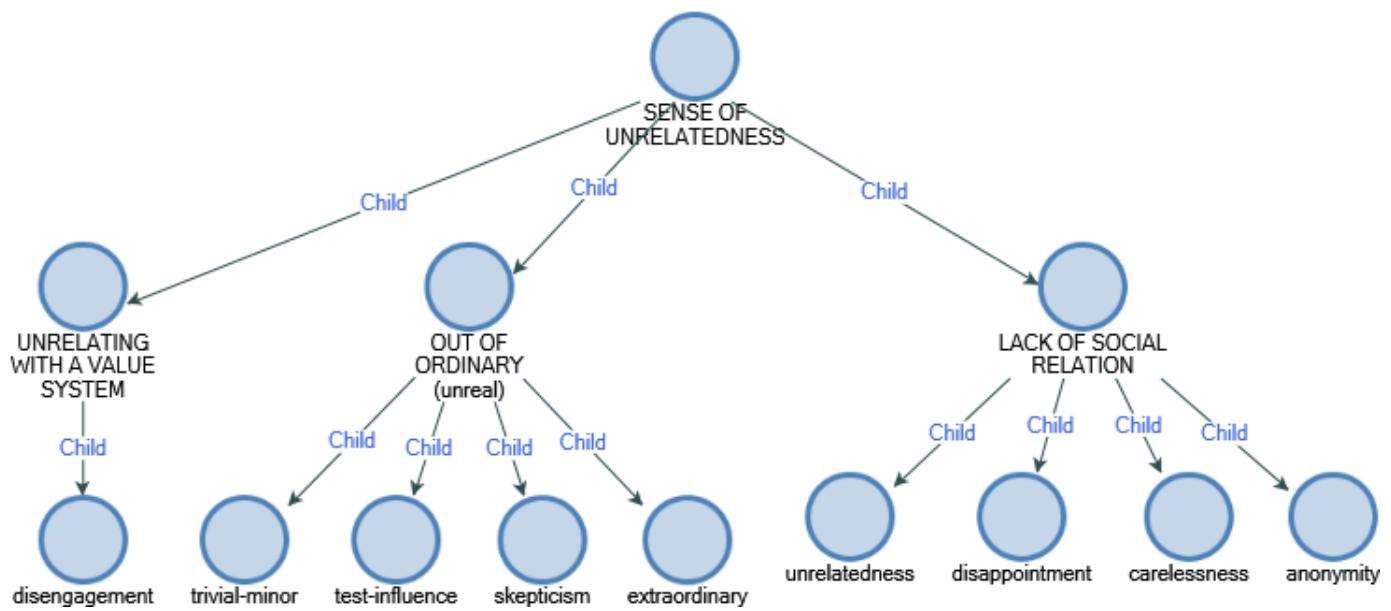
List of categories, sub-categories and related codes

Name	Description	Sources	References
EXISTENT MEANS		0	0
pre-existent awareness		1	2
LACK OF MEANS		0	0
clear bearings		2	4
lack of reference		3	4
reference-comparison		1	2

APPENDIX - 23
Diagrams of the categories and their sub-categories

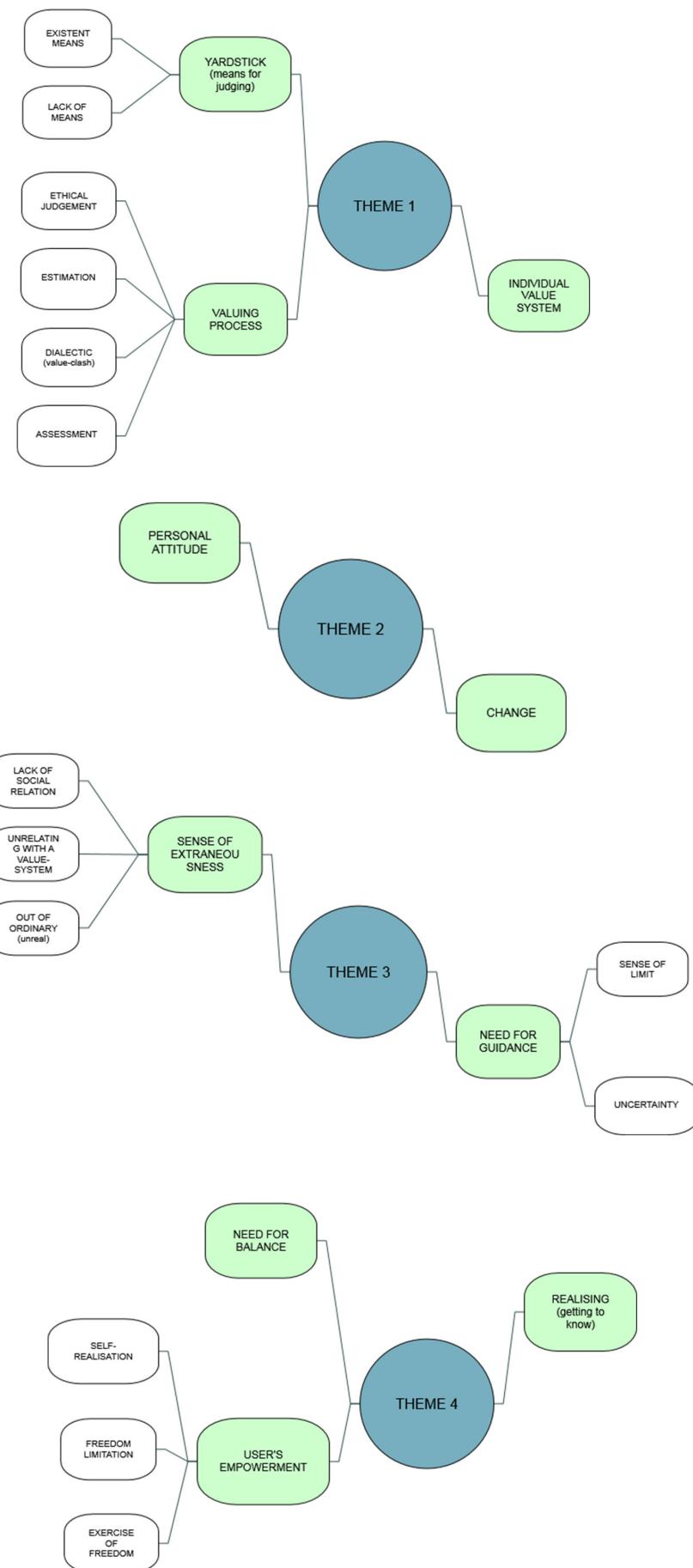


APPENDIX - 24
Diagrams of the categories and their sub-categories



APPENDIX - 25

Maps of the Themes emerging from the categories



APPENDIX - 26

Example of bridging (theme 1)

THEME 1.

{Valuing Process; Yardstick; Individual value system}

The influence of cultural background and available means for judgement, in the valuing process and related (user's) behaviour.

Bridging

This theme groups three main categories: 1) *Valuing process*; 2) *Yardstick*; 3) *Individual value system*.

The first category clusters all those aspects related to the process of expressing value or attributing value to something, which emerged from the conversation with the participant. In the user's experience with the lamp, such a valuing process was characterised by four main aspects (see section about the categories). The most significant aspect was the capability of estimating the wastage of energy consumption and therefore to formulate an ethical judgement accordingly. In this regard, the lack of comparison to attribute a qualitative value to a quantitative reference (e.g., the maximum or minimum quantity indicated by the LED strips on both interfaces) made the valuing process difficult and the quantitative reference meaningless. This relates to the second category which groups the participant's need for clear bearing and references to express a relevant judgement. Finally, the individual value system which plays a huge role in the process of acknowledging as well as adopting certain values (ethical stance) and taking decision accordingly.

THEME 2.

{Personal attitude; Change}

The role personal attitude in change resistance.

THEME 3.

{Sense of extraneousness; Need for guidance}

In search of meaningfulness: lack of guidance and clear bearings as main cause of social disconnectedness.

THEME 4.

{User's empowerment; Need for balance; Realising}

Self-empowerment, exploration and freedom as prerequisites for change.