3 CONTIGUOUS EXPERIMENTS ON A DESIGN HISTORICAL CASE

PIA PEDERSEN

DEPARTMENT OF COMMUNICATION DESIGN

KOLDING SCHOOL OF DESIGN

PP@DSKD.DK

ABSTRACT

This paper contributes to the field of practice-based research and includes insights from research through design, both research perspectives that apply methods and processes from design practice as basis for knowledge generation. The objective of the paper is to introduce a design historical case and demonstrate that it can inform and produce relevant knowledge to practice-based research and research through design. It is the assumption that – by forming the basis for making an epistemic artefact – a design historical case can construct knowledge on how to transform statistics into visualisations. It is also the assumption that the combination of design history and designerly experiments can extend the theoretical scope of practice-based research, which is normally defined by focusing on the present and the future. Three contiguous experiments are demonstrated through dynamic research sketching, a new explanatory tool, with the purpose of showing how, by building on each other, they form a medium for knowledge expansion. Finally the paper reveals visual research methods and tools that should be acknowledged as valuable for knowledge production within the growing field of practice-based research.

INTRODUCTION

In the fields of practice-based research (PbR) and research through design (RtD) it is now widely accepted that design practice and design can generate new knowledge (Chow 2010, 1). PbR, a term sometimes replaced by practice-led research (Rust, Mottram, and Till 2007), has been defined as "research in which the professional and/or creative practices of art, design or architecture play an instrumental part in an inquiry" (Ibid, 11). RtD is therefore seen as a perspective within PbR where methods and processes from design practice are utilized for research. These perspectives become valid only when we are able to show and explain how the practice-based approaches are informed and employed, and what kind of knowledge contribution they provide. For that purpose, several frameworks have recently been developed, for instance the programmatic approaches (Binder and Redström 2006; Brandt and Binder 2007; Redström 2011a) and the explanatory tool Dynamic Research Sketching (Christensen, Markussen, and Knutz 2011; Markussen et al. 2012).

PbR and RtD force the researcher to focus on the future, as existing situations are changed into preferred ones (Simon 1969, 111; Zimmerman, Stolterman, and Forlizzi 2010, 310). Consequently the novel aspect about the present practice-based project is that it employs a design historical case as the starting point to producing knowledge about the visual communication of statistical data. The aim of the project is to find ways of preventing uncommunicative data visualisations where numbers are simply replaced by perfunctory graphical tools. This knowledge could be demonstrated through several design approaches, the most outstanding being the notion of "transformation" inherent in ISOTYPE (International System Of TYpographic Picture Education), which is defined by its founders as the process of extracting, arranging and simplifying data into visual form (Neurath 1974).

The present research has primarily been informed by the Isotype founders Marie and Otto Neurath's writings and secondly by previous research on Isotype (in particular Macdonald-Ross and Waller 2000; Kinross and Neurath 2009). These sources did not focus on expanding and exemplifying what actually happens throughout Marie

Neurath's sketching process, however, so the aim of this research is to do precisely that: revive the notion of transformation by making a close study of all the material related to a specific project. This research hopes to demonstrate that Isotype charts are more than just a styling feature, and that they could be the first step in formulating a valuable philosophy for today's designer. With help from archivists and design historians at the Isotype Collection at the University of Reading, one suitable case was found (apart from loose sketches), namely a project named the Bilston Venture, an exhibition from 1947, containing 12 charts on plans for a new housing project in Bilston, England. Some of the reasons for choosing this case was that the principal transformer, Marie Neurath, produced it in a mature period of Isotype; furthermore there had to be sufficient material to represent the whole process.

Thus, the first purpose of this paper is to explain how the criss-crossing between experimental and design historical work extends theory. This issue will be answered by zooming in and out of the three contiguous experiments, namely from the overall research position and program to the details that constitute each experiment. The second objective is to show that an epistemic artefact can construct knowledge about how and why people design. Thus the paper visually demonstrates and discusses how knowledge has been generated through the methods and tools employed.

POSITION

The term PbR can be applied to "research in which practice is integral to the method and not just the medium of the output" (Biggs and Buchler 2008, 5). It is often used interchangeably with the more recent term RtD, originally coined by Sir Christopher Frayling, who in 1993 made three characterizations of design research: research into, research through and research for art and design with the purpose of giving design research equal status to traditional research disciplines (Frayling 1993). *Research into art and design* is research such as traditional historical research. *Research through art and design* is materials research, development work or action research defined as research "where the action is calculated to generate and validate new understanding" (ibid, 4). Finally in *research for design* the end product is the purpose and the thinking is embodied in the artefact. These three categories are employed as the widespread labels for the present research approach and as a steppingstone for further clarification.

The first position, research into design, relates to the object of study of this project—a design historical case. My investigation of archival material includes design historical references and methods meant to frame and understand the empirical material. Some of the addressed issues, namely the description of Marie Neurath's design process within the social and cultural aspects of the empirical periods (which again is described within the whole development of the transformation approach) is directly inherent in the

design history field of research and relies on design historical methods. The last two positions are integral to the practice-based part of the present research. I am primarily researching through design, because I am doing action research, i.e. employing methods and processes from data visualisation and communication design as a basis for formulating empirical data. One could argue that I am also researching for design, as the artefact is informed by the research. However, the purpose is not to make an artefact in itself, but to use the design of the artefact as a way to produce and communicate knowledge.

Recently RtD has been applied for instance within Interaction Design and Human–computer Interaction (Zimmerman and Forlizzi 2008; Zimmerman, Stolterman, and Forlizzi 2010). Here RtD is defined as a research approach that employs methods and processes from design practice (Zimmerman and Forlizzi 2008, 42). It forces the researcher to focus on the future which "allows researchers to become more active and intentional constructors of the world they desire" (Zimmerman, Stolterman, and Forlizzi 2010, 310). RtD centres on the making of an artefact, in the form of a prototype, a model or a product, which forms the basis for understanding and framing the problem and proposing a preferred state (Zimmerman and Forlizzi 2008, 42). Zimmerman and Forlizzi distinguish between two approaches within RtD: 1) the *philosophical approach*, characterized by the investigation of a "previously articulated theory" and 2) the *grounded approach*, focusing "on real-world problems that force a concrete framing of the problem" (Zimmerman, Stolterman, and Forlizzi 2010, 313).

Both approaches are applied in this PhD-project: The grounded approach, because this project is driven by a real-world problem, where I have experienced and observed problematic situations of the visualisation of statistical data within educational and professional practice; the philosophical approach, because the real-world problems could not be solved through previously articulated theories, which further emphasized the real-world problem. As a consequence the project investigates previously articulated theory with the purpose of solving real-world problems. Even though this distinction has been criticised for being based on a false separation, it has been discovered that theory construction occurs in the link between the two approaches (Christensen, Markussen, and Knutz 2011, 3).

A new approach to conducting practice-based research has been developed in recent years (Binder and Redström 2006; Brandt and Binder 2007; Redström 2011a). It centres on the notions of program and experiments, where the program can be seen as a provisional knowledge regime that forms the frame for running experiments (Binder and Redström 2006, 10). The programmatic approach proves to be suitable for the present research, because the current knowledge about transformation is constantly expanded and refined

through the experiments. The experiments are not used to prove or falsify the existing theory on transformation; rather it is a way of exploring the material. The approach was recently subject to further development as Dynamic Research Sketching (Christensen, Markussen, and Knutz 2011; Markussen et al. 2012), an explanatory tool that aims to show how practice-based design research is able to feed back into and transform theory. By integrating theory construction and by being dynamic in its ways of showing the dialectics between components and ways in which experiments and theory inform each other, it forms the central tool for an elaborated explanation of the present research.

Consequently this Ph.D.-project, principally positioned within the perspective of PbR and using insights from RtD and research into design, aims to improve an undeveloped practice, the visualisation of statistical data within visual communication design, by producing knowledge on the past. Reference studies, material collection and sampling procedures form the basis for a further investigation where the process of creating artefacts is central for the knowledge production.

RESEARCH ARTEFACT

I will borrow the term *epistemic artefact* (Hansen 2009) to describe my artefact. It is epistemic (involving knowledge) because it came through the archival material, being bound to the material in such a way that it cannot be seen out of context or used as a commercial artefact in itself. It is, indeed, a tool for understanding and developing theory on the historical work of Marie Neurath from a designerly perspective. Being a visualisation, it also becomes a tool for explaining the research outcome, as pointed out by Sadokierski and Sweetapple, who unconventionally explore ways of visually analysing texts (Sadokierski and Sweetapple 2012). Using Zimmermann's characterizations: *theory on design* (creating knowledge about how and why people design) and *theory for design* (conceptual frameworks, philosophical guidelines, and design implications) (Zimmerman, Stolterman, and Forlizzi 2010, 313) classifies the artefact as theory on design since it shows how Marie Neurath designed. In addition, in that context, it is also a theory for design, because it extends the theoretical foundation of how to transform numbers into pictures.

KNOWLEDGE FLOW

In order to comprehend how the criss-crossing between experimental and design historical work extends theory, I will explain the relationship between research questions, program and experiments. When looking at Zimmerman and Forlizzi's two approaches it becomes evident that the tension field between the grounded and the philosophical approaches drives the program. Real-world problems motivated me to try to establish the right balance between data and picture in a statistical chart and in this context the role of the designer. Subsequent literature studies directed the research

towards the notion of transformation inherent in the theory on Isotype and to empirically investigating how transformation influences the statistical chart. Thus a tension exists between wanting to contribute to today's practice and achieving this by looking into the past. The result is the program: *Recover the notion of transformation*, where the purpose of the experimental work is to *recover*, and the historical work included in *the notion of transformation*. The program becomes the temporary knowledge regime materialised over time by the three experiments X1, X2 and X3, which are based on design historical references and the framing and collection of suitable material.

X1

The first study of the material clarified that Marie Neurath's way of approaching the visualisation of statistics has enduring value for today's designer, but exactly *how* remained unclear. The vast amount of statistical material, journal articles, sketches and black & white photographs of the final charts related to the Bilston case had to be explored. The idea was to identify the essential principles of transformation looking "from the table to the graph and from the graph to the Isotype chart" (Neurath 1955, 34). However, this presented a conflicting agenda, because showing transformation as a set of principles or a list of rules would be misleading, as the work was constantly modified, refined and influenced by real life (Kinross and Neurath 2009, 103).

The material therefore had to be approached in an exploratory fashion, starting by looking for fixation points to map the work. Final charts with their respective blueprints (an instruction drawing for the artist who finished the artwork) were placed vertically from chart no. 1 to 12 in the order they appeared at the exhibition. Subsequently the process of transformation was rewound as the blueprints were the starting points from which to move back in time vertically (see Pia Peder 2012a, 7–8). When a map had taken shape the different types of material were given different colours. A more systematic way of understanding relationships and patterns in the material was needed, however, a problem that was solved through data visualisation. Every time a transformation was observed from one sketch to another a new symbol was designed. Every time a symbol could be reused its significance was revised and refined. The process occurred in loops of observing, visualising, checking, comparing and changing (e.g. several sketches were repositioned in the mapping). Finally the symbols of each sketch were placed on top of each other as a combined symbol and placed into a grid based on the mapping. It became a diagram, the content of which could be split into categories. Now it became possible to analyse the relationship between the detailed transformations in their corresponding category from the single sketch to the whole process landscape.

Experiment 1

Map

Material example (Isotype Collection): sketches showing rotation
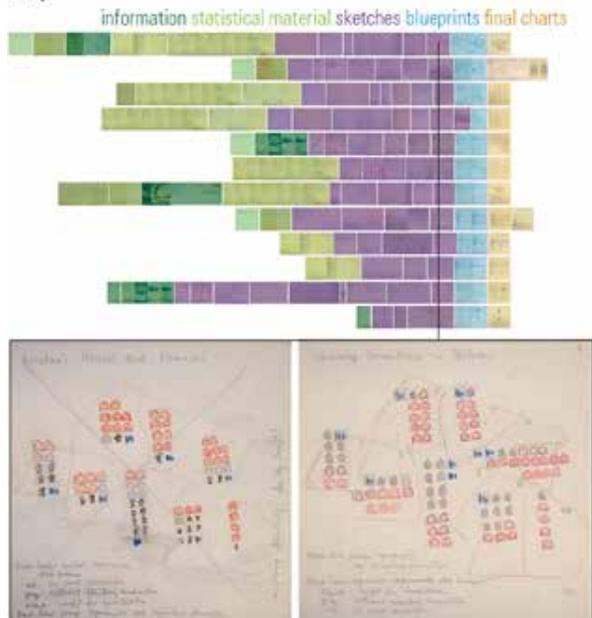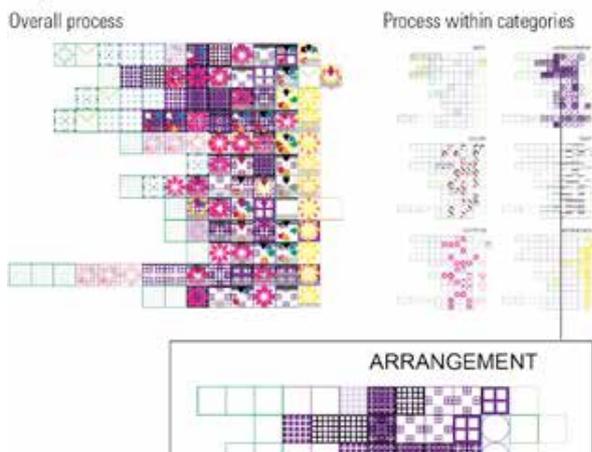
Symbols (in 6 different categories)
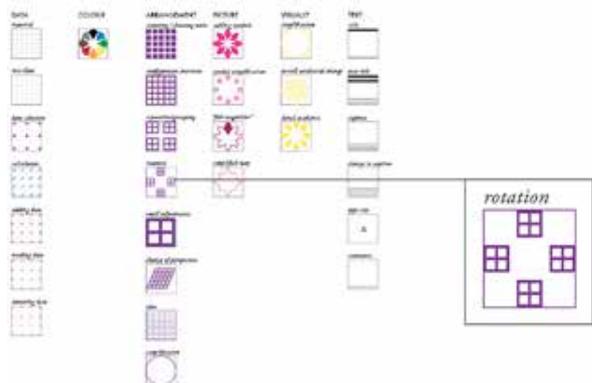
Diagrams

Figure 1

Mapping of the sketches—a set of symbols portraying the principles of transformation—and diagrams showing the transformation landscape, expanded the knowledge of transformation (see Pedersen 2012a). A case in point was how the message in the chart was developed along the process; for instance by rotating units over and over the setting in a given chart, and hence the message, was reframed. However, certain things remained unclear e.g. how Marie Neurath proceeded in the selection process. Luckily additional material in the form of letters was collected in the course of X1. They had remained unread in order to let the sketches speak for themselves. So how would the collaboration presented in approximately 100 letters exchanged between Otto/Marie Neurath and Bilston Town Clerk Williams change the picture?

X2

The letters would hopefully provide more information and help re-evaluate the findings from X1; but the first reading did not answer the questions I was asking. The letters were then simply arranged chronologically according to month and year (1945-1948), but that just revealed certain facts e.g. that there are fewer letters in May than in October 1946. A new and more precise timeline with additional information that could help keeping track and create an overview of the letters was needed. I now gave the letters colour codes that differentiated between sender and receiver, and additional symbols were designed to represent enclosures, phone calls and meetings. On top of the symbols I inserted keywords referring to important content or reference points in the sketches; hence I could see the flow of the collaboration and discover when material was missing. I could directly track facts like "a few days after Marie Neurath met With Mr Williams she sends him a letter in which…" or "Marie Neurath mentions a letter, but on that date there is nothing on the timeline. Does it really exist, and if so, is there any information on its content?" The timeline was a tool and a key to the historical investigation and to the next step: to illustrate the connection between the letters and the transformation process.

The letters provided hints on details to look for in the sketches. When building up the timeline, these reference points were represented on the map from X1 as black spots (for examples see Pedersen 2012b, 9–20). They indicated that the map needed to be re-evaluated and visualised once again in a process of zooming in and out, between the map, the sketches, the timeline and the letters. Hints from letters compared with the sketches had provided a new fixation point, namely a miniature exhibition produced early in the process for a meeting with Mr Williams in the form of 12 numbered sketches.

Experiment 2

Timeline 1945-1948 (letters)

New map (sketches)
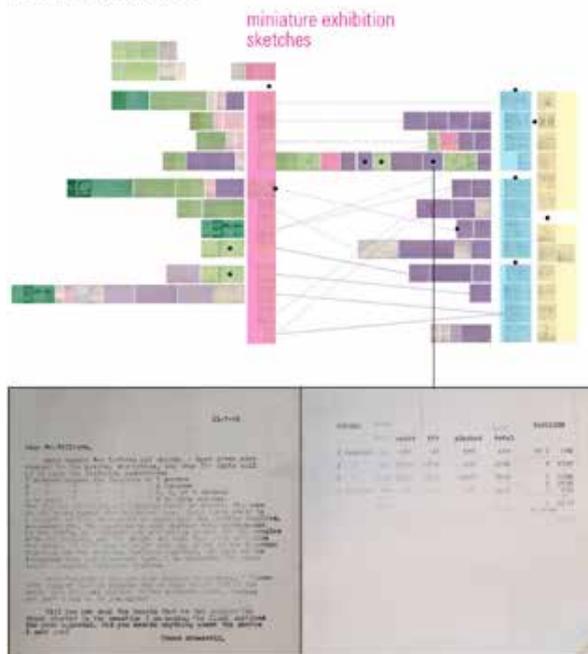
Material example (Isotype Collection): Letter by Marie Neurath (11-7-46) linking to a table found among the sketches and resulting in map changes

Figure 2

The new insight required a rethinking of the whole transformation process, and in rewinding the process according to this information new links and relationships within and between the sketches fell into place. It became evident which sketches were made before or after the miniature exhibition, for instance sketches produced with data received after the meeting could not be placed before the miniature exhibition. On the map the changes appeared as rearrangements of the sketches and connecting lines.

Historical details, timelines and a revised map of the sketches expanded the knowledge of the process further (see Pedersen 2012b), ranging from details about the single sketch to the overall process. For instance by rewinding the map according to the new fixation point, it was discovered that Marie Neurath had reorganised the order and the content of some of the charts (i.e. connecting lines) and had sometimes gone back and made changes in the sketches. However, further elaboration on how these new findings would influence the findings from X1 was needed.

X3

It was necessary to go one step deeper into the material and explore how the relationship between the small transformations had changed with the new knowledge; hence the previous two experiments had to be combined and extended by reusing and revising the symbols and diagrams used in X1 and incorporating the knowledge gained from the letters in X2.

Based on knowledge and experiences acquired through the earlier experiments, the way the symbols were used was refined into a more thorough analysis. The material was analysed from a wider perspective, namely looking at the process four charts at a time rather than one chart at a time. When a symbol from X1 was reused it was re-evaluated to ensure that it fit the observations. If something new was found in the sketches, and a new symbol thus needed to be designed, all the material was examined once again to see if anything was missing. I was continuously looking for discrepancies with the first experiment, and if so, I went back and forth between the visualisations and the historical material. For instance new insights into the sketches indicated that the material needed to be reorganised, and the process of rewinding the map was repeated revealing new patterns. Finally, the symbols where placed (like in X1) into the new grid illustrating how the whole picture had changed. A new mapping, sets of symbols, and diagrams were created helping to further analyse and expand the content of the process of transformation. For instance, it was discovered that the process of selecting data took place throughout the whole process and not only in the beginning.

The research traces in detail how the Isotype approach was put into action and can teach the designer how such a process of transformation helps to discover and create meaning from statistics. Further research will juxtapose the knowledge on transformation with other perspectives by feeding into the tension field between the grounded and philosophical approach.
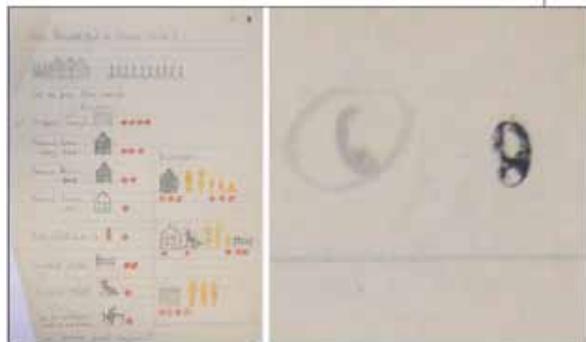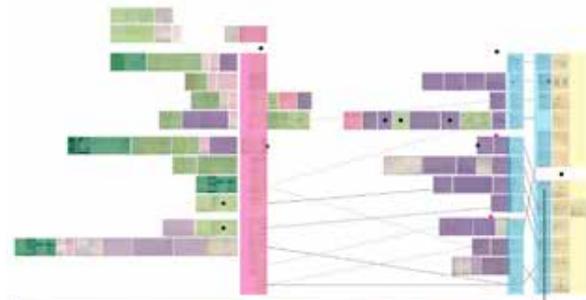
Experiment 3

Refined & new symbols
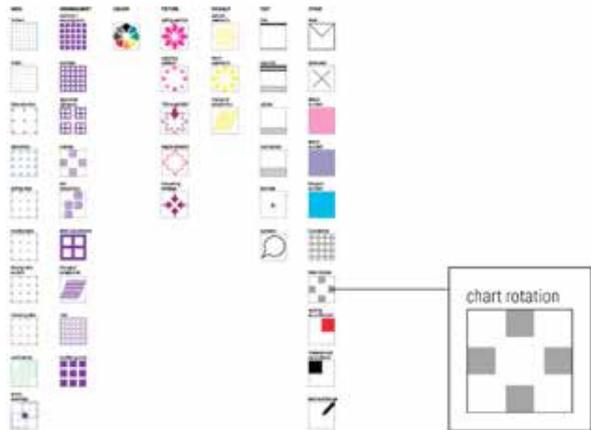
chart rotation

Diagram
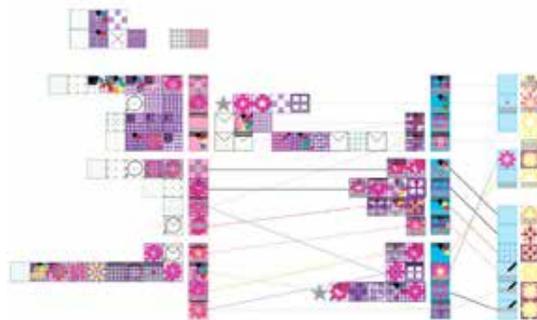
Refined map

Material example (Isotype Collection): Because of info from X2, added numbers were acknowledged on several blueprints. This changed the map and the view on the process (i.e. chart rotation)

Figure 3

OVERVIEW

The dynamic research sketch below presents an overview of the relationship between research questions, program and experiments.
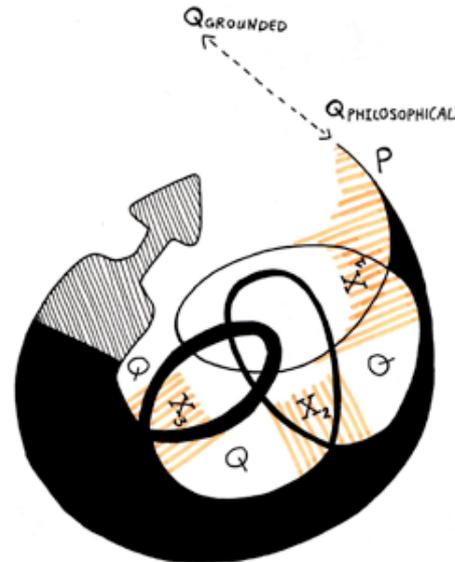

$Q_{GROUNDED}$

$Q_{PHILOSOPHICAL}$

P

Figure 4: Dynamic research sketch

The program circle (P) is a timeline, most of it coloured black as it runs to its end. What has not been completed or defined is striped, emphasizing that this might look different in the future. Each experiment is drawn as a loop that comes out of and into the program like a roller coaster; once a loop is over you re-orient yourself, analysing the situation, asking new questions (Q) from the latest experience and consequently forming the next loop. Throughout the experiments the actual knowledge expansion occurred in a dialogue between material and visual experimentation. The experiments could be completed because the material had been through the historical process (hence the orange spots on the diagram), which again was informed by theory. Going the other way round the knowledge output of each experiment—further analysed through theory on design thinking—feeds into the general theory on Isotype and into the broader purpose of the program. Thus the design historical work, constantly reflected in the experimentation and in the questions, emerges and fortifies a loop. Although the loops overlap because every experiment is an extension of the previous one, they are subsequently guided by different questions or material. As the program grows stronger the experiments become more focused and finally at their closure develop into the knowledge contribution of this research, hopefully feeding into the tension field between the grounded and philosophical approaches, both in practice and in theory.

METHODS & TOOLS

Like in physics, a further explanation of the properties that come into play within a loop enables our understanding of the way the construction holds. By

taking a closer look at the tools and methods applied, it will be evident how much the knowledge flow within each experiment depends on the criss-crossing between historical and experimental work.

1. REWIND MAPPING

Using logic and finding fixation points from which to move back in time, rewind mapping has been a way of mapping the transformation process. From a fixation point (e.g. a blueprint) the mapping proceeded to search for the sketch that most resembled the fixation point where good indicators could be the title or the configuration. Subsequently this sketch became the fixation point for choosing the next sketch and it continued in this fashion in a process of comparison and evaluation between the single sketch and the whole. Like building a puzzle, some knowledge is needed about the picture that the puzzle becomes; in this case it was roughly traced through design experience and knowledge of Isotype. The X1 process was very time consuming, as the mapping was built from the bottom. One sketch with more similarities with the fixation point would often replace another. In X2 and X3 new fixation points where discovered and the rewind mapping process was resumed.

2. REFERENCE MAPPING
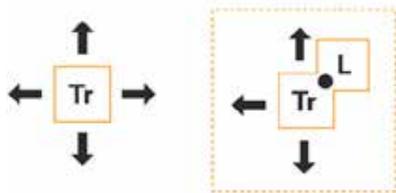
The outcome of rewind mapping is a map with thumbnails of the sketches in which a sketch can be seen as part of the whole by zooming in and out. As the map forms the reference for further experimentation it is crucial to view it as a projected and not a true picture of the process. It becomes a reference point in the way colour codes represent different kinds of material; lines represent links between sketches; and black spots represent links to the letters. Furthermore the colour codes helped explain how the map changed throughout the experiments.

3. COMBINING SYMBOLS

Both in their design and usage the symbols are a way of illustrating what happens from one sketch to another. Making a symbol for an observed transformation forces you to understand and reflect on what kind of act this represents. In addition, when placing a symbol below a sketch you are forced to make a decision not only of

what is happening in the sketch, but also go back and see how this symbol has been placed in other sketches. If for example two different symbols can be used for the same act, the system is challenged. It is therefore impossible to place the symbols without understanding the whole process. Similarly when something new is acknowledged in the sketches, and another symbol therefore needs to be designed, you have to go through all the material again to see if there is something you missed.

The symbols are a vehicle for continuous discussion, self-evaluation, reflection and creation of knowledge about the material, based on a comparison with adjoining sketches, with the whole project, and in the case of X3 also the symbols from X1. It is a comprehensive way of generating knowledge, by detecting patters in a constant interweaving of reflection and visualisation. The symbols become data in themselves and a tool for reviewing what is happening in the sketches. While the data was the result of a certain amount of subjectivism, it was challenged through the letters in X2. Furthermore one of the purposes in X3 was to evaluate the initial finding in X1, as illustrated by this research note, "I am in constant competition with my earlier experiments".

4. DIAGRAMMATIC GRID
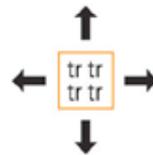
The diagrammatic grid moves away from the sketches by contextualising what is happening in them. Based on the mapping and the way in which all symbols have been placed, the diagrammatic grid, in spite of its complexity, points to patterns and relationships between the combined symbols representing transformations within one sketch. For instance, in the diagram none of the combined symbols were similar. When separating the diagrammatic grid into different layers of categories other patterns and relationships can be revealed in the data. It is possible now to move back and forth from details of single actions to the overview of the flow of the actions. The diagrammatic grid becomes a tool for analysis, but every finding should be evaluated thoroughly as it relies on the map and the symbols. In X1, comparing the two categories' title and arrangement revealed how Marie Neurath formed the message in the data.

5. COMPARATIVE TIMELINE

The comparative timeline was applied primarily in X2 and occasionally in X3 to keep track and create an overview of the letters. Attaching a letter symbol on a

precise timeline makes it easier to see the flow of the collaboration. Keywords above the letters assisted in remembering and noticing the most important content like points of reference with the sketches. Furthermore, colour codes differentiated between sender and receiver, and symbols representing enclosures, phone calls and meetings helped indicate missing material among other things. In X2, the map from X1 and the timeline were constantly compared, which was a step forward in an improved mapping of the process.

THE COMBINATION OF METHODS AND TOOLS

The second dynamic research sketch below (figure 5) elaborates on the relationship between the presented methods and tools (represented by numbers) and indicates how they assist the knowledge production in the broader aim of the program.
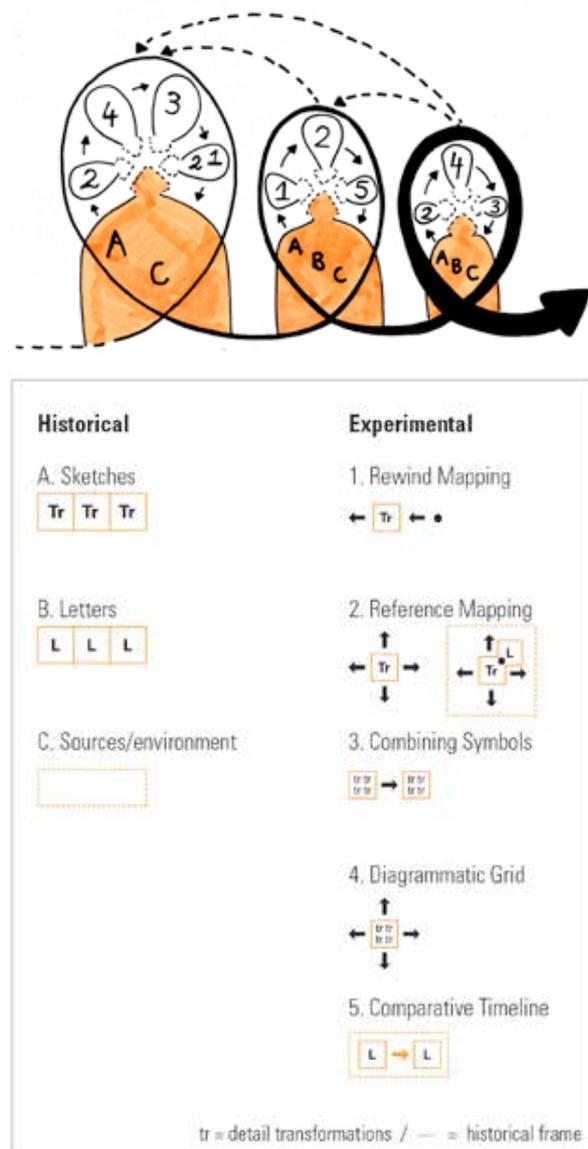

Figure 5: Elaborating on dynamic research sketch with its legend portraying historical and experimental work

Each experiment was based on several tools and methods. They were connected because they were all shaped around the material. When a new tool was developed, guided by new questions or aims, it was constantly reflected in the previous one, hence the arrows pointing back. New tools were employed to correct the previous limitations or outcomes. The process moved towards knowledge expansion by constantly comparing, challenging and freely moving between the different components (arrows pointing to the middle), e.g. from a diagrammatic grid to the detailed words within a historical letter, like a structure that becomes stronger and stronger in an interchange between making and thinking. In X1 a lot of energy was put into the development of the tools and methods, whereas in X3 they were simply refined. Furthermore, it was not only the tools within one experiment that built on top of each other; the process also expanded from one experiment to the next. This is knowledge expansion in its widest sense.

DISCUSSION

The present research, with its criss-crossing between research into and through design, is unconventional. By means of dynamic research sketches we have seen the flow of knowledge production from the overall program to the single experiments built on top of each other. It became evident that the tension field between the grounded and the philosophical approach drove the program and that each experiment was initiated through and ended back in the program. When taking a closer look at the tools and how they were employed it is obvious that the border between thinking and doing has been eliminated, as these elements are more tangled than shown in earlier dynamic research sketches (see Markussen et al. 2012). Furthermore it was obvious that the historical work not only forms the basis for an experiment, but is also part of the experimental work.

The tools in the present research work differ from those that are usually employed for an investigation of such material. First one must understand that most of the analysed materials are sketches that are in a stage between numbers and image, not a finished image. Second, when looking at the traditional methods for investigating images, termed *Visual Methods,* they are rarely visual by nature. Gillian Rose, among others, explores the making of photographs as part of a research project, but merely mentions diagrams, maps and drawings (Rose 2007, 237). Hence visual tools and methods such as the ones presented here should be explored and further acknowledged.

The purpose is not to replace traditional methods but to explain that the present method and tools can add to those that already exist. Traditional methods, like the good eye (often employed for the compositional interpretation of painting within art history (Rose 2007, 57)), would be a way of approaching each sketch, as well as a way to help the rewind mapping, but it would not provide an overview or a detailed picture of the

process. Symbol thinking resembles certain aspects of content analysis, which in visual contexts is used to explore large amounts of images, mostly in a quantitative manner. Although the symbols become a kind of coding system, their purpose, as we have seen, is not to count how many times Marie Neurath rotated within one sketch; rather they were—inspired by the words of Archer—a way *to shed light on*, *enact* and *embody* the process (Archer 1995, 11).

Many other visual methods stem from theory, for instance semiology and discourse analysis, which are established in theoretical frameworks that understand the visual in particular ways (Rose 2007, 238). Semiology would be relevant in the interpretation of how the Isotype language works and creates meaning, but it does not help in for instance discovering new links between the sketches. For example, I responded to new discoveries in the sketches by revising the mapping and subsequently discovered indispensable aspects of the transformation process. Furthermore, the visualisations were a way of moving away from the symbols and the visual style of Isotype in order to embody the process of transformation.

The outcome, namely the maps, the symbols and the diagrams, becomes a prototype for looking into the rest of the archival material. The prototype then progresses by moving back and forth between visualisation tools and historical work in a series of experiments that build on each other. Hence we are dealing with an epistemic artefact that in a research context is used for enacting, understanding, and reflecting on design historical material. How the artefact advances through the research becomes an illustration of how the program is constantly challenged through the experiments. Furthermore, when the artefact is based upon design historical research, it becomes a path from the past to the future. In the present case, the artefact was both an analytical tool and a communication about the newly gained knowledge about the past, as well as a basis for a philosophy to guide the future.

This interdisciplinary approach therefore contributes to the fields of design history, design research and design practice. We have seen how design history can contribute to an extension of the scope of RtD, both in terms of the object of study, but also in the way design history has informed the artefact. We have seen how the process of creating an artefact based on design historical material and methods can contribute with expanded knowledge about the material and the visualisation of statistical data.

Hopefully this paper will encourage more researchers to believe in and describe their particular visualisation methods and tools and also inspire more visual communication designers or design historians to conduct research into design history through design. Finally this is a step on the way to widening the conceptual foundation of RtD.

CONCLUSION

By incorporating tools and methods into dynamic research sketches, the border between thinking and doing is eliminated, and it becomes evident that design historical and experimental work can easily blend together. Consequently RtD is an approach which also benefits the past by crisscrossing between design historical and experimental work. Visualisation tools and methods have shown patterns and relationships in archival material, which would have been incomprehensible without these supporting components. Their particularities are inherent in the way their on-going outcomes challenge and build on each other through new experiments. Consequently the present epistemic artefact is in a constant move towards reviving the past, a past that becomes visually communicated and relevant for the field of data visualisation because of the designerly methods and tools, thus tapping into a growing field of research. Finally, acknowledging an age-old object of study within RtD, the visual tools and methods presented here are a step on the way to widening the conceptual foundation of RtD and PbR.

REFERENCES

Archer, B. 1995. "The Nature of Research." *Co-Design Journal* 2 (11).

Biggs, Michael, and Daniela Buchler. 2008. "Eight Criteria for Practice-based Research in the Creative and Cultural Industries." *Art, Design & Communication in Higher Education* 7 (1).

Binder, Thomas, and Johan Redström. 2006. "Exemplary Design Research." In *International Conference in Lisbon. IADE.*

Brandt, E., and T. Binder. 2007. "Experimental Design Research: Genealogy, Intervention, Argument." *International Association of Societies of Design Research, Hong Kong.*

Chow, Rosan. 2010. "What Should Be Done with the Different Versions of Research Through Design." *Entwerfen. Wissen.Produzieren. Designforschung Im Anwendungskontext.*

Christensen, Poul Rind, Thomas Markussen, and Eva Knutz. 2011. "Making Theory Come Alive Through Practice-based Design Research." In *International Design Research Symposium.*

Frayling, Christopher. 1993. "Research in Art and Design."

Hansen, Flemming Tvede. 2009. "Epistemic Artefacts: The Potential of Artefacts in Design Research." In Brussels, Sint‑Lucas, School of Architecture, Belgium.

Kinross, Robin, and Marie Neurath. 2009. *The transformer, principles of making Isotype charts*. Hyphen Press.

Macdonald-Ross, Michael, and R. Waller. 2000. "The Transformer Revisited." *Information Design Journal* (9/2&3): 177–193.

Markussen, Thomas, Anne Louise Bang, Pia Pedersen, and Eva Knutz. 2012. "Dynamic Research Sketching – A New Explanatory Tool for Understanding Theory Construction in Design Research." In *DRS* Bangkok.

Neurath, Marie. 1955. "Isotype." *Health Education Journal* (13.1): 28–38.

———. 1974. "Isotype." *Instructional Science* (3): pp. 127–150.

Pedersen, Pia. 2012a. "Visualizing Transformation." In *DRS* Bangkok.

———. 2012b. "Visualising the Process of Transformation." *Information Design Conference*. London.

http://www.dskd.dk/index.php?id=663&user=pp.

Redström, Johan. 2011a. "Some Notes on Program/experiment Dialects." In *MAKING DESIGN MATTER!* School of Art and Design, Aalto University, Helsinki, Finland.

Rose, Gillian. 2007. *Visual Methodologies*. SAGE.

Rust, Chris, Judith Mottram, and Jeremy Till. 2007. *AHRC Research Review Practice-Led Research in Art, Design and Architecture*. Arts & Humanities Research Council.

Sadokierski, Zoë, and Kate Sweetapple. 2012. "Drawing Out: How Designers Analyse Written Texts in Visual Ways." In *DRS* Bangkok.

Simon, Herbert A. 1969. *The Sciences of the Artificial*. Third Edition (1996). The MIT Press.

Zimmerman, John, and Jodi Forlizzi. 2008. "The Role of Design Artifacts in Design Theory Construction." *Artifact* 2 (1) (April): 41–45.

Zimmerman, John, Erik Stolterman, and Jodi Forlizzi. 2010. "An Analysis and Critique of Research Through Design: Towards a Formalization of a Research Approach." In *DIS 2010*. Aarhus Denmark.