

Creating a Sense of Unity: From Quantified Self to Qualitative Space

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Abstract. The design and usage of Personal Informatics (PI) systems have been subjects of rapidly growing interest in recent years. PI systems are typically designed to monitor individuals' physical activity and encourage them to be more active, thereby 'hacking' the habit of prolonged sitting. Most PI systems focus solely on collecting quantitative data to encourage self-reflection and are therefore sometimes discussed in terms of the Quantified Self movement. However, this perspective is wholly focused on individual bodily movements and neglects the role of architectural spaces. This paper discusses an ongoing project focused on PI systems design at the intersection of bodily movements and the office as an architectural space. Taking this as a point of departure, we introduce a simple prototype interactive lamp known as the NEAT lamp, which was designed, implemented and evaluated in relation to everyday office work. The rationale underpinning the prototype's design is presented, followed by the results of a real-world evaluation of its effects in practice. We also discuss the role of the NEAT lamp as an ambient light that promotes awareness of sedentary behavior in the office as an open architectural space. Finally, we highlight the role of ambient displays as a medium for creating a sense of unity between the self and the architectural space, and propose that this observation suggests that we should move the discussion away from "quantified selves" towards qualitative spaces.

Keywords: Personal informatics · Design · Notification systems · Ambient light · Architectural space

1 Introduction

Interest in the design and development of personal data gathering systems has recently increased substantially because of their usefulness in the context of self-reflection and self-monitoring (Swan 2012). Concepts such as Personal Informatics (PI) and the Quantified Self (QS) have motivated researchers in the field of Human-Computer Interaction (HCI) to explore various aspects and designs of such interactive systems (Li et al. 2010; Ploderer et al. 2014). Many personal informatics systems have been designed, ranging from mobile applications to wearable sensors (Swan 2012; Ploderer et al. 2014). In addition, some researchers have explored novel ways of designing, resulting in the creation of ambient displays and informative art pieces intended to improve efficiency in self-reflective applications (see e.g. (Jafarinaimi et al. 2005; Hazlewood et al. 2011; Burns et al. 2012)).

The term “Personal Informatics” first gained currency among the HCI community in 2010 (Li et al. 2010), and the majority of the research interest in such systems is rooted in a utilitarian perspective whereby PI and QS are seen as tools for promoting self-reflection and behavior change (Ploderer et al. 2014). More recently, a number of researchers have expanded their focus beyond traditional PI research by attempting to promote certain experiences as well as the gathering of quantified personal data (Elsden et al. 2015). These investigations have focused on mapping out novel design opportunities and challenges to broaden the field of PI and QS. In particular, they have emphasized revisiting reported experiences with similar systems from a more critical and holistic point of view (Wiberg and Moradi 2013; Ohlin and Olsson 2015). As suggested by Kirk et al. (2015), this expanded focus will open up new horizons for design and research opportunities within our field.

Beyond the traditional first-person/user-centered perspective surrounding the design of PI systems, our work suggests that it is important to recall that bodily movement is affected by (and in some cases, configured by) the surrounding architectural space. An architectural space can fuse our image of ourselves and articulate our experience of the being-in-the world. One important architectural space in which many people spend much of their adulthood is the traditional office environment. According to the United States department of labor, adults aged 25 to 54 with children spend more than 8 h per day on work-related activities in office spaces (Bureau of Labor Statics).

Throughout history, designers and technocrats have planned workspaces in order to increase productivity and efficiency (Moradi and Wiberg 2013). As a result of this development, our bodies have become significantly inactivated and sedentary in the physical architectural spaces where work is performed, i.e. in office spaces. During the 80 s and the 90 s there was a heavy focus on office workspace design from an ergonomics perspective. During this period “efficient” workspaces were designed – but this “efficiency” was defined in terms of reducing or even eliminating physical movement in office spaces (Barnes 1953; Corlett 1983). As a consequence, prolonged sitting emerged as a risk factor associated with increasing all-cause mortality as well as mortality due to cardiovascular disease (CVD), certain types of cancer and non-CVD/non-cancer mortality in adults (Levine 2004; Van der Ploeg et al. 2012). In addition, the reduction in physical activity together with increased food consumption has increased the risk of weight gain and obesity, which is associated with an increased risk of cardiovascular disease (CVD), certain types of cancer, and non-CVD/non-cancer mortality.

The interdisciplinary InPhAct research project aims to address the increasingly important health problems associated with increasingly stationary working patterns in modern office workspaces. In our project we are addressing this problem from a multitude of perspectives and accordingly our project team includes researchers with various backgrounds and competences from disciplines including Informatics, Medicine, and Architecture. This allows us to simultaneously adopt medical, architectural and technological perspectives when attempting to determine how the traditional office environment, as a potentially dangerous setting from a health perspective, could be re-imagined and ultimately re-designed. Our main objective is to identify ways of increasing physical activity in office workspaces and thus to break the habit of prolonged sitting during office hours.

The authors of this work have backgrounds in Informatics and HCI. Here, we seek to contribute to the overall project by answering the following research question: “*How can we design an ambient notification system that stimulates increased bodily movement during office hours and how can we understand what this reconfiguration of the office space means not only in technical terms but also from an architectural point of view?*” With this question as our point of departure, we use this paper to present a suitable notification system (the NEAT lamp), the conceptual work that led to the design of the NEAT lamp, and some preliminary results from an early evaluation of this prototype system.

2 Our Research Approach

In our project we have been influenced by the concept-driven design method (Stolterman and Wiberg 2010), which we have taken as our guiding approach for advancing the design of PI systems in office environments. This method focuses heavily on producing knowledge in the form of theoretical and conceptual developments and then articulating and manifesting this knowledge in the form of a prototype (Stolterman and Wiberg 2010). Broadly, it can be described as an explicitly concept-driven design method that emphasizes theorizing about the nature of the interactions of interest and then manifesting the identified concepts in a concrete design.

To establish an appropriate and well-grounded concept, we conducted an ethnographic study in a contemporary office-based workplace over a period of 80 days in the fall of 2013 in order to understand local movement and mobility in the landscape. The aim of this study was to characterize the bodily movements and mobility patterns of office workers within an office-based landscape. Unlike other ethnographic studies that have investigated mobility in workspaces (Bellotti and Bly 1996; Luff and Heath 1998), we did not focus on the employees’ working procedures and the role of mobility in increasing workers’ efficiency. Instead, our main interest was in assessing the role of architectural elements in fostering bodily movements among the office workers. Because we were interested in whole-body movement, data were gathered by mapping the walking paths taken by workers. By mapping and drawing office workers’ daily walking paths, we gathered visual data, which were supplemented with field notes, informal interviews and photographs (see Fig. 1).

Observation alone was not considered to provide a sufficiently robust foundation for theorizing on the nature of the interactions that occurred in the workspace or for the development of novel prototype concepts. However, we considered it necessary to immerse ourselves in the office space to acquire a deeper understanding of the context, forms, materials and cultural values that were hidden in the work environment. We therefore considered our preliminary ethnographic study to be an essential component in the process of producing theoretical and conceptual knowledge. The nature of design ethnographic studies requires the researcher to seek inspiration everywhere during the field study (Clarke 2010). During our observational study, we quickly became sensitive towards particular objects in the workspace and their contexts as architectural elements. In particular, the apparent relationship between the two provided a valuable inspiration



Fig. 1. An example of the visual data collected during our ethnographic study. This data presents the walking paths of the office workers during a typical working day.

for our design by revealing the potential benefits of harmonizing the office workers’ bodily movements with the architectural space and thus creating a sense of unity.

NEAT-Lamp. The interdisciplinary perspective adopted in this work gave the advantage of being able to integrate the results of our ethnographic study with previously published research on sedentary behavior in offices from the fields of Medicine and Architecture. The Public Health literature includes several publications describing efforts to increase physical activity in workspaces and break the habit of prolonged sitting (McAlpine et al. 2007; Thorp et al. 2012; Van der Ploeg et al. 2012). One of the concepts that has been explored extensively in this context is the role of “Non-Exercise Activity Thermogenesis” (NEAT) in reducing the risk of chronic disease associated with prolonged sitting (Levine 2004). Put simply, NEAT is any physical activity other than intensive exercise, such as standing while working or taking a short walk.

Returning to the project’s initial objectives, we explored ways to develop a concept-based prototype that would foster physical activity in workspaces and also achieve saturation within the context of the office space. Based on our study, we quickly concluded that the new design should be a simple subtle prototype that would not demand extra attention from the office worker. In other words, we were looking for a non-intrusive design that would not disturb the workflow within the office. Keeping simplicity as our driving motto in this process forced us to analyze and evaluate the situation at hand in a very fundamental way, taking our cue from a statement made by John Maeda in his book *The Law of Simplicity*: “simplicity is about subtracting the obvious, and adding the meaningful” (Maeda 2006).

Because the project’s primary aim was to break the habit of prolonged sitting and increase physical activity in offices, we were drawn to the simple concept of notifications. Modern digital lives are filled with various notifications, especially in the context of office work. While office workers are familiar with the concept of being notified, these

notifications are typically screen-based and serve work-related purposes. Such screen-based notifications are striking and demanding. We conceptualized the NEAT-Lamp prototype by referring back to the idea of increasing NEAT as an effective way of breaking the habit of prolonged sitting and promoting physical activity while keeping the design simple and subtle, and without imposing extra burdens on the office workers. The NEAT-Lamp was conceptualized around the idea of designing a notification system in the form of an ambient display with the form factor of a traditional desk lamp (see Fig. 2). In this way, the NEAT lamp can retain the advantage of being a notification system without becoming a burden or a distraction during the process of work. The design of peripheral display-based notification systems intended to break the habit of prolonged sitting has been explored before (Jafarinaimi et al. 2005). However, these designs have not been evaluated anything like so thoroughly as the NEAT-Lamp.

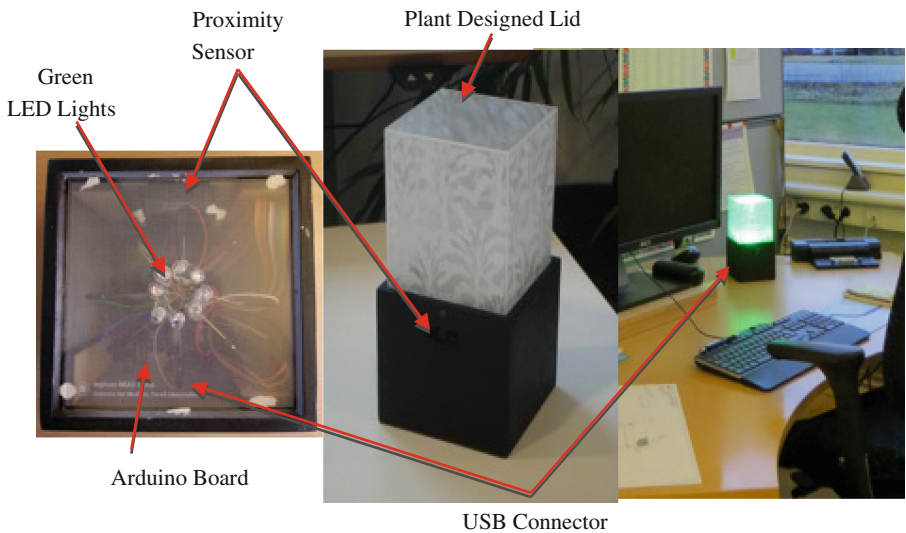


Fig. 2. The NEAT-Lamp and its components. In the right you can see how the NEAT-Lamp notifies an office worker of sedentary behavior.

From a technical perspective, the NEAT-Lamp is a sensor-based notification system connected to a computer via a USB connector and it is placed on the table in front of the office worker (see Fig. 2). If the data from the sensor indicates that the worker has been stationary for 25 min or more, the NEAT-Lamp will turn on. Similarly, the lamp will automatically turn off if the office worker changes his/her position. Whereas most screen-based notification systems have timers, the lamp avoids presenting any information regarding time. This was a deliberate decision intended to prevent the worker from being unduly distracted by the lamp. Moreover, reducing the information supplied in a given message increases the attention that is paid to it and makes us appreciate all that is less, more (Maeda 2006). To promote a sense of affiliation to this simple lamp, we decided to refine the aesthetics of the prototype. As shown in the figures, the lamp emits green light through a translucent plastic lid bearing a plant-like pattern that is

intended to remind people in the office of living plants and thus make the lamp more meaningful (see Fig. 2). In addition to being a tangible artifact that gives workers reminders to avoid sitting for prolonged periods, the NEAT lamp was found to have a hidden conceptual feature that was discovered during our second study.

This prototype was tested several times during the design process and then in a three-week pilot study. Based on the results obtained in these tests, we employed it in a second ethnographic study, which lasted for ten weeks and was conducted in the fall of 2014. During this test, six NEAT-Lamps were tested by six office workers the same office-based workspace that was examined in the first study. As in the first study, workers' daily movement patterns were monitored and recorded, both before and after the introduction of the NEAT-Lamps to the setting. To obtain data amenable to statistical analysis, the six participants who volunteered to test the prototype wore step-counters while at work, both before and after the installation of the NEAT-Lamps. Each participant was asked to only carry the step counters during working hours when in the office space. After the observational phase of the study had finished, semi-structured interviews were conducted with each of the six participants. In general, the participants responded well to the design and claimed that the NEAT-Lamp had functioned as a positive reminder to hack their habits of prolonged sitting. Each participant reacted to the lamps in their own way: some of them preferred to switch position when notified by the lamp, for example by going from a seated to a standing working position. Others took the lamp's activation as a cue to take a short walk. The installation of the lamps triggered a significant increase in the number of steps taken by the participants; one participant's step count increased by more than 20 % after the lamps' installation relative to that during the pre-installation phase.

The Hidden Feature. Like most PI systems, the NEAT-lamp was designed to inspire workers to increase their daily step counts and generally be more mobile in the workplace. However, our second ethnographic study revealed that this was only one side of the story. It is well established that prototypes are multi-faced and thus open to many



The NEAT-Lamp

Fig. 3. The light from the NEAT-Lamps shines on the ceiling, creating an intersection between the body and the architectural space.

different meanings (Zumthor et al. 2006). Consequently, combining a prototype's evaluation with an ethnographic study creates an opportunity to identify any silent or hidden features that the prototype may exhibit. Our prototype NEAT-lamp was found to have such a hidden feature, which had been overlooked during the design process. Specifically, during the second ethnographic study we observed that the light emitted by the lamps shines upwards onto the ceiling. Because the study was conducted in an office with an open space environment, the green light shining on the ceiling was visible across the architectural space. The workers in the office quickly picked up on this hidden feature, which represents a novel example of the intersection between the interaction design and the architectural space (Wiberg 2015). This intersection contains hidden meanings associated with the office worker's bodily movement and the workspace that he/she inhabits (see Fig. 3).

In other words, this hidden feature creates a unity between the bodies inhabiting the space as elements of the architectural space and the architecture itself. Such a reflection of the self onto the ceiling can be seen an initial step in the design of PI systems that go beyond the quantification of the self and instead seek to make the space qualitative in a way that encourages reflection on our behaviors. However, it is important to recall that such designs can provoke other challenges, mostly relating to privacy and user confidentiality. The NEAT-lamps do not present major issues of this sort because they do not gather any personal private data and only respond to routine stationary/sedentary behavior in the workspace. Regardless, once we recognized the potential implications of the lights shining on the ceiling, we asked the participants if they were comfortable to continue with the study. All six participants were comfortable with this feature of the lamps and found that it made them more interesting and appealing. In particular, they were fascinated to see how this feature would influence the movement patterns of other workers in the office who were not taking part in the study. Accordingly, this hidden feature created social reflection and informal discussions among the office workers in the office space. In particular, they became interested in discussing how often they moved around during their working hours in office. This experience with the NEAT-lamp made the office workers realize that they have significant ability to shape their architectural space, causing them to recognize themselves as active architectural elements in the office. Being and moving in the workspace was now not only a matter of the self but also a noticeable factor in configuring the quality of workspace.

3 Moving Beyond

The NEAT-Lamp is an example of a concept-driven design situated in the context of office work and architecturally manifested as a physical object that sits on the desk in the office space.

This prototype is similar to other situated designs in that it is embodied, adapted and articulated inside the architectural space (McCullough 2007). Theorizing from the observations presented above, one could say that architectural spaces are shaped by our experiences of being. This is clearly reflected in the results of our second ethnographic study but can also be linked back to the early work of the renowned phenomenologist,

Martin Heidegger. As Heidegger noted, a building is not only related to dwelling but also a sense of being (Heidegger 1971). The term phenomenology means looking at phenomena or viewing their essence. As a school of thought, it basically focuses on how perception, thought, emotion and actions are directed toward things. In the context of this work, taking a phenomenological approach means engaging in a pure “act of looking” that reveals a robust connection between our ethnographic studies, the NEAT-Lamp and its effect on architectural space.

Fascinatingly, many architectural theorists have argued that phenomenology has the ability to bring us closer to our existential being and permits us to understand architecture as part of our life-world (Shirazi 2014). Individual architectural phenomenologists have theorized this field in rather different ways, however; here, we mainly draw on the theories of Norberg-Schulz and Pallasmaa.

The Heideggerian architectural phenomenologist Christian Norberg-Schulz regards phenomenology as a method for penetrating into the world of everyday existence. He thus contends that it is imperative to adopt a phenomenological approach towards humanity and the environment (Norberg-Schulz 2000). His argument for this proposition begins with the different understandings of Descartes’ life-world relationships. Descartes divides life into the opposition between subject and object. While engaging with things as objects, we tend to establish a quantitative relationship towards them, which would lead to a mechanical view of world-life. As a result, the world-life is reduced to an abstraction and space is understood as a system lacking quality (Shirazi 2014). This quantitative approach leads to atomization and thus dominates all aspects of modern life. This reduction towards an understanding of life solely in terms of numeric facts has indeed influenced the way we design PI systems to promote bodily movement in architectural space. It could therefore be useful to incorporate phenomenology into our design thinking as a way of moving beyond this numerical abstraction. Natural experiences of the life-world are neither subjective or objective but rather fundamentally qualitative and should be understood as unified phenomena (Norberg-Schulz 2000). For Norberg-Schulz, phenomenology works better than psychology and sociology because it considers the unity of life and place: life is related to place and a true analysis of place will embrace life (Shirazi 2014). In other words, our being-in-the-world combines aspects of “*how*” and “*where*”. Space is considered as a dimension of human existence not just our thoughts and perceptions.

From another perspective, this defective view of architectural space is the result of the supremacy of vision over the other senses in western cultures. This dominance of the visual sense in modern life has been greatly enhanced by the proliferation of screens - from TVs and PCs to small mobile displays. As Pallasmaa states, this leads to an architecture that decenters and isolates the body (Shirazi 2014). For Pallasmaa as a Merleau-Pontian, ‘a sense of sight’ had supremacy over the Cartesian eye because it is an embodied vision that incarnates part of the ‘flesh of the world’ (Pallasmaa 2012). Pallasmaa thus argues that the fact of experiencing the architectural space is a multisensory act where the qualities of materials’ spaces and scales are measured not only by vision but also through the nose, skin, and ear as well as the muscles and bones (Shirazi 2014). We thus experience the architectural spaces we inhabit with all of our senses in a bodily interaction. He then goes further, saying “*Experiencing a space or a house is a dialogue, a kind of exchange: I place*

myself in the space and the space settles in me" (Shirazi 2014). In this existential experience, the body and the space unite and fuse, giving rise to a body-space: "A building is encountered; it is approached, confronted, related to one's body, moved through, utilized as a condition for other things" (Pallasmaa et al. 2005).

We thus live in 'the flesh of world', which corresponds to an extension of our being. Architectural spaces articulate this experience and give it meaning. Bearing in mind the role of architectural space in configuring our daily bodily experiences, interaction design can enhance this relationship. Our NEAT-Lamp is a concrete example of an interaction design that serves as an architectural element, reinforcing bodily experiences through a phenomenological perspective within the workspace (see Fig. 3). As noted above, the NEAT-Lamp was designed with the objective of moving beyond numeric representations of physical movement. In addition, there was a deliberate attempt to conceptualize the core of the design towards ambient display. Both of these points can be linked to the two basic intentions of Norberg-Schulz and Pallasmaa. The reflection of the lamp's light from the ceiling not only links the sky and earth as discussed by Norberg-Schulz (Shirazi 2014) but also creates a sense of sight and glance (Pallasmaa 2012). This reflection of light is a unifying act that links bodies to the architectural space and represents a superior form of embodiment when compared to screen-based notifications. It is argued that experiencing a space means participating in a dialogue between the space and the body; adopting a suitable interaction design-based approach in the development of PI systems could foster such dialogues. This would mean that in addition to being experienced, our bodily movements could be translated by the architectural space into personal or social meanings that are broadcasted to its inhabitants.

4 Conclusion

We hope that the presentation of our prototype in this paper will help to open up a discussion on new ways of designing PI and QS systems. Our prototype NEAT-Lamp (see Fig. 2) is a simple design that has been implemented and tested in a real setting where it functioned as a motivating element, encouraging users to see and use their bodies as interactive elements within this architectural space (Wiberg 2015). We also wish to point out that this ambient notification system creates an intersection between the body and the architectural space (see Fig. 3).

At the same time, there exists a unitary point of view in architectural thinking that considers all the elements within the space and the way they co-create an architectural form (see e.g. (Zumthor et al. 2006; Pallasmaa 2009; Shirazi 2014)). Bodies within the space are among these elements. This relationship between the body and the architectural space can create meaningful insights of self and being. There have been attempts within the field of HCI to use architectural thinking as a way of grounding new interaction designs and to move towards using interactive technologies as architectural elements (Wiberg 2015). Similarly, some architects have adopted a phenomenological perspective on architectural design. As Pallasmaa stated, "*the ultimate meaning of any building is beyond architecture, it directs our consciousness back to the world and towards our own sense of self and being*" (Pallasmaa 2012). By focusing on the intersection of

interaction design and architectural space when designing PI systems, we move beyond the traditional first-person/user-centered perspective and create new horizons for examining the lived experience of such systems. As noted above, new voices are calling for novel designs in PI that go beyond the individual, contain dynamic trajectories, and represent data in new ways (Ohlin and Olsson 2015). Fusing our moving bodies through the use of ambient displays in the architectural spaces we inhabit can be seen as one such design. By adopting similar architectural thinking, we can expand the field of PI and interaction design in general as a way of unifying bodily movement with space to create a novel understating of self and being-in-the-world.

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