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Interacting with Computers

Design Research as Conceptual Designing:

The Manhattan Design Concept

Abstract

The term "conceptual designing" refers to an activity that various practitioners already undertake, but for which we lack a clear definition. This article provides that definition and uses an example of a design concept called "Manhattan" to present how exactly this type of process happens. We define conceptual designing as a constructive framing and re-framing activity, which is mediated by and targeted at the creation of new design concepts. Conceptual designing as an approach is valuable for addressing the fuzziness and ambiguity typical of research that explores novel areas with new partners, methods, and resources. It is by no means a new phenomenon, and the main contribution of the article is the clarification of conceptual designing as a particular approach to designing and researching. The approach embraces openness, resource-construction, and collaboration. We conclude that conceptual designing can be especially useful in research and design projects that bring different kinds of people, organisations, technologies, and domains together into the forming of new well-founded proposals for development. The presentation of conceptual designing in this paper is written with an intention to provide designers and researchers with terminology and concepts that they may use to structure their work as well as to become more resourceful in reflecting upon their projects.

Keywords: HCI theory, concepts, and models; Conceptual designing; Research through Design.

Research highlights:

- This article defines conceptual designing as a particular kind of design and research activity, which is mediated by and targeted at the creation of new design concepts.

- The article uses the development of the "Manhattan" design concept as an example of conceptual designing to show how exactly the process takes place.

- Conceptual designing is not a new phenomenon, but by articulating what it is more clearly, the article shows how researchers and designers can benefit from the approach.

- Conceptual designing is well suited to clarifying the ambiguity and fuzziness in multi-disciplinary research and innovation projects.

Introduction

The value of using design approaches for research is a topic often discussed under the rubric of "Research through Design" (RtD), see e.g. (Zimmerman, Forlizzi, & Evenson, 2007). The ways in which designing serves research are varied, and currently there exist dramatically different views as to what is the appropriate way to frame design's role within research, see e.g. (Fallman & Stolterman, 2010; Findeli, Brouillet, Martin, Moineau, & Tarrago, 2008). Our focus is on the role that designing plays in research, i.e. on what Fallman (2003) calls Design-oriented Research. Fallman drew a difference between Design-oriented Research and Research-oriented Design, and argued that the aims and agendas of these sorts of activities are fundamentally different. Research-oriented Design is geared towards the creation of new artefacts, whereas, Design-oriented Research aims at producing new knowledge (Fallman, 2005).

Fallman and Stolterman (2010) further elaborate design's role in research and assert that research, which aspires to be relevant and rigorous, must be based on a firm understanding of the aims of three major practices that are

related to design research: *design practice* (i.e. what practicing interaction designers do), *design explorations* (e.g. critical design that questions the relationship between design and society, business, particular user groups, and science), and *design studies* (i.e. analytical work that contributes to design theory, design methodology, design education, design tools and techniques). These broad categories differentiate between the different agendas where design is employed as part of research.

The relationship between design and research is often categorised in terms of research 'for,' 'about' and 'through' design, see e.g. (Findeli et al., 2008; Forlizzi, Stolterman, & Zimmerman, 2009; Jonas, 2006). These terminological distinctions were inspired by Frayling's (1993) pioneering essay in which he considered design's role in academic research in terms of research 'into,' 'through,' and 'for' design. While these distinctions across various practices and types of design research have contributed to a more diverse and nuanced view of the field, the distinctions have also resulted in a more fragmented view of design. These developments have complicated the ability to perceive the common core of designing that makes it valuable for research. This is reflected in the lack of solid definitions of design in theoretical accounts of RtD, see (Fallman, 2003, 2005; Fallman & Stolterman, 2010; Zimmerman et al., 2007; Zimmerman, Stolterman, & Forlizzi, 2010). The theoretical accounts on RtD have also focussed on elaborating on the differences of multiple types of designing within research instead of reflecting on the common core of design that could form foundational associations across ostensibly different practices.

There are, however, some exceptions that focus on how to bring the practices of designing and researching together, i.e. seeing designing as a form of research. The Concept-Driven Design Research approach (Stolterman & Wiberg, 2010) uses theoretical concepts in concrete designs in an manner that transforms the practice into a design-centred and theory-oriented one. Stolterman and Wiberg (ibid.) assert that working with innovative design concepts can lead to intellectual development through definitions, conceptual constructs, and theories. The Strong Concepts approach (Höök & Löwgren, 2012) explores the role of theoretical concepts, such as 'seamfulness,' in the design of

interactive products. What is still left unexplored is how novel concepts emerge in the interplay of design research and design practice, and how they enable the bridging of both design and research agendas.

We argue that a particular type of designing and researching activity, which we call *conceptual designing*, can be helpful in providing concrete strategies and a language to discuss how knowledge is developed in constructive design research. We define conceptual designing as the framing and reframing activity, which is targeted at the creation of design concepts. While we place our approach within what Koskinen et al. (2011) call *constructive design research,* we acknowledge that conceptual designing can be used outside academic practice as well. Conceptual designing is an approach, which embraces openness, resourcefulness, and collaboration. It is by no means a new phenomenon, and the notion of conceptual designing has been used for decades, see e.g. (Neill, Gero, & Warren, 1998). We shall, however, build on our recent theorising (Ylirisku, 2013) and see conceptual designing as a particular kind of constructive framing and re-framing activity that may be utilised to clarify ambiguous and fuzzy projects and to attain collaborative alignment. We elaborate on the idea in the context of an international two-year design research project where conceptual designing was placed at the centre of the process. Based on the study we conclude that by applying a conceptual design approach in design research it is possible to merge the agendas of designing everyday artefacts and of constructing academic knowledge.

Theoretical background

According to Jonas (2006) the design research movement was founded on two key questions in the 1980s: 1) How can design become a respected academic field? 2) How can design contribute to human-centred innovation? The central dilemma behind these questions according to Jonas (ibid.) was that, if designing begins to adopt scientific standards in its practice, it will be more likely to fail in addressing the practical issues of social and economic innovation and human well-being. Jonas (ibid.) asserts that this is due to the de-contextualized nature of

scientific approaches, being neither capable of handling the systemic complexity of real world situations nor dealing with future developments in the social world.

Gaver (2014) lets us see the issue differently. He argues that, even though scientific practice appears different from designing, this is largely due to the way in which scientific practice is presented. The actual process of scientific conduct is typically not fully described, giving way to a clean, theoretically informed and methodically correct process to address the hypotheses in scientific reports. The same insight led early pragmatists, especially C.S. Peirce (1998/1903), to develop a new foundation for a different logic of inquiry, which he called abduction. Following the pragmatists' insights, Glanville (1999) proposed turning the idea of developing designing into a research practice on its head. He (ibid. p. 81) proposed seeing research as a "(restricted) design act, rather than design being inadequate research." He embraced design's role as conversational activity through which *the new* becomes created.

Design research aims at the production of *new knowledge*. The knowledge that design research develops is, nevertheless, different from the 'true' knowledge that scientific research aims to produce. According to Jonas (2006) design research knowledge may be characterised by how Gibbons et al. (1994) define "Mode-2" knowledge. This form of knowledge is *contextualized* and *socially robust* rather than *true*. Nowotny et al. (2005) claim that we cannot rely on traditional discipline-based peer review system any more in the new production of knowledge, because disciplines themselves are changing. Moreover, it makes little sense to apply strict rules for rigour, i.e. that of following a particular methodology would always result in quality outcomes, since the quality criteria are being transformed in response to new "players that are joining the research game" (ibid.). So, what counts as *knowledge* in design research projects has to be reconsidered in the context of pragmatist and social constructivist thought.

Design concepts as knowledge

Fallman (2005) sets knowledge and artefacts apart on the basis of their origins, i.e. that Design-Oriented Research is targeted at the construction of new

knowledge and Research-Oriented Design is aimed at creating new artefacts (Fallman, 2005). Design concepts, however, do not fit these distinctions well, since they may be the result of a unified theoretically oriented design research practice, as argued by Stolterman and Wiberg (2010). According to our earlier research, a design concept is an entity that expresses minimally a *name*, a *purpose*, and a set of *design principles* (Ylirisku, 2013). Design concepts are closely related to scientific concepts, in the sense presented by Blumer (1998/1930) who focused on how scientific concepts work in action. He (ibid.) wrote that scientific concepts have three essential characteristics:

1) Concepts *give a name* to the phenomenon that is being studied;

2) Concepts *enable the collaborative orientation* towards the phenomenon that a concept addresses; and

3) Concepts *propose a way* to perceive and structure the phenomenon that is being oriented to.

We have earlier argued that design concepts have these functions as well (Ylirisku, 2013). Design concepts, however, have further functions that relate to their role as part of design agenda, which is about changing the world rather than explaining it. Design concepts are *purposive* and *generative*. The purpose assigned to a design concept justifies its existence. It tells the 'preferred situation' toward which the world is aspired to be changed. Alike scientific concepts, design concepts give a name for the thing that is collaboratively oriented to. However, instead of only structuring the way in which a particular thing is being perceived and understood, design concepts outline, or imply, principles that guide the generative action to be released towards the desired outcome. These principles are sometimes called 'design drivers', see e.g. (C. Lindholm & Keinonen, 2003), and they form the basis for making consistent decisions upon design features.

Scientific concepts, as well as design concepts, are the result of a process of abstracting and generalising on problematic situations. Schön (Schon, 1963) has argued that concepts are used by people to cope with the world and to

approach problems. A concept enables a practitioner to talk about a phenomenon and to make it an object of shared attention on a more abstract level (Blumer, 1998). The main difference between scientific concepts and design concepts appears to be related to their role in mediating the relationship between actors (whether researchers or designers) and world (whether external or internal to the practice). With design concepts designers are aspiring to change the world out there, whereas, researchers are working to change our understandings of this world.

Scientific concepts are the carriers of academic knowledge and they enable researchers to approach problematic situations. Scientific concepts not only function to structure perception and understanding of the world out there, but they bring to bear concrete effects on how academic studies become organised and reported. And, if we see this in light of the pragmatist insight, that the practice of academic research is actually design activity as well, it should be apparent that scientific concepts function very much alike design concepts albeit on different agendas and within different domains.

The construction process

In addition to design being an approach to developing something new, Zimmerman et al. (2010) promote two other essential characteristics of design that make it especially valuable for knowledge production: the *iterative framing* of the problems and the *holistic and integrative* approach. Zimmerman et al. (ibid.) argue that the knowledge that is brought about by RtD is related to so-called 'wicked problems'. These problems are inherently social, see (Rittel & Webber, 1973), and they may not be appropriately addressed by methods of pure science or engineering, or by the use of inductive and deductive reasoning alone. Connection to the idea of knowledge as presented by Gibbons et al. (Gibbons et al., 1994) as well as by Nowotny et al. (2005) is apparent. This kind of knowledge is foundationally contextual and social, and as such, requires an approach that takes advantage of these characteristics rather than considers these as a flaw in research rigour.

Understanding knowledge as a contextual and social achievement is deeply rooted in pragmatist philosophy, see e.g. (Dewey, 1929). The works by Donald Schön (e.g. Schön, 1983, 1987) are perhaps the best known theoretical accounts within the field of design research that interpret human practice through this socio-contextual framework. A central theoretical notion in Schön's work is the activity *framing and reframing*, see e.g. (Schön, 1984; Schön & Rein, 1994). With framing Schön (1983) refers to how a practitioner perceives a situation and how they promote the essential structures and relations in such a way that enables one to act in a relevant, consistent, and coherent manner.

Design Research as Conceptual designing

Conceptual designing, as presented by us earlier (Ylirisku, 2013), places framing and reframing at the centre of the process. We shall build on this work and define *conceptual designing as the constructive framing and re-framing activity mediated by and targeted at the creation of new design concepts.* This approach emphasises the role of the construction of the resources that enable practitioners to achieve a particular kind of framing. We (ibid.) have argued that it is not possible to frame a situation in a particular manner prior to developing the resources for doing so. The construction and integration of various resources make possible the framing of a situation in a particular manner. This is also implied by Schön's theorising as well as in the recent works of Dorst (2011, 2015). Schön (1983, 1984) nor Dorst, however, were not predominantly concerned with the construction of the resources, as their focus was on the explanation of how practitioners frame problematic situations.

Below we explicate conceptual design practice in the context of a two-year international design research project, which was organised according to the principles of conceptual designing. These principles are implied by the fundamental characteristics of designs concepts as novel, balanced, and relevant simplifications. Firstly, to be novel a concept must be *distinguishable from alternatives* as such. Secondly, a balanced proposal typically *requires iteration* to account for the important relations. And thirdly, the production of a fit design requires the process to be *sensitive to the context* in which it will be placed. The analysis starts from the final concept, and traces back its evolution in order to

show how the conceptual design approach served to give rise to research questions that enabled to guide the related enquiries.

The Manhattan Design Concept

The investigation centralises on one design concept that was created in the Domesticating Search project (2010-2012), which was an international two-year design research project within the field of HCI. The design concept is called *Manhattan*. The Manhattan design concept (Figure 1) emerged during the project and it became presented as one of the key results in the end. Manhattan is a design concept that was created in order to advance research, and as such, it bears several important features: Firstly, it is a *research outcome*, which was published as a result of design research; secondly, it is a *design outcome* that was stated in the project plan as an intended design artefact; thirdly, it is a *result of collaborative construction*; and fourthly, it is a *generative resource* that guided the design, implementation, and review of an interactive prototype. Let us consider each of these aspects in turn.

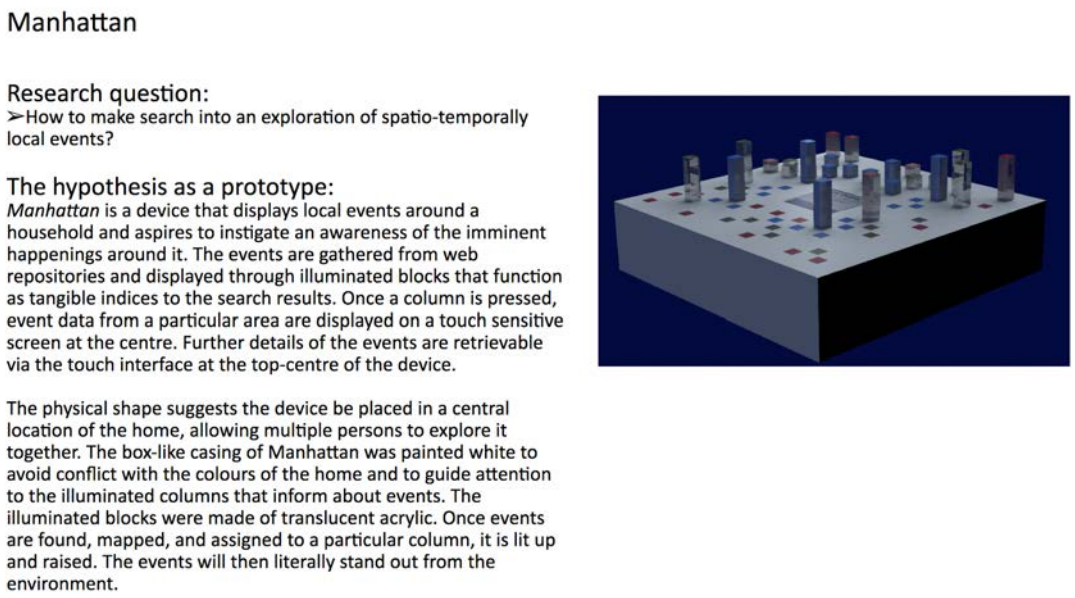

Figure 1. A one-slide design concept presentation.

The design concept as a research outcome

The design concept was one of the *research* outcomes of the project (see Ylirisku et al., 2013, Lee et al. 2014). The Domesticating Search project aimed at

discovering novel opportunities for "re-designing the web for the home" in the form of connected tangible artefacts. The design research agenda was outlined in the project plan in the following manner (p. 2):

> *"The Web is the underlying infrastructure which allows homes to access a vast database of information. The usual way homes do this is through search engines, and the specification of queries, usually through browser application. … search tools need to diversify. The question is what this will entail."*

As a research outcome the design concept was investigated within the framework of designing for the aesthetic of the home, adapting the interpretation of 'aesthetic' from Daniel Miller (2008). Miller (ibid.) conceptualises aesthetic as the whole of relationships that are established in a particular locale in connection with the material and social worlds. According to Miller, a household can be understood as a microcosm with a recognisable order of relations. In terms of project work, this starting point required the researchers to become acquainted with the related theoretical works as well as other reported projects that have addressed the same design space, i.e. the domestic micro-cosmos. Through the investigation the researchers made available to them the resources that connected their conceptual work to the themes and discourses in the academic field. The work to produce the academic text, including the groundwork on related literature, and the elaboration of the argument and contribution, formed part of the key activities in the project.

The design concept had a significant role in guiding how the researchers invested their time during the project, i.e. in terms of planning the field studies, review meetings, consideration of related work, and publishing. The aim to publish the research for the related academic community justified the substantial investment of time by the designer-researchers to construct the design concept and implement it as a functioning prototype. The design concept was a central carrier and expression of the research project's agenda to investigate the domestic design space for web-connected artefacts. The role of the design concept in serving research purposes was enforced by the inclusion of

the research question as part of the design concept: "How to make search into an exploration of spatio-temporally local events?"

The design concept as a design outcome

In addition to the research objectives the project plan outlined objectives with regards to designing. The aim was to generate new concepts for functioning interactive web-connected objects that could be placed into homes of everyday people and assumed to be valued by the household members. These were expressed in the project plan (2010, p. 3):

> *"• Develop an approach to conceptualizing new search technologies for the home through the integration of product and interaction design, user understanding, and technology.*
>
> *• The sketching out and cataloguing of a number of new concepts that derive from the above, addressing a number of diverse kinds of home activities, and ranging from new interfaces or twists on existing search engines, all the way to bespoke, and crafted new objects for the home which embody search.*
>
> *• The building of two or three prototypes selected from the above primarily for the purpose of research.*
>
> *• The deployment of these prototypes in real homes to evaluate the ways in which they find their place (or not) in family households."*

When the expressed goals became adopted into the project team's action, the goals gained a particular kind of status as guides, criteria, and drivers of the design work. Actions that would be considered to advance the project towards the aims were well-motivated and justifications for such actions could be retrieved from the project plan. The project resulted in three design concepts that were implemented as functioning interactive prototypes. The iterative concept design, mocking-up, and prototyping enabled gathering insights from potential future users of the intended-kind of technology. The concepts were refined on the basis of the findings from the field studies as well as from the technological experimentation. The design concepts functioned in the end as design outcomes embodying the lessons learned with regard to user value and

technological feasibility. As design concepts they were aimed to be *novel*, *balanced*, and *relevant* results from the contextual sense-making process of designing.

The collaborative construction of a design concept

The Manhattan design concept, as well as the research question it embodied, did not exist at the outset of the project. These were the results of a series of collaborative construction activities that were staged in an attempt to meet the goals expressed in the project plan. These activities were arranged according to the ideals of the innovate design process, see e.g. (Laseau, 2001; Pugh, 1991), where divergent, expansive, and generative phases are followed by convergent and reductive activities. Through these phases a set of possible issues to consider are explicated, refined and narrowed down in a repeated and iterative fashion. All of the expansive activities were grounded in preliminary studies, such as project-related user studies, that provided particular resources for the participants of the collaborative design sessions to generate and articulate new ideas with.

The key form of the generative activities was the use of collaborative design workshops. The project organised in total four workshops where the initial ideas for the design concepts were created. The workshops involved participants from different backgrounds, such as electronics engineering, computer science, furniture design, industrial design, interior design, textile and fashion design, new media art and design, sociology, psychology, and HCI research both from within and from outside the project. Each workshop utilised methods that merged personal sense-making with collaborative articulation and elaboration of the ideas. This was done with the intent to build on different people's expertise and to incorporate their point of view into the emerging ideas already in the generative phase. In addition to having a diverse set of skills and expertise in the workshops, the workshops involved the key stakeholders who had the power to make decisions over what would be actually done. These key decision-makers from both of the involved institutions were participating in all of the workshops. The design of the collaborative activities in the form of

intensive workshops, i.e. one-day events, enabled also the participation of managers in the constructive work.

Articulating and re-articulating initial design concepts

The four workshops resulted in a total of 200 design ideas that were collected for collaborative review. Based on a review of these ideas the project team outlined six initial design concepts, or *design directions*, in the form of broad thematic labels for what to design:

- ***Local Community Appliance****: A replacement for 'local white pages'*
- ***Family Task Tokens****: A tangible way to collect and negotiate ideas together for things to do*
- ***Creative Wishing Well****: A slow search around the 'results' to foster serendipity*
- ***Home Portal****: A device that provides a sensuous delivery of web streams from a place you care about*
- ***Promoting Relationships That Matter****: A way to perceptualise important social relationships*
- ***Timely Reflection****: An aesthetic means to think about what has happened over time*

The presentation of the ideas in the review meeting was, however, considered too superficial by the key decision-makers. The textual presentation of the ideas on sticky notes lost much of the richness of the original idea descriptions in the workshops. Hence another round of review, where the ideas would be considered in some more depth, was planned. The secondary round of review was then realised through an intranet site, where each of the ideas were presented with additional detail as compared to the sticky notes. The researchers went back to the original data from the workshops and inspected the original presentations of ideas in detail.

contains an example of three ideas from the ideation workshops. The explanations were retrieved from video recordings of the workshops. The three sticky notes show some of the key features that were carried all the way into the final Manhattan concept.

Figure 2. Early ideas on sticky notes that were reviewed in the secondary focusing round.

The ideas on the sticky notes were established on resources generated earlier in the process, i.e. their existence was consequential to what the project team considered before. The ideas in

Figure 2 (A) and (B) were inspired by a video portrait of a bachelorette.

Figure 2 (A) presents a "Digital map that shows what's going on around you, within easy reach. House at centre".

Figure 2 (B) shows an idea of a device that draws together information about what's happening locally, around home, drawn from the web with recommendations from friends. The note was explained in the workshop by one of the participants with the following words:

> *"This is presented as a magazine, using a form factor that is magazine-like (this could be a slate app, but would be better as a separate device). The content should be bounded, i.e. you can explore what's new without getting drawn into other activities such as online forums."*

Figure 2 (C) displays another map-like idea, a "digital map that is based on time to place, not on distance," which was inspired by the review of a video portrait about a middle-manager who valued knowing the time-to-travel. The idea was explained in the workshop in these words:

> *"Sometimes physical distance is not as important as temporal distance. The Digital map creates a temporal map of places and locations relative to your location based on the time to get there. It works in real time using traffic feeds and weather information to create the map. Places that appear closer take less time to get to."*

The re-inspection of the original expressions of the ideas, and the presentation and review of these on the intranet site, resulted in a set of differently named themes as compared to the design directions earlier. It is, nevertheless, possible to see a strong resemblance with the design directions above. The new labels for the most interesting ideas were:

- ***To-Doing****: A flexible form of creating ToDo lists. [..] information about local events, what's playing at the cinema, new restaurants, or courses in your area. [..] This would be a kind of interactive daytimer.*
- ***Search Results Bowl****: During the week a family is developing a list of things to do they save for the weekend [..] into a bowl.*
- ***Wishing Well.*** *A bowl where you can ''throw'' your ideas or early thoughts that you are developing. The well crawls the web making searches related to the idea or thought.*
- ***The Portal****. A big spherical lens sits on a wall. It functions as a portal to a place that you care about. [..]*
- ***DVDJ****. [..] A system that can reconfigure content along a number of axes that correspond to some different ways in which a person may want to consume their media [..] a foreground activity, or more in the background.*

The new list of design directions, or early design ideas, was used as the basis for making decisions about which design concepts should be prototyped. The ideas were the result of a prolonged collaborative construction of new resources to think with and the previous construction was consequential to what happened next.

Design concept as a generative resource

The presentations of the to-be-design-concepts were re-articulated multiple times during the project's duration. Through the iterations the team produced several re-articulations of the overall scheme and principles for each concept and of the particular ideas for the form and functionality. The overall scheme was expressed initially in the design directions, or concept framings, listed above. These framings guided the generation and synthesis work that followed.

The concept framing called To-Doing was the one that would ultimately become the Manhattan design concept. The idea underwent significant transformations, and amongst the first things to be changed was its name into Interactive Daytimer. This name suggested a more concrete sense of physical shape for the design while maintaining the core functionality. It was considered to be an artefact that provided users with the means to relate to local events gathered by a geographically constrained web search. During the first iteration of the Interactive Daytimer it became presented as a mobile-device connected charm with a link to a digital calendar that used web-based event data (Figure 3). It would inform a user about new events by blinking colourful lights.

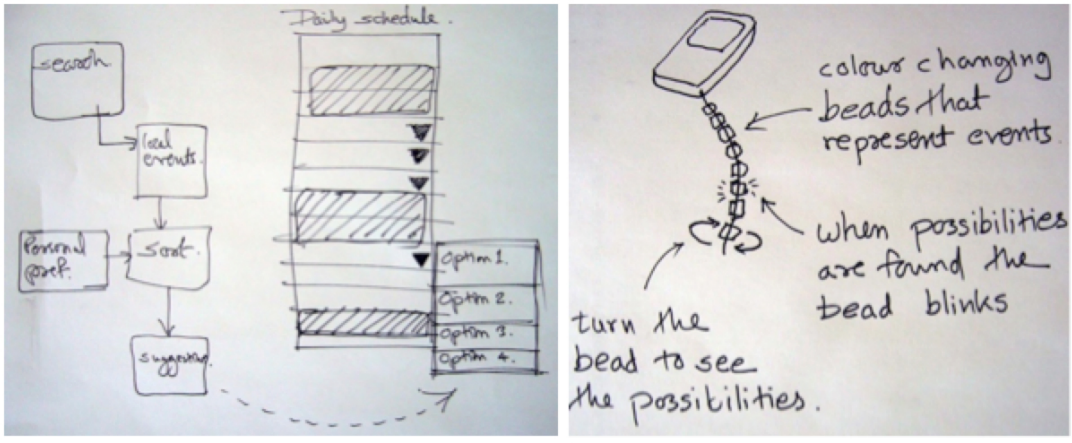

Figure 3. The Interactive Daytimer idea was presented as a charm with a calendar connection.

The charm was, however, discarded after a re-consideration of the focus of the project on physical domestic appliances, and the form of the design

concept was opened again for ideation. The project team realised that they needed to better ground the prototypes on the project's research agenda on human practices in home environment. They also agreed that the Interactive Daytimer would be a household device that would be accessible to all the household members instead of being something that resides on a mobile phone. This was to encourage the use of the device to become more embodied and social, and hence, be more interesting considering the research agenda of the project.

Along with this realisation, nine months into the process, each of the design concepts was assigned a dedicated research question or set of questions. The team realised that the research question could drive designing and give criteria for making choices over alternative design features. The research questions for the Interactive Daytimer became:

> *1) How to make search into an exploration of the spatial and temporal locale i.e. the events which are local as geographical and local as happening around the 'now'?*
>
> *2) How does the artefact know what are the likes and dislikes of the members of the family?*

The project team considered alternative physical forms, such as magazine, album, book, radar, and a physical attachment to a phone. The functionality was grounded on the *exploration of events* around a particular *geographical location*. The notion of geographical location guided designers to develop the form into a map where the home would be placed at the centre, very much in the sense as presented in the sticky notes on the

Figure 2 (A & C). The Interactive Daytimer concept was elaborated by the means of physical mock-upping. The first mock-up was a very low-fi model made with Lego bricks and paper. It was presented as a map where different events were placed on a squarely surface. The designers envisioned presenting the landscape of events around the home in a colourful format with physical blocks that represented the local events in different colours based on their type, e.g. concerts in blue, theatre plays in red, sports events in green, etc., see Figure 4.

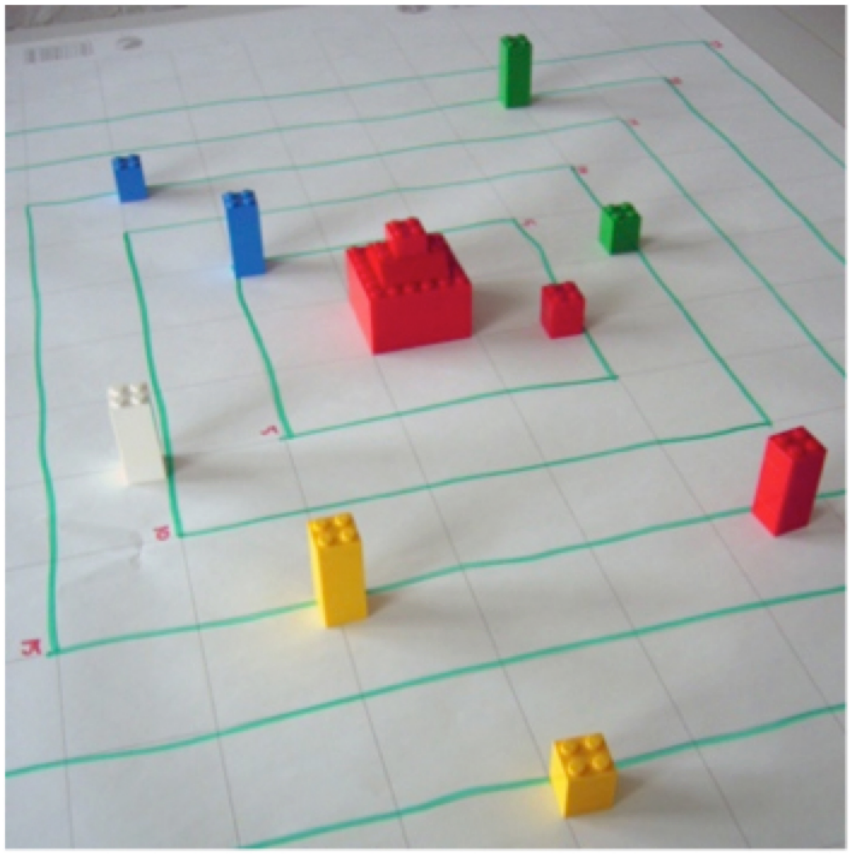

Figure 4. The Interactive Daytimer was transformed into a squarely map.

Once the initial shape was sketched out, the designers re-articulated the design concept in the form of an A4 leaflet, which they shared with the rest of the project team. The physical form was presented with a wire-frame rendering and the functionality was illustrated with photographs showing how users would interact with the device. The presentation included also a textual explanation of the key functionality and interaction. At this stage the design of the Interactive Daytimer looked as in Figure 5. It still had ingredients from the idea that originated in the video portrait of a middle-manager who valued knowing the time-to-travel that were originally presented on the sticky note Figure 2 (c).

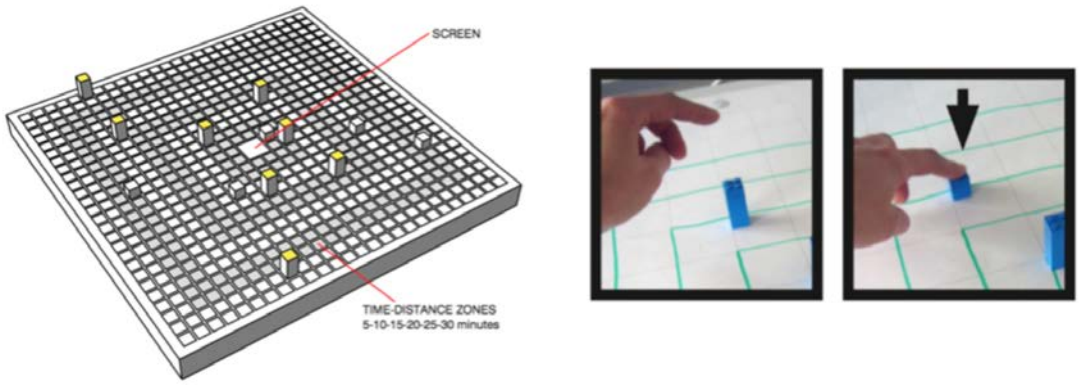

Figure 5. The Interactive Daytimer concept was presented as a map with a tiny screen in the middle and 'pop-up' poles that the user could push to configure preferences.

The first wireframe rendering of the design featured a grid containing in total 670 locations and a tiny screen that would display data about an event if one of the colourful columns would be pressed. Based on feedback from the rest of the project team, the designers enlarged the screen to accommodate more information about events. A compass was added to help to orient the map and the height of the device was increased to make enough space inside the box for the anticipated technical components. Once the team had decided upon the overall physical shape of the device, a more detailed mock-up was created with foam board, see Figure 6. It was used to collaborative design the functionality with participants from various households. The design team did not plan the details of the interactions up front. The potential users of the device were encouraged to openly imagine with the box what would make sense in their home. The collaborative designing was led by an experienced interaction designer who was able to go through the imagined interactions that the participants suggested in detail.

Figure 6. Collaborative designing of interactions with the Interactive Daytimer mock-up.

The collaborative design was followed by the constructing of a functional prototype according to the scheme that was outlined in the design concept presentation. The prototype-building involved the making a physical casing, electronics, and software (see Figure 7). The electronics became rather complicated, considering the time and resources in the project. The team was also working on two other design concepts and prototypes in parallel.

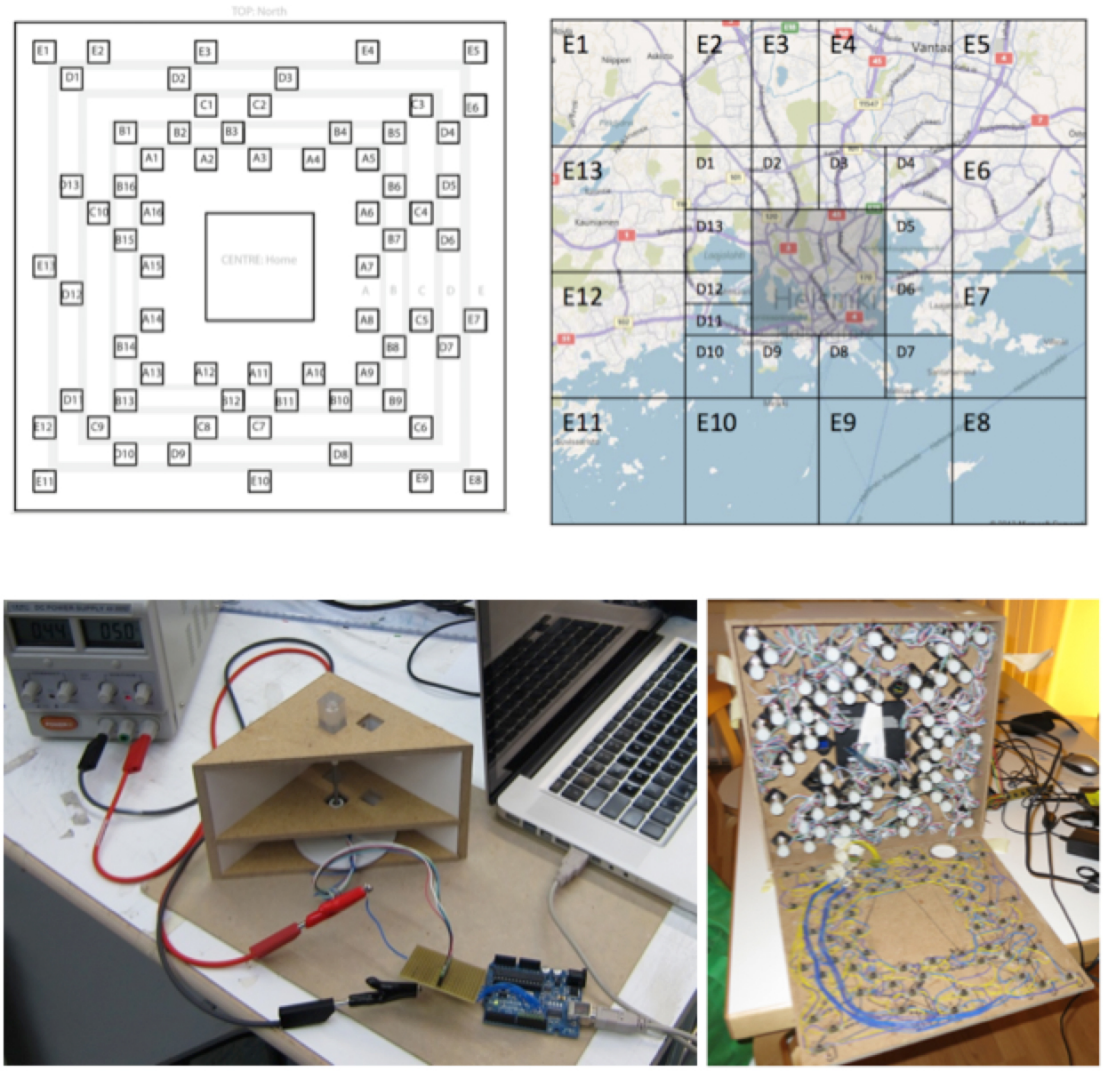

Figure 7. Technical development of the Manhattan prototype proved to be very complex and involved server and client software as well as physical design. The design featured 68 illuminated and moving columns that functioned also as push buttons. The sheer amount of hand-soldering the connections and cablings (68 stepper motors, each with custom-created controllers, 68 individually controlled RGB LEDs, MiniPC, touch screen, 2 MegaArduino Boards, Fan) remained substantial. There were over 1100 physical connections to be made by hand and to be tested for potential errors.

Ultimately the technical complexity prevented ever deploying the prototype and testing the interactivity in households. The technical prototype failed to function reliably enough when all of the motors were connected. Nevertheless, all the technical and computational parts were actually functioning. Data were scraped from actual web event repositories, and they were mapped onto the illuminated columns. The touch screen displayed the real event details, it featured real interactivity, and so on. The technological

exploration informed the project team about the technological feasibility of the designed form and functionality. The functioning final prototype, with a reduced set of illuminated columns enabled, is shown in Figure 8.

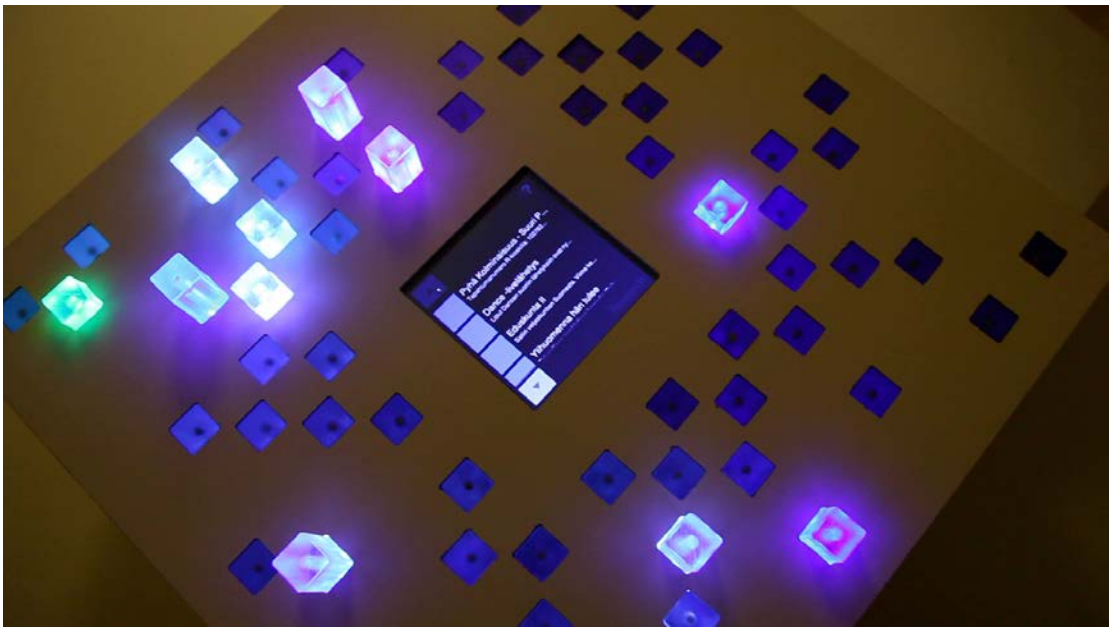

Figure 8. The functioning implementation of the Manhattan prototype.

The design concept had a pivotal role in guiding the planning and implementation of details as well as serving as the justification for making decisions upon the details that emerged along the prototype-building work. One such decision is the leaving of the configuration of the block mapping completely to the web-back end of the system. The final form followed closely the rendering shown in Figure 1. The final name of the design concepts, Manhattan, was actually inspired by the 3D-rendering in the concept presentation, as it resembled the towering buildings in central New York.

Table 1 summarises the key phases and changes in the development of the Manhattan design concept in regards to three project-relevant agendas: use, technology, and research. Construction of design resources happened in parallel in these agendas that informed and established each other, i.e. the work conducted in one of the agendas was consequential for work conducted on another. For example, the design drivers that were reported in the academic paper (Ylirisku et al., 2013) did not actually exist as explicit phrases during the

designing, but rather, they were implicitly present in the way the design moves were made during the collaborative design and prototyping phases.

Phase	Use agenda	Technology agenda	Research agenda
Design Idea Generation	A repetitively mentioned user need is figuring out what to do.	Automated suggestion of things to do, browsing supported. [*Visual to do –list, FiloFax booklet*]	Knowledge gathered about reported design cases. No specific RQs yet. Development driven by generic research objectives as outlined in the project plan.
Concept ideation	Users with a lot of free time is considered to benefit most of automated suggestions about what to do	Calendar-integrated interactive mobile application to suggest things to do [*Computer software + physical mobile phone add-on*]	Knowledge about already reported cases was used to exclude ideas.
Research questions development	Awareness of spatio-temporally local events could be valuable for all household members.	Display of very local events around 'here and now'. Learn user preferences in easy and intuitive way. [*Multiple vague ideas about the form*]	Research agenda becomes clearer through the RQs: 1) How to make search into an exploration of the spatial and temporal locale i.e. the events which are local as geographical and local as happening around the 'now'? 2) How does the artefact know what are the likes and dislikes of the members of the family?
Concept elaboration		A squarely range-map with colours indicating travel times. Setting user preferences by pushing columns. [*Shallow box with illuminated columns as a map, tiny display, compass*]	
Mock-up co-design	The support of peripheral awareness of local events in a calm and aesthetically neutral way.	A web back-end for setting user preferences. E-mails about chosen event details. Lighting hue as event type cue. [*Higher box with illuminated columns, larger display, compass removed*]	
Prototyping		Too complex functionalities omitted, e.g. the web-based configuration back-end omitted.	The second research question was dropped and the first question elaborated.
Reporting		Explicit design drivers added to the design concept in the publication.	Miller's work on 'aesthetic of the home' is studied and the project is interpreted through it. Concept design is also related to recent theorising.

Table 1. The evolution of the Manhattan design concept during the project (empty cells indicate that there were no important changes).

The three agendas (use, technology, and research) provided design resources for each other as well as required dedicated resources for their own respective construction. Within the use agenda the resources were based on user studies and collaborative design studies with the design mock-up. Within the technology agenda the resources were based on existing software and electronics tools and knowledge that various development communities and organisation share for the development. In the research agenda the development

was based on the reading of related research and having expert HCI researchers participating in the process, and in ideating and evaluating the designs. People were very resourceful in contributing to the development and review of the results.

Discussion

Conceptual designing may help to bring design and research together. The presented approach shares many of the characteristics of concept-driven interaction design research (Stolterman & Wiberg, 2010) but is different especially in the focus on the construction of novel concepts. Stolterman and Wiberg (ibid.) present concept-driven interaction design research as an approach where theoretical concepts become manifested in concrete designs. Conceptual design, on the contrary, centralises the construction of novel conceptual understandings and manifesting these understandings through novel, balanced, and relevant simplifications into concrete design proposals. We pinpointed some of the fundamental similarities between academic concepts in the social construction of knowledge and design concepts in the social construction of ideas about what ought to be created.

Conceptual designing is similar to concept-driven interaction design research in that both of these approaches can be conducted for the advancement of academic knowledge while at the same time producing relevant designs for a non-academic audience. Conceptual designing, however, is not constrained to the field of design research, i.e. conceptual designing can be conducted without the intention to advance academic knowledge. Concept-driven interaction design research is explicitly framed as a form of research (Stolterman & Wiberg, 2010).

Conceptual designing also shares similarities with the strong concepts approach (Höök & Löwgren, 2012) in that conceptual designing is geared towards the development of generalised simplifications that serve the aspirations to transcend particular design solutions. Design concepts, like strong concepts, are generative and address interactivity. Conceptual designing, however, departs from the strong concepts approach in its focus on the

construction of concepts (emergence) rather than on their manifestation through concrete proposals in different projects in various domains. Conceptual designing focuses more on the role of constructive design practice and less on conceptual properties as compared to the strong concepts approach.

The conceptual design approach was presented as an approach to what e.g. Zimmerman et al. (2010) call Research through Design (RtD). RtD refers to research that uses design methods as legitimate means of enquiry. Theoretical accounts on RtD, see (Fallman, 2003, 2005; Fallman & Stolterman, 2010; Zimmerman et al., 2007, 2010), have typically left the definition of design approach very open or they have focussed on elaborating on the differences of multiple types of designing within research. We have focussed on the characteristics of design that could form foundational associations across ostensibly different practices.

We presented a research project where conceptual designing was employed as a means to advance both research and design agendas. The project is in many regards similar to previously reported projects, such as Active Badges (Want & Hopper, 1992), Bricks (Fitzmaurice, Ishii, & Buxton, 1995), the Drift table (Gaver et al., 2004), and the Alternatives (Gaver & Martin, 2000). In all of these projects conceptual designing have played a pivotal role in guiding both design and research activities. We have attended on the similarities that research activities have with designing, and presented conceptual designing as a means to bridge the agendas related to design and research.

Conceptual designing was presented as the framing and re-framing practice that is aimed at the construction of new design concepts and that is mediated by the concepts. We presented design concepts as novel, balanced, and relevant simplifications that guide design action. Design concepts functioned as purposive and generative means for constructing design resources related to the multiple agendas of the project. A design concept features a *verbal name* that enables the easy reference to them in talk, a *purpose* that justifies their existence and motivates the implementation of interactive artefacts that realise their idea. Design concepts also outline implicit or explicit *principles* that guide the

generative and evaluative work and enable the development of distinguished and coherent results.

We argued that design concepts may function in a much alike manner as scientific concepts in social constructivist research. According to Blumer (1998) scientific concepts give name to phenomena being studied, enable collaborative orientation towards the phenomenon that the concept addresses, and propose a way to perceive and structure understanding about the phenomenon. Scientific concepts, however, do not merely function to structure perception and understanding but lead into concrete changes in how academic studies become organised and reported. Academic research practice can be understood as a form of design and designerly approach may be emphasised by a more explicit focus on conceptual design approach.

Foundational in the conceptual design mindset is the iterative framing and re-framing of research questions along with re-articulations of the evolving design concept. Each round of re-stating of the design concept name, purpose, questions, and principles may lead into radical changes into the concept as the result of the project team attempting to reflectively accommodate their new insights into the presentations. This is due to the contextual character of conceptual designing that encompasses activities focused on the construction of such design resources that enable to bridge the various agendas involved. The present study recognised some of the foundational characteristics of conceptual design practice that may be shared across different agendas within a project. The most important of these were expressed through the study of the role of the design concept in the project.

When design research is conducted as conceptual designing, and especially when the activity of concept design is placed central to the process, it is possible to benefit from the multiple roles that design concepts may have for the process. First of all, a design concept can be seen as *a research outcome*, which may be published as a result of design research in the academic domain. Secondly, it can be appraised as *a design outcome* serving user needs in a technologically feasible manner. Thirdly, a design concept can be understood as

a *result of multi-disciplinary collaborative construction* carrying the considerations and traces of expertise from the participants of the process. And finally, it may serve as a *generative resource* guiding ideation, design and implementation work.

The role of design concepts in regard to design action may also vary over the duration of the process. In the early phases a design concept may be *a goal* that guides and justifies action. During the project it may *mediate* the constructive actions to attain the goals by guiding the generative work and decision-making. And, in the end of the project a design concept may be presented *as a result*. We argue that these multiple roles should be acknowledged already at the stage of project planning in order to promote the centrality of activities targeted at the construction of design concepts. The study showed how conceptual designing can be assigned a key role as the central integrator of multiple agendas in a research project.

Conceptual designing may also propose new agendas for further research beyond the single project. For example, the concrete proposals of how people may participate into the use of networked resources in their households have already resulted in further studies in other projects, such as that presented in (Bellucci et al., 2015). Hence, conceptual designing may serve design research beyond agenda-integration, in an agenda-forming manner.

Iterative framing and holistic integration

The findings from the studied project underline the two aspects that Zimmerman et al. (2010) consider as the key characteristics that contribute to making design valuable for research: iterative framing and holistic integration. The project plan was designed in a manner that supported iterative framing in the studied project. The plan outlined high-level aims that were roughly chronological instead of defining very clear steps and procedures on how to organise the project. It did not set out specific steps, or work packages on how these aims would be reached, but rather, exposed in an open-ended fashion the outcomes of the project. The plan thus encouraged the project team to explore

diversity and to adjust the process in response to discoveries along the way. The goals were also set in a fashion where all the project participants could share the same goals. So, regardless of the two project partners were institutions with very different working cultures and expertise, the abstract and mutually relevant brief enabled and fostered true collaborations in a manner where the expertise from both organisations could be integrated into collaborative design and review events.

With regards to the holistic and integrative approach of design, the studied project shows how important the investment of time for the construction of the resources was for the development of the final research questions. During the project the team created a wide array of ideas, and iteratively articulated and re-articulated their ideas about what should be done. In this manner the project team was all the time building on top of the most recent understanding of what is it that they are "dealing with". These ideas spanned across the three agendas of the project, i.e. use, technology, and research. Moreover, the intentional staging of the project activities in the form of collaborative construction where people from various backgrounds participated, served to make the considerations more holistic.

The design concepts functioned in integrative role as they guided project team towards articulating shared entities (design concepts) that would capture the discoveries along the way. Binder et al. (2011) address these resources in terms of 'design things,' appreciating the at once concrete and abstract nature of these entities. These design things emerge as the result of constructive activities that build on top of each other. Due to the consequentiality related to the construction of resources, these 'design things' integrate knowledge from multiple agendas into shareable objects that communicate over disciplinary boundaries, in the sense Star (1989) spoke of the role of boundary objects.

Design artefacts vs. research knowledge

The key difference in considering a result as research knowledge or design artefact is related to the audience, agenda, and resources that are employed in the construction. The design concepts had a role *as research*

knowledge in the part of the work that was targeted at the academic audience. This part of the work contributed to the understanding of the academic community with regards to the phenomena that need to be taken into account when designing interactive connected artefacts for the domestic space. These detailed discoveries are reported in (Ylirisku et al., 2013) and will not be repeated here. The resources that the project team utilised in the construction of the research knowledge were not only the materials related to the design concept, but particular academic literature in the field as well as the researchers' embodied skills to author academically accountable texts.

The design concepts functioned as design artefacts exposing design opportunities for the domestic design space. They expressed new possibilities based on the experienced gained during the process. They were designed to propose a feeling of desirability from the point of view of domestic life especially considering the agenda of improving people's awareness of temporally and geographically local events surrounding the home. In the realisation of the design artefacts designers employed understanding about users, about people's homes, and about particular technologies that would enable to implement the designs. The project was not directly connected to business agenda, and it was never explicitly considered.

In sum, design artefacts and research knowledge can be treated as different labels for essentially the same things. What these labels achieve is a difference in the role that will be given to them by people working on different agendas.

Conclusions

By labelling the paper "Design Research as Conceptual Designing" we align with Glanville (1999) who argued that research can be understood as a form of designing. We defined conceptual designing as a constructive framing and re-framing activity, which is mediated by and targeted at the creation of new design concepts, and explained how it may serve to clarify ambiguities that are typical when different kinds of people and organisations set out to do

exploratory work. We showed through the study of the creation of the Manhattan design concept how exactly the conceptual designing process works. We also illustrated the many roles that design concepts may have in the process. Design concepts were defined as novel, balanced and relevant simplifications that outline a name, purpose, and principles for the realisation of the object of constructive action. They can facilitate the construction of academic knowledge and design artefacts in a manner that both guides the generative action and grounds it on the resources that are collaboratively created during the process. Similarities between academic knowledge construction in the social constructivist sciences and in constructive design research were highlighted.

We see that conceptual designing is also beneficial outside the domain of academic research. Our key pragmatic insights for design research practitioners who are planning new exploratory projects are:

1) Establish design concepts as high level and high priority research and design objectives that are loosely constrained.

2) Reserve time for collaborative multidisciplinary activities to construct the resources that enable the iterative framing and re-framing of the agenda of the project.

3) Employ design concepts as the central means to direct the implementation and research investigation, and reflect lessons learned back into the design concepts.

We expect the conceptual designing approach to be most valuable in complex projects with high uncertainty, ambiguity, and value conflict – terms that Schön (1983) employed for describing the problems where the re-framing is typically most helpful. Our work is aimed at contributing to opening up novel areas for research that investigates the relationship between the initial resource construction, the schemes that are employed to pre-structure creative work, and a project team's ability to articulate original results that serve multiple agendas.

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