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ABSTRACT

Persuasive technology aims at supporting people to change their attitudes and/or behaviors sustainably. Application areas include energy saving, green mobility, medical observance, addiction, etc. Emergency to solve these societal challenges makes the field meet a great success. We propose UP!, a problem space to structure the exploration of the design space, an increment to the SEPIA framework. UP! combines two perspectives, the User and the Phenomenon under study, so that to create the right system that makes the user understand the problematic phenomenon and act appropriately to change sustainably.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI) → HCI theory, concepts and models**

KEYWORDS[1]

Human Computer Interaction; Persuasive interactive systems; Design space; Properties, Functions;

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1 INTRODUCTION

Persuasive technologies aim to support human behavior change without coercion, persuading users to voluntary progress in a process of change [6]. The targeted changes may belong to different domains and impact different aspects in the life of a person. Behavior changes related to health have been widely explored by persuasion-related studies applied to different domains (e.g. to quit smoking).

Persuasive interactive systems result from applying Persuasive technology to the engineering of interactive systems. They are expected to sense inappropriate or undesired behaviors (e.g., over smoking), and then enact functions suitable to make user change (e.g., suggestions).

This paper reports a study of existing systems found in the literature that shows that exploration of the design space is still partial ten years after the creation of the conference dedicated to the field. Indeed, it remains difficult to design persuasive interactive systems: people have first to master the state of the art in persuasion and then to reconcile these specificities with their expertise.

We propose UP!, a problem space to structure the exploration of the design space, an increment to our SEPIA framework [15]. UP! combines two perspectives, the User and the Phenomenon under study, so that to create the right system that makes the user understand the problematic phenomenon and act appropriately to change sustainably.

Section 1 covers fundamental knowledge in persuasive technology, useful for the following sections. Section 2 presents our study that concludes the exploration of the design space is partial from a theoretical point of view. Section 3 proposes UP!, a design space for structuring the exploration of the design space. Section 4 concludes on a discussion and perspectives.

2 FUNDAMENTAL KNOWLEDGE

A thorough review of the state of the art lets us identify four main classes of contributions in the field of persuasive technology: those about (1) definition, (2) human behavior and persuasion, (3) persuasive design principles, and (4) design methods.

2.1 Definition

Persuasive technology refers to "an interactive technology that changes a person's attitudes or behaviors" [6]. Fogg introduces the concept of captology to denote persuasive technology as research area. It neither includes computer-mediated persuasion nor non-intentional persuasion [7].

Oinas-Kukkonen and Harjumaa [16] prefer the concept of Behavior Change Support Systems (BCSS), a specific topic in persuasive technology. Contrary to captology, BCSS can play the role of mediator between two human beings. In both cases, coercion and betrayal are excluded from the field, for ethical reasons.

2.2 Behavior change, persuasion, influence

Research on persuasive technologies is a cross-discipline research field. It is based on theories, models and principles borrowed from various disciplines including computer science, social sciences such as psychology, or medicine. Our approach mainly relies on the Transtheoretical Model but also on other principles such as influence, design techniques and behavior models. In order to provide background, this section presents a synthesis of the fundamental concepts.

2.3 Transtheoretical Model of Behaviour of change

The Transtheoretical Model of Behaviour (TTM) of change [19] formalizes the steps of the change by stating that progressing can be achieved using motivation, required for the focus, effort and energy to move through the stages. It has been used to promote behavior change in a variety of behaviors.

The stages progress as follows:

- *Precontemplation*: where subjects are not considering the idea of change, maybe because they are unaware or not informed or possibly frustrated by a previous failed change attempt. They do not intend to take action in the next 6 months.
- *Contemplation*: subjects are aware that they should change a certain behavior, and they consider attempting the change in the next 6 months. In this stage they try to get informed about the problem, but they are not ready to take a concrete action for changing.
- *Preparation*: subjects are ready to make a change in the near future (usually measured as the next month), they are trying to develop a plan to take their first concrete action in the direction of the change.
- *Action*: subjects are passed to action and modified their behavior within the past 6 months.
- *Maintenance*: subjects try to keep the behavior change, and struggle to prevent relapsing. In case they fail in this stage a relapse will occur, making them regress to an earlier stage and they will have to restart the process from the first stages.

2.4 Behavior Model

In the Fogg Behaviour Model [6], persuasion is represented using two dimensions, ability and motivation, plus an enacting trigger. Triggers can be of different types: sparks (used to increase the motivation), signals (which serve only as reminders) and facilitators (used to make the change easier). In this model, the change is likely to happen if the target behavior is sufficiently motivated, if it has the ability to perform the behavior, and if it is triggered to perform the behavior. These three factors must occur and reach a certain threshold simultaneously to trigger an effective change. Otherwise, the behavior is likely not to happen. Some specific elements can affect the level of ability and motivation. The three core motivators, central to the human experience, are: Pleasure/Pain, Hope/Fear and Social Acceptance/Rejection.

Therefore one can observe either an in-phase (acoustic) or an out-of-phase (optical) character of the modes, with respect.

2.5 Design methods

Oinas-Kukkonen and Harjumaa [16] develop a three-step method for designing BCSS, called Persuasive System Design or PSD. The first step consists in understanding persuasion along seven statements (e.g. "Persuasion is often incremental"). The second step is the analysis of the persuasion context. It includes: (a) recognizing the intent of the persuasion, i.e. determining who is the persuader. It could be "*those who create or produce the interactive technology (endogenous); those who give access to or distribute the interactive technology to others (exogenous); and the very person adopting or using the interactive technology (autogenous)*"; (b) Understanding the persuasion event by considering the context of use in terms of user and technology; (c) Defining and/or recognizing the strategies in use by analyzing the message and considering the proper route to be used in reaching the user.

In the vein of user-centered design, the Behavior Wizard [7] is centered on the type of behavior that is targeted. The method is supported by both a questionnaire for identifying the behavior, and a classification grid of behaviors. This grid is structured into two dimensions: five stages of the behavior and three durations of behaviors.

3 STATE OF THE ART: MOSTLY SUPPORTS FOR UNDERSTANDING

We identify three classes of functions related to three classes of user actions. The latter, at coarse grain, are related to the TTM model:

To understand: people in the pre-contemplation stage need to observe their current behavior to move to the contemplation stage. For the latter, people need to understand the pros and the cons of their current behavior deciding for change.

Table 1: Analysis of existing persuasive systems.

Functions	Details	Total
To understand	**Making consumption observable**: EnergyLife (for each appliance and global consumption observable), PowerAdvisor (compare to national consumption average), Eco-feedback, PowerWiz, Handy Feedback, Abstract Ambient, Ghost Hunter, EnergyDiet (make it intelligible in terms of Kg), Show-Me (based on LEDs), ShowerCalendar (over time per user), Hydrao (thanks to colored LEDs) **Putting into context**: FigureEnergy (Consumption graphs annotated with icons representing events), CasaCalendar (Calendar coupled with consumption graph to reveal behavioral patterns, support annotation), Washing Machine (Provide feedback about washing activities) **Explain**: EnergyLife (a quiz is implemented to help users to understand how appliances consume energy)	14/15
To decide	**Suggesting or recommending**: EnergyLife (Provide contextual advice on how to reduce energy), Washing Machine (Suggest best time of the day to minimize energy consumption), Eco-feedback (Tips), PowerAdvisor (Provide tips and guides to help reducing consumption) **Simulating**: FigureEnergy (Practice tub to experiment adding or removing consumption sources)	5/15
To act	EnergyLife (Through gamification, allow users to target savings to be reached as well as to set goals; support ranking and social comparison), FigureEnergy (Progress board indicating savings, ability to set a threshold in the practice tub), CasaCalendar (Support scheduling of some electric equipment), Washing Machine (Provide an automatic start), UpStream (Alert on water overconsumption based on a traffic light metaphor), Hydrao (Ability to associate colors to water consumption thresholds. Blinking colors may indicate water overconsumption)	5/15

To decide: people in the preparation stage are planning their change and have to decide and plan actions such as "tiny habits" as identified by Fogg [7]. As highlighted by Fogg's principles, suggestion and/or recommendation functions are a means of support decision.

To act: people in the action or in the maintenance stage are accountable for their actions. Therefore, functions are needed to support action as well as maintenance. According to Fogg's principles, rewards are a means of sustaining a behavior change.

We analyze fifteen designs from the state of the art: eleven works related to energy consumption (EnergyLife [9], PowerAdvisor [11], EcoFeedback [18], FigureEnergy [5], CasaCalendar [14], Washing Machine advisor [3], Powerviz [17], Handy Feedback [22], Abstract ambient [21], GhostHunter [1], EnergyDiet [12]), three about water consumption (UpStream [13], Show-Me [10], ShowerCalendar [14]), and a commercial product (Hydrao, www.hydrao.com) related to water consumption too. For each system, the first step is to identify the phenomenon under study. For instance, in PowerAdvisor [11], power consumption is the phenomenon under study. Second step consists in capturing the persuasive functions they support. Although we consider systems targeting energy and water consumption domains, we expect that our work covers any application domain.

Table 1 shows that:

- Making the invisible phenomenon visible is the most explored feature in the literature: fourteen of the fifteen systems address it,
- 'To Decide' and 'to Act' functions are significantly less considered and rarely together: only five of the fifteen systems combine these features.

As examples, let us describe Hydrao and FigureEnergy which characterizations are respectively: Understand+Act and Understand+Decide+Act.

Hydrao is an industrial electronic showerhead capable of projecting colored light, of changing color and of blinking to reflect water consumption. Colors and thresholds (medium and maximum number of liters per shower) are programmable via a mobile phone application that also informs the user about his/her consumption over time. Basically existing systems monitor water consumption and alert people as soon as a threshold is passed (e.g., the maximum number of liters per shower). Several presentations have been explored: for example, a green versus red light in UpStream that reflects a judgment to the user or a set of LEDs in Show-Me that more calmly informs the user about his/her consumption. In both cases, the system reflects the state with regard to the threshold to the user under the shower.

FigureEnergy goes beyond reflecting the user behavior through a user interface: it supports interaction to make people understand the phenomenon of water consumption by action. The user can remove elements (e.g., the morning shower or the washing machine) to see impact on consumption. The user can also annotate events for example to explain extra consumption (e.g., visit of family, vacation, deep cleaning).

4 UP!, A SUPPORT FOR EXPLORING THE DESIGN SPACE

UP! (User and Phenomenon) is a new version of the initial SEPIA (Support for Engineering Persuasive Interactive Applications) framework [15]. Both intend to structure the exploration of the design space when engineering persuasive interactive systems. In this new version, it does not explicit the properties the user interfaces must support (six in SEPIA). Rather it focuses on the key questions designers must consider when deciding the role the user and the system must have for mastering the phenomenon under study.

4.1 The two dimensions: User and Phenomenon

UP! is structured into two dimensions: on the one hand, the phenomenon to address in its causes and/or effects and/or causality (cause-effect relationship) as in SEPIA; on the other hand, the role the user and the system have in the change process. The dimensions are independent giving rise to a set of combinations, each defining a persuasion function.

4.1.1 Phenomenon dimension: cause, effect, and causality. A phenomenon is "a fact or situation that is observed to exist or happen, esp. one whose cause or explanation is in question" (Oxford dictionary). For example, water consumption is a phenomenon. It is impacted by long showers (cause) that in turn induce (causality) extra cost, time waiting for others, running out of hot water, etc. (effect). UP! invites designers to investigate the causes, effects and their causality (relationship between cause and effect) in depth thanks to a set of functions corresponding to the roles user and system will play in the interactive system.

4.1.2 User dimension: understand, decide and act. Understanding, deciding and acting is the process of human change. As a consequence, to support the user appropriately, the system must support three classes of functions: enlighten for to make the user understand, recommend helping the user to decide, and facilitating positive actions while protecting from negative ones. Compared to SEPIA, UP! introduces an additional class: deciding.

4.2 A taxonomy of functions

By combining the two dimensions (Table 2), we obtain a set of functions persuasive interactive systems should integrate to fully support human change. We refine each role of a persuasive system (Enlightener, Recommender, Facilitator/Protector) into classes of functional features for each aspect of the phenomenon it addresses (Effect, Cause, Causality). As SEPIA uncovers 18 functions, UP! organizes the design space into 9 persuasive functions and sharpens their coverage.

4.2.1 Enlightener. We characterize the enlightener role into three classes of functional features: Reflecting behavior centered on causes; Revealing situations centered on effects; and explaining centered on causal relationship.

Reflecting situation. Functionalities making the causes observable that reflect user activity related to the problem tackled by persuasion. For instance, such functions could make observable a water leak or a very high number of showers per day. Providing indicators (e.g. consumption average) would make it possible to better understand if a behavior is appropriate by making sense of the information.

Revealing behavior. Functionalities giving users access to raw data or information that inform about a current state or reached situation (i.e. the effect) due to user activity related to the problem tackled by persuasion. The system can reveal water over consumption by detecting facts such as a sudden short-term consumption peak or a long-term average above a regular consumption. Thus, the "Reveal" function makes effects basically observable.

Explaining. Functionalities to explain the causal relationship given the current state (i.e. the induced effects), to make explicit the correlation (i.e. causal relationship) between human activity and observed facts. For instance, although a shower currently wastes 80 liters of water, a system could explain that taking a shower should not exceed 10 minutes and use more than 40 liters. For instance, such functions may illustrate how a phenomenon occurs from thanks to a system-based explanation engine.

4.2.2 Recommender. We refine the recommender role into three classes of functionalities: Recommending actions centered on causes; Suggesting situations centered on effects; and Simulating centered on causal relationship.

Recommending actions. Functionalities to recommend alternative behaviors (i.e. causes) suitable to solve the problem tackled by persuasion. For instance, the system could recommend someone who takes two showers each day to reduce to one so as to comply with the social norm.

Suggesting situation. Functionalities to suggest alternative situations (i.e. effects) to be reached. For instance, indicating an average water consumption (e.g.

Table 2: Persuasive functions.

Phenomenon \ User / **System**	To understand **Enlightener**	To decide **Recommender**	To act **Facilitator& Protector**
Cause (Behavior)	To reflect behavior	To recommend actions	To engage & protect
Effect (Situation)	To reveal situation	To suggest situation	To reward & alert
Causality	To explain	To simulate	To sustain & prevent

for a country or state) provides a comparison means to suggest an alternative situation to be reached.

Simulating. Functionalities allowing users to conduct and iteratively evaluate inductive-deductive cycles in order to identify relevant and desired user-defined behaviors and effects. For example, based on simulator, first the user decides to experiment a reduction of the number of showers from 20 a week (each consuming 60 liters) to 15 (deduce #1): the system computes that the whole water consumption drops by 300 liters a week, thereby moving from 1200 liters to 900 liters. Then, the user wants to reduce more than 600 liters a week (induce #1): the system recommends having 10 showers a week. Finally, the user experiments having 12 showers a week but each consuming at most 50 liters of water (deduce #2): the systems indicates the whole water consumption would be 600 liters.

4.2.3 Facilitator and protector.

Engaging & Protecting. Functionalities allowing users to engage in a desirable change of behavior and to protect users from unwanted behaviors. For instance, the system could make it possible for the user to take the decision to have one shower a day at best. A reminder system engine, through notification mechanisms, may support user engagement. As well, a prevention system may warn that a maximum number of showers will soon to be reached or to indicate a remaining time before ending a shower.

Rewarding & Alerting. Functionalities making the user aware of desirable (respectively undesirable) effects now or in the future and to alert users in case of unwanted consequences compared to a desired goal. For instance, the system may indicate the corresponding financial saving as reward or may display greetings (i.e. positive feedback) to the user if he/she succeeded maintaining an appropriate behavior (e.g. having reduced the number of showers by 30% within a week with a water consumption which dropped by 20 liters per day). However, while taking a shower, the system may alert the user thanks to a gauge that he/she is beyond a critical amount of consumed water (i.e. threshold), close to a user-defined maximum.

Sustain & Prevent. Functionalities to maintain high motivation and ability, and making the user aware of appropriate (or inappropriate) behaviors or of behaviors suitable to become valuable (or risky) in the near future. For instance, a system might emphasize unplanned/unengaged efforts to keep motivation. To maintain ability, if the system detects that showers are longer for users just getting back from office, it could suggest the user to first have dinner in order to relaxing before taking shower and thereby be more sparing. A learning machine-based system engine could be used to identify such events and thus to provide recommendations to avoid inappropriate behaviors.

5 DISCUSSION AND PERSPECTIVES

Considering the three powers of notations [2], at practical level as well as at theoretical level, UP! brings a support for description, evaluation and generation.

Descriptive power. UP! enforces to explicit the very role the system plays in the problem to be tackled. This is highly important for reasoning beyond usability as claimed in worth-centered design [4].

Evaluative power. Based on theory and practice, section 2 concludes that the role of recommender is under explored. From a theoretical point of view, UP! can be used to question existing design spaces or persuasive principles from an engineering point of view. For instance, UP! is conceived to bridge knowledge coming from persuasion (TTM, Fogg, etc) with the engineering of interactive systems.

Generative power. As examples, to illustrate a practical use of UP!, we suggest a few extensions to FigureEnergy, providing additional uncovered functionalities:

As a recommender:

- To recommend appropriate behaviors, in the practice view for instance, the system could highlight boxes to be removed for a user-given consumption amount (user-chosen effect).
- To suggest situations, based on consumption history and machine-learning mechanisms, the system may suggest an appropriate number of dishwasher uses per day or per week.
- To simulate, in the practice view, the system may compute and present different sets of behaviors based on a minimum number of boxes (i.e. consumption sources) and a maximum amount of consumption set by the user.

As a facilitator and protector:

- To engage, in the practice view, the system may allow users to target and set a maximum number for each category of consumption sources (shower, washing-machine, hair dryer, etc.) within a week. Moreover, to control his/her engagement according to a desired target, the system may allow the user to set a level of difficulty as well as a policy (promoting/demoting a behavior). Such settings can be used by the system to decide whether or not to notify a reminder.
- To protect users from undesired or inappropriate behaviors, as users are able to tag history consumption events, such a system might highlight critical moments of the day (e.g. back home after work) that aggregate many individual consumption events. Thus, the system would suggest alternatives to reduce the number of events related to comfort. For instance, if many events are related to heating, the system may prevent users from augmenting the

temperature and suggest wearing comfortable and warm clothes (transferred comfort).

- To reward, the system may greet the user for achieved difficult actions.
- To sustain desired or appropriate behaviors, such a system might greet engaged efforts (e.g. reduced number of showers). For instance, a user may target to reduce the number of showers but the system could also greet his/her efforts when the system detects that media appliances are unplugged more often.
- To prevent, such a system might emphasize unplanned/unengaged efforts: it could help break routines in terms of planned efforts and move the focus to other behaviors.

UP! Conceptually opens rich perspectives for exploring the design space methodologically. In particular it is a first attempt to bridge the gap between persuasive technology and recommender systems. Indeed, although UP! can be used to produce a first design, algorithms of recommender systems (e.g., [20]) would powerfully learn user's intent and traits that would fuel an accurate persuasive engine.

We currently are conducting a practical study with students on the intelligibility and the practical applicability of SEPIA and UP! with junior HCI engineers. To conduct this experiment we conducted three separated studies: designing persuasive interactive technologies without our framework; a study to evaluate the intelligibility of our frameworks compared to a baseline; a field study on the applicability of the frameworks to design persuasive interactive systems. The early results confirm the suitability and relevance of our framework.

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REFERENCES

[1] Amartya Banerjee and Michael S. Horn. 2013. Ghost Hunter: Parents and Children Playing Together to Learn About Energy Consumption. In *Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction* (TEI '14), ACM.

[2] Michel Beaudouin-Lafon. 2004. Designing interaction, not interfaces. In *Proceedings of the ACM working conference on Advanced visual interfaces* (AVI'04), 15–22. ACM.

[3] Jacky Bourgeois, Janet van der Linden, Gerd Kortuem, Blaine A. Price, and Christopher Rimmer. 2014. Conversations with My Washing Machine: An In-the-wild Study of Demand Shifting with Self-generated Energy. In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (UbiComp '14), 459–470. ACM.

[4] Cockton, G., 2006. Designing Worth is Worth Designing. In *Proceedings of NordiCHI '06*, pp. 165–174. ACM.

[5] Enrico Costanza, Sarvapali D. Ramchurn, and Nicholas R. Jennings. 2012. Understanding domestic energy consumption through interactive visualisation: a field study. In *Proceedings of the 2012 ACM Conference on Ubiquitous Computing* (UbiComp'12), 216–225.

[6] B. J. Fogg. 2009. A behavior model for persuasive design. In *Proceedings of the 4th ACM International Conference on Persuasive Technology* (PERSUASIVE'09), 40. ACM.

[7] B. J. Fogg. 2003. *Persuasive technology: using computers to change what we think and do.* Elsevier, Boston.

[8] B. J. Fogg and Jason Hreha. 2010. Behavior Wizard: A Method for Matching Target Behaviors with Solutions. In *Proceedings of Persuasive Technology*, 117–131. ACM.

[9] Luciano Gamberini, Anna Spagnolli, Nicola Corradi, et al. 2012. Tailoring Feedback to Users' Actions in a Persuasive Game for Household Electricity Conservation. *Persuasive Technology*. Design for Health and Safety, 100–111.

[10] Karin Kappel and Thomas Grechenig. 2009. "show-me": water consumption at a glance to promote water conservation in the shower. In *Proceedings of the 4th International Conference on Persuasive Technology* (PERSUASIVE'09), 26.

[11] Jesper Kjeldskov, Mikael B. Skov, Jeni Paay, and Rahuvaran Pathmanathan. 2012. Using mobile phones to support sustainability: a field study of residential electricity consumption. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '12), 2347–2356. ACM

[12] Pei-Yi Kuo and Michael S. Horn. 2014. Energy Diet: Energy Feedback on a Bathroom Scale. In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (UbiComp '14), 435–446. ACM.

[13] Stacey Kuznetsov and Eric Paulos. 2010. UpStream: motivating water conservation with low-cost water flow sensing and persuasive displays. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI'10), 1851–1860. ACM.

[14] Matthias Laschke, Marc Hassenzahl, Sarah Diefenbach, and Marius Tippkämper. 2011. With a little help from a friend: a shower calendar to save water. In *CHI '11 Extended Abstracts on Human Factors in Computing Systems*, 633–646. ACM.

[15] Yann Laurillau, Gaëlle Calvary, Anthony Foulonneau, and Eric Villain. 2016. SEPIA, a Support for Engineering Persuasive Interactive Applications: Properties and Functions. In *Proceedings of the 8th ACM SIGCHI Symposium on Engineering Interactive Computing Systems* (EICS '16), 217–228. ACM.

[16] Harri Oinas-Kukkonen and Marja Harjumaa. 2009. Persuasive Systems Design: Key Issues, Process Model, and System Features. *Commun. AIS* 24, 1.

[17] Jeni Paay, Jesper Kjeldskov, Mikael B. Skov, Dennis Lund, Tue Madsen, and Michael Nielsen. 2014. Design of an appliance level eco-feedback display for domestic electricity consumption. In *Proceedings of the 26th Australian Computer-Human Interaction Conference*, 332–341.

[18] Petromil Petkov, Suparna Goswami, Felix Köbler, and Helmut Krcmar. 2012. Personalised Eco-feedback As a Design Technique for Motivating Energy Saving Behaviour at Home. In *Proceedings of the 7th Nordic Conference on Human-Computer Interaction*, 587–596. ACM.

[19[James O. Prochaska, Carlo C. DiClemente, and John C. Norcross. 1992. In search of how people change: Applications to addictive behaviors. *American Psychologist* 47, 9: 1102–1114. DOI: http://doi.org/10.1037/0003-066X.47.9.1102

[20] Ruotsalo, Tuukka , Giulio Jacucci, Petri Myllymäki, and Samuel Kaski. 2015. Interactive intent modeling: Information discovery beyond search. *Commun. of the ACM* 58, no. 1, 86-92.

[21] Johnny Rodgers and Lyn Bartram. 2011. Exploring Ambient and Artistic Visualization for Residential Energy Use Feedback. *IEEE Transactions on Visualization and Computer Graphics* 17, 12: 2489–2497. IEEE.

[22] Markus Weiss, Friedemann Mattern, Tobias Graml, Thorsten Staake, and Elgar Fleisch. 2009. Handy Feedback: Connecting Smart Meters with Mobile Phones.In *Proceedings of the 8th International Conference on Mobile and Ubiquitous Multimedia*, 15:1–15:4. ACM.