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EXPERIMENTS ALL THE WAY – DIAGRAMS OF DIALECTICS BETWEEN A DESIGN RESEARCH PROGRAM AND EXPERIMENTS

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ABSTRACT

Experiments take various forms, have various purposes, and generate various knowledge, depending on how and when they are integrated into a design research study. In this paper, as reflective (co-) design researchers/practitioners, we exemplify and argue ways in which different experiments can be at the core of a research project throughout the study. As former PhD scholars, with design backgrounds, both of us were engaged in the XLab project (2006), proposing a programmatic approach to experimental design research. This paper reflects our experiences of adapting this approach in PhD studies. Furthermore it exemplifies, discusses, and adds to the understanding of different experiments during a design research (PhD) process. In the paper, we also reprint our two modifications of the original XLab 'working diagram' and discuss rationales for adapting this as a part of the research process.

INTRODUCTION

Since Frayling (1993) coined the term 'research through art and design', many have been addressing and exemplifying ways in which design examples and practice can contribute to the field of design research. Today it is commonly acknowledged that very often different experiments play a central role in practice-based design research (see e.g. Brandt et al. 2011; Koskinen et al. 2011; Gaver 2012).

As early as 1983, Donald Schön described how design practitioners engage in different types of experiments (Schön 1983). He observed and argued that experiments in practice are different from experiments in science, and he defined three types of experiments: exploratory, move testing, and hypothesis testing. The main point was that each type of experiment has a different purpose and generates a different knowledge (ibid).

To investigate this area of design research, in 2006 the Danish Centre of Design Research hosted the 'XLab' meta-project which included a series of three hands-on and reflective workshops: 'Beginnings', 'Per:form', and 'Intersections' (see Brandt et al. 2011). As PhD scholars at that time, both of us were engaged – one of us in the core team, the other as an active workshop participant. Inspired by Frayling, Schön, and others, XLab explored and proposed a programmatic approach to design research with experiments at the core of the research projects (ibid; Binder & Redström 2006; Brandt & Binder 2007). This main argument was condensed into a working diagram, which is further explained below (for other discussions about the diagram see also Bang 2010; Bang et al. 2012; Eriksen 2012; Markussen et al. 2012).

This paper aims to add to the above mentioned body of work in terms of discussing and understanding different experiments in design research and in terms of adapting existing diagrams and views to fit one's research.

First, we introduce the original XLab working diagram. Then we discuss different selected experiments and how they intertwine with our adaptations of the diagram. The XLab workshop titles are used as a reflective layer structuring the discussions and reflections also relating to Schön's classic (1983) and Gaver's recent (2012) views of experiments. We end the paper by reprinting our modifications and discussing rationales for how we both identified a need to modify the working diagram.
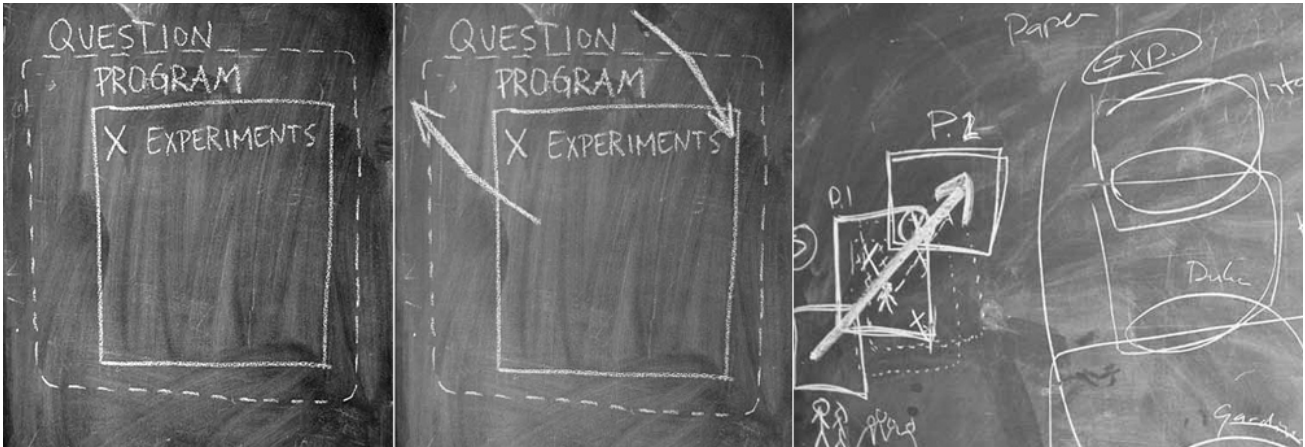
Figure 1-3: Figure 1 (left): The XLab diagram, visualizing the central role design experiments are suggested to take in exemplary design research (re-printed from Brandt et al. 2011:24). The arrows in figure 2 (middle) emphasize that a research project may be initiated from 'the outside' or from 'the inside' (re-printed from ibid:26). Figure 3 (right): As new knowledge is gained the 'program' drifts; later come stabilization and closure – leading to the formulation of the next research program (re-printed from ibid:34).

A WORKING DIAGRAM

The XLab meta-project (in 2006) provided a way of understanding and working with experimental design research (Brandt et al. 2011). This approach is captured in the working diagram, visualizing the central role a research program and design experiments are suggested to take in a design research project (Figure 1). Thus, the diagram was developed to help understand, visualize, and talk about design research as a dialectic relationship between an open program with experiments at its core. Developed in parallel with the diagram, with the notion 'exemplary design research', it is acknowledged that design experiments in a research project also must engage with a wider research context and question (Binder & Redström 2006; Brandt & Binder 2007).

Figure 1 illustrates the dialectic relationship by positioning the 'Program' between core 'eXperiments' and a larger (research) 'Question'. The arrows in Figure 2 emphasize how a research project may be initiated from 'the outside' through a larger (research) question or from 'the inside' through design experiments. Finally, Figure 3 illustrates the processes of drift, stabilization, and closure that lie in a programmatic approach to experimental design research.

From the XLab project, it is suggested to view a research 'program' as stating an attitude and position,

and capturing core issues and research intentions. At the same time, the 'program' is understood as being 'open' for explorations, surprises, and new insights for example from practical experiments (Brandt et al. 2011:37). As such, there is a fine balance between being open to new insights caused by the practical research and ensuring that the work is loyal to the frames and intentions that lie in the program.

It was recognized that experiments in a research project build on or complement each other. That is, they assist in practically exploring, challenging, expanding, and substantiating the research program. Thus, when a program is initially formulated and initiated it includes no, or only a few, experiments (from previous work). Throughout the research, more experiments are added in order to challenge and substantiate the program.

In the original diagram 'Question' can be viewed as a research question that has a larger scope than the program (Brandt & Binder 2007). This means that it refers to a reality outside the program.

In the next sections, we describe how we continually explored the programmatic approach and diagram in our respective former PhD studies in order to adapt and operationalize it to fit our specific (co-)design research contexts. (Hereafter MAE refers to Mette Agger Eriksen and ALB refers to Anne Louise Bang.)

Mette Agger Eriksen / PhD title: *Material Matters in Co-Designing – Formatting & Staging with Participating Materials in Co-design Projects, Events & Situations* PhD start: Jan. 2004 (Studies almost paused for a year three times). Thesis defended: June 2012. Affiliation: Malmö University. Four years full time studies plus one year teaching. Financing of studies: European 'Palcom' project (2004-2006), the Danish Centre of Design Research (2006-2009 / 50 %), The Swedish Research School (bits 2007-2012), the rest by Malmö University. Prior studies: Architect / user-centred industrial designer. During her studies MAE has engaged in and drawn experiments from five different co-design research projects (WorkSpace, Atelier, PalCom, XLab and DAIM), from a workshop series and teaching mainly interaction and service design. Experiments here are 'co-design events'/ workshops.	Anne Louise Bang / PhD title: *Emotional Value of Applied Textiles – Dialogue-oriented and participatory approaches to textile design.* PhD start: Jan. 2007. Thesis defended: May 2011. Affiliation: Kolding School of Design. Three years funding including one semester teaching and knowledge dissemination. Funding: The study was conducted as an Industrial PhD, which means that it was partly funded by the Danish Industrial PhD programme and partly by Gabriel A/S – a company in the Danish textile industry. Prior studies/practice: Textile designer. During her studies, ALB had the opportunity to develop experiments in close collaboration with the design unit at Gabriel, and with students at Kolding School of Design teaching mainly design processes in textile design. Experiments here are mainly 'co-design events'/ workshops.

Table 1: The paper draws from two finalized practice-based, co-design research PhD studies. Their formalities and contexts are briefly outlined above.

BEGINNINGS: GET GOING WITH EXPERIMENTS

In the XLab project, the 'Beginnings' workshop had a focus on how to understand the workshop participants' different projects as program-experiment relations and drifts (Brandt et al, 2011: part 1) (see Figures 1-3). Here we have a similar focus on roles of previous and early experiments as a part of framing the research program, but also emphasize how experiments assist in shaping the experimental methodology and establish engagement with the specific research context.
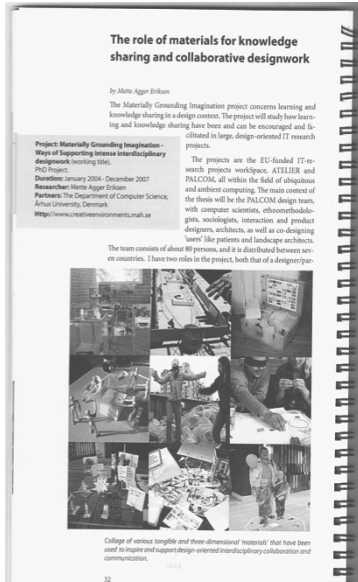
FRAGMENTS FROM MAE'S BEGINNINGS

Figure 4: Published 2-page 'researcher's statement' (Eriksen 2004) combining nine previous experiments and textual descriptions.

Prior to MAE's PhD studies, she engaged in two multidisciplinary EU 'disappearing computer' projects, other co-design workshop series, and some teaching. In addition to MAE's design background, from these experiences she brought a participatory design (PD) research approach and a collection of experiments about engaging tangible materials in staging co-design work, mainly at workshops. From MAE's background as an architect, she brought the approach of working with a 'program', which she in addition to PD wished to apply in the PhD studies, rather than start by formulating one clear-cut research question.

Building upon MAE's previous co-authored publications about some of her previous experiences/ experiments, very practically having to write a PhD study-plan and an official 'researcher's statement', for the first time forced her to individually formulate research interests – a research program. This statement/program (Figure 4) briefly described her main initial research context (WHERE), the approaches (HOW), and with the nine previous experiments, revealed some of the qualities and challenges she had discovered so far of materially engaging various stakeholders in co-designing, which she wished to further explore (WHAT).

In parallel, from day one, her PhD studies were intertwined with a new EU-funded participatory IT research project, PalCom (PalCom), with many of the same colleagues from the previous years and many new people too. There were many different agendas, but the project provided use contexts and a network of people (and materials). Thus, to get new, shared experiences, right away MAE's initial PhD studies largely were spent engaging in various activities (experiments) with multidisciplinary stakeholders at thematic workshops.

FRAGMENTS FROM ALB'S BEGINNINGS

Figure 5: In the "Fabric-as-Upholstery-Workshop" the Repertory Grid technique was explored as a tool for dialogue.

The first experiment that had a significant influence in ALB's project was conducted in the pre-doc period developing the research in collaboration with the partner company. It was decided to conduct a pilot experiment in order to experience (instead of just talking about) ways in which an experimental approach could be an advantage for the project. This also contributed to strengthening the partner's engagement in the PhD studies.

In the pilot experiment, ALB explored whether a variation of the Repertory Grid (interview technique from psychology) could support the dialogue about sensory perception of fabrics and other flexible materials, which in this case were examined as if they were upholstered. For many reasons, the pilot experiment had a lot of flaws and malfunctions (for a thorough description see Bang 2007; 2010). However, over time it turned out to have a significant influence on the experiments in the PhD study. Firstly, the Repertory Grid was continually explored and refined through the project as a tool for dialogue in design practice/design research. It was a way to structure a dialogue about soft and immeasurable concepts such as emotional value in relation to applied textiles. Secondly, the experiment caused a reframing of the emerging research program from a narrow focus on tactility to a broader focus on emotional value.

Thus, the pilot experiment heavily contributed to the first tentative objective and formulation of the research program. It also laid out the ground for experimentation during the PhD study, 'suggesting' ways in which the next experiment could be formed and conducted. It became the 'mother' of the series of iterative experiments in the PhD study, allowing ALB to continually explore and (re)frame various themes.

REFLECTIONS ON/ BEGINNINGS: GET GOING WITH EXPERIMENTS – WHEN TAKING A PROGRAMMATIC APPROACH TO EXPERIMENTAL DESIGN RESEARCH

The XLab project suggested that as a design researcher it is necessary to establish a knowledge regime or a hypothetical worldview in order to frame and contextualise the specific research inquiry (Brandt et al. 2011: part 1:19) Additionally, the team behind XLab claims that in order to concretise the hypothetical worldview, the program needs the materialisation in the form of experiments. In a similar way, the experiments need precise frames in order to turn them into more than undirected exploration (ibid: 35). Further, as argued and captured in Figure 2, there is not one linear way of doing design research, since the program can emerge both by formulating questions and positioning the work in a research context, and by conducting experiments (Brandt & Binder 2007).

These views intertwine with a pragmatic understanding of knowledge production, emphasizing learning-by-doing, which inspired by philosopher John Dewey, is a basis for Donald Schön's understanding of the practice of a reflective practitioner (Schön 1983; 1992). As stated, what we exemplify and discuss in this paper is being reflective (co-) design research practitioners. Schön argues that experiments in practice are different from experiments in (traditional) science, because the (design / research) practitioner has an interest in transforming the situation into a preferred one. Schön describes experimenting as: *"In its most generic sense, to experiment is to act in order to see what the action leads to. The most fundamental experimental question is, 'What if?'"* (Schön, 1983:145).

As described in the introduction, Schön defined 'exploratory experiments' as one of three different types of experiments. An exploratory experiment, he describes, is undertaken only to see what follows in order to get a feel for things and it succeeds when it leads to a discovery (ibid). This corresponds with Gaver's characterization of research-through-design as a research practice addressing wicked problems, where the situation at the same time is formulated and addressed (Gaver 2012).

In general, the XLab project can adhere to the same understanding of experimenting and doing research. As described on the previous page, both of us used experiments to form our first tentative research program. In traditional (scientific) research, experiment(s) are not carried out until a proper hypothesis has been formulated; we therefore had to ask the question: "What is it that makes experiments in the absolute beginning of a project so fruitful?" Trained as reflective design practitioners, experienced in working with design programs and briefs, we both found it very fruitful to get going with experiments and reflecting upon these from the beginning of our PhD studies and inquiries. We learned while doing and reflecting on

them – either a collection of previous ones or one pre-study experiment – and they played important roles in enabling us to verbally and in text describe our research interests and programmatic positioning. With our backgrounds, only doing this from theoretical points of view would have been challenging, but as our examples show, the experiments enabled us to frame and reframe our focuses. In other words, this argues for not spending half a year formulating the right research question before starting to experiment and gather empirical data.

Documenting the experiments – in our studies considered as co-design workshops or events – generated the 'data', upon which we could reflect and intertwine when framing our initial programs. However, conducting the experiments was not only an empirical data collection. As exemplified by ALB, conducting one main pilot experiment as a part of the pre-doc period, also largely worked as a way of getting a shared experience with people from the partner company (the specific research context). The pilot experiment further engaged them in the PhD study, and in shaping the experimental and participatory research methodology. Thus, this ('exploratory') experiment had a crucial influence on the further development of the PhD study. It helped ALB to formulate the tentative project description/program and it laid the groundwork for the series of iterative experiments that were conducted later.

MAE's beginnings were quite different. When she began her PhD studies, she already had experience with experiments in different design research contexts and was confident about her participatory design approach. In parallel with starting new participatory activities/ experiments in a new project as a part of engaging herself in that research context, an important part of beginning the PhD studies was to choose relevant examples in the collection of previous experiments, and initially analyse and reflect upon these as a part of formulating the first research statement/program.

For MAE it was challenging and took much iteration to formulate the research interests in images and text on a few pages, but on the other hand, it proved important to materialize and temporarily complete this as a text that was published and printed. It became a text that MAE returned to, and it assisted her in the move from being a research assistant to becoming a PhD scholar with her own research interests, agendas, and program. This and later re-formulations (e.g. on websites, in yearly PhD study plans and in published articles) assisted her to navigate and position her work in the PalCom project and other research projects she participated in later during her studies.

Despite two different starting points, this shows how the program of a specific design research does not come out of the blue, but emerges from a combination of: i) establishing a research context, ii) previous and new experiments related to that context and iii) programmatic formulations of interests and challenges – sometimes phrased as questions.

PER:FORM: ITERATIVE REFLECTIONS WITH EXPERIMENTS AND DIAGRAMS

In the XLab project, the 'Per:form' workshop had a meta-level focus on performing and making an actual experiment to reflect upon what really happens in practice (Brandt et al. 2011:part 2) Here we further emphasise performing iterative reflections on and with the experiments and actions. This is intertwined with re-visualizing and re-formulating the diagram and program – both as a part of positioning the work and developing initial knowledge claims.
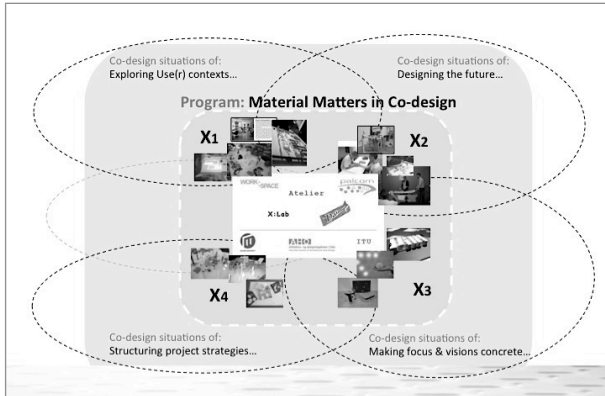
FRAGMENTS FROM MAE'S PER:FORM

Figure 6: The diagram above focuses on naming different clusters of experiments (X1-X4) from the central co-design projects in MAE's study. The purpose is to expand and challenge the program.

About two years into MAE's PhD studies (in 2006), the PhD program drifted somewhat. Initiated by publishing an exploratory paper with initial claims (Eriksen 2006), the naming of her program changed first from the initial focus on 'Materially Grounding Imagination' (X1 in Fig. 6) to the more overall 'Material Means', to the more fruitful 'Material Matters', which developed and stabilized as the research program (Eriksen 2012).

Also, at that time, MAE was mapping and reflecting upon the experiments she already had, and she e.g. saw a large collection of experiments exemplifying co-designers working with various forms of mock-ups, prototypes, and scenarios as useful collaborative ways of imagining and 'designing the future' (X2 in Fig. 6) – generally, well-established and very fruitful practices of engaging tangible materials in multidisciplinary co-designing. However, relating this to the large body of PD literature about such practices, it was clear that many others were researching this too. MAE realized that she needed to make a programmatic decision. Either, she could narrow her focus and really study those materials in co-design situations, or she could aim for a broader collection of experiments also addressing other materials and focuses of co-design situations, events, and projects. She chose the last.

This decision and program re-framing were affecting the specific staging of MAE's coming co-design experiments. Practically (and interventionistically) it pushed her to explore co-design situations in which materials were engaged for other purposes than e.g. prototyping (X3 and X4 in Fig. 6) – for example during the XLab project. Theoretically, this move also pushed MAE to explore broader perspectives of how materials are participating and performing in co-designing, which is the main focus of the PhD thesis.

FRAGMENTS FROM ALB'S PER:FORM

Figure 7: The diagram above represents a late stage of the PhD study where ALB tentatively organised the experiments in groups, as a part of planning the structure and content of her thesis.

Throughout ALB's PhD study, each design experiment challenged and substantiated the research program in various ways. This was challenged in the sense that each experiment revealed knowledge gaps in her research, and was substantiated in the sense that each experiment added to the knowledge generation. Thus, the experiments were conducted in an iterative process, with each design experiment building on the previous one. Reflecting upon each experiment, three main themes dominated the iterations (Bang 2010).

One major theme was the study of emotional value in relation to applied textiles. During the experiments, ALB's focus on textiles changed from a narrow focus on 'textiles as material' to a broader focus on 'textiles as part of an object in a context'. This change in focus influenced the choice of materials in the experiments.

Another major theme was the dialogue about emotional value. As ALB described earlier, the Repertory Grid proved to be a useful tool for dialogue in a pre-stage of the PhD study. As it happened, each experiment throughout the project explored a modified version of the Repertory Grid and thereby refined the use of the technique in the field of textile design.

The third major theme was participation. One of the objectives with the project was to explore ways in which different stakeholders could participate/contribute to the design process in the collaborating company. Different participatory approaches were tried out during experiments, and in the final stage it was decided to continue with design games and therefore the final experiments tried to refine an appropriate procedure.

Thus, by mapping the different experiments and themes ALB's program was being 'filled out'.

REFLECTIONS ON/ PERFORM: ITERATIVE REFLECTIONS WITH EXPERIMENTS AND DIAGRAMS – TO CREATE PROGRAM DRIFT AND STABILIZATION

In addition to arguing for program-experiment dialectics and thus for learning with experiments, an XLab project recommendation was to acknowledge that the program drifts as new insights are gained during the process (Figure 2+3 / Brandt et al. 2011).

This too is tightly coupled with Donald Schön's views of practice as a reflective conversation with the material of the situation, for example, as continual naming, framing, and reframing of what problem to attend to (Schön 1983; 1992). Schön further argues that reflection in action happens through understanding the back-talk of the moves made and the materials in the situation. Such back-talk can be probed and simulated by what he calls a 'move testing experiment', which is an action to produce an intended change with an end in mind. It is affirmed when it produces what it is intended to do, while also making it possible to go beyond the initial understanding of the problem. Further, he argues that it is essential as a reflective practitioner to master reflection-on-action or 'double-loop' learning processes (ibid).

Partly related to this, Bill Gaver argues that *"an endless string of design examples is precisely at the core of design research"* (Gaver 2012:938). Related to the idea of design space, Gaver views one artefact/ design/ example as filling out one point in a design space, while a collection of multiple examples – what he calls a 'portfolio' – establish an area or domain of concerns and judgments in the design space (ibid: 944).

As described on the previous page, both of us made many sketched and graphic diagram modifications during the research in order to assist our reflective processes in relating the program to selected experiments. Figures 6 and 7 are steps in the modification/development of the diagram. Each of them matches a specific situation in the PhD study and expresses actual ideas of the dialectics among our unique research context, program, and experiments.

As the stories and diagrams show, much in line with what Gaver suggests, both of us were clustering and naming collections of multiple experiments as a part of identifying programmatic concerns and themes.

MAE's diagram (Fig. 6) reflects a time in her PhD project in which there still was time to open up and further explore the program (and design space). As described above, her inventory and contextualization in relation to PD literature and the mapping of experiments from different projects, resulted in a reframing of what the program 'Material Matters…' covered. The intension and outcome of the reframing was to stronger position the research and to provoke, challenge, expand, and thus partly drift the program. This programmatic

decision closely intertwined with a material methodological shift to stage exploring other corners of the program.

As already captured in ALB's Beginnings, likewise, when reflection upon an experiment was carried through, ALB also learned when a smaller or larger adjustment of the staging and thematic framing of the next experiment was needed, to further explore her research topic of emotional values (Fig. 7). Yet, the intension here was slightly different – to 'fill out' and sharpen the program through the chain or iterations of experiments. This way of working with the program-experiment became a process of continually learning with every experiment, as a part of driving the research forward.

In other words, in both PhD studies the WHY, WHAT and HOW of the programs were continually contested by the experiments and by relating them to the wider research context – often resulting in a reframing with a new diagram modification.

Further, as briefly emphasized in the reflections on Beginnings, MAE's story also emphasizes how publishing an early argument, also further into her studies, proved fruitful. Not only because of the academic merits of publishing a peer-reviewed paper, but largely because it manifested one of the minor program drifts and materialized the current program. In this exploratory paper (Eriksen 2006), the title was similar to the current title of the program and as a core of the paper, it intertwined description and brief analyses of selected experiments/exemplars clustered in pairs. With these she argued for an activity at co-design workshops – there called 're-representing' – that she saw needed further work. This activity – later called 'rematerializing' was further explored and became a central contribution in the PhD thesis (Eriksen 2012).

The stage ALB was in at the time of the modified diagram in Figure 7 represents a period when her program was stabilizing, and she was beginning to frame emerging themes. This was done by filling out the program with collections of two-three experiments, and then naming these as themes addressing the (at that time) dominant research themes. Such modified diagrams, worked for both of us as a way to practically begin structuring the content and arguments of the PhD thesis.

Also at these stages, more or less in the middle of our studies, experiments still played a central role – but here we address the iterative performing of experiments of a more reflective character. By sketching and naming the dialectics between the program and collections of experiments, these smaller individual experiments could be viewed as 'move testing', to use Schön's phrase. For both of us these adapted diagrams became a material, whose back-talk assisted in understanding where we were in our studies and in naming and (re)framing themes, focuses, and initial claims.

INTERSECTIONS: MAKING EXPERIMENTS AND PROGRAM TO EXEMPLARS AND ARGUMENTS

In the XLab project, the last 'Intersections' workshop had a focus on being each other's peers by relating three, at that time, newly defended PhD theses, to understand different ways of making arguments with experiments in design research (Brandt et al. 2011:part 3). Here we further place emphasis on intersecting in both our processes of physically drawing our material together, generating knowledge, and making arguments. This process meant intersecting our still-at-play program, selected exemplary experiments, chosen theoretical perspectives, and research contextualization and questions.

FRAGMENTS FROM MAE'S RESEARCH

Figure 8: 'Material Landscape of Co-designing' drawing different insights, concerns, and arguments together in a catalogue (copied from Eriksen 2012:343).

While writing the PhD thesis, MAE continually worked with how to 'draw together' (e.g. Latour 2004) the programmatic arguments in a 'designerly way' (Eriksen 2012). Eventually, in the latter analytical process of reflecting on the chosen exemplary experiences/ experiments and drawing together issues and concerns related to the program, *material matters in co-designing,* MAE engaged in another experiment. She was physically intersecting main insights and arguments made in the previous chapters/parts of analysis of selected exemplary experiments with different theoretical perspectives.

For about three days, MAE's living room was changed into a laboratory, where she, with various tangible materials, built a three-dimensional so called 'landscape'. With a camera, she zoomed in on and captured details in the landscape highlighting certain points, then into the computer and merged with different styles of texts. MAE often found the image was not quite capturing the point she wanted to make in that close-up, which caused another iteration of the landscape. What MAE made and 'rematerialized' was a tangible but abstract 'landscape' in which her understanding of and proposed staging of (future) co-designing were intertwined and drawn together. In the thesis, this catalogue of 25 images and corresponding texts ended up being a very central part of the concluding chapters (further see Eriksen 2012).

The title of MAE's program and thesis, *Material Matters of Co-designing*, did not change for several years, but its detailed positioning and programmatic statements still developed while writing the thesis. Making the 'landscape' assisted in finally stabilizing and closing the program and arguments.

FRAGMENTS FROM ALB'S RESEARCH

Figure 9: Writing up in a practice-oriented way. The dark paper snippets pose questions that are answered by the following bits of text and images representing analysis and experiments.

While organising and analysing the material for the PhD thesis, ALB realised that she needed to find an approach, which allowed her to use design skills in the writing process. ALB learned that the Bauhaus designer, Anni Albers always made scrolls when she wrote her essays (Albers 2000:vii). She did this in order to create an overview of the text, securing flow and continuity. Figure 11 shows how ALB physically worked with the text. She cut it in pieces and combined these pieces with questions and images from various presentations and experiments. After that, she revised and rewrote the text on the computer and repeated the cut-and-scroll process. ALB did that numerous times, step by step building and physically making the PhD thesis.

This 'scroll-work' was conducted in parallel with the final analyses of the experiments. It assisted ALB in the final selection and combination of experiments for the thesis. It was a means for extracting the arguments/exemplars and making decisions for the final structure of the thesis. In the end, this way of approaching the writing-up and analysis processes enabled ALB to extract four main themes – each theme consisting of an argument and a tool/framework.

The four themes, which express the core of the 'Answers' to ALB's program, *Emotional value of applied textiles,* are centred on 1) the textile design process and applied textiles, 2) understanding and exploring emotional value in relation to design of applied textiles, 3) the rules and procedures of a Repertory Grid as tools for dialogue among a group of participants and 4) stakeholders' participation structured as design games (Bang 2010:246).

REFLECTIONS ON/ INTERSECTIONS: MAKING EXPERIMENTS AND PROGRAM TO EXEMPLARS AND ARGUMENTS - TOWARDS CLOSURE

The XLab project argued that at some point in a program there is a *"need for distillation, of bringing things together"* (Brandt et al. 2011:part 1:47). This means that a program is ready for closure when experiments do not provide new knowledge or are about to change into a new program with new objectives. Further, with the notion of 'exemplary design research', Binder and Redström (2006) also argued for practical experiments/examples to be made into exemplars in relation to the specific area of research.

Donald Schön proposes that we think of the practitioner's knowledge in terms of a repertoire: *"As a practitioner experiences many variations of a small number of types of cases, he is able to 'practice' his practice. He develops a repertoire of expectations, images, and techniques. He learned what to look for and how to respond to what he finds"* (Schön 1983:60). In other words, a core part of becoming a reflective (design research) practitioner is to gather a repertoire of (e.g. experimental) experiences with which to act (and here, argue). Additionally, the third kind of experiment Schön has observed in practice is the 'hypothesis testing experiment', which is a process of elimination that succeeds when it affects an intended discrimination about competing hypotheses. We do not use the phrase 'hypothesis' in our work, but the logic of hypothesis testing is the same as in (design) research. In practice, the programmatic 'hypothesis' or worldview in our work also was implicit in the pattern of our moves.

As described earlier, Bill Gaver emphasizes that what to expect from research through design is many examples or what he calls artefacts or designs that embody designer's judgments and concerns (Gaver 2012). Further, he suggests that the collection of examples is made into what he calls 'annotated portfolios' capturing conceptions and contributions (ibid: 944-45). By this, he argues that to respect the richness and particularity of the design examples, the role of theory is to annotate these rather than to replace them. Still by focusing on a collection or portfolio of examples, it can establish a balance between particular details and teased out concerns.

When it was time to write the thesis in our PhD processes, we both had a research program that was clearly positioned in relation to the research context as well as a repertoire and collection of experiments / examples that could assist in arguing for the program. In design research, as in other research, it is necessary to conduct a systematic analytic inquiry in order to meet academic standards. Yet, when working with the program-experiment dialectics (unfortunately) this is not straightforward since many perspectives and angles could be relevant in the analyses. It surely is a challenging job to choose the 'right' (angle on)

experiments, annotate and analyse them with the chosen theoretical perspectives, and turn them into exemplars, which can be offered for critical knowledge dissemination among peers. During our analysis and writing processes, it was therefore highly relevant for both of us to ask: "Which examples/ experiments can/should be highlighted and turned into exemplars supporting an argument ready for critical knowledge dissemination?" and "How should these exemplars be integrated in the thesis?" As exemplified on the previous page, using hands-on design skills and designerly ways to analyse the experiments and express the arguments/ exemplars allowed us to approach the writing process as an (hypothesis-testing) experiment in its own right.

MAE decided to integrate six complementary co-design experiments as Exemplars in a special layout, placed in pairs before the three main parts/arguments of the thesis. She then refers to and goes into details with these from different angles throughout the text (further see Eriksen 2012). Additionally, she chose to work with the 'landscape' as a part of 'drawing materials and arguments together' in more than words. In a sense this was a 'hypothesis testing' experiment, to use Schön's phrase, as all her main arguments had been made in the previous chapters in three main parts. But was it possible to also materially draw these together in her concluding chapters? As described, after various iterations, it worked, and this assisted in finally closing her program and thesis.

ALB chose to work physically with the text in parallel with developing and conducting the analyses of the experiments. In her thesis, she chose to present each exemplar in two ways offering both a design tool/framework and a refinement of existing theory. This was a way for her to emphasise the relevance for design practice and at the same time contribute to theory development in her area of design research.

As described here and in the Per:form discussion, both of us have continually adapted and operationalized the XLab diagram to match the current state of study. This displays how we both experienced a certain resistance in making the stabilized XLab diagram fully work for us as it was. In the next section, we present our two modified versions of the diagram (Figures 10 and 11), which were materialized and closed towards the end of our studies. Yet in different ways, we both intended to contribute to the XLab discussion on practices of doing experimental design research, and we both intended to capture the dynamics of the program in our revised diagram. What we found a need to emphasize was the relationships among the program, practical experiment and theories, and related works (in short 'the research context'), and how these together become the arguments or 'Answers' claimed in the PhD theses. The above discussions of hands-on practices of intersecting theories and experiments were parts of making both our theses into one long argument for the closed programs.

ADAPTING AND OPERATIONALIZING THE XLAB DIAGRAM - TO TWO OTHER DIAGRAMS

We both found the arguments, vocabulary, and illustrations of the program-experiment dialectics suggested by the XLab project highly relevant in relation to our different co-design research contexts. However, in practice, we also both found a need to reformulate the surrounding 'Question' in the XLab diagram and operationalize and adapt it to our work. Throughout our PhD studies, we both made many variations of the diagram – Fig. 10 and 11 are our final published version.
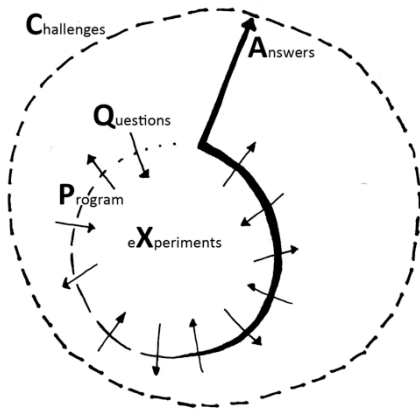

Figure 10: ALB's modification of the working diagram – capturing the dynamics of a research program (P) framed within an overall challenge (C) (reprint from Bang 2010:50).

Figure 11: MAE's modification of the working diagram – capturing the stabilized program between experiments (X) and the larger positioning in relation to Theoretical perspectives and related works (T) (reprint from Eriksen 2012:74).

In line with the original diagram, we fully agree that the program is surrounded by and positioned in 'a wider context'; however, we both found the word 'Question' misleading in the context of experimental design research, as it can be (mis)understood as the commonly used 'research question'. Questions have been central in both our co-design research studies, but not as the overarching, hypothetical 'research questions', which in many fields is guiding a specific research. For both of us the final 'research questions' were not formulated until finalizing the PhD thesis. Thus, as illustrated by ALB in figure 10, to both of us various kinds and many questions were asked and formulated, framed, and reframed as questions or statements testing claims, as both our projects and arguments dynamically developed with the experiments as well as theoretical and research context positioning.

In our view, an experimental programmatic approach means reframing questions continually, which is in line with the arguments of the XLab project, but in ALB's operationalization and subsequently reformulation of the original XLab diagram, she also aims to capture the dynamics of her research project. With this modification, ALB suggests distinguishing between two types of research questions. The first type of research questions is identified as 'overall challenges' (C) within which the initial program is established (similar to MAE's notion of 'concerns and issues' (Eriksen 2012)). The second type of questions (Q) more specifically functions as 'dynamic guides' during the project in the sense that these research questions are continually shaped and sharpened during the project to keep the program alive.

Likewise, in MAE's final version of the diagram (Figure 11), what surrounds the program has been rephrased from the larger 'Question' to be more specific by emphasizing 'Theoretical perspectives and related works' (T). In other words – her operationalization of the diagram aimed to capture how the various chosen (academic and research field) references assist in positioning and contextualizing the research, and sharpening and stabilizing the program/arguments. The reason for doing this was to match how her program and final programmatic statements and arguments slowly and finally matured and stabilized when writing the thesis. In her project, in addition to what was learned with the experiments while doing them, the different chosen theoretical perspectives intertwined in and influenced the later reflection-on-the-experiment-actions when writing the thesis.

In MAE's thesis work the larger challenges/concerns, the specific program focus, and the theoretical perspectives worked as data qualifying the arguments. Thereby, it practically assisted in choosing which parts of the experiment to highlight and discuss when these are changed into exemplars. In this way, the final, materialized and stabilized PhD thesis worked as one long argument for the program.

During ALB's thesis work, the program finally stabilized as 'Answers' (A), which are combinations of experimental and theoretical perspectives. An 'Answer' is thus offered as a practical tool as well as a theoretical consideration. Thus, in her work, theoretical perspectives and related works are considered to be included in the program constantly relating to the overall challenges.

SUMMARIZING AND CONCLUSION

Throughout this paper, we have exemplified and discussed different practices of being a reflective (co-) design researcher. With backgrounds as a user-centred industrial designer and a textile designer, we were both highly influenced by the programmatic approach to exemplary and experimental design research co-developed in and proposed by the XLab project. Overall, we have shown how the program-experiment dialectics – clearly positioned in a research context − have been central to both PhD studies. Building upon that, we have also shown how different experiments have been at the core of and intertwined in our work all the way. In other words, we have shown and argued ways in which experiments were important to both of us all the way: in the beginning of framing and reframing the specific research program and contextualizing the study; in the middle part where we were performing experiments intertwined with continual programmatic reflections; and in the closing part of writing the thesis and intersecting experiments and theoretical perspectives by formulating contestable exemplars and arguments.

Finally, the XLab working diagram inspired our work. Yet, as displayed, we both found a need to continually modify the diagram in order to constantly adapt it to where we were in the process, but also to finally propose revised versions to display how the approach worked for us in practice as co-design researchers.

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