

## **A IS B, DISPLACEMENT: EXPLORING LINKING PATTERNS WITHIN METAPHOR IN THE DESIGN PROCESS.**

CHIA-HUI LO,<sup>1</sup> IH-CHENG LAI<sup>2</sup> and TENG-WEN CHANG<sup>3</sup>

*Tamkang University, Taipei, Taiwan,*

*1. ihcheng@ms32.hinet.net, 2. nicoinschool@gmail.com*

*3. National Yunlin University of Science and Technology, Yunlin, Taiwan, tengwen.chang@gmail.com*

**Abstract.** Design educators often apply metaphor as a teaching tool to help novice designers in their design process. Richards(1936) defines metaphor as the form “A is B”. The most important operation in metaphor is displacement—the linking process of moving A to B. Linking ideas is the key mechanism in the design process. By linking ideas, a graph-like knowledge represents the individual memories with the nodes and arcs that are the ideas and the links between ideas respectively. Such linking knowledge provides an interesting way to understand the operation of displacement within metaphor. This research applies a computational tool (called DIM) to produce a graph-like knowledge. Protocol analysis is then used to understand how designers organize ideas. The objective of this research was to explore the linking patterns of idea displacement within metaphor in the design process.

**Keywords:** Metaphor; displacement; linking ideas; graph-like knowledge; protocol analysis.

### **1. Introduction**

In the early stage of design, designers often use metaphor for their design inspiration. Through the clues of linking knowledge that metaphor reveals, designers can understand the relationships between diverse ideas and design outcomes (Antoniades, 1992). Design educators often apply metaphor as a teaching tool to help novice designers in their design process (Casakin, 2006). The idea of metaphor is that two unrelated concepts link together to generate a new meaning (Lakoff, 1987). Richards (1936) defines metaphor as the form

“A is B”. A is the tenor through which we intend to understand B. B is the vehicle which helps us to understand A. The most important operation in metaphor is displacement—the linking process of moving A to B. In the process, A (tenor) and B (vehicle) can be regarded as ideas (Schön, 1963).

For example, in the case of the John F. Kennedy International Airport in New York City, the airport was used to link concepts of “flying” (as a tenor A) such as birds’ wings, aerofoil, or hydrodynamics . . . etc in order to generate an airport with a freeform roof (as a vehicle B). Therefore, displacement involves the process of linking and generation. Lai (2005) indicated that idea linking plays an important role in the generation of diverse ideas through linking designers’ memory. Such linking knowledge, which includes ideas and relationships, provides an interesting way to understand the operation of displacement within metaphor.

Furthermore, the Dynamic Idea Map (*DIM*), constructed by Lai and Chang (2005, 2006), reveals processes and reinforces image operational information. Our study used DIM as a platform along with an IE map of different ideas connected by three different linking relationships: similarity (si), contrast (cr), and contiguity (ci). Thus, ICFP, as the knowledge representation, helps construct knowledge and provides an efficient method to reveal the design ideas and the knowledge links between them. Using the keyword for the domain conceptual vocabulary of designers, Issue (*I*), which combines the descriptive Concept of the text (*C*) with the Form created by the keyword and the image (*F*), and the Preference value 1–5 of those surveyed (*P*), they constructed a database with ideas and links. DIM primarily combined case-based reasoning with the software agent operation mechanism and, through the agent communication platform (JADE) and reasoning engine (JESS) technology, produced graph-like knowledge links.

## **2. Displacement as the process of linking ideas**

Schön (1963) points out that designers often apply metaphor to displace different ideas. This is done to solve design problems through linking their constructive knowledge in their memory. Antoniades (1990) argued that designers use the phrase “architecture is . . .” to link and generate ideas. By using the phrase effectively in the design process, designers can have creative design outcomes. But how are A and B actually displaced in the metaphor? How does the knowledge associated with object A link with the knowledge associated with object B? Only when one knows how knowledge is displaced and linked by the designer is the metaphor process slowly revealed.

## 2.1. LINKING KNOWLEDGE IN DESIGN

Oxman's research (2004) showed that by not measuring the quantity of knowledge gained, but by knowing where to find it, we can know which specific kind of knowledge to apply in a particular situation, and how to use it when needed. Norman (1988) believes that during the search the designer obtains the best solution by mapping, relating, and deciding between design-related objectives and policies through special limiting factors.

The issues with the metaphor displacement process during design are: 1) how the relation between A and B is found through this searching, and 2) how the conceptual mapping process of the designer is revealed by their linkage.

## 2.2. LINKING OPERATION WITHIN DISPLACEMENT

A metaphor is the significant displacement between A and B (Ricoeur, 1977). Black (1962) believed that a metaphor is the similarity between the creation of A and B where A and B are additionally linked at different levels and are combined to produce significant variation. Way (1991) showed that in the displacement of A to B, the level of A will gradually link with the field of B through the re-description of the attributes of A and B, gradually blurring the differences between the two.

For the field of architectural design, the designer often deconstructs a design into architectural elements (Mitchell, 1990), and builds architectural design knowledge through the relationship between the element symbols and the elements themselves. Liao (2009) also mentions that designers search for meaningful keywords or images as concepts of metaphor, and then transform the concepts to meet their design needs. Based on the rules of metaphor (Ricoeur, 1977), the concepts can be classified into four types: *property*, *form*, *function*, and *structure*. They provide our understanding of the sources of metaphor to link and generate ideas. According to the above theory, A and B should possess these four metaphor rules if they are to be considered displaceable. The description is as follows:

- property: The classifications and associations of metaphor object A and the architectural characteristics of metaphor object B.
- form: The form of metaphor object A and the architectural appearance of object B.
- function: The special functions of metaphor object A and the architectural function or program of object B.
- structure: The composed structure of object A and the architectural structure of metaphor object B. sign Research in Asia

For example, we can use the four rules of metaphor to analyze the Beijing

Olympic National Aquatics Centre, or the “Water Cube” (designed by PTW, 2008). For A, the water in the swimming pool was deconstructed into some properties. The molecular form of water are constantly linked to bubbles, so its form is a bubble and its function is the functions associated with bubbles, such as isolated temperature and a high load capacity. The structure is the crowded structure of the water molecule. Architecturally, the bubble form changed into the architectural appearance, the bubble functions transformed into the temperature barrier of the outer wall, and the crowded molecular structure of water became the architectural model. Figure 1 shows the metaphor design process analysis for the Beijing National Aquatics Centre.

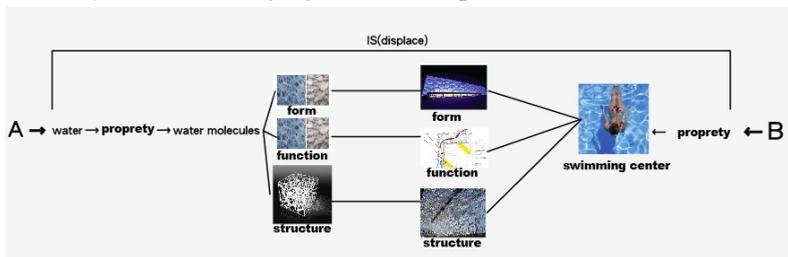


Figure 1. The metaphor displacement of the Beijing National Aquatics Centre.

### 2.3. SUMMARY

Previous studies have emphasized on the use of metaphor for generating design outcomes in the process of displacing A to B, but lack more detailed descriptions of the knowledge linking process. Oxman (2004) claims that only through a concept structure of the entire knowledge linking network can we understand the analogy reasoning pattern in the thinking process. For this reason, the objective of this research was to explore these linking patterns by discovering the displacement process used by designers.

To find the underlying structure of displacement via mapping the linking behaviour, a mapping mechanism and an observation method over the experiment are needed. The mapping mechanism should generate a graph-like knowledge structure which composes vast amount of ideas and their links (the relationships between puzzle pieces). Thus DIM mentioned above, which can generate the graph-like knowledge (called idea map) of links and nodes, can support the mapping mechanism.

Based on the protocol analysis methodology, through the process of encoding, recording, and data analysis, a design's behaviour can be comprehended. This research applies think aloud and conceptual sketches to understand design operation of displacing ideas.

### 3. Design experiment

To explore the linking operation of displacement, this research applied the DIM as a supporting tool to conduct a design experiment.

The purpose is to understand the linking relationships among four types of concepts (property, form, function, and structure). Tenor A can be set to the attribute issue (I). Four types of metaphor rules can be set to the attribute concept (C) (Figure2). Three types of linking relationships (si, ci, and cr) allow us to explore the relationships between A and B.

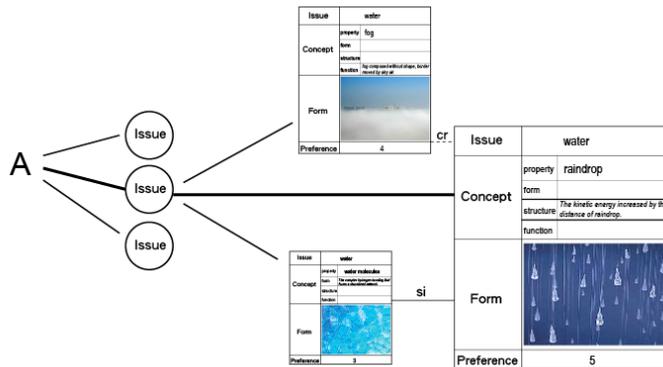


Figure2. The relationship between A and ICFP (Issue, Concept, Form, and Preference).

It is hoped that this experiment will help novice students to enhance their own concepts and ideas in developing design solutions and to help them overcome their lack of knowledge and experience. The participants in the design experiment were ten third year architecture studio students. Utilizing the tourist information station on the Danshui waterfront as the topic, this study observed how the designers used this tenor (A) as metaphor to apply the property, form, function, and structure as Concept. By doing this we can understand the pattern of how the knowledge was then displaced through displacing the links from si, ci, and cr to the vehicle (B). The students' design operation of displacement was recorded and interpreted via protocol analysis.

The main elements of this experiment are described below:

- Participants: Ten third year architecture college students who have undergone basic architecture training and are familiar with DIM and design within metaphor.
- Design Task: So that the experiment could observe directly the thinking transition during the design process, we took as a topic the simple function of a design project of an information station for tourists located on the Danshui River. Being the displaced vehicle B, because the site and rivers are closely

related, the subject fixed water as the primary metaphor issue, meaning tenor A.

- Process: The test ran for 75 minutes. The participant carried out DIM experiment warm-up and operation for 15 minutes prior to the test. During the last 30 minutes, he/she was required to draft his/her conceptual sketches whilst undergoing thinking aloud. The whole process was videotaped.

### 4. Analysis and observations

After the test described above, 15 design ideas were created by every participant within a 30 minute period. From the 15 ICFP, each participant again found an object that could be displaced by A, and carried out link displacement with the B displacement object. In this way, patterns were observed.

#### 4.1. ANALYSIS

This research fixed the information station as metaphor displacement object B, set the design issue (I) as the water (tenor A), and separated it conceptually into different properties. Providing property image F as a reference, students first chose an ICFP according to their Preference and then began to construct a knowledge framework about water from the form, function, and structure in the Concept. After using si, cr, and ci to link the corresponding architectural function, structure, and form, students recreated the concept map and derived the design. The entire experiment process is shown in Table 1.

Table 1. Metaphor displacement process.

	A	is (displacement)	B
1	① water	property → P → F → C → form function structure → form function structure → form function structure →	form function structure → form function structure → form function structure → form function structure →
2		property → P → F → C → form function structure → form function structure → form function structure →	form function structure → form function structure → form function structure → form function structure →
3		property → P → F → C → form function structure → form function structure → form function structure →	form function structure → form function structure → form function structure → form function structure →
4		property → P → F → C → form function structure → form function structure → form function structure →	form function structure → form function structure → form function structure → form function structure →
5		property → P → F → C → form function structure → form function structure → form function structure →	form function structure → form function structure → form function structure → form function structure →
6		property → P → F → C → form function structure → form function structure → form function structure →	form function structure → form function structure → form function structure → form function structure →
7		property → P → F → C → form function structure → form function structure → form function structure →	form function structure → form function structure → form function structure → form function structure →
8		property → P → F → C → form function structure → form function structure → form function structure →	form function structure → form function structure → form function structure → form function structure →
9		property → P → F → C → form function structure → form function structure → form function structure →	form function structure → form function structure → form function structure → form function structure →
10		property → P → F → C → form function structure → form function structure → form function structure →	form function structure → form function structure → form function structure → form function structure →

After translati

nd data, there

was approximately one displacement process for ten participants' metaphor concept issues, which were created through new connections produced after recombining the four different rules. In the entire displacement design process, the rules for A is B was similar to Figure 3:

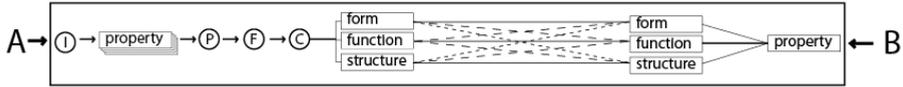


Figure 3. Linking pattern during the experiment.

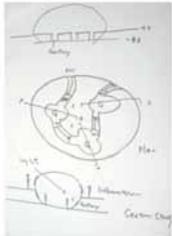
The displacement design process was as follows:

Through translating protocol analysis and observing participants in the design process of displacement, we discovered that when displacement is used in the design process, the designers will first focus on the water issue of the overall metaphor, using DIM links to different properties like water molecule, bubbles, and mist. They will then search the property image F for visual references and, according to the form or structure and function deconstructed from the guiding concepts in the image, create an object displaceable by A, thereby deriving the design.

In another aspect, architectural design will also be deconstructed into different properties. Because the information station is set as the subject, participants will first consider its properties, also divided into form, structure, and function, to find an object that can be displaced by B.

The protocol analysis of two participants, code-named participants 1 and 2, are used as an example (see Table 2).

TABLE 2. Protocol analysis in the design within metaphor displacement.

Participant 1: protocol and sketch	Participant 2: protocol and sketch
<p>Because the weather of this site is rainy, people get use to live here with <b>raindrop</b>. My concept of this design is to catch the <b>moment of raining</b>. The form of station is looks like the form of the <b>drops</b> through pressure become fog that is <b>without specific shape and border</b>. The structure of the station is like <b>ice column</b> filled in bubble. The function of station is like <b>still water</b> can be <b>reflected and interactive</b>.</p> 	<p>My initial idea is about the <b>function</b> of information station such as collects information, rest point, gallery or it could be an iconic building. First I apply the concept of form called <b>oil-water separation</b> into the function of station. My imagination of the architectural <b>form</b> is like the structure of <b>bubble</b> that <b>flexible and movable</b> description with <b>colorful and malleability</b> form. The program of gallery (like oil) is separate the information center (like water), people are like drop that can effect the space dynamically.</p> 

- The displacement objects of A and B will gradually link. For example, Participant 1 used the concept of oil-water separation as the function from the water issue (A). The description of oil dispersed on the water surface, unable to dissolve but instead floating became the primary concept for the program of gallery in the information station (B).
- Participant 2 used the A issue property of mist and raindrops as the displacement concept link for the form of the roof.

#### 4.2. OBSERVATIONS: THE PATTERN OF DISPLACEMENT

The findings of this study should assist in the computing of displacement, and can help designers understand the linking pattern and knowledge construction for effective use during design processes.

The analysis of the displacement process from A to B shows that:

- More participants linked the form of A with the form of B.
- The form of A was applied most, and could be si-linked to the form of B, or ci- or cr-linked to the function and structure of B.
- If the participant started with function for the link to B, it was easier to directly displace the function of A with the function of B.
- If the participant started with structure for the link to B, it was easier to directly displace the structure of A with the structure of B.

### 5. Conclusion: Linking pattern of displacement

In this experiment we discovered that when the designer designs within displacement, the pattern between A and B showed that, primarily, the form, function, and structure of A tenor C corresponded with the form, function, and structure of B. The state of these corresponding relationships could be separated into four different patterns (see Figure 4).

- Pattern 1: Participants more often corresponded the form of B with the form, function, and structure of A tenor.
- Pattern 2: Participants would simultaneously si, cr, and ci link the form of A tenor C with the form, function, and structure of B.
- Pattern 3: Participants would simultaneously si, cr, and ci link the structure of A tenor C with the form, function, and structure of B.
- Pattern 4: Participants would directly si link the form of A tenor C with the form of B, the function of A tenor with the function of B, and the structure of A tenor with the structure of B.

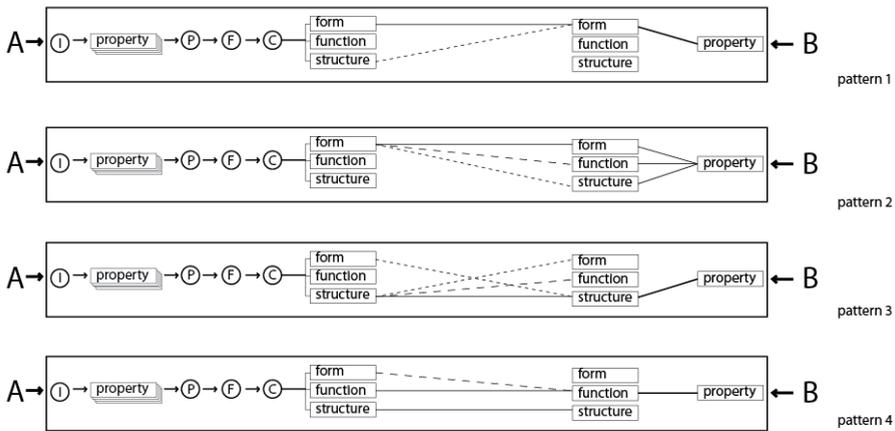


Figure 4. Linking pattern of displacement.

The experiments indicate that designers proceed in metaphor displacement by first linking characteristics of a metaphor target with itself, then derive to the sources of a completely different field. This further leads to the development of a multi-dimensioned imagination that transcends the functional requirements. The richer variety of architectural design possibilities then emerges while the connection with its characteristic of site might possibly get closer. This research has explored the linking patterns that designers apply in the displacement process. In this process, they can also develop brand new perspectives and imagination toward design. Future research will aim to conduct experiments with more participants and test the mechanisms for further applications. It is hoped that the mechanism will lead to develop a type of supporting tool for computerization and application in the field of architectural design education. Whether or not this can further be developed into a dynamic metaphor teaching game will be the focus for future research on this topic.

### Acknowledgements

This research is supported by the National Science Council under grant No: NSC- 99-2221-E-032-055-. The authors want to thank for the students in Tamkang University who participated in our experiments.

### References

Antoniades, A. C.: 1990, *Poetics of architecture: theory of design*, John Wiley & Sons Inc. Canada.

- Black, M.: 1962, *Models and Metaphors*, Cornell University Press, Ithaca, NY.
- Casakin, H. P.: 2006, Assessing the use of metaphors in the design process, *Environment and Planning B: Planning and Design*, 33, 253–268.
- Gero, J.S.: 2000, Computational models of innovative and creative design processes, *Technological Forecasting and Social Change*, 64(2–3), 183–196.
- Lai, I. C.: 2005, Dynamic Idea Maps: A Framework for Linking Ideas with Cases during Brainstorming, *International Journal of Architectural Computing*, 3(4), 429–447.
- Lai, I. C. and Chang, T. W.: 2006, A Distributed Linking System for Supporting Idea Association in the Conceptual Design Stage, *Design Studies*, 27(6), 685–710.
- Liao, Y. Y.: 2009. Some Phenomena of Analogical Thinking In Design. Proceedings of the 14th International Conference on Computer-Aided Architectural Design Research in Asia CAADRIA 2009, Association for Research in Computer-Aided Architectural Research in Asia (CAADRIA), Yunlin, Taiwan.
- Mitchell, W. J.: 1990, *The Logic of Architecture*, MIT Press, Cambridge, MA.
- Norman, D. A.: 1988, *The psychology of everyday things*, Basic Books, New York.
- Oxman, R. E.: 1994, Precedents in design: a computational model for the organization of precedent knowledge, *Design Studies*, 15(2), 141–157
- Oxman, R. E.: 2004, Think-maps: teaching design thinking in design education, *Design Studies*, 25(1), 63–91
- Richards, A.I., 1936, *The Philosophy of Rhetoric*. Oxford University Press. Oxford.
- Ricoeur, P.: 1977, *The rule of metaphor: Multi-disciplinary studies of the creation of meaning in language*, University of Toronto Press. Buffalo.
- Schön D.: 1963, *Displacement of Concepts*, Humanities Press, New York.
- Way, E. C.: 1991, *Knowledge representation and metaphor*, Kluwer Academic Publishers, London.