ASSOCIATIVE THINKING AS A DESIGN STRATEGY AND ITS RELATION TO CREATIVITY

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ABSTRACT

Associative thinking can help designers to reflect over a problem situation by focusing on unrelated perspectives. During this process, a mapping of high order relations can be established between a source and a target situation. Associative thinking has much to contribute to design in general, and to design creativity in particular. This research centered on a particular form of associative thinking concerned with metaphorical reasoning. The aim was to analyze empirically the relation between associative thinking and creativity. A particular form of associative thinking based on the use of metaphors in the design studio was considered, and its relationship to the four standard creativity factors proposed by Gilford was explored. Results indicated that originality and elaboration were the most dominant factors characterizing metaphorical thinking during the design process. In contrast, fluency and flexibility were the weakest factors, poorly correlated with most variables of metaphorical thinking. Findings from this study have implications not only for design in general, but also for design education.

Keywords: Associative thinking, metaphors, creativity, flexibility, fluency, elaboration, originality.

1   INTRODUCTION

Associative thinking enables people/designers to reflect on a situation from a new perspective, by considering information that is not directly related to that situation. During this process, a mapping of associations can be established between the target situation, and representations stored in our memory [1]. The ability to identify, retrieve, and transfer relevant information stored in our minds is critical to the process of associative thinking. Reasoning by means of prototypes, precedents, diagrams, visual displays, analogies and metaphors are among the common strategies on which associative thinking is based. In this study, however, we focus on metaphors as a cognitive tool supportive of associative thinking.

Metaphors make it possible to reflect on a concept by considering other concepts that are either weakly linked to it or not linked at all [2][3]. In problem solving, metaphorical reasoning is shown to be very effective in the production of innovative and unconventional ideas [4]. Associative thinking by means of metaphors is widely applied in a variety of problem solving domains that demands creativity, including design [5]. This powerful cognitive mechanism aids in structuring design thinking and reflecting over design problems anew [6]. Design problems are ill-structured, non-routine, exceptionally complex, and singular (for example [7] [8]). As such, they cannot be solved by applying known operators or algorithms. Metaphors can assist in converting ill-structured problems into manageable ones.

The implementation of metaphors in educational contexts such as the design studio can help students in the acquisition of design skills, and fostering independent judgment to achieve individual goals. The reflective power of metaphors also serves to challenge design studios that induce design learning based on hidden curriculum [9]. These tools are viewed as heuristics that aid structuring design thinking. But not less important is that metaphors also support design creativity [10] [11].One of the reasons is that design embraces the search of a large number of alternatives, the most innovative of which extend besides known or familiar solutions. Moreover, metaphorical thinking assists in looking for candidate solutions from innovative viewpoints. The fuzzy character of metaphors contributes to capture the fundamental nature of a design problem under different and new interpretations. Shifting from one reflective view to another affects how a design situation can be perceived and structured [12]. The broad range of concepts that can be identified from different between-domain metaphors can lead designers to a large number of interpretations of the design situation, with a positive effect in the

production of creative solutions

Many allegorical examples of the use of metaphors in design can be found in literature [9] [12] [13], but only few of them are empirical investigations [4][6][14]. It is therefore maintained that more research should be done in order to gain further insight into the role played by this cognitive took in design problem-solving in general, and design creativity, and design education in particular.

The current study examines the use of associative thinking in design problem solving by means of metaphors. In particular, it analyzes the relationship between metaphors and design creativity in the design studio. A brief introduction about metaphors as a tool for associative thinking in design, and architectural design in particular, is presented. The role of creativity in design problem solving is discussed, followed by an empirical study. Finally, results are reported and major conclusions about metaphors, and creativity in design are presented.

2   ASSOCIATIVE THINKING AND CREATIVE ARCHITECTURAL DESIGN: THE USE OF METAPHORS

In the 'front edge' design where fuzzy ideas need to be elucidated, associative thinking can endow the designer with a starting point in the creative design process. Metaphors as a strategy by means of which is possible to apply associative thinking might efficiently contribute to this aim. The intrinsic power of this cognitive mechanism is mainly related to its ambiguity, considered an essential component at this stage of the process [6][11].

Metaphors are particular useful in architectural design problem solving [4][6][15]. They allow establishing associations with domains that generally are not connected to the design problem [16]. Metaphorical reasoning makes possible exploring innovative ideas, restructuring design problems, and reflecting on the new outcome. It also allows designers to deal with goals and constraints imposed by conventional design in an unconventional manner [10][15].

Investigations carried out on analogy offers a number of tested processes that can be helpful to understand the processing of metaphors in problem solving. Bearing in mind that basic processes of analogical reasoning like structural alignment between source and target, abstraction, and re-representation are used in the processing of metaphor, then metaphors can be seen as a kind of analogy. In her structure-mapping theory, Gentner [17] offers a useful framework where metaphors and analogies can be understood within a single mechanism. In this regard, the structure-mapping theory approaches analogical and metaphorical mapping as an identical process of establishing structural correspondences between two different situations, and then projecting inferences through a mapping of relationships. In this way, metaphors can be processed as structural alignments, based on initial relational commonalties. While alignments are projected from the base, new knowledge is created in the target. Metaphors, however, can be more variable than analogies, since in addition to matching structural relations, they can also be used to establish non-structural correspondences based on common object attributes [18]. Nevertheless, Clement and Gentner [19] showed that this is quite often infrequent.

The use of analogies in creative design was found to play an important role in creative design [16] [20]. However, in the architectural domain the use of metaphors were more influential than the use of analogies. Metaphors influenced and directed the actions of a variety of design movements [5]. The large number of examples in the architectural design literature reporting the use of metaphors testifies this claim. For example, in the 60's, the dictum 'less is a bore' was proposed by the famous architect Robert Venturi as a substitute for the dictum 'less is more' suggested by Mies van der Rohe to reflect on the engineering idea of reducing a space to its fundamental nature. In his pioneering book "Complexity and Contradiction" Venturi [21] argued that architecture should 'promote richness and ambiguity over unity and clarity, contradiction and redundancy over harmony and simplicity'. A case in consideration is the Vanna Venturi House, an emblem of the Post- Modernist Movement, was based on associations of 'fun and humor' (See Figure 1). In this design, the symbolic expression is stressed over functional aspects, and a deliberate disjuncture of the building's form is used to cause a sense of play, and joke. Historical references to indigenous American architecture are audaciously combined with Greek and Roman motives, while the scale of different components of the house is distorted.
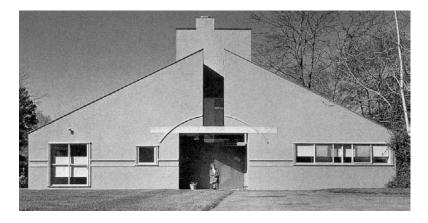
Figure 1. The Vanna Venturi House by Robert Venturi, 1962

Deconstructivism constitutes another example of an architectural movement that used metaphorical thinking as a strategy to reflect on and confront with traditional established values such as solidity, harmony, and unity of the building. Distortion and contamination of pure form, and the creation of unstable and dynamic design compositions were proposed as leading metaphors of the Deconstrutivist architecture. The Wexner Center for the Visual Arts at Ohio State University by Peter Eisenman is an example of a building viewing architecture as 'disintegration and renewal' that manages to provoke and shock the observer (See Figure 2a). In his work, Einseman used associative thinking as a design strategy to apply this concept by dissolving a previously existing urban design situation, and rebuilding it anew [22]. The outcome was an innovative design that resulted from a superimposition of two different urban grid systems: one belonging to the University campus, and the other to the Ohio City. Another example of associative thinking and Deconstructuvism is the Victoria and Albert Museum Bolerhouse Extension by Daniel Libeskind (See Figure 2b). The 'spiral progression of art and history', constitutes the basic metaphor for the design of the museum. The 'spiral dynamics of art and history' can be observed in the outward appearance of the building, as well as in the internal circulation pattern of the different floors of the museum revolving around an uneven vertical axis. A series of interlocking spaces arranged around the twisting spiral, and enabled experiencing the museum, its art, and history from a variety of viewpoints [23].
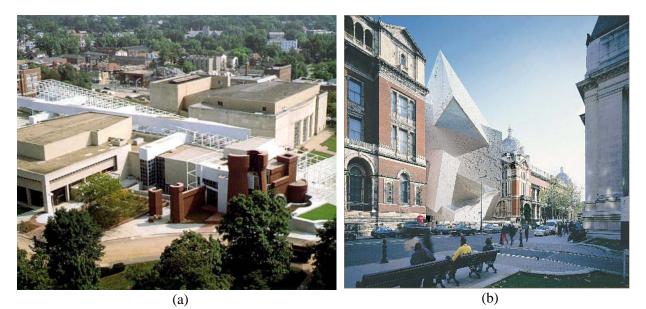

(a)   (b)

Figure 2. Examples of Designed based on Associative Thinking: (a) The Wexner Center for the Visual Arts at Ohio State University by Peter Eisenman, 1989. (b) The Victoria and Albert Museum Bolerhouse Extension by Daniel Libeskind, 1997

2.1 Design and creativity

Apart from allowing the study of associative thinking, design problems are ideal for exploring creativity. The act of thinking creatively involves the perception of situations from new perspectives, which is a major characteristic of non-routine problem solving [24]. Design is such a unique and complex activity that requires lots of innovation. Independently of the scale or size of the problem at hand, design is first of all a non-routine problem-solving activity that relies on creative thinking [25]. Characteristic in creative design is the exploration of a considerable number of solutions extending besides the designer's own knowledge [26].

Some investigations on design creativity were concerned with the personality of the designer (for example [27] [28]). Others examined the design process as a creative exploratory activity [29], as a generator of creative ideas [30], and unexpected solutions [31]. Literature on creativity is highly prolific, but few empirical studies on the evaluation of creativity in design, and in architectural design in particular, were carried out. A frequent problem is that design creativity is assessed as a comprehensive evaluation supported by the agreement of field experts. Although specialists normally share a common view on the topics under assessment, criteria considered to carry out the evaluation resides for the largest part biased, and at least blurred. A few exceptions about studies on the assessment of creativity are those carried out on self-perceived creativity in architectural design [32], comparative evaluations between students and architects [33], and assessment of motivation for creativity [34] [35].

When creativity is put into practice to assess individual performance, it is typically defined by the following four main factors proposed by Guilford [36]: fluency (defined as the total number of relevant responses), flexibility (defined as the different categories of relevant responses), elaboration (defined as amount of detail in the responses) and originality (defined as the statistical rarity of the responses). In a recent research, Casakin and Kreitler [37] found that originality was the most dominant factor in the assessment of design creativity, followed by fluency and flexibility. Elaboration, on the other hand, was the weakest factor. Being creativity a fundamental aspect of associative thinking, its relationship with metaphorical reasoning needs to be investigated.

3   RESEARCH GOALS

The goal of this study was to gain an insight into the role of associative thinking in creative design. Specifically, we wanted to explore how designers assess metaphors in design problem solving by considering the four standard factors of creativity suggested by Guildford [36]. Metaphorical reasoning is considered to be highly effective in the production of innovative designs. Therefore, the aim was to investigate the relation between indices of metaphor use and the Guildford's creativity factors.

4   METHOD

Sixty five design students belonging to the first year of studies in a school of architecture at a university center in central Israel participated in the task during eighteen meetings. They received no payment for their participation.

The problem dealt with the design of an urban block of 12 dwelling units located in a neighborhood of Tel Aviv. The aim was to produce an innovative outcome in order to improve the environmental quality of the area, and generate a singular urban image. Students were requested to deal with the design problem using metaphors and associative thinking. Metaphorical concepts retrieved from a variety of sources such as art, sciences and nature assisted in reinterpreting information about traditional dwellings anew.
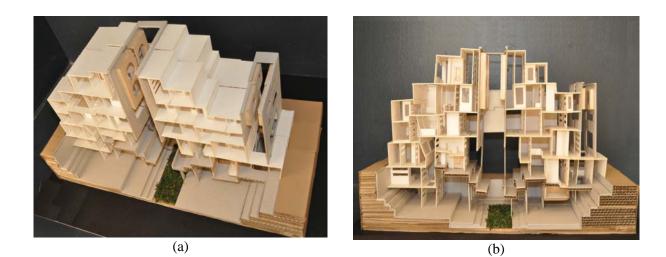
The meetings were organized into two sessions per week as part of the design studio course. The process was divided into the following main stages: at the beginning, students were asked to think about a number of metaphors, and select one that might be helpful for the purposes of the design task. They were requested to reflect on the metaphor and identify aspects that maybe of assistance to understand the design problem from a personal viewpoint. That is, students were encouraged to use metaphorical thinking in order to establish uncommon associations between the dwelling problem and other more remote domains. They were informed that the metaphors should help them broaden the spectrum of existing traditional solutions, and would invite to considering other less conventional

views of the problem. In consequence, metaphors were seen as a tool that can potentially contribute to enhance the creativity of their designs. Students used the selected metaphor to refine their design intentions. They produced a series of abstract 3D abstract mockups that helped them visualize and redefine their design purposes.

In last stages of the process, students applied the metaphorical concept identified in the first stages to approach the design of the 12 dwelling units. The major challenge was to use the abstract metaphor and arrive at a concrete design outcome that will satisfy their initial design intentions. This was carried out through a cyclical and interactive process, in which students produced sketches, drawings, and 3D mockups, while they received feedback from their instructors. All the meetings were carried out in a design studio containing individual drawing tables, a computer room, and a room for group meetings.

Two major design presentations took place in the middle and end of the design process. The following information was requested in each design presentation: a sheet briefly explaining design intentions and the relation to the metaphorical concept; 1:200 site plan drawing describing the location of the dwelling units in the urban context, 1:100 plan and sections of the dwelling units, and the mockups produced during the process.

Figure 3 shows an example of a design solution by a student. "Lantern dwellings" was the metaphor used as an inspiring source for the design of the project. One central vertical core accompanied by two secondary ones was seen as structural 'columns of light' that organized the 'parti'. This design concept made possible to illuminate the dwellings through vertical piers, concentrate the circulation system in a monumental space, and helped define a series of meeting points with different levels of privacy between the dwellings and the urban passage.
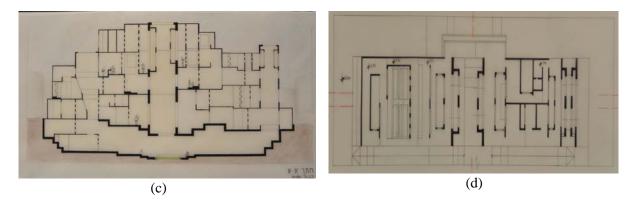

(a)

(b)

(c)

(d)

Figure 3. Example of a design solution of the twelve "lantern dwellings" organized along a series of vertical spaces by a first year design student. (a) and (b) Mockups of the dwellings; (c) Section; (d) Plan.

4.1 Survey

At the end of the task, participants were requested to respond to a questionnaire that focused on the four creativity factors proposed by Guildford [36] and different aspects of metaphor use. Responses were submitted to statistical analyses (See Tables 1 and 2). Each question included an explanation of the aspect under assessment, and a Likert scale of evaluation from 1 (minimum) to 5 (maximum). The items from the questionnaire related to metaphors were based on transcribed interviews of pretested architecture students that were requested to provide their views about the aid provided by metaphors in design. . The interviewees were 10 students of the first year. Those aspects that were more frequently mentioned during the interviews, at least by 3 students (30%), were included in the questionnaire..

Table 1. Items in the survey related to the role of associative thinking in design

No	Items	Mean	Standard Deviation
1	Fluency of the design process	2.50	0.61
2	Originality of the design product	2.75	0.77
3	Elaboration of the design product	3.12	0.60
4	Flexibility in the design process	3.19	0.54

Table 2. Items in the survey related to the role of metaphors in design

No	Items	Mean	Standard Deviation
1	Look for singular ideas	2.76	0.78
2	Organize design thinking	2.93	0.83
3	Think more conceptually than concretely	2.81	0.85
4	Generate design alternatives	2.87	0.75
5	Ask critical questions to frame the design situation	3.06	0.79
6	Engage in an efficient design process	2.59	0.77
7	Approach the problem in general rather than in small details	2.78	0.79
8	Search relationships between remote domains and the design problem	2.77	0.71
9	Gain a deep insight about the design problem	2.90	0.73
10	Develop a central design idea into depth	3.03	0.75
11	Produce a novel design	2.78	0.76
12	Analyze the problem from a different viewpoint	3.01	0.75
13	Define design objectives	2.99	0.70
14	Arrive at unexpected outcomes	2.91	0.74

5   RESULTS AND DISCUSSION

From correlation analyses it was found that the four factors of creativity were related to all the metaphor indices (See Table 3). These ranged from .250 to .416. The highest correlations for the creativity factors were observed for Originality, Elaboration, and Fluency, and the lowest for Flexibility. The most correlated factors were Originality and Elaboration, while the lowest were Fluency and Flexibility. While the most correlated metaphor variable was to 'Look for singular ideas', 'Think more conceptually than concretely' did not correlate with any creativity factor. It is suggested that novice students lack the expertise necessary to make generalizations and establish associations between remote domains and the problem at hand. Table 3 shows that 20 correlations turned out to be significant (out

Table 3. Pearson Moment Correlations between the role of metaphors in design and the four creativity factors

No	Variables based on the students' assessments about metaphors	Variables based on the students' assessments about creativity
1	Look for singular ideas	Fluency: r=.250* Originality: r=.317* Elaboration: r=.380** Flexibility: r=.283*
2	Organize design thinking	Fluency: r=.370** Originality: r=.287*
3	Think more conceptually than concretely	Fluency: r= n.s Originality: r= n.s Elaboration: r= n.s Flexibility: r= n.s
4	Generate design alternatives	Elaboration: r=.252*
5	Ask critical questions to frame the design situation	Originality: r=.282*
6	Engage in an efficient design process	Elaboration: r=.336**
7	Approach the problem in general rather than in small details	Originality: r=.323** Elaboration: r=.278*
8	Search relationships between remote domains and the design problem	Originality: r=.323**
9	Gain a deep insight about the design problem	Originality: r=.398**
10	Develop a central design idea into depth	Originality: r=.277*
11	Produce a novel design	Originality: r=.380** Elaboration: r=.389**
12	Analyze the problem from different viewpoints	Originality: r=.416**
13	Define design objectives	Fluency: r=.251* Elaboration: r=.289*
14	Arrive at unexpected outcomes	Originality: r=.242*

*p<.05, **p<.01, ***p<.001, ns p>.05

of a total of 56, i.e. 14 variables correlated with 4 variables). Analyzing the content of these relations helps understand some of the processes considered when using associative thinking in design creativity.

Additional results showed that Fluency has significant correlations with the following metaphor variables: 'Look for singular ideas', 'Organize design thinking', and 'Define design objectives'. Although Fluency factor was not very much correlated to other variables of associative thinking, it is observed that designers were confident when structuring, reflecting, and defining goals and ideas. Findings show that the design process was much more dynamic at its earlier stages.

Originality in design was found to be strongly correlated with all the variables of metaphors, except for 'Think more conceptually than concretely', 'Engage in an efficient design process', and 'Define design objectives'. Originality is generally considered to be the most important factor defining creativity. Actually, most metaphorical variables were significantly related with this creativity factor,

suggesting that the use of associative thinking in design problem solving was a strong predictor of creativity.

Elaboration in design was correlated with: 'Define design objectives', 'Look for singular ideas', 'Generate design alternatives', 'Engage in an efficient design process', 'Approach the problem in general rather than in small details', and 'Produce a novel design'. One of the reasons since Elaboration was related with different metaphorical variables belonging to many phases of the design process could be that moving from one stage to the other necessarily demands elaboration.

Flexibility, the least dominant factor of the process, was mainly correlated with the 'Evaluation of possible alternative solutions', and 'Analyzing problems from different viewpoints'. These variables indicate that Flexibility manifested itself in the ability of designers to consider design alternatives, which in the course of the design process enable them to enlarge the universe of conventional design solutions.

6   CONCLUDING REMARKS

The main goal of the present study was to assess association measures between variables of metaphor use in design problem solving, ,and a set of four standard creativity factors dealing with fluency, flexibility, elaboration and originality, defined by Guildford [36].

Generally speaking, associative thinking studied through different aspects of metaphor use was found to be related to factors of design creativity. It is interesting that most metaphor variables related to the design phase of reflection on the design problem (i.e., 'Ask critical questions to frame the design situation', 'Organize design thinking', 'Search relationships between remote domains and the design problem', 'Analyze the problem from different viewpoints') were strongly correlated with Fluency and Originality factors. On the other hand, most metaphor variables related to the design phases of development and production of solutions (i.e., 'Develop a central design idea into depth', 'Generate design alternatives', 'Arrive at unexpected outcomes') strongly correlated with variables like Originality and Elaboration.

Elaboration is an essential component for turning a design idea into a successful design solution, and according to the perception of the students it was one of the most dominant factors characterizing the use of metaphors during the process. Originality, on the other hand, was the most correlated creativity factor. From this it can be suggested that metaphors played a significant role in helping students arrive at original and unique solutions. Probably, this explains why 'Search of original ideas' was the most correlated variable.

Previous studies in the use of metaphors showed that metaphors encourage flexibility in thinking (for example [2]), which is concerned with the possibility of perceiving a situation from different viewpoints. However, in our study Flexibility was found to be poorly correlated with most metaphor variables. We suggest   that although students managed to arrive at original solutions, they lacked an analytical capability to reflect on the design situation from a variety of viewpoints. This argument can be supported by the fact that Fluency was weakly correlated with most metaphor indices. Possibly, students arrived to specific design solutions before engaging in a dynamic process that may have contributed to reflect on a larger number of potential design alternatives.

Findings from this study have implications not only for design in general, but also for design education. Intervention programs that seek to enhance creativity in the design studio and to contribute to a fluent and prolific design process should consider training metaphor use. This will help students to learn how to establish mappings and make generalizations from remote domains that transcend the frontiers of the familiar, and to apply new knowledge to known design problems.

Findings from this study were obtained by analyzing the self-assessment carried out by students about their feelings and perceptions of metaphor use in design problem solving, and its relation to creativity. This approach has some limitations, considering that views from students may differ from that of the teachers. In a future research we plan to compare both views, and to combine quantitative with qualitative research to gain further depth.

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