THE VALUE OF DESIGN RESEARCH

11TH EUROPEAN ACADEMY OF DESIGN CONFERENCE

APRIL 22-24 2015

PARIS DESCARTES UNIVERSITY
INSTITUTE OF PSYCHOLOGY

BOULOGNE BILLANCOURT
FRANCE

CONFERENCE ORGANIZERS:

PARIS DESCARTES UNIVERSITY
PARIS SORBONNE UNIVERSITY
PARIS COLLEGE OF ART
ISTEC PARIS

REDUCTIONISM AS A TOOL FOR CREATIVE EXPLORATION

Shiro Inoue Northumbria University School of Design shiro.inoue@northumbria.ac.uk

Paul Rodgers Northumbria University School of Design paul.rodgers@northumbria.ac.uk

Andy Tennant Northumbria University School of Design andy.tennant@northumbria.ac.uk

Nick Spencer Northumbria University School of Design nick.spencer@northumbria.ac.uk

ABSTRACT

This paper reports on research that investigates how qualitative reduction of elements of an object might stimulate creativity amongst design practitioners. As humans, we have the ability to generate a complete image of an object as a representation even when parts of the three-dimensional object are missing, as long as appropriate visual clues are given. If reduced elements of an object describe the complete state of the object, element reduction might be utilised as a trigger for further creative imagination. In other words, designing the way to reduce elements of an object might be an opportunity to stimulate a design practitioner's imagination. In order to explore the possibilities of reductionism in design, the authors conducted an experiment wherein design students were given varying levels of reduced information in a design representation and asked to complete the design using simple 3D materials. We observed the ways in which the design students approached the original image of an object using images whose quality were reduced in a variety of ways. The results indicate that even if the design students saw a visually-reduced image of an object, they develop their imagination relying on three factors: materiality, composition and prior-knowledge. The authors suggest that reducing these informative elements could possibly be the key to stimulating their imagination.

Keywords: Design reductionism, imagination, creativity, communication

1 INTRODUCTION

Humans are able to find meanings in limited amounts of information. Human perception is capable of creating a complete image of a 3D object even if elements are reduced or removed, identifying separated regions of deep concavity into an arrangement of simple geometric components in their mind (Biederman, 1987). We recognise meaningful objects from meaningless low-level features of information through forming patterns in both bottom-up and top-down strategies of our cognition (Ware, 2008). Evidence also shows it is possible to imagine an object's semantic property in archetypal categories of existing objects effortlessly, even if only very small portions of the object are seen (Athavankar, 1989). These facts imply that we are inherently capable of finding out more meaning in incomplete information of an object.

THE VALUE OF DESIGN RESEARCH

11TH EUROPEAN ACADEMY OF DESIGN CONFERENCE

APRIL 22-24 2015

PARIS DESCARTES UNIVERSITY
INSTITUTE OF PSYCHOLOGY

BOULOGNE BILLANCOURT
FRANCE

CONFERENCE ORGANIZERS:

PARIS DESCARTES UNIVERSITY
PARIS SORBONNE UNIVERSITY
PARIS COLLEGE OF ART
ISTEC PARIS

Reductionism as a Tool for Creative Exploration

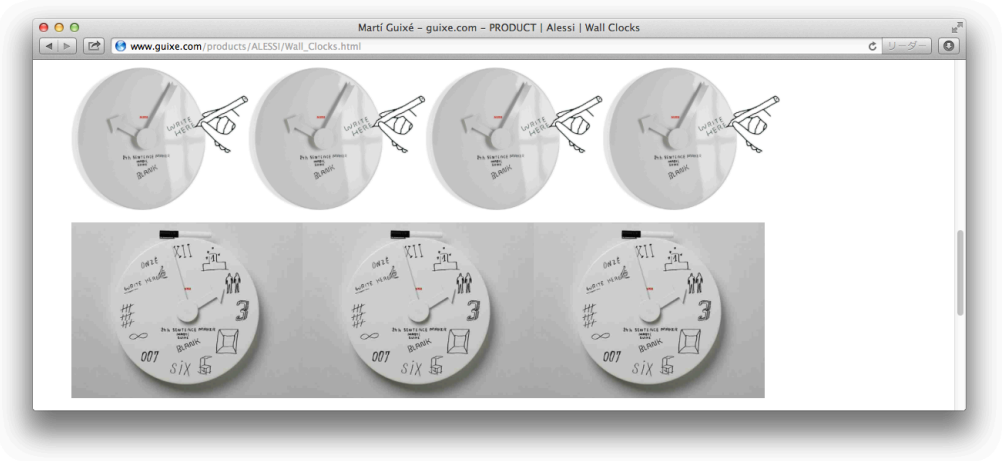
Inoue, T., Rodgers, P., Tennant, A. and Spencer, N

At the preliminary phase of a design process, reduced clarity plays an important role in the designer's imagination. Designers' sketching activity, where they explore ideas, ambiguity is considered a useful factor (Goel, 1995). It is an interactive medium wherein designers discover unexpected meanings within spontaneous relationships among depicted elements (Goldschmidt, 1994). The unintended relations and features are detected even from the sketch drawn for other purposes, and it prompts designers to generate new ideas (Suwa and Tversky, 2002). Zumthor (1998) stresses the importance of less clarity in architecture drawing:

If the naturalism and graphic virtuosity of architectural portrayals are too great, if they lack "open patches" where our imagination and curiosity about the reality of the drawing can penetrate the image, the portrayal itself becomes the object of our desire, and our longing for its reality wanes because there is little or nothing in the representation that points to the intended reality beyond it (Zumthor, 1998, p.13).

Good designers cope with uncertainty (Cross, 2011) and appreciate putting themselves in situations where ideas lack resolution and they hold both incomplete and conflicting ideas together as a matter of course (Lawson, 2005). For designers who strive for ideas, dealing with amorphous visual information is part of their intrinsic activities. In this respect, incompleteness is the driving force for designers' imagination.

Reducing the obviousness of an object might enrich the user's interpretation. Gaver (2003) asserts that ambiguity is a potential opportunity for design. Concepts such as uncertainty is regarded in traditional Human Computer Interaction, as a problematic factor. However, ambiguity can also stimulate



people's interpretations and encourage them to establish deeper and more personal relationships with diverse meanings.

Figure 1 – 'Blank and sentence Maker' by Marti Guixé, 2010 (http://www.guixe.com/products/ALESSI/Wall_Clocks.html).

Figure 2 – 'Do Scratch' by Marti Guixé, 2002 (http://www.guixe.com/products/DROOG_do_scratch/do_scratch.html).

There are several design practices that take a similar approach. For example, Marti Guixé's (2002; 2010) '24h Sentence Maker Wall Clock' (FIGURE 1) allows users to express their own ways to indicate time with a pen by removing dials on the clock and using the material like a whiteboard. Similarly, his 'Do Scratch' project (FIGURE 2) lets users create their own graphical meaning by scratching figures on the surface of the lighting object coated in black paint.

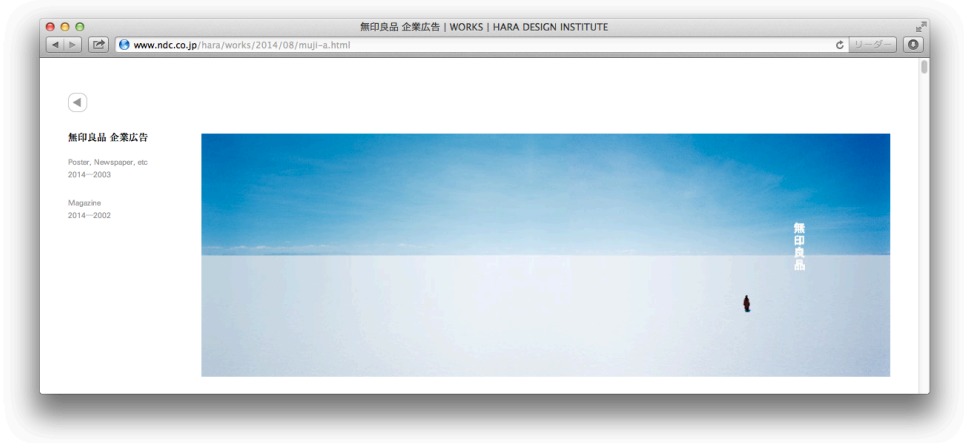


Figure 3 – 'Advertising of Muji' by Kenya Hara, 2003 (http://www.ndc.co.jp/hara/works/2014/08/muji-a.html).

Kenya Hara (2007) developed a similar approach for the advertising concept of Muji - a Japanese retail brand (FIGURE 3). In this project, Hara suggests that offering an empty vessel rather than presenting a lucid advertising message enables the audience to freely deposit their ideas and wishes. He referred to this as "emptiness" and stressed the importance of the role of communication:

Communication is not dispatching information from one entity or person to another, but facilitating the mutual exchange of information. (…) communication happens when the recipient, offered not a message but an empty vessel, supplies the meaning himself (Hara, 2007, p241).

These examples illustrate that it is possible to design the interaction between the user and the object to facilitate his/her imagination by reducing the

information required to recognise the object's identity. Merely reducing elements or information of an object just leads to miscommunication or misunderstanding. However, if the method is designed appropriately, a reductive approach might be considered as a technique that compels diverse interpretations or imaginations of the person who engages with the object.

Therefore, it could be argued that the reductive approach has the potential to be deployed across a number of design disciplines. The authors believe the relationship between reduction and imagination can be deployed as an effective tool for designers. In order to better understand how design practitioners react, think and visualise their imagination, triggered by the image whose visual information is reduced, the following study was conceived. If incompleteness impacts upon a participant's imagination process, then this reductive approach might suggest a way to stimulate designer's creativity. The main research question is - what kind of visual cues do designers rely on for "representation completeness" when they build an image of an object based on a reductive image in their mind?

2 METHODOLOGY

We conducted a study to observe the imagination processes of a group of design students when they are given images of an object whose descriptive information is reduced. The main purpose of this study is to explore patterns and characteristics against reductive images in the participants' behaviour.

2.1 Participants

This study involved 17 undergraduate design students of Northumbria University. The group was composed of 4 students in the 2nd year and 13 in the 3rd year, all from the Industrial Design course. They were recruited as volunteer participants .

2.2 Image Prompts

The study comprised 17 different types of image reduction from the original image of an armchair and each participant being given a specific reduced image (FIGURE 4):

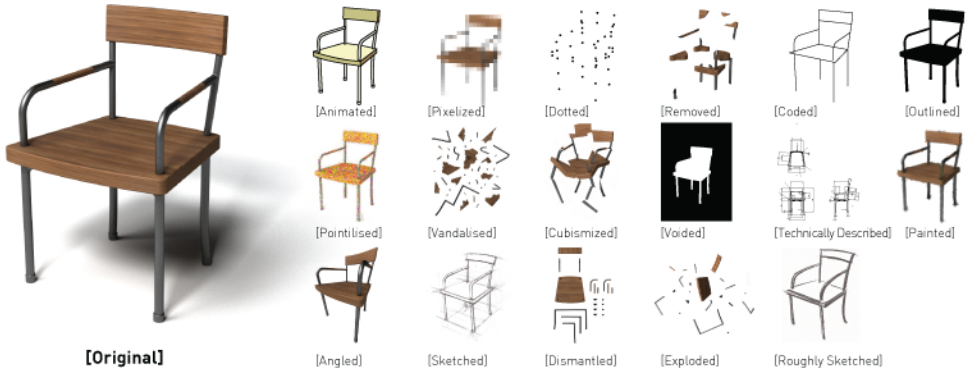


Figure 4 – The original image of object and the 17 reductive images provided for the participants.

— Cubismised,

— Pixelised,

— Pointilised,

— Sketched,

— Dotted,

— Angled,

— Exploded,

— Dismantled,

— Coded,

— Outlined,

— Vandalised,

— Voided,

— Removed,

— Painted,

— Roughly sketched,

— Technically described and

— Animated.

The original image of the armchair used in this study was arbitrarily produced by the researchers. Accordingly, the participants have never seen this particular image before. All images except for the 'Sketched' and 'Roughly Sketched' were modified by computer-graphic software based on the original rendered image and the CAD data of the object. The other two styles of hand drawing (Sketched and Roughly Sketched) were created by the researchers.

2.3 Procedure

This study has been carried out according to the following procedure:

1. A reductive image was provided to each participant.

2. The participant was informed by the instructor (first author) that this image whose quality is reduced represents an original object.

3. The participant was asked to imagine the original image of the object.

4. The participant was asked to visualise their object using sketching and model making using the provided materials within 30 minutes.

5. The participant was interviewed after they had created their image and model.

2.4 Equipment provided

Each participant had access to:

A3 paper, pens, model making equipments and tools e.g. clay, board, plastic sheet, balsa, craft knife, handsaw, pliers and glue.

Figure 5 – Provided materials for model making.

2.5 Questions Asked During the Interview

In order to understand the participants' imagination process, we conducted semi-structured interviews after the exercise wherein the participants were asked to respond to the following:

1. What did you do first when you saw the image?
2. What kind of visual characteristics in the provided image did you use as a clue for your sketching?
3. How many ideas did you have while you are imagining?
4. How did you identify the category of the object in the provided image?
5. How do you feel about the gap between the image you created and the original image?
6. Have you referred to an image of existing object as a reference during the imaging process?
7. What was the most exciting thing while you are imagining?
8. What was the most difficult thing throughout the process?
9. Did you use the provided image after sketching?
10. Do you have anything else to tell about this project?

2.6 Data Collection and Analysis

We collected 3 types of data: sketches, 3D models, and participant interviews. The depicted sketch describes the participant's idea development processes and some key elements for model making. Additionally, the 3D models represent what they imagined or what the sketches actually mean. These, two representations (sketches and 3D models) were treated as supportive data, and the content of the interviews was addressed as the main data source for the analysis. The participants used their visualised representations when they needed to refer to particular details of form or to describe relationships amongst the provided image, their sketches and the 3D models during the interviews. After recording the interviews, the contents were transcribed.

We analysed the data of the transcribed interviews employing a Grounded Theory approach (Glaser and Strauss, 1967) in order to explore and explain the phenomenon being studied. We followed through with these 2 stages of coding process to complete the analysis:

— Open coding to find the categories

— Axial coding to interconnect them

General Grounded Theory suggests going on to selective coding process (Strauss and Corbin, 1990). However, we did not take this stage for the analysis because the main purpose of the analysis was to describe the phenomenon rather than identifying one single aspect as a conclusion (Robson, 1993).

3 VISUALISED OUTCOMES

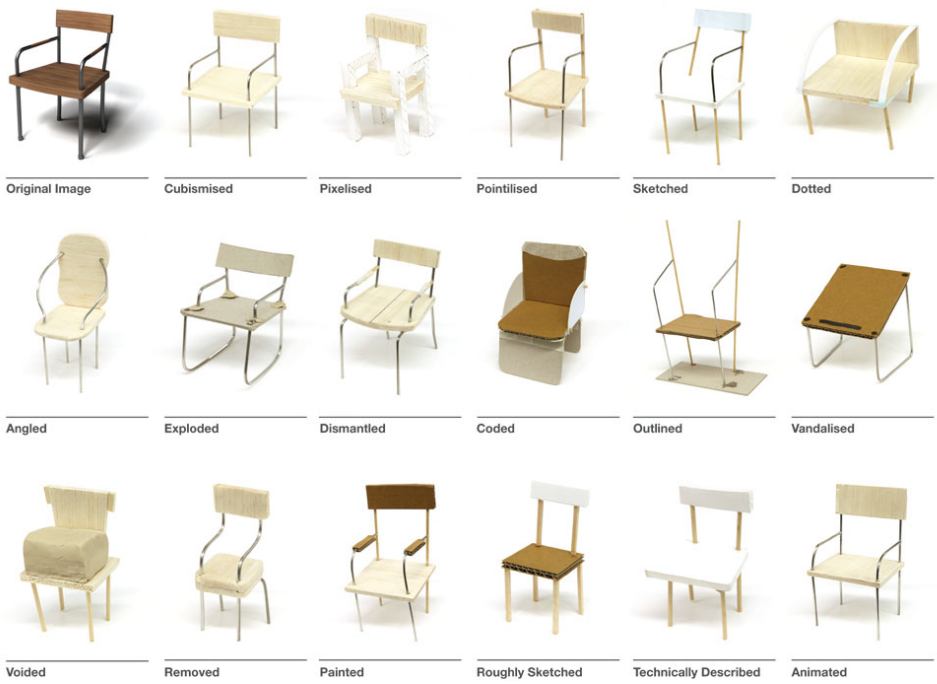


Figure 6 – Models created by the participants.

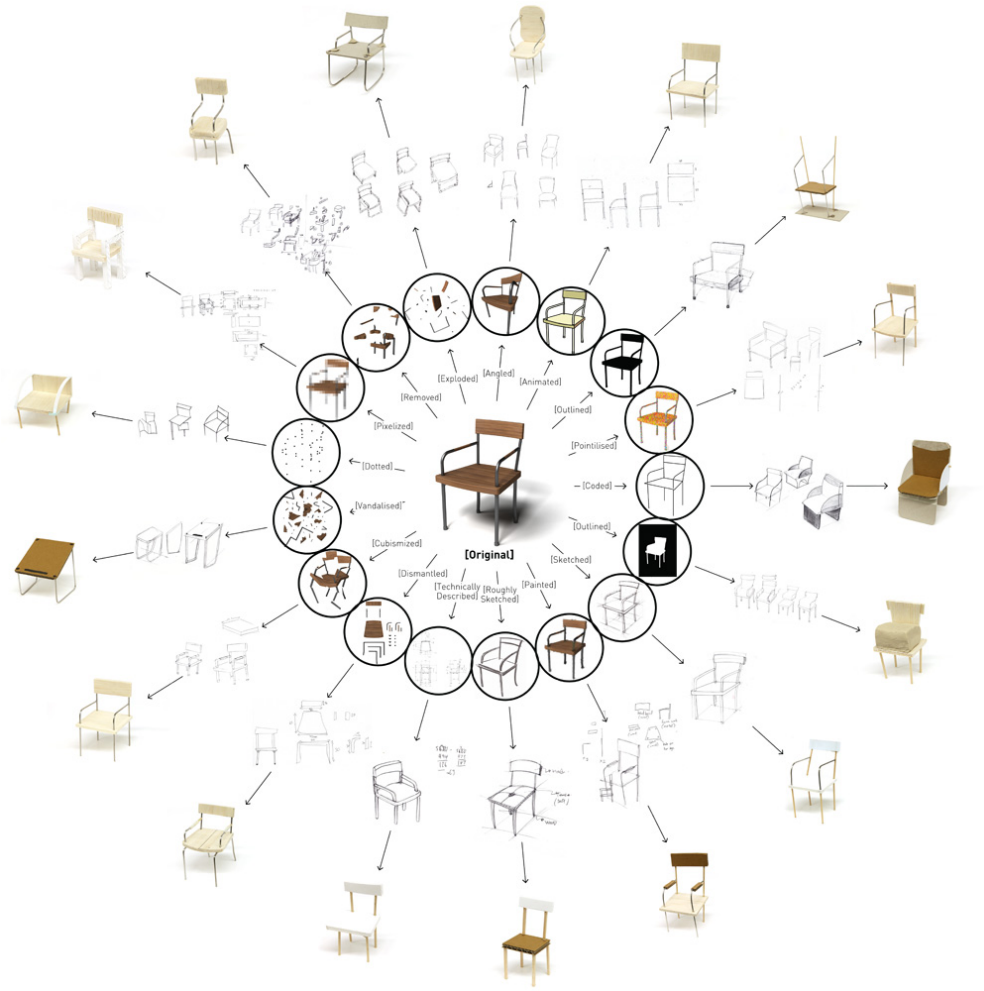


Figure 7 – Development process including the sketches and the models.

Except for the participant who received the image of 'Vandalised', 16 replicated the models that represent a chair (FIGURE 6 & 7). Furthermore, 13 participants created armchairs, and 6 out of 13 produced the models that are very similar to the original image of the object (Exploded, Cubismised, Dismantled, Sketched, Pointilised and Animated). In fact, some of the provided images are easily identifiable as an armchair. However, a few outcomes (e.g. Exploded and Dismantled) illustrate that the participants could build similar compositions of the object to the original even if the positional relationship amongst components is shown separately. Only the image of 'Vandalised' in which the components are not identified easily enabled the participant to create an object that belongs in a different category from the original.

4 CODING

The transcribed contents of the interviews have been treated as raw material for the coding process. The highlighted key sentences were picked up from the transcription and cut into stripes, in order to make the process of finding correlations or common patterns among each other easier. The sentences were categorised into 6 columns as open coding categories:

— The First Action;

— Constituent Identification;

— Material Association;

— Prior-knowledge;

— Constituent Arrangement and;

— Visual Cues for Object Recognition.

4.1 Open Coding Categories and Axial Coding Subcategories

The First Action

The first approach to the reductive images the participants took was collected in this category. The 2 key axial coding subcategories have been identified: 'Matching components together' and 'Thinking about materiality'.

It appeared that positional disarrangement of the constituents of an object encouraged the participants' assembling action of objects in the participants' imagination processes. The descriptions referred to matching components of the object were mainly seen in the participants who received the images of which the positional relationship among constituents of the object are portrayed separately (e.g. 'Exploded' or 'Dismantled'). The following types of description were derived:

> *'work out the scale of each piece (...) take the pieces and trying to start matching together' (Exploded)*

> *'I was trying to plan while I was gonna cut the components and then trying to assemble them.' (Dismantled)*

On the other hand, the behaviour of thinking about materiality has been discerned when the colour of the object isn't described appropriately. This feature appears to suggest that the reduction of colour information stimulates the designer's imagination as to materiality of the object:

> *'figure out which bits represent what kind of materials' (Pointilised)*

> *'I tried to imagine what materials would be used' (Outlined)*

Constituent Identification

The descriptions that include the words referring to the constituents of object were collected in this category. The subcategory was: 'Name of constituent used in descriptions of composition'. This subcategory indicates what kind of constituents the participants recognised in order to identify the category of object. All participants, except for one who received the 'Vandalised' image mentioned the names of constituents as a chair, and 8 out of 17 participants referred to those constituents in relation to the descriptions of object composition. The examples of description are as follows:

> *'4 legs which could be distinguished, and the colour makes clear look a chair has sometimes wooden sheet, these are fitted in my image... ok, 4 legs and a seat, this is a chair.' (Pixelized)*

> *'sort of the same principals of a seat, legs and a backrest and then it was, when it came to the metal, I was judging how high you want for the backrest like, lower support, higher support and then I started categorising what was legs and what wasn't' (Exploded)*

The participant who received the 'Vandalised' image referred to the constituent object as a desk. Although the category of the associated image was similar to a chair, the object recognition prompted by this particular reductive way became unique. The participant mentioned the constituents of the object in this way:

> *'tiny dots (...) reminded me of American style desks which is slanted up where the legs go through'*

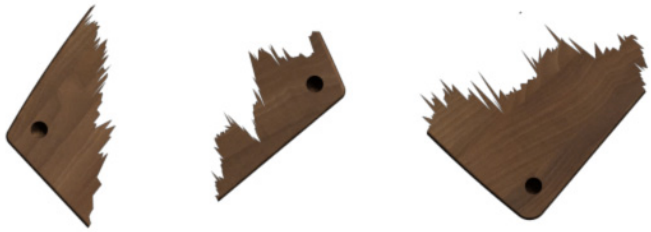


Figure 8 – Fragments in 'Vandalised' that the participants used as a visual cue.

This participant developed the imagination of the object and its composition by identifying the 'dots' as visual clues for an imagined desk (FIGURE 8).

Material Association

The descriptions as to material association/identification were collected in this category. The following subcategories were found: 'Imagining materiality in accordance with colour available' and 'Prompted material images by particular forms (such as curves or straight lines)'.

Some participants imagined the materials of the object based on the colours that were given as visual cues. This fact suggests that colour information has a significant effect on the imagination process. 7 participants referred to the process of material association in relation to the colour properties of the object. The examples of descriptions are as follows:

> *'it is just a black image (...) I wonder what the colour is. Because in my head, it was gonna be green foam.' (Outlined)*

> *'mine is in colour so it helps me, and I could tell one bit is supposed to be made of wood one bit is supposed to be made of pipe metal' (Pointilised)*

Meanwhile, particular details of form e.g. a curve of handrail, a straight line or a cylindrical shape were used for material association. The examples of descriptions are as follows:

> *'that (curving handrail) assisted me in thinking about tube steel' (Sketched)*

> *'the way of lines and how it is straightened or curved helped me to guess the materials' (Outlined)*

Prior-knowledge

The descriptions relating to the prior-knowledge that were used as a clue for imagining and recognising the object were collected in this category. Prior-knowledge had a great effect on the participants' imagination/identification processes in diverse ways. The 4 subcategories were: 'Prompted prior-knowledge by past experiences', 'Prior-knowledge as to materiality', 'General knowledge regarding the object (chair)', and 'Existing objects used as reference for composition'.

The memories of past designing experience were used as a clue in the processes of the participants' object imagination:

> *'I did a project (...) about a manufactured product. I looked at chairs (...) and I think there were a lot of metal chairs which are completely different from this. I related to it.' (Cubismised)*

> *'I did a little bit of furniture stuffs (...) sort of the same principles of a seat, legs and a backrest (...), when it came to the metal, I was judging how high you want for the backrest (...) and I started categorising what was legs and what wasn't.' (Exploded)*

Prior-knowledge regarding materiality supported object identification:

> *'the idea of the steel tube chair with wood base kind of thing working straight from so almost this is like a (...) applied kind of a list think of those chairs we've already know.' (Pointilised)*

> *'The sort of chair I was thinking was the one you might find in a waiting room of a dentist. That's why it is foam based. It is quite soft and warm' (Outlined)*

The general knowledge relating to the object were also used for their identification and imagination processes:

> *'as soon as you start looking at it as a chair, those curves make senses as handles' (Dotted)*

> *'certain things I thought if it is a chair it has to be.. can't be 80 height so it's have to be 40 that's why this is 440 mm' (Removed)*

The knowledge regarding existing objects was also used as a reference for some participants during their imagination process:

> *'I was thinking about kind of Marcel Breuer's tube steel chair. thinking about how it is made' (Sketched)*

> *'I think I had the image of the Eames's Eiffel Tower which is completely nothing like it' (Exploded)*

Constituent Arrangement

The descriptions referred to the arrangement/layout of the constituents of an object were collected in this category. The subcategory was: 'Description of composition in relation to materiality'. In the gathered sentences, 8 participants mentioned about materiality of object. The examples are as follows:

> *'one bit is supposed to be made of wood one bit is supposed to be made of pipe metal kind of thing. so there was a few clues there towards the structure.' (Pointilised)*

> *'I kind of assumed that the legs of the chair are metal because I could see on the drawing that meets in the cross section. It looks like screwed to keep in the place' (Technically Described)*

Visual Cues for Object Recognition

The descriptions that referred to the elements used as important prompts for imagining the object were collected in this category. These 2 subcategories were identified: 'Form recognition prompted by lines of object' and 'Prompted comprehensions as to the composition of the object by identifying its parts and details'.

8 participants mentioned that they have used forms of line such as straight lines or curves for their imagination processes. The examples are as follows:

> *'I used that lines sketching perspective with the supportive lines to understand the form of object' (Sketched)*

> *'trying to figure lines out from the same intervals and the dots' (Dotted)*

The other subcategory identified was that 8 participants comprehended the compositions of object identifying its parts or details. The examples are as follows:

> *'I don't see any metal running here, I mean in the corner. so the metal should be a little bit behind' (Pixelised)*

> *'I was trying to look at the ends to see I could see that one has a male connector on it and this one has a female connector so I thought this must slide into here' (Dismantled)*

5 RESULTS

The findings derived from the previous coding processes will be presented in the following subsections. They illustrate the factors that the participants considered as important elements in their imagination processes.

5.1 Material and Compositional Information

In the previous axial coding process, in total 13 subcategories have arisen (TABLE 1). In the table, the 2 words of 'materiality' and 'composition' were found as a prominent feature. In fact, the word 'materiality' can be seen 4 times in the categories: the first action, material association, prior-knowledge and constituent arrangement. Additionally, the word 'composition' can also be seen 4 times in those categories: constituent identification, prior-knowledge, constituent arrangement and visual cues for object recognition. This result

suggests that both the material information and the compositional understanding of the object played a significant role in the participants' imagination processes inspired by the reductive images. This fact implies that by reducing those aspects of the object may be an effective reductive action to prompt designer's imagination.

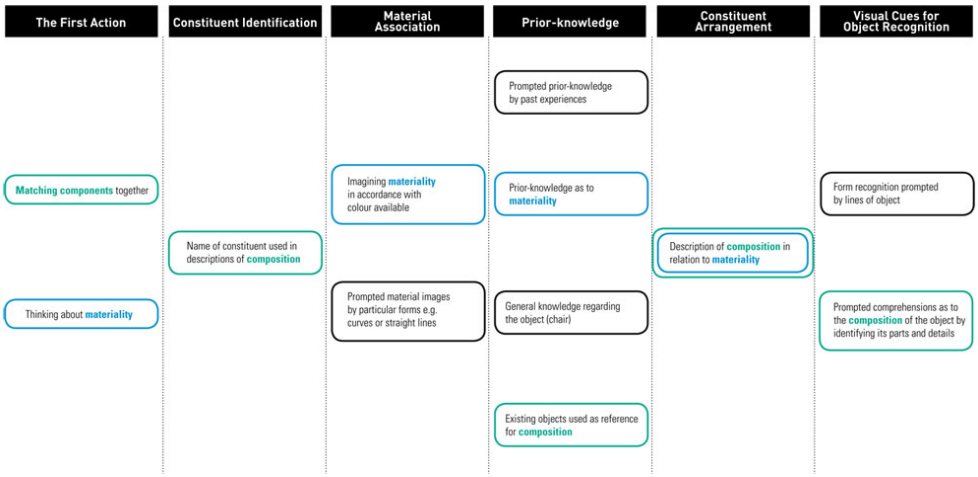


Table 1 – Open coding categories and axial coding subcategories.

5.2 Influence of Prior-knowledge

Another fact we found during the coding process was that prior-knowledge impacts a variety of other open coding categories. As you can see in figure 9, many of the utterances collected in the open coding categories were actually overlapped with the ones in the prior-knowledge category of the open coding. In fact, many participants developed their imagination activating different types of prior-knowledge such as association between particular colours and materials, past designing experiences, general knowledge regarding a structure of object, or understanding of the meaning of a specific component. In this sense, the 2 findings of both 'materiality' and 'composition' are also supported by this prior-knowledge. Thus, prior-knowledge can also be considered as an important factor when the participants developed their imagination based on reductive images.

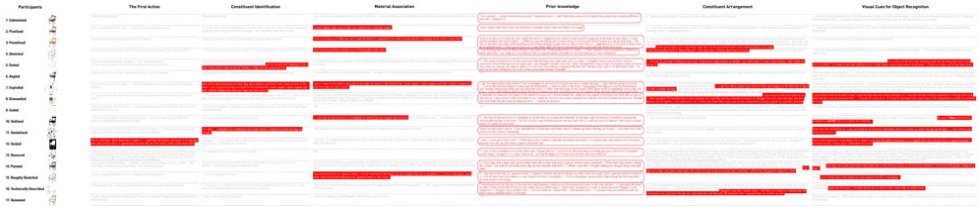


Figure 9 – Highlighted quotes overlapped with the ones in the category of 'Prior-knowledge'.

6 CONCLUSION

The principal interest of this study is to explore how the design students develop their imagination of an object when they see varied types of reductive images. As for the developmental approaches the design students took to imagine an object being inspired by reductive images, we propose a structure of information set (FIGURE 10). The design students manipulated 'material' and 'compositional'

information supported by prior-knowledge available in a visual image of which information is reduced for the process of image development. The authors learned that the participants were capable of identifying an object from the incomplete visual information of an object whose quality is reduced. On the other hand, the authors also acknowledge that providing an opportunity to stimulate the participants' imagination by simply reducing the visual elements of an object is not easy. However, it might be possible to effectively prompt a designer's imagination by reducing both the 'materiality' and 'compositional' information as a key element for the participants' imagination. A strategic approach wherein the reductive elements and levels of an object are manipulated is essential.

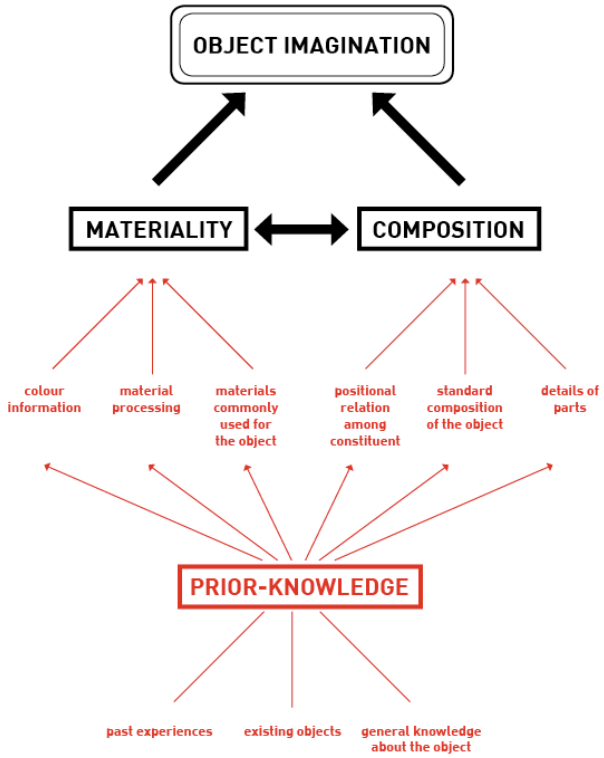


Figure 10 – Structured information set that illustrates the elements the participants mainly used for their imagination process.

The reductive approach this paper proposes is not aiming to develop an alternative to existing design methodologies. However, if the impact of a reductive approach on designer's imagination is better understood, it can potentially be deployed within design processes as a useful tool. The authors continue to examine the effectiveness of reduction in the field of product design through a number of empirical experiments. A further study of design reductionism will contribute to building a body of knowledge for stimulating designer's imagination.

REFERENCE

ATHAVANKAR, U. (1989). Categorization... Natural Language and Design. *Design Issues*. 5 (2). pp100-111.

BIEDERMAN, I. (1987). Recognition-by-components: A theory of human image understanding. *Psychological Review*. 94 (2). pp115-147.

CROSS, N. (2011). *Design Thinking: Understanding How Designers Think and Work*. Berg Publishers, Oxford.

Gaver, W., Beaver, J., & Benford, S. (2003). Ambiguity as a resource for design. *ACM CHI*. pp233-240.

GLASSER, B. G. & STRAUSS, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Aldine Publishing, Chicago.

GOEL, V. (1995). *Sketches of Thought*. MIT Press, Cambridge.

GOLDSCHMIDT, G. (1994). On visual design thinking: the vis kids of architecture. *Design studies*. 15 (2). pp158-174.

GUIXE, M. (2002). *do scratch* [Online] Available from: http://www.guixe.com/products/DROOG_do_scratch/do_scratch.html [Accessed 5 June 2014]

GUIXE, M. (2010). *24h sentence maker wall clock* [Online] Available from: http://www.guixe.com/products/ALESSI/Wall_Clocks.html [Accessed 5 June 2014]

HARA, K. (2003). *MUJI corporate advertising* [Online] Available from: http://www.ndc.co.jp/hara/works/2014/08/muji-a.html [Accessed 5 July 2014]

HARA, K. (2007). *Designing Design.* Lars Muller, Baden.

LAWSON, B. (2010). *How Designers Think: The Design Process Demystified*. 4th edn. Architectural Press, Oxford.

ROBSON, C. (2002). *Real World Research: A Resource for Social Scientists and Practitioner-researchers*. 2nd edn. Blackwell, Oxford.

STRAUSS, A. L., CORBIN, J.M. (1990). *Basics of qualitative research: grounded theory procedures and techniques*. SAGE Publications, California.

SUWA, M. & TVERSKY, B. (2002). *External Representations Contribute to the Dynamic Construction of Ideas: proceedings of the Diagrammatic Representation and Inference-Second International Conference, Diagrams 2002*,. ed. HEGARTY, M., MEYER, B. & NARAYANAN, N.H. April 2002. Callaway Gardens: Springer. pp341-343.

WARE, C. (2008). *Visual Thinking For Design.* Morgan Kaufmann Publishers, Burlington.

ZUMTHOR, P. (1998). *Thinking Architecture*. Lars Müller Publishers, Baden.