Erroneous Features in Freehand Sketching: Opportunities to Generate Visual Analogies

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ABSTRACT

The value of visual analogies in problem solving has been extensively researched, with most of the work focusing on their benefits [1, 2, 3]. This study explores the much less investigated research question of how visual analogies as cues for insight problem-solving are generated using freehand sketching. More specifically, we focused on the creative process of the first author who is a professional artist, to generate two sets of visual analogies to support solving the classic *8-coin* insight problem. First, a set of sketches was generated for analogies capturing the problem insights through static images, while the second set captured the problem insights through a dynamic, time-based media format. We employed an experiential research method consisting of the artist's reflections on his freehand sketching practice in his creative process. Inaccuracy of freehand sketches presents opportunities to generate new concepts for analogy. This study contributes to a deeper understanding of how visual cues can be generated, and what principles and tools, in particular freehand sketching, and what methods of practice can be used in research.

Keywords: Sketching, Creative Process, Generating Ideas, Visual Analogy, Reflection-On-Action Research.

1 INTRODUCTION

Sketching techniques facilitate reflection and provide a rich medium for discovery and communication of design ideas [4], in particular, in the early ideation and exploration stages [5]. These techniques are rich and diverse being used more as tools for exploring, thinking and discovery [6, 7] rather than for their aesthetic qualities. Leonardo da Vinci and the modern painter Carlo Carra used lines, shadows, arrows, dots, maps, and handwriting, all crowded on the same page in their sketchbooks [8]. Ideational sketching, both as process and artefact, offers a fluid space where thinking is presented in the immediacy of the thinking-act [9, 10]. Sketching content varies from simple to more elaborate drawings and develops over time as the project unfolds [8]. Sketching in both arts and design can be framed as a way of externalising thinking [11] through media (dry and wet), materials (pen/ink, charcoal, graphite pencil, pastel, chalk, marker) and techniques (scribbling, hatching, stippling). This paper focuses on sketching and its role in the creative process of ideation and the generation stages for visual analogies to support insight problem-solving.

2 GENERATING VISUAL ANALOGIES

Much previous work has shown that analogies are often employed by artists, architects and designers, particularly in the initial stages of planning, generating and visualising ideas [10, 12, 8, 11] for a concept.

Garner [13] suggested that freehand sketching in the design process may be a powerful catalyst in the generation process as the "inherent-imperfect" lines and shapes of sketches create *ambiguity* in visual representations, thus continuously stimulating reinterpretation. Suwa and Tversky [14] pointed out the value of developing computer-based design tools involving sketching capability to "enrich designers' perception", while Purcell and Gero [15] considered sketching an "essential part of the process of thinking about a design problem and developing a design solution".

Clement [16] identified three methods of generating analogies: via a principle (abstract – often mathematical or verbal), via a transformation (changes) and via an association (a familiar situation to the unresolved problem). The first and the least used was the generation of analogy via a principle. Representations or relations based on a principle might sound like an analogy: "the cat's tail is like the steering wheel to the car" – suggesting the principle of navigation control. This method can be applied to generate analogies both within and across domains, i.e, near and far analogy. The second method of generating analogies is via transformation, when objects, situations or contexts are modified to obtain new objects, situations or contexts that still resemble the old ones while supporting new interpretations. Analogies generated via this method are often used within a field or domain. According to psychologists' views on the developmental curve [17], reasoning based on similarity in early childhood follows rule-based reasoning in adulthood; therefore, similarity relates to the figurative quality and is largely visual [18].

Although research in constructing visual analogy is limited, some studies suggest that contextual cueing [19] plays an important role in visual tasks and "is driven by incidentally learned associations between spatial configurations and target locations".

3 THE *8-COIN PROBLEM*

We generated the two sets of visual analogy (VA) concepts with the aim of developing and using visual analogies as an aide in the *8-coin* problem-solving process; the *8-coin problem* is notoriously difficult to solve. The success rate in solving the *8-coin problem* without external cues is between 4% and 8%, while providing participants with visual cues during the problem-solving (PS) process increases this rate to 42% [20, 19].

The *8-coin problem* requires the arrangement of an array of eight coins by moving only two of them to create a final array in which each coin touches exactly three others [20]. Like other similar visual insight problems [21, 22], its primary insights require a perceptual shift in terms of moving the elements of the problem in three rather than two dimensions [20].

Figure 1 Initial configuration for the 8-coin problem

The generation of the two sets of VAs was a lengthy process, involving several sketches of cues concepts and compositions that we thought would resemble the source (problem) and the target (solution).
The first set of generated concepts was intended for use in an experiment to test the effects of VAs capturing the problem insights in a static format (e.g., diagram, image) on participants in the PS process for the *8-coin problem*, and the second set of concepts for an experiment that was intended to test the effects of VAs when capturing the problem insights through a multimedia format (e.g., animation, video).

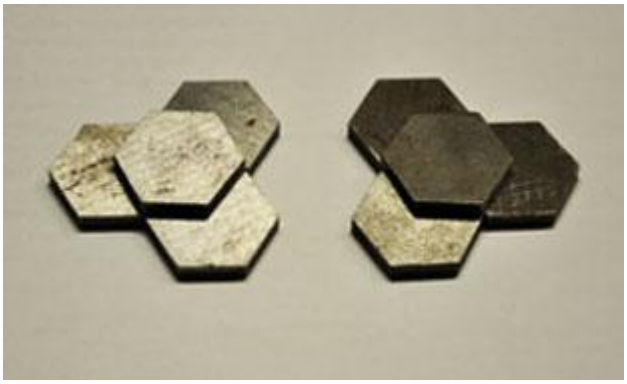

Figure 2 The configuration for the 8-coin problem solution

Both VA sets were intended to capture the problem's visual insights in appropriate formats to facilitate the incubation effect in the solving process of the *8-coin problem* leading to its correct solution (see Figure 2).

4 REFLECTION-ON-ACTION RESEARCH

Donald Schön's [23] influential work has inspired new approaches for exploring creative thinking and creative outcomes. The idea that a visual product gains richer meaning once is reflected upon is central to Schön's reflection-on-action approach. This suggests considering not only the outcome, but also the experience of the creator in the design process. The unexpected events during a creative process initiate two kinds of reflective practices: one that occurs immediately and one that occurs later. Reflection-in-action is the ability to develop artefacts or artistic events by applying professional competencies and reasoning to unfamiliar surprises at the same time, when they occur. In contrast, reflection-on-action is the process of thinking back to what happened during the creative act [24, 25]. The context of an occurred action and its relationship to the created artefact is equally important for a deeper understanding of the creative process and the tools used in such an act. The reflection-on-action method adds up to the research not only reflecting of the finished product but also the process that leads to its result.

5 METHOD

In this study, we employed a reflection-on-action method with the aim of observing sketching practices in the creative process of generating visual analogies to support insight problem-solving.
In order to capture this process, we employed a structured approach based on a self-observation template shown in Table 1. This template is based on Wallas' [26] model of the creative process and Schön's [23] guidance to a situation to reflect upon to capture the stages involved in the generation of each concept and its sketch. Schön defines reflection-on-action as reflecting on how practice can be developed, changed or improved after the event has occurred. The reason for employing the reflection-on-action approach rather than reflection-in-action [23] was to avoid the observed memory bias, and overshadowing effect [27] stating that when talking aloud, the perceptual information can interfere with the retrieval of that information from memory [28].
Traditional video recording footage used in studying the creative process has its benefits in exploring human behaviour; however, it is limited to only what is observable. The unspoken feelings and thoughts of a subject can only be guessed at or inferred [29], hence the need to employ a more introspective method. Some limitations of the chosen reflection-on-action approach include forgetting some thoughts and details about performed actions, or sources for analogy generation. In order to mitigate this, notes were taken right after each sketch was produced.

Understanding the challenge	1.	Understanding the task
	2.	Brief description of the goals
	3.	Promising opportunities to pursue
	4.	How am I going to do it?
Generating ideas	5.	How can the problem be stated differently?
	6.	What can be changed to achieve the set goals?
	7.	Explore the alternative possible solutions
	8.	Consider the possible solutions in a different context
Analyse, evaluate and refine promising solution	9.	Examine the most promising ideas
	10.	Analyse the possible best solutions for the task
	11.	Choose the best solution from the explored and state why it was chosen
	12.	Is there something to change in the chosen version?
Plan for support; appraising the task	13.	Analyse and examine the possible outcome of the created product
	14.	How can the chosen idea be strengthened?
	15.	Examine the actions and forms of implementing the idea
	16	Are you satisfied with the sketched idea?

Table 1 Reflection-on-action questionnaire

The strengths of such an experiential method of inquiry are in the data obtained from first-hand experience.
For data analysis, we used Hyper RESEARCH [30] software for coding and qualitative analysis.
Theoretical sampling was used to categorise the artist's reflective notes. Theoretical sampling is a technique that suits the need to obtain data to help the research in explaining its categories [31]. It enables the researcher to narrow down the emerging categories from the gathered data sets, and in particular, in analysing these two main sets of generated sketches for two experiments using static and dynamic analogies. By filling out the properties of a category, the researcher can create analytic definitions and rules for that category, describe and explain it, and specify the links and relationships between other categories and subcategories.
Several psychological [32, 33, 34], neurophysiological [35] and developmental [36] data on analogy-making [37] through a practice-based approach and reflection on practitioners' actions [23] support this research method.

5.1 Procedure

Twenty-two reflective notes were taken by the researcher during the developmental phase for analogies that were designed as cues for two experiments for a larger project to investigate the support of insight into the *8-coin problem*. The researcher used the reflection questionnaire (Table 1) to answer each question, for each sketched concept right after it was generated. The notes were gathered during the generation period for visual analogy development for the two experiments: the first using static and the second using dynamic analogies as aides in the solving process for the insight *8-coin problem*. In this article, we will refer to the generated set of VAs for Experiment 1 as the static set and for Experiment 2 as the dynamic set.
The gathered qualitative data from the notes was codified, categorised, and subcategorised for further qualitative analysis.

5.2 Coding Scheme

The primary data consisted of 22 reflection notes (10 for static and 12 for the dynamic set) and were completed with an overall number of 16 quotes (answers to each question from the template - Table 1) related to cues. During the coding process, we identified 34 emerging concepts (see Figure 3) that led to the development of categories grounded in the text and based on grounded theory approaches [38]. We employed the Glaser & Strauss approach, whereby the researcher does not have to force preconceived categories on the data, but allows the categories to emerge from the data [39] through a constant comparison of codes, subcategories, categories, and their properties. The following sentence is an example (an answer to question 15 from Table 1 on sketches - Appendix 1**)**:

> "So, let me have a go: in the first frame will be shown (or not shown) a person with several buckets (probably 8 in total), aligned in 3 rows and seen from a frontal view; then the individual enters the scene and picks up a bucket from the centre and stacks it on the other 3 ones on the side".

This sentence was encoded into four codes. The first part of the sentence "So, let me have a go: in the first frame will be shown (or not shown) a person with several buckets" was encoded "Media" as the subject is pointing out the entrance frame for the animated cue. The second code was assigned to the part of the sentence where the artist mentioned the quantity of objects or order – "(probably 8 in total)" and "in 3 rows" and this was encoded "Number". The following segment: "aligned and seen from a frontal view" was coded as "Perspective", and the rest of the sentence "then the individual enters the scene and picks up a bucket from the centre and stacks it on other three ones on the side" was described as a "Transformational" indicator.

Codes including "Adding new things", "Break in", "Discarding things" and "Transform" trigger changes or transformations to be made in the sketch. "Character", "Composition", " Emphasis and focus" codes are describing aesthetic design principles, " Form", "Shape", "Line", "Perspective", "Media", "Number" and "Other sources" are related to the design elements and design tool groups. The ideation category included segments of the text describing thoughts, feelings and sources of inspiration in the generative process of VA and was coded as "Imagination", "Impression giving", "Thinking and inspiration", "Logic" and "Inspiration from real life". The last set of codes is composed of instances of evaluating and supporting cue development: "Promising ideas", "Satisfied", "Usable", "No good idea", "Too much" and "Unexpectedness" segments.

5.3 Categorisation

Categories and subcategories emerged from a constant comparison of data and codes.

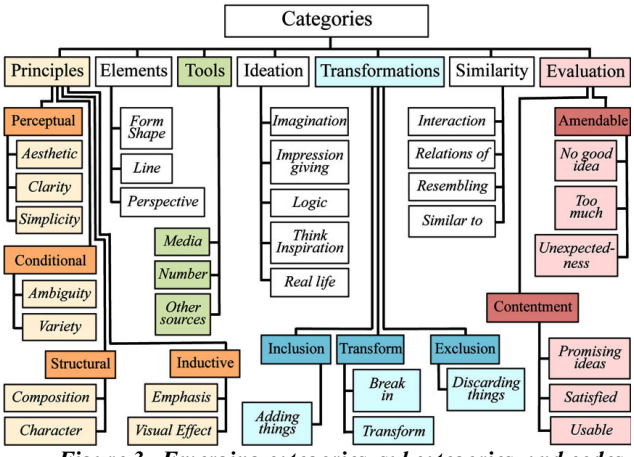

Figure 3 Emerging categories, subcategories, and codes

To gain a better understanding of how categories (1st level) and subcategories (2nd level) emerged, we assigned each code (3rd level) to a central category taking into account the structural aspect of objects and their properties mentioned by the artist, the relationship between them, instances, tools, inspiration sources and the evaluation of the sketch (see Figure 3).

The category "Principles" of the design was divided into the following subcategories:

1. "Perceptual" – including "Aesthetic" quality, "Clarity" and "Simplicity" codes describing the qualitative properties of perceived objects;
2. "Conditional" – such as "Ambiguity" (misleading insights in the sketch) and "Variety" (diversity of ideas in the concept) codes;
3. "Structural" – including "Composition" (harmony), and "Character" (object's quality) codes;
4. "Inductive" purpose – containing the "Emphasis" and "Visual Effect" codes.

The category of "Elements" of visual design included subcategories:

1. "Form and Shape" emerging from descriptions of surface(s) properties;
2. "Line" emerging from descriptions of lines characteristics (straight, curved, implying direction, etc.);
3. "Perspective" describing spatial structures of objects and their relationships.

The category of "Tools" consists of the instruments and mechanisms of communication to carry the *8-coin problem* insights and was divided into the following subcategories:

1. "Media" – codifying the text that describe discrete or continuous format of the future visual analogy in the sketch;
2. "Number" – describing the number of objects to be presented in the sketch; and
3. "Other sources" – describing other tools used in generating visual analogy (see example of a sketch for experiment using dynamic VAs - Appendix 3).

The category of "Ideation" includes a set of codes that divided it into subcategories:

1. "Imagination" – describing mental images, imagined things or situations;
2. "Impression giving" – describing the perceptual qualities of structures in the sketched concept;
3. "Logic" – containing text of analyses of objects and relations between them;
4. "Think and inspiration" – brainstorming for new analogy concepts;
5. "Real life" – descriptions of sources of inspiration (real life situations, art, etc.).

For example, the researcher writes in one of his notes: "Just sharpened my pencil to get ready, and there is a loaf of bread that's left from my breakfast", which points to the source of inspiration, and in this case, the segment was assigned to the inspiration from "Real life" subcategory and placed in the "Ideation" category. In the sentence, "The bread could be of a perfect cylindrical form and sliced into eight equal parts to match exactly the number and the forms of the units in the problem", the researcher uses his imagination and thoughts on how to connect that real-life situation (as inspiration) to come up with an analogy for a new cue (see Appendix 3) for the *8-coin problem*. In this note, he talks about forms, associations, number of units and structural components in common with the target problem, and fractured data were assigned to appropriate codes, subcategories, and categorised, respectively.

The category of "Transformations" emerged from the segments of text that describe changes to be made in sketches and was divided into three subcategories of instances:

1. "Inclusion" – describing adding things to the sketch ("Adding things" code);

2. "Transform" – describing changes such as break in or divide ("Break in" code) and transforming the imaginary object or visual sketch ("Transform" code);
3. "Exclusion" – discarding or abandoning things ("Discarding things" code).

The category "Similarity" is composed of four subcategories codified as:

1. "Interaction" – describing the interactivity of objects and their relationships;
2. "Relations of" – describing the connectivity of objects and relationships between objects;
3. "Resembling" – describing associations with other objects; and
4. "Similar to" – describing correspondences between objects, attributes, and their properties.

The last category, product "Evaluation", is divided into two subcategories:

1. "Contentment", which combines codes such as "Promising ideas", "Satisfied", and "Usable" as positive values; and
2. "Amendable", which includes "No good idea", "Too much" and "Unexpectedness" codes as a negative appraisal of the sketched analogy.

6 FINDINGS

Emerging categories are based on image making and theoretical frameworks for visual analogy. The four subcategories indicating the use of principles of design [40] in the analogy-making process [16] describe the perceptual, conditional, structural and inductive spatial arrangement aspect of objects in a scene [10]. Analysing the frequencies of the artist's statements between categories for the two sets of analogies, we noticed a significant increase in the dynamic set of the principles of design category (Figure 4). "Conditional" and "Inductive" subcategories (Figure 5) for this category show significant differences between static and dynamic sets. The "Conditional" subcategory consists of two codes: "Ambiguity" and "Variety" (Figure 6), which will be discussed later in more detail. Another two codes: "Emphasis" and "Visual Effect" from the "Inductive" subcategory of the "Principles" category will be detailed here, as well.

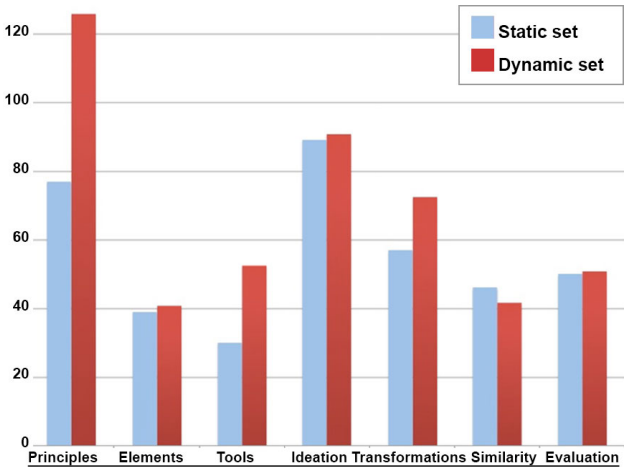

Figure 4…Between overall categories: static and dynamic

The statements about "Elements" of design in the researcher's reflective notes are aligned with the theoretical framework of elements identity [9] to represent forms and space [41]. In this category, no differences were observed between the static and dynamic sets of VA.

The "Tools" category also involves the intended media (static or dynamic) to fit the requirements [42] for the type of analogy and how the insight will be presented in the image [7]. Slight differences in statements between the two sets from this category were observed. The differences appear to be as a result of adding the dynamic feature to the visual analogy intended to be used in the experiment with the dynamic analogy.

The "Similarity" category included segments of statements related to similarities, resemblances, relationships [43] and interaction between objects in context [19] and was based on Gentner's [44] structure mapping theory. There are no differences in this category between the statements of static and dynamic sets. The "Ideation" category includes segments of statements about mental images, inspiration, impressions, and logic that help the artist to come up with the concepts for analogy and are based on Clement's [16] methods to generate analogy and sources of inspiration for analogy [45, 46, 47]. The statements from this category were balanced in both sets of analogy.

The "Evaluation" category consists of two subcategories: "Amendable", where statements are negative, and "Contentment", where the artist is satisfied with the outcome of the sketched analogy. Overall, there are no differences between the two sets in this category. However, we noticed an opposite effect when comparing their subcategories: the "Amendable" and "Contentment" subcategories counteract each other. The more amendable the statements that are addressed during the process of development for an analogy concept, the less contentment is expressed and vice versa.

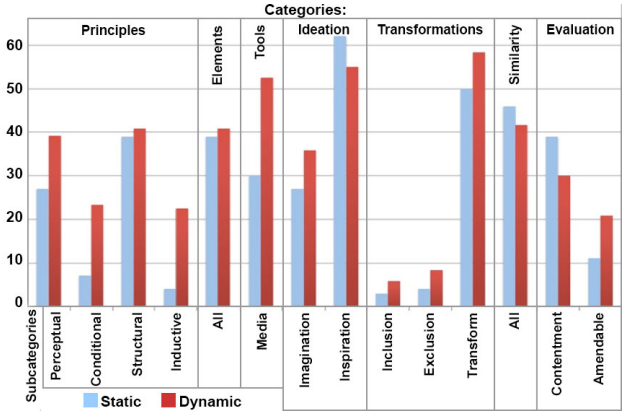

Figure 5 Between subcategories of static and dynamic sets

A careful examination and comparison between each code statement in both categorical and in-between sets of analogies revealed that the increase in the use of these means in the artist's reflective notes is due to the specific goals and tasks that each set of analogies required. In the first set, the term "Media" was used to clarify, appraise or evaluate a sketch (e.g., "…it will look good in 2D format"), while in the dynamic set of analogies, the term "Media" becomes dominant as the researcher takes into account the inclusion of time-based media and image schemata constraints needed for the dynamic capture of problem insights. The code "Number" from this category is equally used in both sets of sketches (e.g., "the second drawing to show them into two groups"), and the "Other sources" codes show the same ratio, as well. In the "Transformations" category, the increased need to use the terms for incorporated codes is due to the additional tasks requiring capture of the insights "in time" and using "gesture schema" required by dynamic analogy. Statements on "Adding things" and "Discarding things" in sketches that were coded and integrated into the same category are used significantly more in discussion for the same reason – for adapting a generated idea to the specifics of the experimental conditions of dynamic analogy. The second, a salient state with an inductive purpose subcategory of design principles, consists of two codes: "Visual Effect" and "Emphasis". It is worth investigating the combinatorial aspects of the relationships between these two codes in more detail. Here, during the analogy construction for the static set, both are mentioned twice, "Emphasis", in understanding the challenge and in the idea generation stages, and "Visual Effect", only in the evaluation stage. The notes on sketches for the dynamic set

almost hold a perfect balance between the two state instances. During the process, the "Visual Effect" statements decrease at a constant rate, while the "Emphasis" statements increase at the same rate from understanding the challenge to idea generation to evaluation and the support stages (Figure 7).

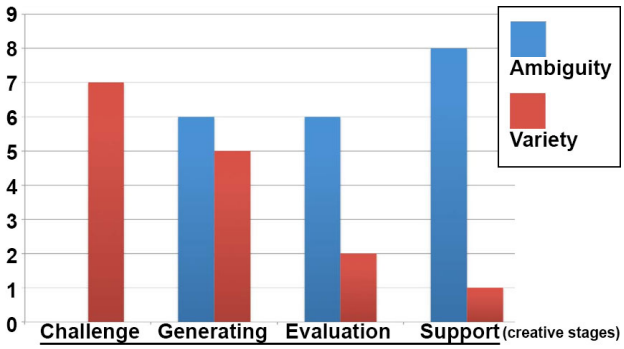

Figure 6…Overall Ambiguity/Variety statements

It is also worth further investigating the statements made for two subcategories of the "Evaluation" category in the generated analogy. The "Contentment" subcategory and "Amendable" subcategory rate is reversed in each set of analogies. The reflective notes for both sets were observed by the stages for their creative processes. Understanding the challenge stage is when the artist describes the goals, imagines potential scenes and looks for opportunities to scribble new ideas on paper. At this stage, the artist is more concerned with imagining and thinking about new ideas or situations along the principles of design and possible transformations to the mental image. As ideas are sought for implementation, a circular generating sketching stage begins and statements on principles of design and design transformations are more frequently mentioned. These increase at the same rate in both sets to their highest level in the evaluation stage and fall to their lowest rate in the plan for support, and the stage for appraising the tasks. It appears that statements on design tools and design element categories are constantly at the same rate, with a non-significant variation mentioned in the artist's notes during the entire creative cycle. The Similarity category, which includes "Interactions", "Relations of", "Resembling" and "Similar to" subcategory codes, is referenced at an increased ratio from the initial to the last stage of the sketching process.

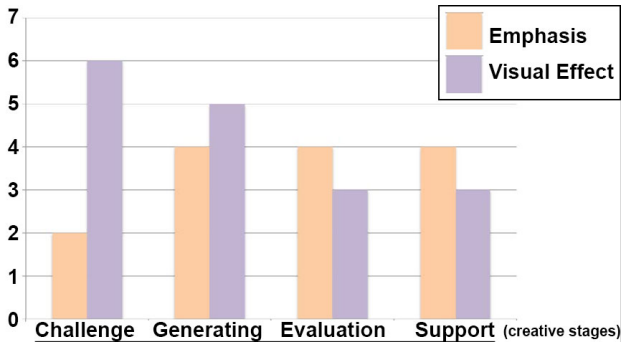

Figure 7 Overall Emphasis/Visual Effect statements

The notions of "Compositionality" and "Composition" appear in many reflective notes in the brief descriptions of the goals. "Simplicity", "Emphasis", "Focus of Attention", "Spatial Organisation", "Content", "Visual Effect" and "Meaning" are mentioned consistently in the artist's notes for all sketches. For example, in the "billiards game" note, the artist writes:

> "Primitive forms like spheres, which can be mobile and appear in focus would be an idea for now. A kind of game like ping-pong, or billiards? Yes, definitely, a billiards game could work if given a meaning to it…there are enough balls and space on that table to think of a scenario."

The artist seeks inspiration for his sketches from different sources such as books, previous personal work, the work of other artists, and frequently, from nature. Doodling or sketching by playing with lines and shapes of objects, combining and transforming them helps him generate new ideas and, through modifications, create other new ones. Taking breaks and going out to watch movies refreshes his thoughts and "eliminates the details and sorts out the order of complex things in his head".

Thinking of scenes from real-life situations or structures, mediating and restating ideas, or the accidental discovery of scenes that are reminiscent of the problem at hand help him to adapt a concept to his tasks, and very often lead to him "working even backwards" (as the artist says in one of his notes). This is because a strategic plan is essential when thinking about many things and answering all kinds of questions related to a problem such as considering it from a different point of view and reassessing its meaning, breaking the whole into parts and bringing it back as a whole in a new configuration.

7 DISCUSSION

The artist's objectives for each concept varies depending on the type of analogy generated. He states that the information about the problem involves patterns, lines, shapes, forms, mental manipulations and transformations of imagined objects that can be selected, combined and refined in a continually dynamic way. As an analogy maker, he points out differences between the information he is attempting to convey while making analogies for the *8-coin problem* in a physical space by using physical objects and information about the created artefacts, which will be presented, on a fixed two-dimensional surface, either on a computer screen or a sheet of paper.

One of the major concerns in the challenges is the additional requirement for constructing an analogy specifically for each intended feature experiment, such as adding sequential and simultaneous delivery of insights, form and order of presentation and kinds of relations between problem insights.

So, the generation of cues is a constrained process of creativity. Once a mental image has been formed and the first line has been drawn on paper, sketching becomes structured thinking; this links back to sketching as a form of organising thinking [9, 11]. Transformations to the content are applied continuously and one idea leads to a different one [8]. These usually take place while thinking about the set problem and reaching its goals [48, 2].

Ambiguity in the freehand sketched concept is very important as it is not mentioned in analogy theory, and this is specific to cues. WordTree Design-by-Analogy Method [49] suggests using rich sources of adaptive mechanisms such as life form collections to overcome the fixation.

We speculate that designers are sensitive to visual inconsistencies; they create *ambiguities*, and these can conceive new opportunities for more ideas in the generative stage of the creative process. The role of freehand sketching in the creative process proved to be beneficial not only in collaborative practices [50], but also in individual practices serving as a method of "looking beyond" and reflecting on the visual qualities [23] of the artefact. In the *design principles* category, from the graph (Figure 5), we observed some differences between the statements of two sets in two subcategories: *conditional* and *inductive*. The *conditional* group combines two codes: "Ambiguity" – a condition of misleading, and "Variety" – a condition of unified diversity used in works of art. "Variety" is discussed more often in the dynamic set, but the frequency decreases towards the evaluation stage as opposed to "Ambiguity", which sees an increase in the supporting stage (Figure 6).

To generate new ideas, one needs ambiguity in sketches, as this ensures that sources of design symbols are unlimited. During visual analogy development processes, the artist had to take into consideration the similarities and differences of the goals between these analogy sets in order to fulfil the specifics for each

experiment. Four main categories: “Elements”, “Similarity”, “Ideation” and “Evaluation” are discussed in reflective notes at the same rate in both studies. A slight increase in using such terms as media is observed in the “Tools” category in the artist’s notes for a dynamic set of sketches.

8 CONCLUSIONS

Design theorists and practitioners have similar methods of analysis such as recording videos, documenting memos, using think-aloud strategies for protocols that provide access to a secret world of non-formal explanation of images as perceptions and actions, in opposition to scientists who use only the formal logic of mathematics. Reflecting on practices for generating ideas from the notes highlights the differences between a creative philosophy and traditional cognitive processes. An important aspect of sketching is that while trying to depict a mental image on a piece of paper, the inaccuracy of transfer or “ambiguity” in the created artefact generates new ideas and thoughts, inviting the practitioner to engage in the integration of cognitive and practical operations. Cheng & Lane-Cumming [51] investigated the drawing process using a digital pen that records graphic marks stroke-by-stroke. They focused more on the use of technology in service to design education and the gap between traditional and digital art issues, rather than on a deeper analytical examination of the cognitive processes associated with inaccuracies when dealing with such graphic marks.

Although the sketches that were reviewed for both experimental studies suggest that most of the analogies were generated by associations or similarities via structures, principles, actions or relationships between objects and inspired from real life situations, inaccuracy of sketches did play a role in the idea generation process for new analogies.

Discovery of an “inaccurate” line in a sketch leads the creator to make associations with other objects and create a new version of a visual analogy. Based on the results of a single study, and the recognition that the hypothesis records a preliminary solution, we propose to add an “ambiguity” mechanism to the existing models for the idea generation process, as it would enhance the quality and usability of analogies for problem solutions. Dealing with ambiguity, a subjective set of measures, leads to different behaviour while still sharing the main features, and this might give people a better understanding of the problem they face and help to generate new ideas to find solutions to the problem. It would also be worthwhile to investigate the effect of self-satisfaction and contentment/amendable procedures during a creative process on the quality and usability of the produced artefact as observations in this study suggest that the more balanced the contentment and amendable concerns are in a creative act, the more likely it is that the product will be of better quality and usability. It may be appealing to further investigate these observations, and particularly, the types of concerns related to the concept and such an investigation may offer surprising results.

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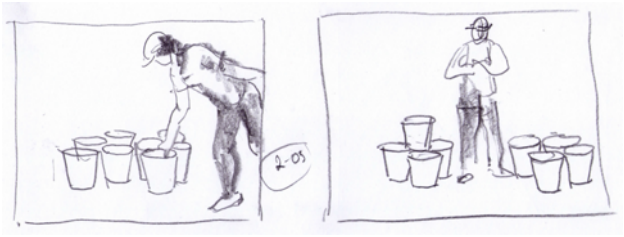
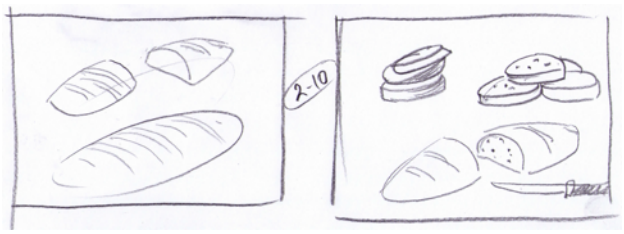
10 APPENDICES



Appendix 1 Stacking buckets

Appendix 2 Photography session (V 1)



Appendix 3 Bread loaves