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Annotated Portfolios as a Method to Analyse Interviews

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This paper explores the use of annotated portfolios as a method to support the qualitative analysis of interview data about design projects. Annotated portfolios have so far been used to support artefacts with text in order to discuss them in the context of 'research through design' In this paper, we interpret the five-step method of McCracken and relate it to annotated portfolios to analyse interviews. We use a case study on design projects related to 3D printing and sustainability to illustrate the process. Five designers were interviewed to obtain a deeper understanding of the role of Additive Manufacturing in practice. These interviews were analysed in a visual process with annotated portfolios. The use of annotated portfolios is considered a meaningful approach to analyse interviews, because it leads to a more transparent analysis process: The visuals are rich in information, bring clarity to the data for interpretation and pattern finding and make this stage insightful for discussion with peers.

Annotated portfolios; visual analysis of interviews; research through design; circular economy

1. Introduction

This paper explores the use of annotated portfolios as a method to support the qualitative analysis of interview data. We want to explore this in the context of design research, because it creates the opportunity to obtain insight about design objects and the process that led to these objects; data is approached differently, because visuals can be incorporated in the analysis phase. 'Annotated portfolios' is a research through design approach that shows a selection of annotated artefacts to analyse these artefacts. Annotations can be described as "the indexical connection with artefacts" (Gaver & Bowers, 2012), making them topical for discussions and comparison with other annotated objects. The annotations draw attention to aspects in the design that are not directly visible, but for example part of the ideas or system behind the object. The combined annotated artefacts generates the annotated portfolio, i.e. a group of artefacts that is described together to show a domain of design and its relevant dimensions (Bowers, 2012; Gaver, 2012; Gaver & Bowers, 2012). Annotated

portfolios allow to translate particular aspects of artefacts into more generalizable theory. They can be seen as a form of intermediate-level knowledge, which indicates the space between the particular artefact and the general theories (Lowgren, 2013). We consider pattern finding in the interview analysis process as a form of intermediate-level knowledge. Therefore, including annotated portfolios in the interview analysis is expected to bring more transparency to the analysis process.

Although annotated portfolio is often mentioned in literature as a meaningful approach, only few examples exist of actual implemented 'annotated portfolios'. All studies have in common that the authors apply the method to describe their *own* design in order to make the design process, with all its considerations, more insightful. Some describe their design and insights in a paper, either directly linking annotations to pictures of their design project(s) (e.g. Srivastava & Culén, n.d.) or summing up annotations in the body of the text (e.g. Hobye, Padfield, & Löwgren, 2013). Others use the approach as a means in their process, for example for collaborative use of annotations to communicate between team members (Kelliher & Byrne, 2015). We consider it appropriate and interesting to describe the work of others with this method as well, especially in the context of qualitative interview analysis. The insights from interviews about the (design) process can be captured in annotations.

Applying annotated portfolios for qualitative data analysis has to our knowledge not been performed before. In this paper, we explore the combination of these methods with a case study on design projects related to 3D printing and sustainability. We first describe the case study in some detail, including the use of annotated portfolios, and then reflect on the use of the annotated portfolios.

2. Case study: 3D printing for design in a circular economy

The circular economy aims to accomplish sustainable production and consumption. Additive manufacturing, also known as 3D printing, could be an enabling production technology, because its production characteristics differ from conventional production methods: It is a digital and additive production process (Despeisse et al., 2017). We are particularly interested in the way in which designers can use additive manufacturing to support sustainable design in a circular economy. Therefore 'research through design' is the applied methodology, because it creates knowledge through the act of designing and in this way allows for the creation of theoretical, as well as practical understanding (Stappers, 2007).

Literature describes many potential sustainability advantages of additive manufacturing. However, it is still unclear how these aspects can be applied in practice. In previous work, literature about the sustainability of additive manufacturing was compared to circular design strategies in the context of five selected design projects (Sauerwein, Bakker, & Balkenende, 2017). The circular design strategies support product longevity and are described by Bakker, Hollander, Hinte and Zijlstra (2014) and Bocken, De Pauw, Bakker and Van Der Grinten (2016) . An example of such a strategy is 'Design for standardisation and compatibility', which can be explained as "creating products with parts or interfaces that fit other products as well" (Sauerwein et al., 2017).

The five design projects were selected, because the designs were produced with additive manufacturing and related to sustainable product design. In figure 1 each project is described. The designers of these projects were interviewed to obtain a deeper understanding of the role of additive manufacturing in practice.

'Standard products': Jesse Kirschner and Jesse Howard (2016)

Furniture is made from standard wood elements, with 3D printed joints. Therefore people can online adjust the furniture to their preferences. Further, they can choose to download the files, receive the printed joints or the complete product.

'BIOMIMICRY; soft seating': Lilian van Daal (2014)

Van Daal designed a seat fabricated in one print, but expressing different material properties through different local structures.

'Value Added Repair': Marcel den Hollander and Conny Bakker (2015)

Value Added Repair (VAR) extends the product lifespan of broken products not only through repair, but also through the addition of an extra functionality. In this way extra value is added to the product.

'Project RE_': Samuel Bernier (2012)

This project explores 3D printing as a do-it-yourself tool for reuse of products. The functionality of used cans and jars is expanded through the addition of customized lids.

'Screw it': David Graas (2013)

Graas designed connectors that transform old PET bottles and their lids into new user objects, e.g. a vase or bracelet.

Figure 1. Explanation of the five design cases.

3. Methodology

3.1. Interview design

Semi-structured interviews were conducted with the purpose to gain insight in the design projects related to 3D printing, sustainability in general and the circular design strategies in specific. The interview was divided into three sections with questions on:

1. The designer's experience of working with 3D printing
2. Sustainability aspects of the designs
3. The applicability of the circular design strategies and the relation to 3D printing.

All designers of the selected design projects accepted the invitation for an interview, which lasted between 40 and 65 minutes. Interviews were preferably conducted face to face, but due to time and distance constraints two of the five interviews were held through a video-conference over the internet. Three interviews were in Dutch and two in English.

3.2. Analysis

The interviews were recorded and transcribed for analysis. The use of annotated portfolios was considered a meaningful approach to analyse the interviews, because the design projects were the focus of the interviews. We interpreted the five step interview analysis method of McCracken (1988) and related it to annotated portfolios. The 5-step analysis provides a scheme to follow in the treatment of data. It describes the steps to take from data to knowledge contribution, each step representing a higher level of generality. The first two steps focus on the creation of observations. The third and fourth step translate these observations into themes. The final step seeks for patterns between the interviews (table 1). Our interpretation of the 5 steps for interview analysis with annotated portfolios integrates visuals from the start of the analysis process, other than just grouping text. Each step and our additions are described below. The work of Piercy (2004) helped us to better understand the 5-step analysis of McCracken. However, we did not always follow her interpretation.

Table 1. five step method and analysis for annotated portfolio's based on the 5-step analysis (McCracken, 1988)

	1	2	3	4	5
5-step analysis McCracken (1988)	Read transcript carefully to create observations	Develop observations	Examine interconnection of observations	Determine themes among observations	Determine patterns between interviews

Step 1

As described by Piercy (2004), the interview transcript is read carefully to identify the important material. She explains 'important material' as the predetermined focus or subject of the analysis. In our case we focus on interview data directly related to the artefact, i.e. the design project. Therefore, we highlighted all sentences that where directly related to the design project. The highlighted sentences create an observation (McCracken, 1988, p. 42).

Step 2

The observations have to be developed beyond their original form to exploit their full potential. Subsequently, they are related back to the transcript and examined, "one in relation to the other"(McCracken, 1988, p. 45). To further develop the observations, we summarized and translated them to English (if needed). These summarized observations were annotated to a picture of the design project to make the design project topical for examination. Throughout this paper we will indicate 'the summarized observations' as 'annotations' and 'the annotated picture of a design project(s)' as 'visual(s)'.

Step 3

McCracken (1988, p.45) describes these stages as follows: “Observations are once again developed on their own accord, and, now, in relation to other observations.” In other words, the observations are examined to identify connections and categories (Piercy, 2004). The focus shifts from the transcript to the observations. We assigned colour codes to the annotations to cluster them into different categories.

Step 4

After examining the observations, the investigator has to seek for more general themes on the level of each individual interview. The developed observations are linked to compose a theme. (McCracken, 1988, p.46; Piercy, 2004). In our case a first evaluation on the level of the visual was made. We indicated the relations between the categories with dotted lines.

Step 5

The final stage seeks for patterns among the themes by comparing all interviews. Patterns are the predominant themes of the data and serve as answers to the research questions (Piercy, 2004). We repeated step 1 to 4 for each transcript. In order to enable comparisons across the visualisations, the same visual language was used for each design project (i.e. colour coding and dotted lines). This enabled the identification of patterns between the interviews. We created separate visuals to make these patterns more insightful, to “subject them to a final process of analysis” (McCracken, 1988. p. 42) and to complete the procedure from the particular details to the general observations.

4. Results

To illustrate the analysis process, we focus on the results of the interview about ‘standard products’. The interview data contains knowledge to answer several research questions about 3D printing and design for a circular economy. This section shows the visuals that support the analysis of the relation between 3D printing and the circular design strategies, in particular design for standardisation and compatibility. The result of the analysis is not yet complete (it is part of an ongoing research project), but is shown here to support the explanation of the analysis process.

Step 1

The transcripts were read carefully and relevant sentences were highlighted. For example, in the interview about ‘standard products’, the following sentence was highlighted: “well, this standardisation and compatibility is really about the fact that there are these standard components and huge infrastructures behind them, so they are not going anywhere, so let’s adapt to those”

Step 2

The process of summarizing observations into annotations can be illustrated by the sentence from the interview about ‘standard products’ cited above. This sentence was summarized into the annotation “standardisation: adapt to existing standardised systems, they will not disappear”. All annotations were connected to specific parts of the design project as shown in figure 2 for ‘standard products’ to illustrate the written text. The demonstrated annotation above, for example, is attached to the connection between the wooden beam of the leg and 3D printed joint to illustrate that this annotations applies to this part of the design project. When the text is not directly connected to the object (e.g. “product attachment is achieved because of practical value), it means that the annotation applies to the whole product, or the idea or system behind it.

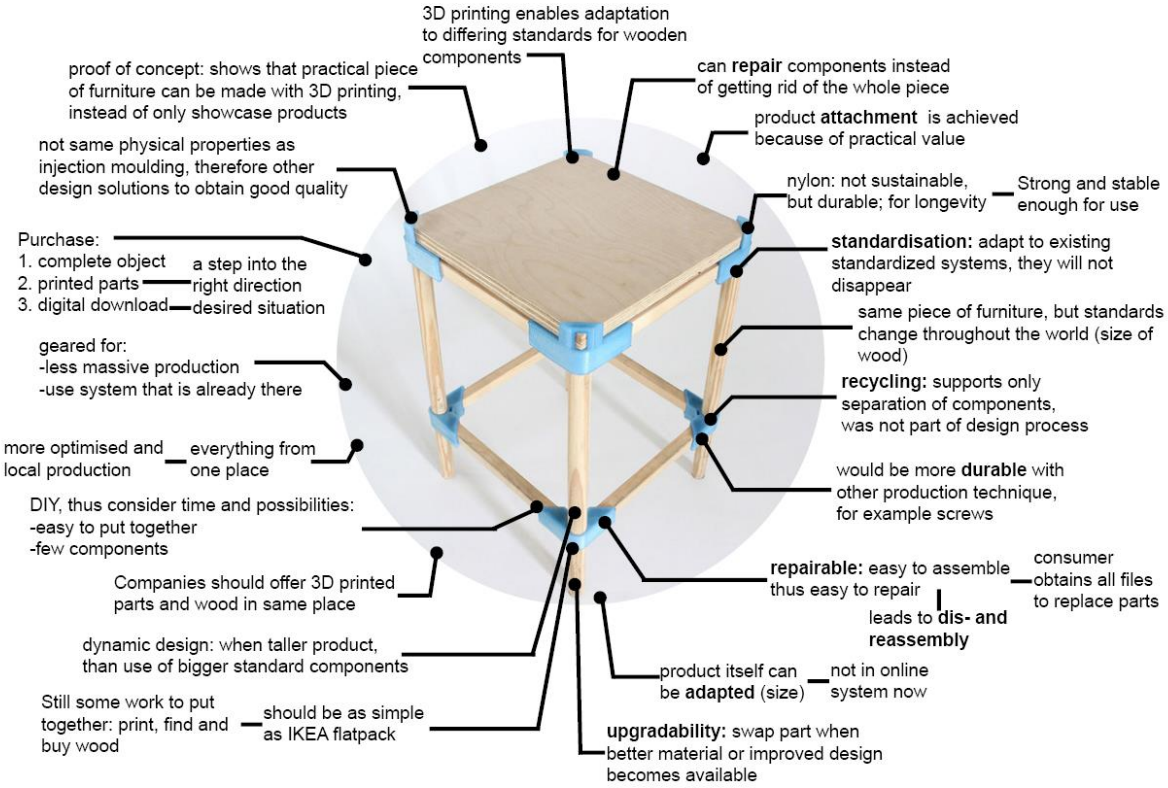

Figure 2. annotations made by 'standard products'

Step 3

The interview had three focal points: '3D printing', 'sustainable aspects' and 'circular design strategies'. These were used to categorize the annotations. From the transcripts two more categories appeared, i.e. 'future opportunities' and 'other aspects'. Below a description of each category is given:

- 3D printing: annotations in this category refer to 3D printing as a production technique. They cover its abilities and shortcomings, but also when a certain aspect could be realized because of 3D printing.
- Sustainable aspects: this category depicts when the interviewee assigned a certain aspect to sustainable behaviour/use/production or lack of it.
- Circular design strategies: this category is used when the circular design strategies are mentioned or when something is mentioned about the circular economy.
- Future opportunities: annotations in this category refer to the instances where designers talked about future possibilities of their design. This was either because they were inspired by the questions or had a future vision, which could not yet be realized.
- Other aspects: annotations in this category give insight about the design project, but do not belong to one of the categories mentioned above.

A colour was assigned to each category and these colours were used to highlight the annotations as depicted in figure 3. Each annotation can belong to one or more categories. The colours put the annotations in context and show the connections within the categories.

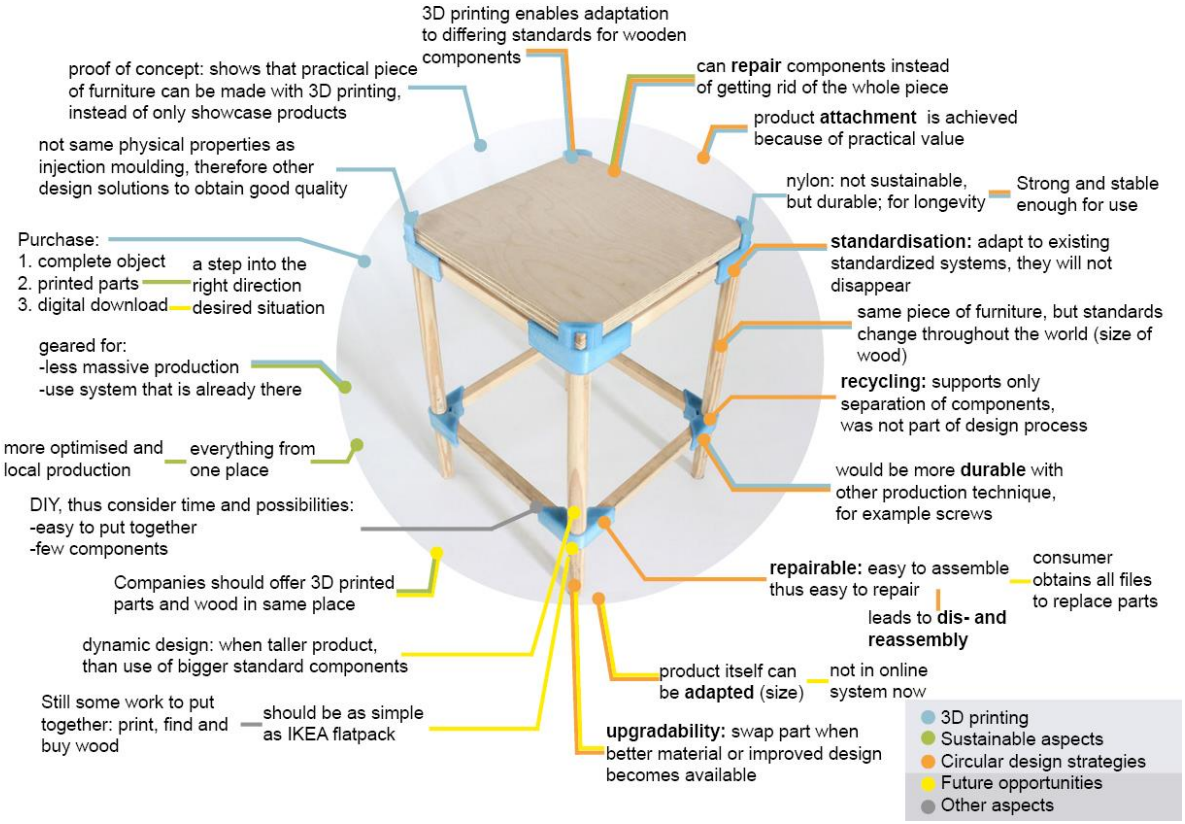

Figure 3. Coloured annotations

Step 4

Dotted lines were used to find patterns on the level of the design project. The size of the dots was increased with an increasing number of connections between and within categories (figure 4). This helped to determine the most prominent themes, to bring hierarchy to the themes and potentially eliminate redundant themes. Sorting the themes is valuable for support of the final arguments (McCracken, 1988, p. 46). Figure 4 shows that for the presented case the annotation on 'standardisation' (in orange) has the largest circle, followed by the annotation on 'optimised and local production' (in green). These annotations exhibit most connections with other annotations and therefore it is likely that they will play an important role in the final evaluation.

The connections help to interpret the annotations, because they show the relations between them. We illustrate this with an example about the relation between standardisation and additive manufacturing. We found that in this project, the use of standard dimensions for wood in combination with 3D printed joints is considered as a means to realize sustainable production. The following connected annotations led to this conclusion. The use of local standards optimizes the production process, because of the accessibility of parts. All parts can be produced in the same place on a local scale. Besides this, adopting local standards increases the reparability and the upgradability of the product: parts can be replaced instead of the whole product, because standard components are widely available. The user will obtain the digital files of the joints, so that he or she can reproduce them him/herself. Our interpretation of these observations is that the design of the object is universal, but local standard dimensions can be used, because of additive manufacturing. Standard dimensions differ throughout the world, making digital storage and adjustability key for successful functioning of this project. Without the digital characteristics, the result would be a too wide range of components to be stored.

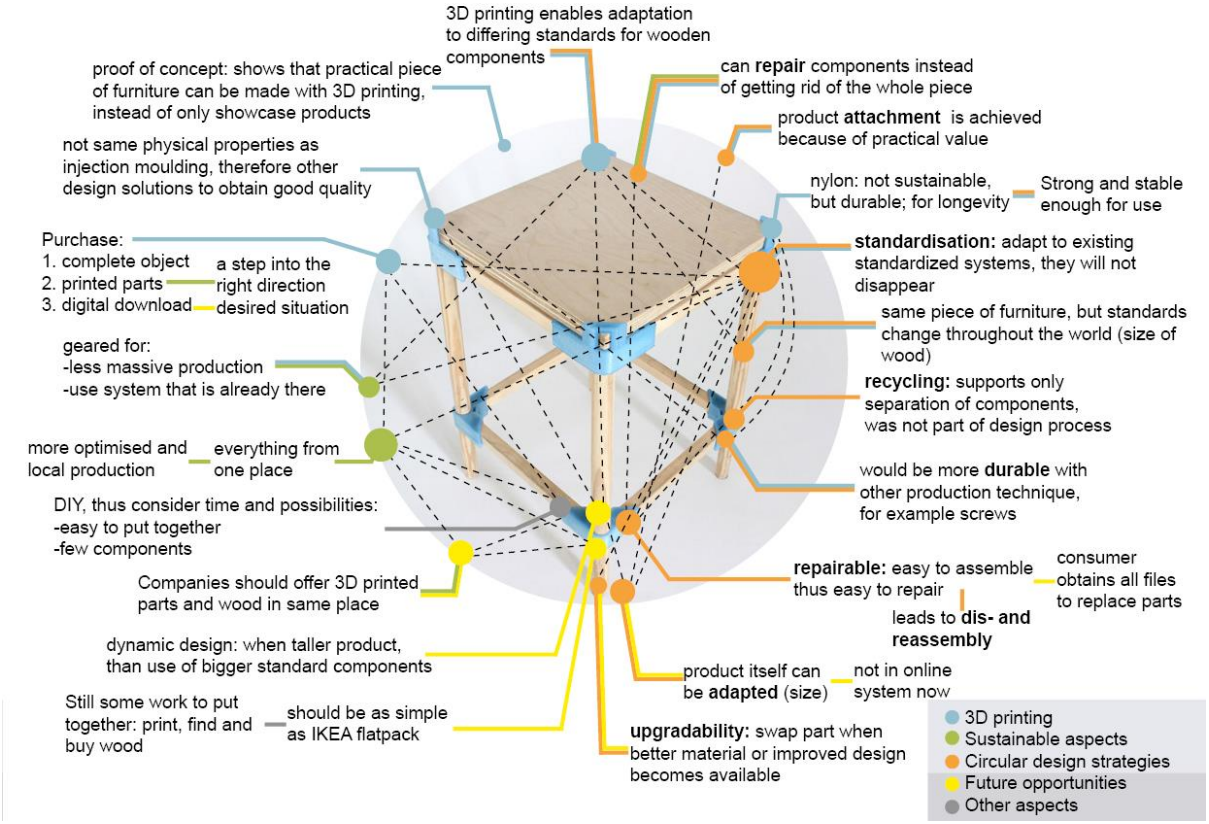

Figure 4. coloured and connected annotations

Step 5

All visuals together create the annotated portfolio. Figure 5 gives an impression of the result of the five design projects. The annotated portfolio allows for the particularity of individual objects, but also show the issues that join and differentiate them (Gaver, 2012).

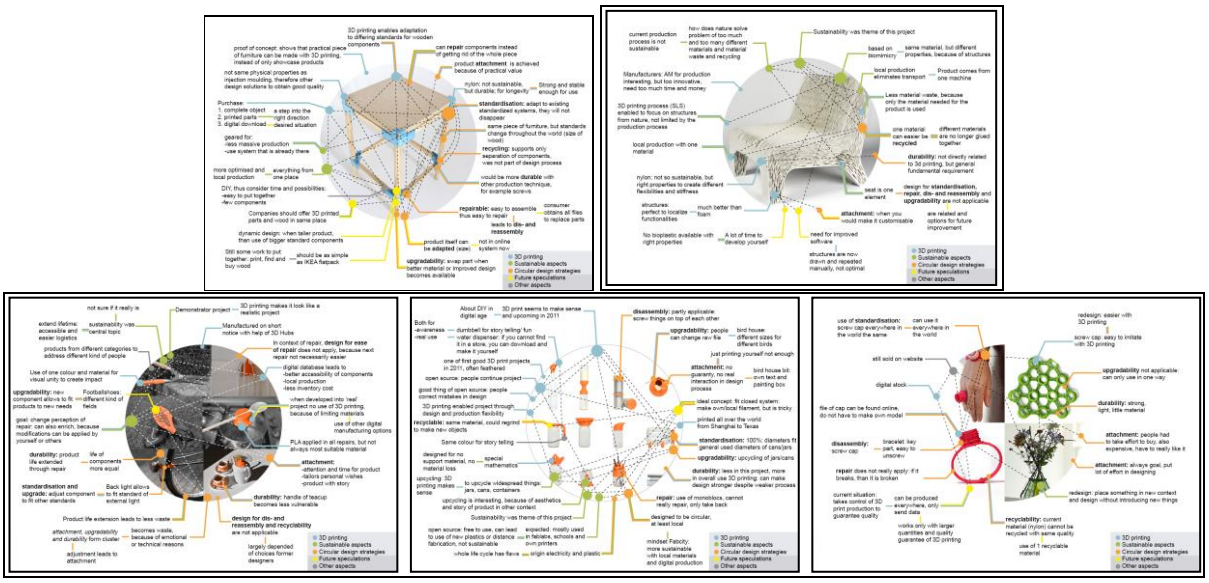

Figure 5. annotated portfolio for 3D printing for design for a circular economy

When establishing relations between the design projects, patterns were found, which in turn can be visualised. When looking for example at the annotations about the circular design strategy ‘design for standardisation and compatibility’, the explicit use of standardisation in combination with 3D

printing to support sustainable production returns throughout the portfolio. In Figure 6 this is illustrated with a combination of all artefacts and the supporting annotations related to this pattern. This figure is the final step of the interview analysis and should therefore reveal the findings.

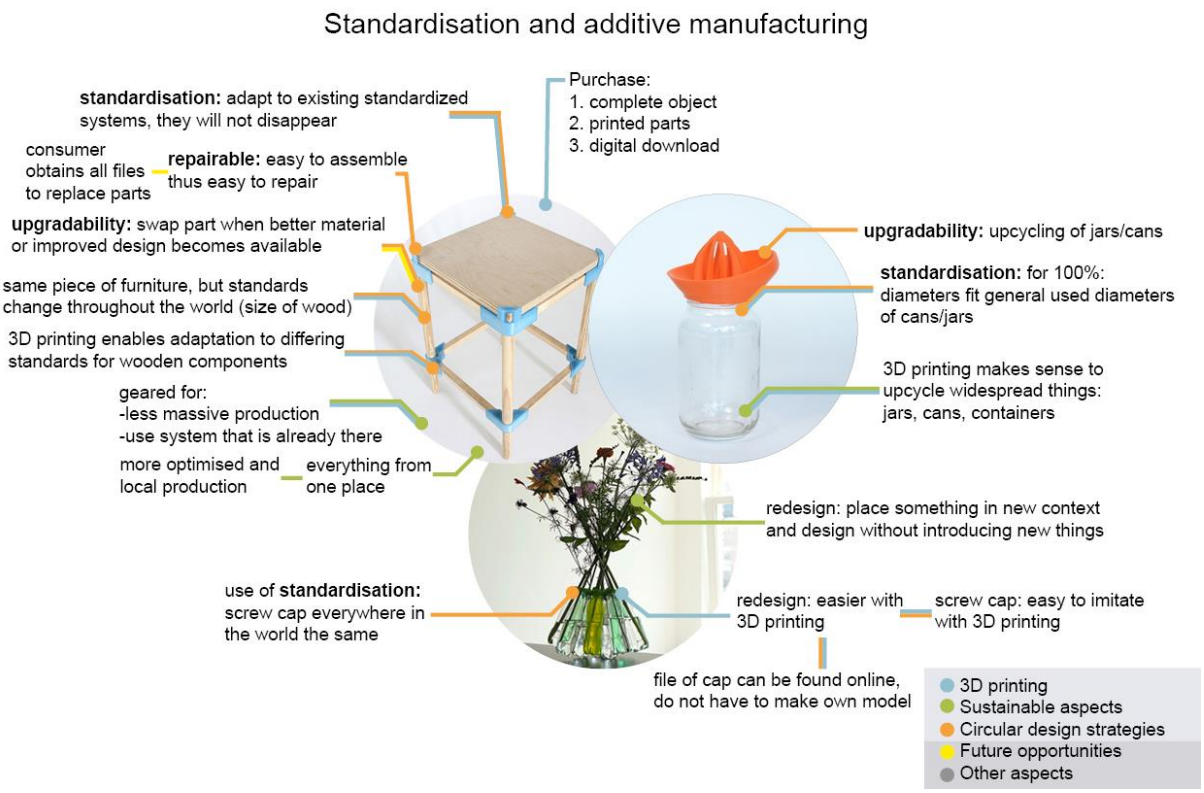

Figure 6. Visual representation of annotations about standardisation and additive manufacturing

In this case, the annotations about standardisation and additive manufacturing in figure 6 present a paradox. In general, it is expected that designers would neglect standardisation and embrace design flexibility with 3D printing. However, the interviewed designers embrace both and use standardisation in an interesting way. The design projects illustrate that additive manufacturing simultaneously enables both the adaptation to standards and the creation of unique solutions. For example, in 'project Re_' and 'screw it' (picture below) standard fittings are used to upgrade an existing product and extend its use. Thus, all three projects embrace the ability of 3D printing to digitally adapt the design to fit a specific context, while using standardisation to make it accessible all over the world. This could lead to product longevity and an efficient use of resources.

4.1. Visuals

The generation of the visuals can roughly be divided in three levels, that are respectively the result of step 1 and 2, step 3 and 4, and step 5. First, annotations are assigned to the product without further interpretations. Next, colours and relations are introduced to categorize the annotations and identify themes. Finally, new visuals are created based on the annotated portfolio, showing patterns that relate specific aspects of the design projects and annotations.

5. Discussion and Conclusion

In this section we reflect on our process and discuss the findings and limitations that we experienced. In general, we experienced that annotated portfolios support the data interpretation in interviews that focus on design projects and make the analysis process more transparent. Being a form of intermediate-level knowledge, annotated portfolios support verification during the analysis process, increasing the responsiveness of the investigator and therefore supporting rigor throughout the process (Morse, Barrett, Mayan, Olson, & Spiers, 2002). The visuals allow the communication of

this intermediate-level knowledge to peers. Therefore, this stage becomes accessible for discussion, which increases the transparency of the process.

Besides communication to peers, it is also insightful during analysis process itself to visually show the steps needed to transform data into knowledge. Figure 2 to 6 clearly show the development from data interpretations to pattern finding; at first only annotations are assigned to the individual design projects, next meaning is given to these annotations and finally all design projects are connected through the annotations. The development of the visuals structured this process, which can be very fuzzy and therefore difficult to keep track of when analysing interviews. When coding an interview with analysis software for example, many layers of interconnectivity can be created. The amount of codes can be overwhelming. Although many software tools allow the creation of visuals (mind maps) to better understand the linkages between different observations, this is only possible after categories and themes have been assigned to the observations. The disadvantage is that it is not directly clear which observations have the most connections. Annotated portfolios, by contrast, allow the creation of visuals right from the start of the analysis process and connect the analysis to (specific parts of) the design artefact. The visuals directly show the amount of connections between annotations and therefore bring clarity to the data.

The visuals allowed us to apply as many layers of interpretation as desired. They could be adjusted according to the focus of the research question. The overall outcome was a visual rich in information, showing that many annotations belong to multiple categories. For example, the annotation 'companies should offer 3D printed parts and wood in the same place' belongs to the categories 'sustainable aspects' and 'future opportunities' (figure 3). Showing this in a visual representation can be seen as a unique advantage, when compared to other interview analysis tools. However, the final version of the visual is likely to have a very high density of information and might therefore be less understandable for outsiders. Therefore, we found it beneficial to create new visuals (figure 6) with a selection of annotations that belong to a certain pattern to make outcomes more insightful.

In comparison to qualitative data analysis software, the analysis with annotated portfolios needs an extra step of interpretation. Analysis software directly links the transcript to categories, but annotated portfolios require the creation of annotations; the observations are first summarized, before they are categorized. These summaries and short sentences are important to present an overview in the visuals. However, the investigator should be careful when summarizing, as this is the first interpretation of the transcript. The summary should be as literal as possible to avoid misinterpretations later on.

Further research is needed to develop this exploration into a more rigorous method. A possible approach could be to perform a comparative analysis between the classic qualitative data analysis and the analysis with annotated portfolios. The same data should then be analysed by two experienced research in two rounds, one first performing the classic method and then the method with annotated portfolios and the other vice versa. This approach would allow for analysis within and between the subjects.

To conclude, this study shows that annotated portfolios do not only have the ability to communicate the design process, but also to support the communication of interview analysis regarding design processes. Applying annotated portfolios to the field of interview analysis broadens the scope of this method. Our study shows that annotated portfolios are also suitable to give meaning to and evaluate the work of others, instead of only own design projects. We even expect that the use of annotated portfolios to analyse interviews does not have to be limited to interviews about design projects, but could be extended to all topics that can be visualized, for example systems or relations. The advantage of visuals is that they stimulate the detection of relations between annotations, as well as patterns within the bigger picture. . Therefore, by introducing a visual analysis this approach

has the potential to contribute to the toolbox of interview analysis, in addition to the current textual analyses.

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