The Productive Role of Material Design Artefacts in Participatory Design Events

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ABSTRACT
Physical design artefacts are employed in a wide range of participatory design events, yet there are few comprehensive discussions of the properties and qualities of them in the literature of the field. In this paper, we examine *the productive role of material design artefacts in participatory design events*. First, we offer a theoretical foundation for understanding material artefacts in design, based on pragmatist philosophy. Then, we employ this theoretical perspective to analyse a case in which a range of physical design materials was employed to envision and explore a projected building, the "Urban Media Space" a new library in Aarhus, Denmark. Drawing on examples from this case, we define a series of design considerations for employing material design artefacts in collaborative design events. Our contribution is valuable both in advancing the theoretical standpoint of interaction design in general, and in allowing participatory design practitioners to reflect on their use of material design artefacts when involving users.

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Design materials, design artefacts, reflection, pragmatism

ACM Classification Keywords
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General Terms
Theory; Design.

INTRODUCTION
Physical materials and artefacts play a crucial role in design. In addition to the shaping of physical objects as the outcome of a design process, a wide variety of physical materials and instruments are often employed throughout the process, as designers envision, explore, communicate, and shape their creations. These physical materials and artefacts, and the activities in which they play a part, have been discussed in many academic contributions, from examinations of specific design materials, such as textiles [10], through discussions of the designer's use of and interaction with materials, for example, Gedenryd's concept of inquiring materials [9], to more comprehensive discussions of the nature of design artefacts (e.g. [1]).

As a natural consequence of their widespread use in design, physical materials and artefacts also feature prominently in a number of participatory design methods and techniques. These may be used in the conception phase, where they may serve as 'containers' for sources of inspiration [11] or as props for ideation [7], through the examination of use scenarios in which physical props may be employed [2], and the exploration of physical manifestations of design ideas, for example, in the form of models and mock-ups, and, as the design process progresses towards a finished product, prototypes that may facilitate hands-on experiments with interaction forms and content [14][8].

In the literature, physical materials and artefacts employed in participatory design are primarily described and discussed in relation to the specific method that they support – for example, articles on props [2] or mock-ups [8] treat the properties of physical design artefacts in their specific roles as props and mock-ups. However, as physical materials play a part in so many stages of the design process, we argue that it is helpful to explore their general characteristics, since this may lead to a richer understanding of how and why physical materials and artefacts may function as productive elements of participatory design events. We focus on their *productive* qualities, that is, the ways in which participants in design events employ physical materials and artefacts to create momentum and move forward in the design process.

In order to scaffold our examination, we present a theoretical framework based on pragmatist philosophy. We chose this approach because pragmatism offers well-developed conceptualizations of how people draw on materials and resources in their efforts to explore, affect, and reshape challenging situations; these are aspects which resonate well with situations encountered in design practice. Specifically, we focus on how different design situations evolve as an interplay among participants, things, surroundings, and social constructs. This perspective is constructive, as it draws our attention to how participants in a design event frame and reframe their understanding, and

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resolve problematic situations through the use of design materials.

In order to demonstrate the potential and limitations of this perspective, we use it to analyse a participatory design workshop entitled *Living Blueprint*, in which participants drew on a number of physical materials and artefacts, to explore and develop concepts for a projected library. Drawing on the theoretical framework and findings of the *Living Blueprint* workshop, we present a set of design considerations for the productive use of physical materials in participatory design events. These considerations highlight how physical design materials may be productive in terms of involving participants, transforming the design space, suggesting design ideas, documenting design moves and decisions, and provoking reflection.

This paper's two principal contributions are 1) *the conceptual framework* for understanding the productive characteristics of physical design materials and artefacts, which may inform and inspire participatory design research, and 2) *the design considerations* that may be employed by designers in practice. These contributions are valuable to us, as the field of interaction design and HCI become more and more pervasive in our everyday lives, thus entering new domains. Each new domain entered means increased complexity for practitioners and researchers, as existing methods and techniques must be adapted and questioned. One way for us to be able to act as designers in new domains is to adapt existing methods. In turn, this requires the ability to reflect on why and how these methods work. Through this paper we hope to contribute to such forms of reflection.

RELATED WORK

Material design artefacts are employed in a wide range of collaborative design events, for instance mock-ups [8] probes [15], props [2] and card-based design games, such as Inspiration Card Workshops [4]. In these examples, the material design artefacts are used to help facilitate cooperation between users and designers, or to frame the design event in a specific way, to provoke insights [17]. We will emphasize two main points that relate to our work, namely that the material qualities of design artefacts clearly play a role in these events, and that they may serve as tools for establishing cooperation among participants in collaborative design events.

As Kyng [13] points out, artefacts such as mock-ups are *representations* of a future system that possess *non-representational aspects*, meaning that aspects of the mock-up that do not represent the future system, such as being made of cardboard, are properties of the mock-up, not the future system. Such properties underpin the cooperation among the various participants in a collaborative design event. For instance, enabling participants in collaborative design events to change a mock-up on the fly supports cooperative design and learning. We find Kyng's approach valuable, as it highlights the role of material design artefacts by focusing on the interplay between material aspects and cooperation. Bertelsen [1] has discussed the role of design artefacts from an Activity-theory perspective that unfolds many of the characteristic roles of design artefacts. Bertelsen's approach directs our attention to the fact that design artefacts often act as go-betweens for the various participants in design experiments. However, this approach does not specifically examine the role played by the physical aspects of a given design artefact; this aspect is left to the reader to explore, by applying the framework. The topic of materiality has played a more prominent role in the field of Science and Technology Studies, which focuses on the interrelations between human and non-human/technological actors. As an example, Olesen and Markussen [21] have used micro-studies of the healthcare sector to illustrate how work processes on hospital wards are shaped and affected not only by human actors, but also by the physical properties of artefacts such as paper-based patient records.

Gedenryd's [9] concept of interactive cognition is closer to our main question of how material design artefacts support designerly inquiry. Building on the notion of distributed cognition [12], Gedenryd argues that cognition in design never happens exclusively within the designer's heads. Instead, it is always enacted in exchanges between the designer and the surrounding environment. This makes cognition interactive rather than intramental (i.e. in the designer's head). These contributions suggest that in order to understand how design concepts emerge and evolve, we must adopt a more systemic perspective, and study the interplay between human participants and the manifest resources in a given situation. This resonates with the work of Mondada [18], who employs a so-called 'praxeological' perspective when analysing interactions in the field of architecture 'which locates cognition not in the head of the lone subject but in the orderly production and recognisability of actions as they are designed, dealt with, and, if necessary, repaired by participants' [18, p. 2]. Our work has been inspired by these thoughts, and we suggest that the field of participatory design may benefit from a more thorough discussion of exactly how and why certain physical design artefacts work well in designerly inquiry. In the following section, we will develop such an approach based on pragmatist philosophy.

THEORETICAL FRAMEWORK: A PRAGMATIST UNDERSTANDING OF MATERIALS IN DESIGN

In examining the productive qualities of physical materials in collaborative design sessions, we draw on the conceptual framework offered by a well-established school of thought, namely pragmatism. This move may be seen as a response to the long-standing and still highly relevant call from Rogers [23] to import and develop theoretically-based approaches to interaction design. Rogers argues that 'Designers and researchers need to begin to engage in more

dialogues, identifying areas of conceptual "richness" and design "articulation"' [23, p. 33]. Our work may be construed as a combination of importing and developing a conceptual framework, in that we build on a set of general pragmatist concepts, develop them for a specific area of study, and develop a series of considerations for design on this basis.

Pragmatism is a philosophical tradition that first emerged in the United States in the latter part of the 19th century. One of the primary tenets of pragmatism is the *primacy of practice* principle, which posits that theory and practice are not separate entities; rather, they are intertwined, as theories arise from practice and must be evaluated on the basis of how they scaffold our understanding of, and actions in practice. Indeed, theory and practice often evolve in tandem as we develop new concepts through our actions, while at the same time, our preconceptions and theories guide our experience of, and interaction with the world. In order to avoid misunderstanding, we will draw on a specific strand of pragmatism in this paper, namely that of John Dewey. We do so because Dewey addressed a number of concepts that are central to design, of which we have chosen to focus on those of *situation*, *inquiry*, *transformation*, and *technology*.

Situation, inquiry, transformation, and technology

From a Deweyan perspective, the world is emergent and always in the making; although we must judge the value of our theories on the basis of practice, this does not mean that it is fixed and stable. On the contrary, it continuously evolves and unfolds, partly because we transform it through our behaviour. It has been vividly described by Shalin [26, p. 10] as '... brimming with indeterminacy, pregnant with possibilities, waiting to be completed and operationalized.' Our thoughts and actions are inherently situated in this world in the making, and if we wish to understand them, we must consider them in the context of the situation. *Situation*, in Deweyan terms, is defined as the assemblage of a subject and his/her environment, including other people, things, spaces, and social constructs: 'What is designated by the word "situation" is not a single object or event or set of events. For we never experience nor form judgments about objects and events in isolation, but only in connection with a contextual whole. This latter is what is called a "situation".' [6, pp. 66-67]. Situations may be more or less stable. In many cases, we find ourselves in stable situations in which we may act according to our habits and routines; however, we also encounter unstable, indeterminate situations in which we cannot grasp what is happening, or in which we perceive an imbalance between the elements of the situation. We may consider these situations problematic, and begin to think about how we might change them, to make them more stable or manageable. Identifying a problematic situation that requires further examination and action marks the first step of what Dewey calls *inquiry*. Thus, Inquiry is the process by which we deliberately try to improve and reshape a situation, so it becomes increasingly desirable, or in Dewey's words, it is '... the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituents, distinctions and relations as to convert the elements of the original situation into a unified whole.' [6, p. 108]. Inquiry unfolds through stages of problem identification and framing, formation of hypotheses or ideas about how to solve the problem at hand given the available resources in the situation, and trying these ideas in practice, in order to see whether they have the desired effect. In practice, these stages are reciprocal and do not necessarily follow each other in a predictable sequence – for instance, we may carry out some action as part of forming a hypothesis (e.g. drawing a series of sketches), which may cause us to reframe the problem space (e.g. we realize new facets of the situation through the sketches, which must be taken into consideration), directing the inquiry in a new direction. However it unfolds, the objective of inquiry remains that of *transformation*: 'The resolution of a problematic situation may involve transforming the inquirer, the environment, and often both. The emphasis is on transformation.' [5, p. 33]. Thus, inquiry involves restructuring the problematic situation, be it by incorporating something new, or eliminating something, by expanding our understanding of the situation through learning, or by transforming or rearranging the existing components of the situation. In this respect, inquiry may be construed as a distributed activity, as it is not just an intramental activity carried out by the inquirer, but a systemic interplay between the inquirer and the components of the situation. Additionally, inquiry relies on *technology*. In this paper, we focus on physical materials and artefacts, but from a Deweyan perspective, technology is a broad classification of the means and artefacts employed in inquiry, be they theories or tools. While we may conceive of examples of inquiry that are not scaffolded by technology, most real-life cases of inquiry involve some form of technology. Technology is an intrinsic aspect of human existence, and from a pragmatist perspective, it is not merely a passive tool, since technology also frames the ways in which we experience and comprehend the world. For instance, in a process of inquiry, the available technologies may be what enable us to experience central aspects of the situation at first hand (e.g. an interaction designer tasked with developing a system for a projected library receives and examines a series of blueprints and digital renderings of the building on his laptop), helps us explore the problem space (e.g. the designer categorizes and reorganizes the images and starts to type out an initial understanding of the design space), develop hypotheses (e.g. the designer creates a series of sketches on a tablet, in which different interactive technologies are placed into the building renderings), and carry out more specific actions intended to transform the situation (e.g. the designer collaborates with stakeholders to revise an aspect of the system interface). Such tools are seldom static entities; they

are developed over time, and gain meaning for us as we use them. Although the foregoing example focuses on an individual designer for the sake of clarity, technology is often interwoven with the social aspects of the situation, for example, mediating communication and supporting collaborative action.

Employing the pragmatist perspective in analysis

While these concepts from Deweyan pragmatism are rather abstract, we intend to demonstrate that when combined, they form a valuable frame of reference for analysing specific design situations. In many ways, pragmatism resonates well with design: it prompts us to adopt a systemic and situated understanding of the subject and his/her relation to other people, artefacts, the physical environment, and social constructs; in light of our agenda in this paper, it offers well-developed insights into the iterative thinking and doing processes in inquiry, by which various resources are employed with the aim of altering and improving the situation in question. This mirrors the process that many designers undertake, and indeed, a number of contributions to the field of design have drawn on pragmatism, both with regard to general conceptual frameworks (e.g. [25], [3], [16]), and with regard to specific domains or topics (e.g. [22], [9]).

Since this paper aims to explore a specific aspect of design, namely, the productive qualities of physical materials in collaborative design sessions, we draw on the set of concepts outlined above to scaffold our analysis. The intertwined concepts of situation, inquiry, transformation, and technology prompt us to examine specific aspects of collaborative design sessions:

- how design situations evolve as an interplay among participants, things, surroundings, and social constructs;

- how problematic situations occur, and are identified and framed by participants;

- how the iterative process of inquiry unfolds to address problematic situations;

- how the situation and its constituent components are transformed through inquiry;

- how the resources in the situation serve as technologies that simultaneously frame participants' experiences and serve as means for them to affect and transform the situation.

In the next sections, we will explore the role of physical design materials in a participatory design case, through the lens of the pragmatist perspective.

CASE STUDY: USING DESIGN MATERIALS TO BRING A PROJECTED BUILDING TO LIFE

In this section, we examine a specific participatory design case, the *Living Blueprint* workshop, in which physical design materials were employed in a number of ways. We will first introduce the workshop's setup and then move on to a detailed analysis of the productive role of the physical design materials.

A participatory building process

The *Living Blueprint* workshop was part of a large-scale project to develop a new public library situated on the waterfront in Aarhus, Denmark, the so-called 'Urban Media Space'. As part of the building process, we, the researchers, began a collaborative effort with the Urban Media Space project group. The project group was already conducting a larger participatory effort aimed at involving various users and stakeholders in the building process. Our specific research project aimed to explore ways of augmenting the projected building with new technologies. As part of this design process, we conducted a series of design events and workshops. This led to an interest in more thoroughly discussing the details of the projected building, which had so far only been investigated through the relatively passive viewing of blueprints and 3D renderings of various parts of the building.

When we hosted the *Living Blueprint* workshop, the building project organization had made several attempts to involve users, with project management identifying 'citizen participation' and 'user involvement' as some of the Urban Media Space project's core values. This had been effected by hosting seminars, workshops, and public meetings, where citizens and intended users of the library had the opportunity to have a voice in the building process. However, few of these events involved the librarians, which we found interesting, given that they may be considered a 'keystone species' [20]: librarians are the human face of Urban Media Space, meaning they will have a significant effect on the experience of visiting the projected building, as well as possessing very detailed knowledge about the inner workings of the existing library. Thus, they are essential to making Urban Media Space function as an institution. However, the librarians did not yet possess detailed knowledge of how life in the projected building would unfold, which motivated the *Living Blueprint* workshop. We wanted to involve librarians in imagining the projected building from the perspective of users. This meant that for the librarians, the workshop was participatory, in that we made efforts to involve them in ways that recognized their specific needs (the difficulty of using the blueprint 'out of the box', the need to reflect on the details of the building). This gave the librarians a richer sense of the projected building, and established a common ground between librarians and designers, regarding what the building could be. Thus the workshop offered librarians a richer sense of the building and how it might be used, so they could participate in its design in an informed manner; it is highly probable that we will arrange joint sessions with librarians and prospective library users in future events.

The Living Blueprint Workshop

The *Living Blueprint* workshop enabled participants to explore the projected building by creating scenarios, using cardboard characters that could be moved about on a modified A0 blueprint. The blueprint was modified with markings indicating areas of interest selected by the librarians, and fields for attaching coloured Post-it® Notes. Each colour corresponded to a category intended to inspire participants, and these included moods, surroundings, other users, activities, and wildcards. The workshop took approximately three hours, and involved eight participants divided into three groups and tasked with creating at least two scenarios by imagining a day in the projected building.

The workshop consisted of three phases: creating the cardboard characters; creating the scenarios; and presenting the scenarios to the other participants. Throughout the three phases, the participants created a handful of different cardboard characters and six different scenarios. Each phase used material design artefacts, as will be demonstrated by the analysis of our findings, in the next section.

During the first phase, the participants created cardboard characters, which may be regarded as embodiments of various personas [19], given a physical form by drawing, cutting-out, and modifying small, cardboard figures that were initially entirely blank. The purpose of the first phase was to make the participants imagine a potential user, in order to discuss the particulars of Urban Media Space through the blueprint. After the initial welcome, the participants were divided into their groups, and each was tasked with imagining a potential user. We called these imagined users 'cardboard characters'.

The second phase involved the creation of two to three different scenarios per group. This was the principal phase, and used the previously created cardboard characters to envision scenarios on a modified version of the blueprint, recording imagined events by writing and drawing on the blueprint and on the Post-its. As the second phase progressed, each group gradually developed a scenario that involved the cardboard characters created during the first phase. The material design artefacts played a vital role in this phase, by serving both to document the scenarios and as a collaborative tool among each group's participants. Often, one participant would be busily recording group decisions on a Post-it, while another participant would be moving the characters about while carrying out lively discussions with the rest of the group.

During the third phase of the workshop, each group presented their scenarios to the others as well as to us, the researchers. Enacting the scenarios, using the cardboard characters on the modified blueprint, and using the various written Post-its and drawn paths as cues accomplished this. We recorded these scenarios in their entirety, both as documentation of the role served by the material design artefacts, and in order to use the scenarios as resources, later in the design process. Participants from other groups were allowed to ask questions and to comment, but the main development of the scenarios took part in the previous phase.

Figure 1 - Cardboard characters from the first phase

Data collection and analysis

We recorded all workshop activities on video, and subsequently conducted a thorough data analysis using video, field notes, and studies of physical material design artefacts as the main input, coding and subsequently classifying all instances of use of material design artefacts. This categorization was then analysed using the theoretical framework presented above. This meant that our codification and analysis was directed at studying the interplay between participants and materials, the occurrence, identification, and framing of design problems, the iterative unfolding of inquiry, the transformation of design problems, and the use of materials to frame, examine, and alter design issues. During the coding and analysis, a clear pattern emerged with regard to how physical design materials were employed, and their roles in the workshop. These roles of the material design artefacts will be discussed in detail in the following section.

ANALYSIS AND FINDINGS: DESIGN CONSIDERATIONS OF THE PRODUCTIVE ROLE OF MATERIAL DESIGN ARTEFACTS

In this section we present our analysis and the findings from the study, based on its theoretical framework. We have chosen to present the analysis in a way that best illuminates the main theme of the paper – the productive roles of material design artefacts in collaborative design events – while offering prospective designers a set of considerations to which they may refer, when orchestrating collaborative design events. Therefore, we present our findings in the form of five *design considerations*, each of which captures a specific productive feature or quality of physical design materials in the workshop: *enabling rapid transformations*, *documenting decisions*, *aligning collaborative efforts*, *provoking reflection*, *and proposing and supporting design changes*. When we use the term 'productive' to designate the way in which the design materials were used, we do not

use the term in its usual sense, that is, as something that is inherently positive for the outcome of the design process (indeed, a highly productive session that lacks focus may be detrimental to the overall design process). Instead, we use it to designate instances when design materials are employed to scaffold and advance the process of designerly inquiry. Even though there were an ongoing interplay among the design considerations outlined above, we present them one at a time with fitting examples.

During the workshop, participants created and explored eight scenarios. For the sake of clarity, we will illustrate the design considerations with examples from one specific scenario, in which the librarians who participated in the workshop created a set of cardboard characters representing an Iraqi family that arrived at Urban Media Space using public transportation. The participants decided that the family had divergent reasons for visiting Urban Media Space, meaning they would split up after a coordination session in the arrival area.

Figure 2 - The Mediaramp: a screenshot from a 3d video

After this, each family member was moved about on the blueprint, as their stories were developed separately. Occasionally, their paths crossed: for instance, the father and the son walked together up the 'Mediaramp', a very wide and prominent staircase in the new Urban Media Space. Similarly, the eldest sister and her mother went through the children's library area, in order to get to differing goals that required them to take this path.

Enabling rapid transformations

The design artefacts used in the workshop were easy for participants to change by drawing, writing, and turning them over. By facilitating rapid transformations of the design space through their materiality, these artefacts helped participants to collaborate effectively.

Throughout the workshop, the design artefact materiality meant that participants were able to easily modify the blueprint to fit whatever direction their inquiry was taking. A powerful example was provided when one of the scenarios envisioned the Iraqi family entering the building. The participants would place the created cardboard users on the blueprint at the entrance area, and then start discussing what each member of the family would do. The participants quickly realized that the family would probably split up after a brief planning session, since they had different goals: The father would read newspapers in his native tongue; the mother wanted to pick up some novels and then go to the café; the older sister was explicitly interested in the study café; and the little brother wanted to play computer games. However, where and how this planning session could actually take place on the blueprint was unclear to participants, since every area near the entrance was transitional and characterized by lots of people walking by. This meant that the entrance area would have a rather stressful atmosphere, lack physical space dedicated to standing still, and generally lack the information needed to actually plan who goes where.

The participants jotted down these characteristics of the scenario (transit area, imagined user goals, need for planning sessions, general mood of the area) on the actual blueprint and the available Post-its'. The participants also drew the paths taken by the users in the scenario onto the blueprint. These transformations of the initial design situation were not just a matter of participants imagining a change, but also about this change being reflected on the blueprint. This change has several qualities that are related to the design artefact materiality, namely the ease and speed of manipulating the design artefacts. First, it was easy: everyone could pick up one of the supplied pens, and change the design situation. Second, it was a rapid change to effect, meaning that participants could very quickly return to discussing what should happen in the scenario. These two qualities meant that rapid transformations of the material design artefacts allowed participants to work through the blueprint as a common and shared artefact.

Documenting decisions

At key points in the workshop, participants used design materials to create physical manifestations of agreements. Thereby participants manifested the currently imagined situations in the scenario, enabling them to have detailed discussions grounded in a shared understanding.

For instance, manifesting a decision about what the Iraqi family would do in a given situation hinges on design artefact materiality. Since these design artefacts were made of materials such as paper and cardboard, the participants were able to agree on a resolution to an inquiry, and then record this decision. For instance, when discussing the path a member of the Iraqi family might take to the second floor of the projected building as part of the scenario, several solutions were presented by participants who, after a brief discussion, agreed that the family would take the stairs. This decision was then documented, meaning that further inquiry took place in a newly transformed situation. We view this as an example of an inquiry that was resolved both through a discussion determining a narrative for the scenario, and by transforming the situation with the available technology – the material design artefacts. Using

the possibilities that were part of the design situation made it possible for participants to quickly build their scenario by discussing, transforming the situation, and then moving on to other parts of their inquiry. The aspect of being able to document design decisions is crucial to the ongoing collaboration, since it means that participants are always in at least partial agreement about what has been decided. As discussed above, inquiry always unfolds in an actual situation, and we argue that the materiality of the *Living Blueprint* workshop meant that the actual situation here was always very detailed. This is highlighted by the way participants often focused on very specific details. We attribute this attention to detail to the fact that inquiry was kept relevant and 'on track' by the ongoing documentation of decisions. This is a very valuable topic, to which we will return later in this section.

Figure 3 - Using the Living Blueprint

Aligning collaborative efforts

The material design artefacts supported the alignment of collaborative efforts, meaning that participants constantly needed to agree on the specifics of the scenario. This was valuable, as it prompted fruitful discussions that might otherwise have been overlooked.

When working together in a workshop like the *Living Blueprint* workshop, participants collaborate through negotiation. This may be viewed as the experimental attempt to resolve a problematic situation, considered through the lens of our pragmatist framework. When a question such as 'How does the Iraqi family plan their visit to the Urban Media Space?' arose, the participants would make different suggestions regarding what might happen in the scenario. These various suggestions were then revised through dialogue, meaning that participants would collaboratively try to determine the best course of action. This may be construed as the participants encountering a problematic situation, and then attempting various transformations to resolve it, in order to be able to move on. These transformations took the form of suggestions, which were then collectively considered with reference to the transformed design space constituted by the now-modified, material design artefacts. The problematic situations discussed were not abstract situations referring back to earlier decisions, but actual problems that had emerged from the collaborative decisions and rapid transformations of the design space represented by the blueprint. Thus, when participants considered possible solutions to a problematic situation such as the one related earlier, they were able to use the modified blueprint as the basis of their discussions. This had the valuable effect of allowing participants to focus their discussions on the 'here-and-now' of the scenario.

Provoking reflection

The ongoing manifestations and transformations of the design space throughout the workshop meant that the detailed and updated design space provoked reflection. By this, we refer to instances where participants created situations that forced them to reflect on whether the current solutions were the best ones, or whether something else should be attempted.

An example of provoked reflection occurred when the participants decided that the father of the family would walk up the Mediaramp. The Mediaramp is a very broad staircase with several levels, each offering different activities. When the father ascended the Mediaramp, the participants started drawing his route onto the blueprint. This led them to consider whether he would just walk past each level, a reflection that revealed that they were not at all sure exactly what activities would take place there. This was due to the fact that no decision had yet been made for every part of the projected library, and the question 'What is the father's experience of ascending the Mediaramp?' was then, for the participants, considered an indeterminate situation worthy of inquiry. Initiating this inquiry led participants to suggest several different solutions. One was that the Mediaramp levels contained only books in which the father was not interested, a hypothesis that was quickly rejected by the other participants as 'The Mediaramp needs to contain something more than just books, it's a unique place'. After a lively discussion across the table, an alternative was suggested: some levels of the Mediaramp could present new, cutting edge gadgets that were not readily available to everyone. This was discussed by the participants, who reflected that even though the father had a good job, he did not buy every new thing, but preferred to first seek inspiration, or just browse. Furthermore, it resonated with one of the purposes of Urban Media Space, namely that it should be more than just any old library, but instead challenge the visitor, and offer him different experiences that could not be had everywhere by everyone. The participants agreed on this, and it was written down on the blueprint, documenting it, transforming the indeterminate situation to a stable one, by answering the question that initiated the inquiry.

Interestingly, the level of detail and specificity involved ensured that this part of the scenario was recognized as problematic. The ongoing transformation of the blueprint kept the inquiry on track, so that when the scenario reached the point where the father of the family walked up the

Mediaramp, it was obvious that what 'ascending the Mediaramp' would be like for him was unclear. By drawing on the previous parts of the scenario, and their initial description of the father from the previous phase of the workshop, participants recognized the situation as problematic and instable, when confronted with the question of what his experience of the Mediaramp might be. This highlights the importance of being both specific and detailed, and similarly highlights how the material design artefacts supported this stimulation of reflection. By facilitating a constantly updated, detailed, and relevant inquiry, participants were able to recognize problematic situations – such as that described here – throughout the workshop. Other provoked reflection includes considerations of the mood of the children's library, detailed discussions of how the family would find their way about, or the example of planning their visit, related earlier.

Proposing and supporting design changes

The material design artefacts supported the initiation of inquiries, which were resolved in various ways, some of which were design or redesign proposals. Thus, from the perspective of our pragmatist framework, the material design artefacts used in the workshop may be regarded as supporting the generation of new ideas for design.

The ongoing creation of scenarios through the use of cardboard characters prompted reflection that initiated new inquiries, which, in turn, were resolved. An example of this include the previous discussion about the form of the Mediaramp, or more mundane examples, such as the question of 'Of what material is this lift constructed?' Questions of the latter kind could often be answered without referring to the material design artefacts, as other participants knew the answer. For instance, one participant knew that the lift was made of glass, and by answering this, resolved the situation. Another option was to ignore a given problematic situation by simply glossing over the problem in question. This seldom happened, possibly because participants were very committed to creating a thorough and complete scenario. Instead a suggestion that made sense narratively would be agreed on, i.e. collaboratively concluding that the question was not that interesting to the character in the scenario, or that the character 'could probably figure out how to do that himself', when discussing how he finds his way out of the building. It is worth remarking that this approach to resolving questions was not a general solution, but a very specific solution to a specific inquiry – it relates to a cardboard character in their scenario. This may be viewed as both a positive effect, in that it underlines that the participants were being very specific, but could also be construed negatively, in that they might neglect problematic but important issues.

The final form of solution to an inquiry was the imagining of different designs, thereby resolving a problem for their cardboard characters. As an example, we refer to the previously mentioned example posed by the participants, of how to navigate the projected building. This question arose as part of the inquiry, and was supported by the material design artefacts, in that moving the cardboard characters on the large blueprint prompted the question. This led the participants to reflect on how the family would organize their visit. However, the imagined family's perceived problem was more far-reaching, as the question of how to determine where to go in a large building is quite common. When the inquiry reached this impasse, the participants tried out several solutions: for instance, it was suggested that the family might look for a map, or for directional signs. Both solutions are implemented at the existing library, so participants were experimentally posing the question of whether the solution from the old library was adequate. However, this was jointly rejected for several reasons. First, the large blueprint, with the many new areas that were not part of the existing library, reminded participants that this solution would be impractical, owing to the difference in scale of the existing and the new building. Secondly, it is a stated intention that Urban Media Space is to be the 'library of the future', as opposed to just the old library in a new building, meaning that there is a general to introduce new technology, in order to make Urban Media Space a "media space rather than a book space" (their words).

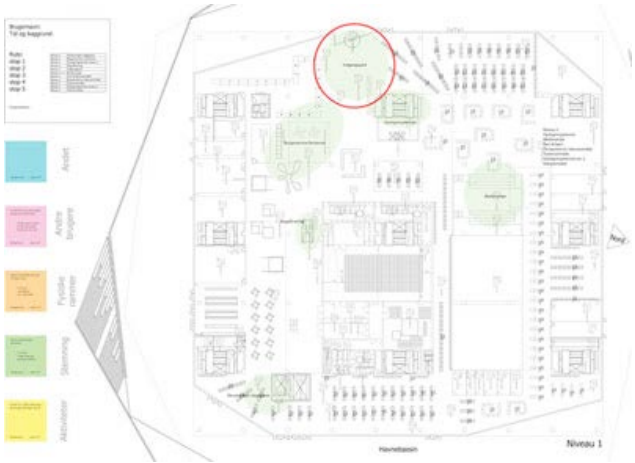

Figure 4 - The Living Blueprint with the entrance area marked, which was transformed into a design proposal

As related previously with these two points in mind, one participant posed the question of whether introducing a digital screen might be feasible and useful, and proceeded to gesture and move her fingers around over the area she considered most appropriate for such a solution. After a brief discussion, the participants began to draw on the blueprint, in order to indicate how the family of cardboard characters could stand in one place and obtain information from the newly proposed digital screen. This was accomplished by attaching Post-its, writing, and drawing lines, demonstrating how the material design artefacts supported the proposal for a new design.

We found the proposing of new designs interesting and valuable, as a primary aim of the workshop was to get participants to relate in detail to the projected building, thereby empowering them as future users. Whether the design suggestion was good or bad is perhaps of lesser consequence, as it at least illustrates a specific need for a defined place from which one may navigate, which might be investigated later on in the design process. Thus the material design artefacts played a vital role in the participants' collaboration, enabling them to both learn from each other, and to suggest changes based on their new understanding of the projected building.

Bringing together the considerations

We have presented five design considerations in the form of productive uses of design artefact materiality: rapid transformations; documenting decisions; aligning collaborative efforts; provoking reflection; and proposing and supporting design changes. Returning to our pragmatist framework, the five considerations also emphasize how design artefact materiality helped keep the inquiry on the right track, so participants moved productively towards the creation of useful scenarios. The properties of the material design artefacts ensured that it was possible for participants to start with a highly detailed design space, which was then kept updated, detailed, and relevant by enabling rapid, documented, and collaborative transformations. This is interesting, in that it highlights how important it is to keep an inquiry focused and relevant, with regard to the aim of the workshop, thus prompting detailed reflections on the interplay between the projected building and intended users. In this case, 'keeping the inquiry on track' meant keeping the aim of the workshop both constantly present and feasible. We have attempted to show how material design artefacts, in the form of the Living Blueprint, supported this.

CONCLUSIONS

This paper has examined the viability of a conceptual framework for understanding the productive characteristics of physical design materials. The two main contributions of this paper are the conceptual framework for understanding the productive characteristics of physical design materials and artefacts, as well as the design considerations elaborated above.

The theoretical frame of reference for this paper is pragmatism, a well-developed school of thought that has inspired a range of other contributions to the field of design, most prominently by Schön [25], but also more specific discussions of design materials, such as Gedenryd's [9] or direct applications of pragmatism to the field of interaction design, such as Dalsgaard's [4].

Our pragmatist framework highlights how problematic situations occur, and are identified and framed by participants. First, it offers insights into the process of identifying challenging aspects and articulating them as problems. Secondly, it addresses how the use of materials leads participants to discover new problems.

New problems are transformed, as the constituent components of the situation are transformed through inquiry. The participants used interesting strategies that included both solving the problem and avoiding/reframing it – the participants thus eliminated problems by consensus, by acquiring knowledge, or by redesigning the whole design situation (e.g. by introducing new design suggestions, as was the case with the scenario discussed above).

The way in which the *Living Blueprint* design artefacts facilitated the resolution of these situations demonstrates how the physical materials in a situation serve as technologies that also frame what participants experience, and serve as means for them to affect and transform the situation. This illuminated the way in which to support the specific kind of inquiry we were seeking in this workshop, an inquiry that allowed the librarians to engage with the projected library in a specific and detailed way.

Pragmatism as a framework also enables us to look at an event in the broader perspective: we can examine how the librarians' situation changed, using a 'before and after' analysis; we may also observe how some transformations led to new situations. This points to the fact that pragmatism is a flexible and dynamic epistemological perspective, in terms of scale of analysis – it allows the granularity desired by the analyst, something that is obviously an advantage, but may also be construed a weakness, or at least an inherent risk. We follow Rogers [23] in her concern for remaining faithful to the tenets of a given theory, while at the same time providing useful applications for specific concerns. In Rogers' view (ibid.), there is a risk of oversimplifying theoretical concepts. We have tried to avoid this by using theoretical concepts in *generative* ways [24], that is, as ways of examining complex situations with the aim of illuminating and generating ideas for interpretation. In this case, our focus has been on the productive characteristics of design materials in collaborative design sessions. To us, the theoretical inspiration of pragmatism has proven valuable in guiding our analysis, and yielded insights in a very specific analysis, highlighting the points above.

Our perspective can probably be enhanced and supplemented by other perspectives – as hinted at in our analysis, far more goes on in a workshop than can be covered here, and we note the need for further, in-depth studies of workshop activities to illuminate power relations, turn-taking, or the role of design materials as sources of inspiration. Our findings have a limited scope, mainly owing to their being based on a single design activity that involves only design artefacts made from traditional materials. We are currently planning further workshops combining digital materials and conventional materials. Revisiting our introduction, it is clear that when entering

new domains, it becomes necessary to also revisit our methods and to try to develop new ones, as well as modify old ones. A careful examination that offers the opportunity to reflect across individual methods is one way of doing this, which is one of the main motivations for our examining the role of material design artefacts in participatory design events.

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