Between generative prototyping and work of synthesis in design: Interplay and adding value in the early concept development

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Published in:
Proceedings of CO-CREATE 2013 conference

Publication date:
2013

BETWEEN GENERATIVE PROTOTYPING AND WORK OF SYNTHESIS IN DESIGN: INTERPLAY AND ADDING VALUE IN THE EARLY CONCEPT DEVELOPMENT

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ABSTRACT

The paper analyzes a case in which generative prototypes are applied as part of a participatory design methodology to elicit insights from practitioners, and how these insights are translated and represented, to inform the following work of synthesis in design.

In literature, arguments are made for the value of involving practitioners as active participants in the development process, which holds the potential to develop innovative products. The paper unfolds a discussion on how knowledge from different sources can be qualified and re-qualified through a methodology of generative iterations, creating a valuable interplay between participatory sessions and background development work. Through an empirical study, it is analyzed how this can be achieved through intermediate methods informing decisions in design to be made based on practitioner wishes and desires, but necessitating re-qualification through iterations.

The paper concludes, that the methodology can frame a process of eliciting explicit and implicit knowledge from different sources, but that the designer, as being part of the entire process, comes to hold 'sticky' knowledge that difficult to transfer, which implicitly influences the design process. It is considered how such brokering of knowledge by the designer can have a role in the further downstream of product development.

KEYWORDS

Design practice, generative prototyping, co-creation, knowledge creation, product development

INTRODUCTION

The iterative nature of design process, with work being problem-oriented and emergent rather than decided at the outset of design calls for the continuous collaboration with relevant stakeholders. To support an iterative and collaborative design process, participatory sessions are reported to be an appropriate framework (Buur & Matthews 2008). Particularly, ambiguous and open-ended materials such as simple prototypes, design games and other explorative tools are fit to motivate a participatory setting in which experiences, containing both implicit and explicit knowledge, can be accessed and explored in practice with stakeholders involved. The paper builds upon the value in such generative tools, and presents the staging of *generative prototyping* through participatory sessions as a methodology for practitioners to break out of taken for granted routines towards the development of innovative products. The paper aims to further analyze how knowledge from such sessions can be interpreted, represented and combined with other relevant 'design'-knowledge and thus translated to add value to the background design process taking place in between sessions. This raises three overall questions, which the paper addresses:

How can knowledge be created and elicited as an emergent part of a participatory session?

The paper presents the notion of *generative prototyping* as an approach to interest and involve practitioners, which arguably qualifies such creation and interaction between explicit and implicit knowledge.

How can knowledge be translated from sessions to be representative and valuable among other sources of knowledge in the design process?

Explored by giving an account and analysis of how knowledge from different sources are applied to act in the design process, upon entering a process in which different concerns are sought represented and negotiated, and where decisions are being taken by designers as work of synthesis in design.

What are alternations between participatory sessions and work of synthesis in design doing to the overarching design process?

Finally, it is discussed what characterizes the interplay between sessions and development work influence the design process, in relation to how the process is qualified and re-qualified through such iterations.

The paper presents its findings based on the analysis of a design process covering the fuzzy front-end towards a concept for equipment to be used by

fire fighters. Other stakeholders have been involved in the process, but present papers focuses on how fire fighters, as practitioners, were engaged. Empirical work presented originates from a Master's Thesis project in Design & Innovation in Engineering, at the Technical University of Denmark. The author of this paper was one of the two graduate students conducting the project, which will in the remainder of the paper be referred to as the *designers*.

THEORETICAL BACKGROUND

Based on literature within participatory design and co-creation, arguments are made for the potential of involving stakeholders as active participants throughout the product development process. Suggested ways to achieve such participations are: in terms of staging participation (Visser et al. 2005), motivating generative behavior to elicit knowledge (Sanders 2002) and enacting the familiar and imaginative (Halse et al. 2010) as being ways to scaffolding ordinary people to contribute to the elicitation of tacit (implicit) knowledge for product innovation (Buur & Matthews 2008). To bring such behavior from participants in action, *generative prototyping* is introduced as an activity to act on the boundary between design knowledge from participants, processes and products (Cross 2006) through their framing, generation and enactment. It is deemed useful to perceive such prototypes, as well as other boundary objects (Star & Griesemer 1989) of the process as *intermediary objects* that are not passive representations, but rather *performative* (Danholt 2005) in that they mediate and translate knowledge across boundaries (Boujut & Blanco 2003).

To analyze and discuss how knowledge is elicited and dealt with in the process, the paper draws on theory of dynamic creation of knowledge within and between individuals. This is perceived as an iterative process involving both externalization of implicit knowledge and internalization of explicit knowledge becoming implicit (Nonaka 1994). To elaborate on how knowledge can be represented in other contexts, it becomes necessary to cope with the inherent 'stickiness' of knowledge, which is situated and rooted in the social practice enacted in participatory sessions, but 'applied' elsewhere (Brown & Duguid 1998). Such theories on knowledge creation and representation agree that it becomes a social process where individuals enter in dialogue with each other and develop a shared understanding through iterations.

Over the course of such interactions and mediations between stakeholders, the process leads to issues of significance emerging through collaborative

activities. It thus becomes interesting to analyze how these matters of significance emerge and are qualified through the interplay, within and between, participatory sessions and development work towards a shared understanding materialized as a, more or less, stabilized concept. The designers, being involved throughout the process, thus become central as *brokers of knowledge* (Brown & Duguid 1998) between participants of the sessions and other sources of relevant knowledge in the design of products.

METHODOLOGY AND DATA

The presented generative methodology involves *generative iterations* throughout the entire process of designing products.

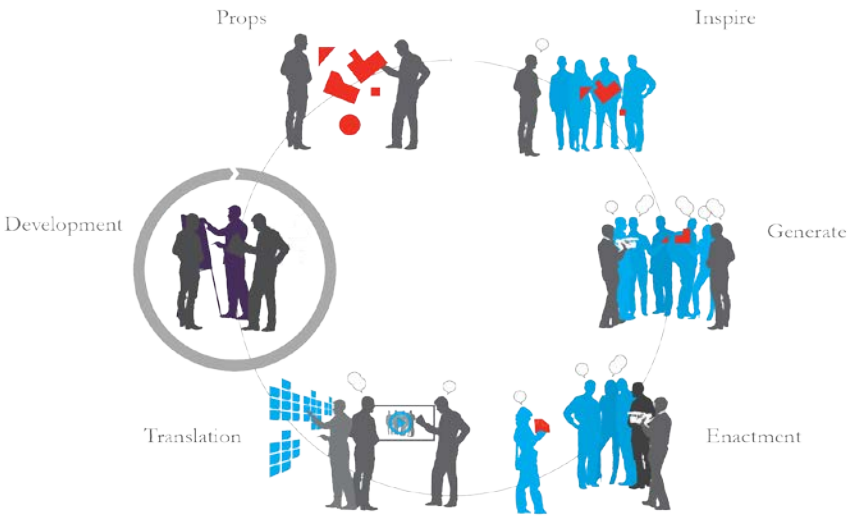

Figure 1: Model sketching the generative iterations central to the methodology

Such iterations revolve around the participatory session where knowledge is qualified through the generation and enactment of prototypes (Figure 1, right side). This knowledge is thus translated into the development work done in between sessions, before being re-qualified in following iterations (Figure 1, left side). Therefore, the participatory session is central to the approach as a means to allow for the co-creation of concepts during the entire process. The following section with describe and analyze such a *generative iteration*.

Empirical data

The empirical study analyzed in the paper covers part of a project concerned with the development of equipment to be used by fire fighters to improve their performance when extinguishing fires inside buildings. Throughout the project, four full generative iterations were conducted. The data treated in present paper covers the conducting of the second generative iteration of the project, and consists of the three overall parts: 1)

Props, activities and conducting of Session II, 2) interpretation and translation of session and 3) development work and synthesis. Throughout the section, methods and process will be accounted for intertwined with analysis and reflection. The session was video recorded with two cameras placed at positions to give the best possible view of the activities of the participants and their actions. Presentation of data and its translation into the development work is highlighted by instances from the case where deciding concerns surfaced and were negotiated. Setting the stage of the generative iteration described was a process of interviews, observations, desktop research and a participatory session resulting in the focus on developing concepts for the water nozzle and self-containing breathing apparatus (SCBA) (see picture 1, below).

Picture 1: Left: A water nozzle. Right: A self-containing breathing apparatus

Props, activities and conducting of Session II

Generative prototyping as a notion describes the application of simple and malleable materials, props, that are put together to form simple prototypes of low fidelity and resolution (Houde & Hill 1997). Being open-ended and ambiguous, they should allow for a mediating dialogue and representation of design concepts between participants of the session. Session II took place in a small workshop located at the back of the garage in the fire station. To set the stage for generative prototyping in the session, the locality was prepared with inspirational material in the form of sketches with ideas for water nozzle and SCBA, respectively. A range of props were put on the table, including: packaging foam, cardboard, markers, elastic and some precut 'basic' shapes, to make the activity more accessible (Sanders 2005). A protocol for the session was made to plan the session to last for about one hour. The protocol was divided into three activities to allow for the creation of two prototypes (one for water nozzle and one for SCBA) and a final activity involving the enactment and demonstration of the generated prototypes.

Picture 2: The stage of Session II containing props and inspirational sketches

Prior to conducting the activities of the session, the participants were divided into two groups consisting of 2-3 fire fighters (practitioners) and one designer. This was done both to create groups of a size where all could be involved in the generative activities and also to make the final enactment activity possible. To kick off the session, the practitioners were presented with the agenda and introduced to how the designers imagined them using the inspirational sketches and props to create prototypes. To do this, they were asked to pick out 2-4 sketches to inspire their prototype generation. During the activity of generating prototypes, the participants initiated a discussion, started mainly by sketches. At first, the fire fighters were a bit hesitant to start applying the props and putting together prototypes, resorting to mainly picking up some of the basic shapes and using them to demonstrate certain points in the discussion. These demonstrations were supported by the designers starting to put together props into prototypes in parallel to the dialogue between all participants, which in turn helped the practitioners in elaborating on their narratives. Following the generation of the prototypes, the practitioners were asked to present them to each other. This enactment of the prototypes was characterized by the practitioners being physically active, gesturing and mentioning how the imagined context of use would affect, and be affected by, the prototype concept. Further, they challenged each other in their presentations and how they would affect new working practices, which surfaced trade-offs that were based on taken for granted conditions, agreed upon between practitioners as well as now apprehensible possibilities for changed contexts facilitated by the prototypes. This process of relating the prototypes to practice seemed to be an effective way externalizing implicit knowledge.

Picture 3: Practitioners generating prototypes during Session II

Over the course of prototype generation and enactment, the prototypes became intermediary objects that mediated, and thus qualified a shared understanding and new meaning to the involved participants. This process involved the creation of both implicit and explicit knowledge in parallel and thus resulted in the prototypes representing the session with its discussions and negotiations (Cramer-Petersen & Marijnissen 2012).

Interpretation and translation of session

Afterwards, the recorded session was reviewed as a process of both designers looking through the video material together, and taking notes on post-its, which gave a basis for discussing what could be deemed relevant. As such, post-its could both hold quotes, observations, viewpoints or random thoughts triggered from watching the material. For later use, each post-it that referred to a particular action in the session was tagged with a time-stamp. Here, it is important to make a note that knowledge from the sessions was not the only source to the Affinity Diagram (Kawakita 1982) emerging from the post-its. Desktop research and notes from interviews with other stakeholders were also added in order to get perspectives on issues regarding the development of equipment for fire fighters.

Picture 4: Part of the affinity diagram after Session II

Following the review of the session recordings, a process of interpretation of data began. Contrarily to their function as intermediaries during the session, the generated prototypes lost most of their ascribed meaning outside the session context, which made them unfit for analysis on their own. Rather, through the recordings of the session, which also contained all the actions taking place around the prototype, it became possible to foster a meaningful translation to add value to the development work. Through the Affinity Diagram, the knowledge, from session and other places, became possible to sort into both existing and new categories by the designers. The designers here made an effort to be open to new interpretations and insights that might not correspond to earlier findings, in order to allow for new categories through combination of knowledge from different sources.

Development work and synthesis

This section investigates how the translated knowledge from the session was applied to add value in the development work by influencing the synthesis towards a more detailed concept. At this stage of the process, to further elaborate on the concepts in development, different methods were applied, as described in the following. Accordingly, these design methods were intended to both externalize *design thinking* and formalize the interpretation of knowledge available towards a problem-orientation and synthesis (Cross 2006). As such, the background work of synthesis in design is intended to further qualify the concepts at hand, but doing so in a reflexive manner assisted by robust representation of practitioner insights and applied design methods. The development work is communicated in a way that attempts to highlight three central discussions and negotiations that occurred between the designers and resulted in decisions that seemed to shape the following design process.

A first important decision taken in the development work was to focus on the further development of an SCBA rather than the water nozzle. This was based on the interpretation of a greater potential for improving visibility in darkness and smoke, through a built in thermal camera and display. Further, it was deemed to be able to accommodate for a radically different practice of extinguishing fires. Undertaking this decision, the categories of the Affinity Diagram were central to assist the designers. This way, the Affinity Diagram became a method for coding and evaluating accumulated knowledge towards synthesis of a concept. Post-its concerning issues no longer deemed directly relevant to the process were put to the side of the diagram, but not removed. This lead to an iteration of negotiation and interpretation of knowledge amongst the designers. Attention now moved towards finding technologies that could make the SBCA with integrated

thermal vision feasible, which resulted in an Internet search for similar products and technologies. Following this, a design specification was formulated, containing requirements and criteria for the concept, creating an explicated frame of reference for the project.

A second decision in concept development originated as the design specification raised inquiries into how to operate the concept in development. Here, a piece of dialogue from the session was found interesting by the designers. During the generation of prototypes of the water nozzle, both teams had imagined functionality aimed at one-handed operation. Through the enactment of the nozzle prototypes the following was expressed:

> "Sometimes you hold, for instance, a ceiling tile [...] then you need to let go and turn on the water. That is annoying. [...] If you make a trigger, here, [to give one-handed operation] it would be brilliant."
>
> Session II, practitioner 1

> "Then you could think it further and make a switch, like this, that changes the water beam [all with one hand]. When you are lying [on the ground], you could change everything with the other hand free to support you."
>
> Session II, practitioner 2

This contradicted what had been said through interviews earlier in the process, where the fact that existing nozzle require at least two hands to operate was not problematized by the practitioners. During the work of synthesis, this piece of dialogue serves as an example of what was deemed relevant by the designers and became an important argument in the resulting work. This points to the importance of going through all material without prior distinction of what might be more relevant, and furthermore, as it turned out that even though the other concept direction (SCBA) was chosen, the meaning of the discussion became deciding for the further development.

A third area of particular discussion was regarding the Lung Demand Valve (LDV), which functions to reduce pressure from the air flask to the mask. It is currently placed on the front of the mask, and this is also where the fire fighters expressed a desire for it to be placed during Session II. However, the designer' insights into other technically feasible structures of the SCBA and knowledge within fluid dynamics, coupled with utterances from the fire fighters that sometimes the LDV could get in way and block visibility, was interpreted differently. While the designers negotiated between such different perspectives, decisions became more ambiguous by intertwining and combining knowledge from different sources through the Affinity Diagram and design specification. This process of increasing

ambiguousness highlights that the interpretation and representation of practitioner's insights becomes less useful over the course of the development work, even with the steps taken to translate them into this other context – the value of practitioner knowledge thus trail off over the course of the development work.

A point to make from these three examples is that decisions are made fluently based on knowledge from different sources. The development work can be enriched by applying the Affinity Diagram as a way to retain the designer's awareness on both explicit knowledge, put in words, but also implicit knowledge from the representation that the diagram, more or less, becomes of the session activities. However, as it becomes more difficult to retain perspectives from the session after decisions are made, a process of re-iterating becomes relevant through the introduction of a new session, which was also the next stage of the project work.

FINDINGS

It was found that the generative prototyping became an intermediary object for the creation and negotiation of new knowledge in the session. As such, examples were found of utterances contradicting that was seen in observations and expressed by practitioners through interviews. Therefore, the generative methods applied have the potential to elicit implicit and explicit knowledge through generative sessions. However, after the session, the design value of the prototype itself diminished, but moving rather to become enacted in the design process through the video recordings and the Affinity Diagram. A central argument here, is that this ability to apply knowledge from prototype to video to the Affinity Diagram, and further to become influential in the synthesis work, stem from the designer's actual participation in the sessions. This can be explained by the highly social character of knowledge creation, and the resulting lasting implicit knowledge between participants of the sessions, which influenced decisions made in the development work done (Nonaka 1994).

It can be questioned whether the representation of knowledge from session to development work can actually take place without the mediation of the applied methods towards this objective of securing unambiguous representation, and whether it is wishful at all. The role of the designer, as being present in both the session as well as doing the actual work of synthesis, allows for decisions being made based on both implicit understandings and knowledge made explicit. These decisions are consequently mediated by the designers in an esoteric manner difficult to

describe in explicit terms, often referred to as *design thinking*. Present methodology of generative iterations, aims to provide a frame for taking such decisions in a manner that retains meaning to the practitioner by introducing alternations between participatory sessions and development work. Through iterations, it becomes possible to qualify and re-qualify a focus for development in collaboration with the stakeholders (fire fighters). This qualification of the process introduces irreversibility in the sense that the participants of the process align their understanding of the problems at hand continuously (Callon 1991) through making decisions from concerns based on shared knowledge. The methodology further attempts to qualify these implicit decisions, as were elaborated through instances of significance in the development work. In this interplay between sessions and development work, designers become knowledge brokers able to make 'sticky' knowledge valuable in different settings (Brown & Duguid 1998) through participation and negotiation towards the synthesis of a concept. This ability to broker the diverse knowledge is dependent on the intermediary functions of the methods and tools applied, as stated in the above, and thus call for reflexivity in their application. Towards the design of products, knowledge is therefore not a goal in itself, but rather something to be applied and qualified towards the cultivation of new conceptual meanings and eventually products. Towards such further development of concepts, departing from the central role of the practitioner, and introducing other central stakeholders, e.g. within an organization developing and manufacturing products, further research in this field could look into the designer applying and maintaining this role of brokering knowledge in the downstream product development, as a means to promote collaboration and an approximated representation of the practitioner.

CONCLUSIONS

The paper has argued for a methodology consisting of generative iterations as a way to create interplay between sessions of co-creation and participation and background work of synthesis towards the design of innovative products. Through an empirical study, it is shown that by applying generative prototyping as a method to elicit explicit and implicit knowledge from practitioners in sessions, and by reviewing video recordings of these sessions, it becomes possible to translate valuable user insights into the development work. The paper concludes that the methodology can provide designers with a valuable frame for qualifying concepts in collaboration with practitioners, but in doing so must be able to handle and broker between (contradicting) knowledge from different

sources and in iterations between sessions and development work. Further, the paper describes the possibility of further qualifying the methodology through designers brokering practitioner insights and meaning as part of the downstream process towards a product being marketed.

Acknowledgements

I would like to extend my gratitude to the fire fighters of Falck, Gentofte, in Denmark for participating in several participatory sessions, and to Thomas Marijnissen, co-author of the Master's Thesis and empirical study.

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