Design Motifs : Abstraction Driven Creativity
– A Paradigm for an Ideal Design –

Yukari NAGAI [1] and Toshiharu TAURA [2]

[1] Japan Advanced Institute of Science and Technology

[2] Kobe University

Abstract

This paper examines design motifs. We focus on the importance of the internal perspective of a designer as a factor that drives the design process ; as we consider that a motif drives a design's creativity. Two types of abstraction processes in design (human-driven abstraction and generalization) are addressed by studying creativity in both design and art. We discuss the difference between design, art and their mainstay in time. An ideal design is expressed as the real meaning of 'a real design activity', also as the issue to be studied for identifying a design, elaborating on 'what design is'.

1. Preface

In this study, we discuss the central issue of what a design is and how people approach this issue. 'What design is' has been a fatalistic issue as a target from both studying approaches : designing and investigation (namely, 'research').

We begin our argument with 'creativity' in design for identifying a creative design. Creative activity is, as a matter of fact, often explained as a characteristic of humanity. Creativity is an issue that should be investigated in cognitive science since it is the foundation of all creative acts, i.e. 'creativity plays a vital role in a host of human activities. It can enrich our lives when it reveals itself in soothing or exhilarating music, etc. People explain creativity as 'it can bring us new tools' and 'it can provoke advances in science' [1]. 'Creative thinking', which involves stirring creativity is also discussed because 'it is crucial as we adapt to our changing world' [2]. Creativity is usually considered as a person's ability to produce something new and unexpected [3]. However, people also realize that there are many different levels of human creative acts [4]. Perhaps, we can appropriately classify personal creative acts into three categories : mundane creativity, productive creativity, and excellent creativity [5]. Mundane and productive creativity are suitable for problem solving, but excellent creativity involves (formulation and re-formulation processes) and activated by 'creative thinking' [+1].

The scope of the discussion in this paper is on excellent creativity, particularly in design. In previous studies on creativity, creativity in design has been defined as producing the concepts of 'really original' products [6]. Thus, the definition of excellent creativity in design can be considered as the ability and/or process of producing original products, which are novel, useful, and unexpected [7]. However, this is only an external viewpoint on creative acts. Viewing design from an external perspective enables explaining its structure by adopting models of systematic processes, i.e. problem solving processes [8]. Thus, for a long time, the notion of viewing designs from an external perspective has contributed to the accumulation of our knowledge for understanding design by adopting a problem-solving framework [9-10]. We obviously support this established perspective. For discussing the creativity of a design, we suggest that it is necessary to develop another perspective on design by 'creative thinking' from an internal perspective. The suggestions from the current studies rethink the vision and viewpoints ; i.e. senses for having another type of viewpoints from previous science 'constructive informatics' that discussed by Nakashima [11], also the ability of switching inner and outer perspectives for designing by Taura et al [12]. The above-mentioned suggestions affirm that setting a viewpoint involves a significant power for achieving more creative process in design. We feel that these viewpoints can be represented as 'motivation' and 'motifs'.

2. Designing from an Internal Perspective

Exploring the issue of 'what design is' itself involves undertaking acts that are highly creative and activated by internal energy. It begins with comprehending 'what design is'

[+1] Distinguishing creative thinking from productive, it is understood as a process of high quality thought including problem formulation, for example, inventions in science and creative work in art. Productive thinking is considered as a process for a given problem.

What is "What's the Design"?
Special Issue of Japanese Society for the Science of Design
vol.16-2 no.62 2009

13

through various studies. Moreover, Cross explained that creative design activity appeared to be 'intuitive' because it appeared suddenly, and 'this is what characterizes creative design as an exploration, rather than a search' [13]. In order to explain the characteristics of a creative design, we emphasize on the internal energy that stimulates excellent creativity, which can be considered as a driving force for the process of designing. To explain internal energy, it is necessary to observe the process of design from an internal perspective. Probably, a desire to understand 'what design is' becomes an eternal motive of design. Therefore, it is necessary for us to argue what causes the emergence of a motive.

In this paper, we first discuss about the motivations behind designs from an internal perspective. Next, we overview current design studies to reorganize the key aspects for research on design in order to raise several issues. Further, we address the motives of design from an internal perspective to respond to the raised issues and characterize creative design.

2.1. Motivation for Producing a Creative Design

Why do people design? In discussions elucidating design, it is usually explained as the activity of people to make products (in other words, 'artefacts') for some purposes [14]. Critically, according to Simon [8], design has been explained as an 'action aimed at changing the existing situation into a preferred one' [15]. Thus, designers were considered as innovators or reformers who helped in producing social improvements. Probably, the wishes or desires of designers to change the world led them to be a designer in the first place and presented them with newer challenges. However, in design research, the importance of motivation is always noted but not explicitly mentioned in the design process. We are afraid that motivation is a hackneyed word ; indeed, the motivation for a design has a double meaning. External motivations, such as 'the purposes' of a design, present one meaning. The 'wish to change the world' is one of the external motivations. The other meaning refers to the intrinsic motivation, and this presents the more important meaning [+2] [16]. Since curiosity is suggested as the 'the biggest factor for motivation' [17-18], intrinsic motivation is the main power for producing a creative design. With regard to

creativity, it would be better if the notion of motivation (especially the intrinsic one) is defined as a 'drive' to avoid confusion. A sense of 'drive' implies the energy behind the driving force in design. A design process as a voluntary creation can be expressed as a creative process engaging with a person's internal feelings that drives the person based on his/her intrinsic motivations [+3]. Based on the viewpoint of an internal perspective and intrinsic motivation (namely, 'drive'), this study attempts to clarify the issue of 'what design is'.

2.2. Three Aspects of Design Research

First, we overview the current issues in design research in order to specify the points of discussions to clarify 'what design is'. Design can be objectively expressed as a process. As described above, thus far, design processes have been studied by adopting a problem-solving framework from an external perspective. In recent times, design processes have been viewed differently from merely problem solving process, by adopting the internal perspective. There are significant issues in previous researches on design that have discussed the identification of design features in a more subjective manner. They have covered the following three aspects : (1) designing is a practice, (2) design produces artefacts, (3) design exists in the society. Since each of these three research aspects has examined recent designs, we review each aspect with regard to the trends of current studies.

(1) Practice

One important aspect of designing is viewing it as a 'practice' [19]. 'Learning by doing' is often valued for studying a designing process. The interesting aspects of a design can be understood only after experiencing it. In design research, 'knowing designs by doing' was highlighted to analyse its distinct features in observed design activities [20] or by reporting it through empirical studies such as 'action research' [21]. There is some truth in these viewpoints. Their claim appears to be that the important steps of acquisitions (i.e. awareness, schematic knowledge acquisition, knowledge transfer, and so on) of design involving embodied knowledge, including the tacit knowledge of people, are related with experiences [22]. Thus, practice is likely to be an essential experience for people to learn design and to become design experts. In current studies, how to formulate design goals is an important issue in understanding the processes of design learning and the

---

[+2] The two reported types of motivation are : (1) intrinsic motivation, which occurs when people are internally motivated to do something because it either brings them pleasure, or they think it is important ; (2) extrinsic motivation, which comes into play when a student is compelled to do something or act in a certain manner because of external factors.

[+3] See 'Design Creativity' by Taura and Nagai in this special issue.

14

What is "What's the Design"?
Special Issue of Japanese Society for the Science of Design
vol.16-2 no.62 2009

process of gaining expertise [23-24]. However, why people (students) became enthusiastic with regard to design activities was not explained. This is our first doubt.

Commendably, practice is also pointed out as necessary for people engaging in creative acts. Edmonds and Candy have developed 'practice-based research' from the viewpoint of creativity [25]. They address the concept of the creative relationships between participants and art systems for interaction design [26], identifying a creative engagement between art systems and participants as new dimension of HCI.

Since practice-based research provides knowledge of creativity with regard to its intrinsic motivations, we develop our discussion to the researchers' dual motives for elucidation and for producing design (or art). Discussion on how does practice in designing differ from art practice is another issue and will be described in the last section of chapter 3.

(2) Producing Artefacts

Another aspect of designing is highlighting its outcomes. A number of design researches surveyed design outcomes, for example product designs. Plastic arts of such products provide a considerable amount of information on learning how to make good designs ; however, there are more important aspects in understanding designed objects. By analysing designed objects, we may be able to understand designers' thought processes and how they decided the forms and mechanisms of those objects. As noted by Visser, design can be employed for understanding the human mind, that is, for understanding 'cognition' ; thus, studying a design implies knowing the artefact as a 'cognitive artefact of designing', referring that Simon's 'designing' is formulated in 'creating the artificial' [27]. Although Visser emphasized on the importance of research on real design activity, we suspect that studying 'real design' does not imply studying the work of real designers. Innovative objects are an example of a remarkably successful outcome of the creative process. The process to obtain such successful outcomes is often called as an 'innovative design' process [*4]. Although some successfully designed objects represent attractive beauties (colours, shapes, and symbols), there are limited as designs in 'styles' (plastic arts). Moreover, artefacts

---

[*4] Sometimes, people confuse 'design inspired innovation' and the innovative process with product development, including its elaborations. People tend to pay attention to the trials of product developments, without paying attention to the newness of the idea itself. In this study, we discuss the characteristics of a creative design, apart from the process of product development.

represent functions as well. Thus, many studies pointed out that the embodiment of usefulness in designed objects is also necessary [26]. However, there is a remarkable missing link between designed objects and a designer's criteria for a novel design. How can we explain that designers are aware of the criteria for a novel design? Do they learn the criteria for a novel design through their experience? Of course, they can learn these criteria from previous designs by studying designed objects. On the other hand, these criteria limit the designers' performances in adding some features to the previous designs. Therefore, we suspected the presence of contradictions between the external and internal criteria of the designers. This is our second doubt with respect to the previous researches.

(3) Design problems

Further, the notion of viewing designing as a feature of a civilization has arisen only recently. Ulrich explains the design process as 'human endeavour' to find design problems in a situation and then to change it into a better situation [29]. Circulation models represent the relationship between designers, users, and the society. Krippendorff claims that the users' requirements based on their experiences by using artefacts represent social needs that keep up with the times [30]. Design is believed to be a social act to introduce changes. In other words, designers probably find their target for designing from users' requirements or from society. Knowing users' experiences and social needs are believed to provide a hint for future designs [31]. Scenario-based designs (SBD) and persona-based designs (PBD) have developed designs by including participants (users). Thus, the notion of a design problem is considered as an expanded design space in a society. The designers' contributions may be considered as community service from this viewpoint. Thus, service design reforms the framework of a design model into a wider developed one–similar to a business model. To understand design in a society, design education should be developed based on cross-disciplinary collaborations [32]. A view of the 'design for society' gives a 'raison d'être' to both designers and users for sharing the world, enables the opening of doors to knowledge related to other disciplines, and provides a sense of responsibility towards sustainability. However, our third doubt is whether 'observing the outer world (humans in a society) is the only way to determine a design problem?' Where we find 'a design problem' is the central issue in understanding 'what design is'.

What is "What's the Design"?
Special Issue of Japanese Society for the Science of Design
vol.16-2 no.62 2009

15

2.3. Designs Motifs[+5]

In order to answer the above-mentioned doubts on previous design research, we propose our view that 'approaching the notion of "what design is" would provide a deeper understanding of the motives of design'. In other words, internal perspectives and criteria form the motives of design, and they drive people to study design (designing or research).

Fig. 1 expresses the setting of our view and the framework of research on creative design. On the basis of this framework, we attempt to address the above-mentioned issues. With regard to the first doubt, we infer that the motivation to promptly practice a design lies in not only the design goals but also in the intrinsic motivation that is the centripetal force that drives design learning through practice. With regard to the second doubt, we suggest that the discussion on how innovative (novel) ideas are generated must be investigated to understand creative artefacts. With regard to the third doubt, we infer that designers have an internal criteria for their designs if they aim at understanding 'what design is'. Further, we propose 'design motifs' of a design that drives the design process and leads to the creation of a design from an internal perspective.

To discuss designs motifs, we found some different types of potential motifs. Rosenman and Gero proposed a diagram of processes involved in creative design to illustrate knowledge-based models of creative design via the classification of the different types of design processes : combination, mutation, analogy, and first principles [33]. Combination has been also reported as one of the examples of creative thought that evokes creative leaps in a design process [13]. A process of concept-synthesis in design has been focused upon as it leads to generating a novel design idea [34-35]. The phenomenon of the concept synthesizing process in design shows that a process can be driven without any external goals. For example, a process of synthesizing a new idea of animal from the existing animals is explained as paradigm model [12]. We focused on factors that evolve a design process. From the internal perspective, 'abstraction' is found as another type of design motif that activates design processes.

In the next chapter, we argue about abstraction in design as a motif and how it influences the creativity of a design,
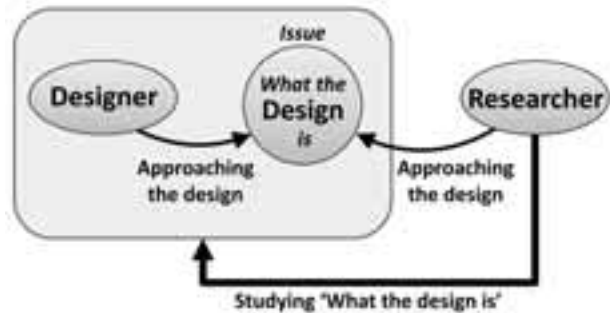

Fig.1. Study approaches to design

beginning with some recollections of art and design.

3. Abstraction

In the early twentieth century, modern styles were expressed as art and design movements. One movement called as 'Abstraction-Creation' expressed the new world in abstract shapes[+6]. Usually, people recognized art and design as styles (namely, plastic arts). However, its creation process, rather than its appearance, is much different from that of previous art. Thus, artists began designing systematic paintings and sculptures. In this paper, we discuss abstraction power as if it naturally inhabits minds, and it is deeply connected to the problem of how we approach 'what design is'.

3.1. Abstraction Process

The ability of abstraction is explained as 'the quality of being abstract' that implies 'a general idea not based on any particular real person, thing, or situation'. 'The state of thinking deeply about something and not paying attention to what is around you' is the second formal meaning of abstraction. In technical terms, 'the action of removing something from something else' is also called as abstraction, because it is the process of being removed from something else in order to extend to 'abstraction'. Abstraction is defined as follows : (1) preoccupation, (2) the process of formulating generalized concepts by extracting common qualities from specific examples, (3) a concept formulated in this way : good and evil are abstractions[+7].

The abstraction process has illuminated mechanisms of human thought, in particular of the creative thought concerning 'analogical reasoning' [36]. The structure of mental mapping

---

[+5] The notion of a 'motif' is used in the same meaning as 'motive', that is, 'a reason for doing something, one that is hidden or not obvious' ; moreover, motif is similar to 'theme', 'subject', or 'conception', in this paper. 'Motif' is also the origin of the term 'motivation'.

[+6] see Abstraction- Creation', in The Oxford Dictionary of Art.

[+7] 'Abstraction' (a) a general idea not based on any particular real person, thing, or situation ; the quality of being abstract ; (b) the state of thinking deeply about something and not paying attention to what is around you ; (c) the action of removing something from something else.
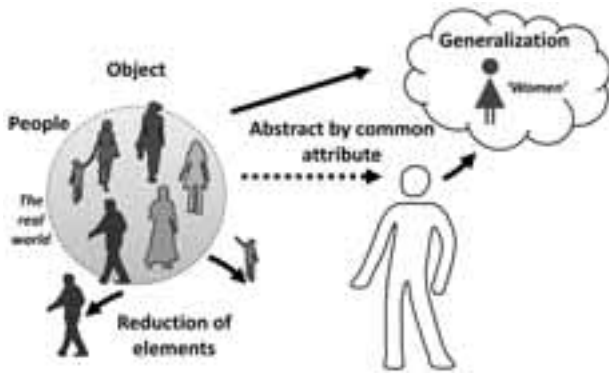
16

What is "What's the Design"?
Special Issue of Japanese Society for the Science of Design
vol.16-2 no.62 2009

Fig.2. Process of generalization in abstraction

Fig.3. Process of human-driven abstraction

was explained as a process of abstraction and knowledge transfer. However, what evokes abstraction is not yet clarified.

Since we believe that 'what design is' is a key issue to understand creative thought, we focused on the process of abstraction in design. The abstraction process perhaps plays the role of a driving force for design. To formulate a concept, extracting the essence by capturing the nature of the object is the main process of abstraction. To determine a common quality within various objects, people remove separate objects during the extraction process. We consider abstraction as a human ability for capturing the essential quality with entireness of an object.

To be sure, it is necessary to inductively capture a common denominator of the features in order to extract common features. This is referred to as 'generalization'. However, generalization is possible without being preoccupied with objects, and it is not a human-centred abstraction process (Fig. 2). Generalization helps in simplifying the representation of objects. To introduce the human-driven abstraction process, Figure 3 illustrates a human abstraction process (e.g. abstract painting) activated by a drive (intrinsic motivation) from an inner perspective. On the basis of this human driven abstraction process, the designers discover what 'a design should be' in essence, namely, an ideal design.

Notably, based on the above classification, human emotion can be also considered as an abstracted feeling without any logical operations [+8]. The basic power to extract the nature of the objects–which is called as 'sensation'–has been discussed in psychology ; it views the inherit phenomena within an object rather than its surface attributes [37]. However, the ability of extracting the inherent nature of things or objects only acts as perception, and it does not represent excellent creativity. The ability of designing is required to create a new art. For example,
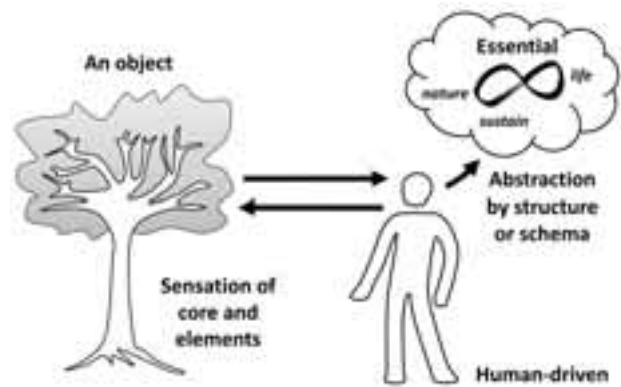
a painting in 'abstract expressionism' is not representative of art, but it expresses not only human emotions but also abstraction of the object (the world) [+9]. The motif of a painting is extracted from a relationship between the self of an artist and the world from the viewpoint of the artist, resolving the issue of 'what the art should be'.

It is believed that the ability of abstraction typifies human thinking. We have argued that the abstraction process and the ability of abstraction in design are required in every piece of art, especially in the case of a designing a creative piece of art. Abstraction can be considered as a strong motif for achieving excellent creativity both in art and design. The sentence 'nothing emerges from nothings (zero)' represents an aspect of human creativity. It implies that 'new ideas, whether wondrously creative or merely unusual, are almost always constructed from the building blocks of prior knowledge' [38] [+10]. These creative features occur in both art and design and are also related with the process of human-driven abstraction. Although there are many similarities between design and art at the excellent creativity level, we now consider the characteristics of design.

In the next section, we investigate the design abstraction process to distinguish design from art.

3.2. Comparison between Art and Design

Leonardo da Vinci had argued that the significant contributions

---

[+8] See 'abstraction' in The Encyclopaedia Britannica regarding 'Souriau, E. (1947) *La correspondance des arts,* Flammarion'.

[+9] The dominant movement in American painting in the late 1940 s and 1950 s. (see 'Abstract Expressionism' , in The Oxford Dictionary of Art).

[+10] 'Picturesque' is a feature of art. Strains and spots of such modern painting regard to the memory of the things which reflected on eyes. This imagination process can be viewed as a discovering process by an interaction between the self and the object in a world. Such a process occurs in design, in particular in sketches in the early stages of the design process.
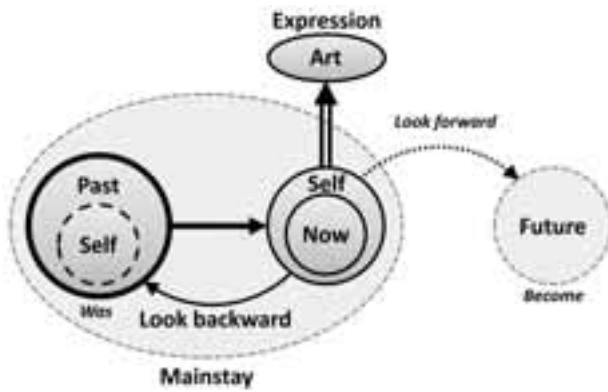
What is "What's the Design"?
Special Issue of Japanese Society for the Science of Design
vol.16-2 no.62 2009

17

Fig.4. Mainstay of art motif

Fig.5. Mainstay of design motif

of art activity were not only in the form of skills related to handwork but also in the form of a human approach to realize the world [38]. Therefore, the formative art activity involves both 'handwork' as well as 'mind-work' at the same time. Understanding a characteristic of an artwork involves increasing its clearness. In recent times, the notion of 'art' has shown a particular tendency. That is, 'art expresses the human thought'. Then, the most important feature of art is that it represents the authors's view of the world. The most important feature of art is considered to be one that represents the artist's awareness for recognizing the world. In contemporary art, abstract art is divided into 'abstract expressionism' and 'hard edge'. These two types of abstract art are called as 'hot' and 'cold' abstract expressions. In modern society, these types of abstract arts reflect the typical views of artists to the world. Corresponding with art movements, emotional and simplified designs have been the two main types of designs. In both design and art, abstraction is a motif used to enact creative imagination.

At this point, we find the distinguishing features of 'the design' via abstraction. As mentioned above, there are no differences between art and design on the basis of the view that 'nothing emerges from zero'. However, the driving forces of both art and design are in opposite directions. Normally, artists evoke their imagination from any image–even from a stain on a wall– through their own memories. Their pictorial expressions are always related to any ad hoc vision. Art usually is related to its history because the intention of art is to provide the orientation for searching its origins. A stage of art is usually in the present 'is' stage and is formulated by looking back at the 'was' stage in the past (Fig. 4).

In contrast, design does not orient to the past. Figure 5 shows where the mainstay of a design is. To identify the creativity in a
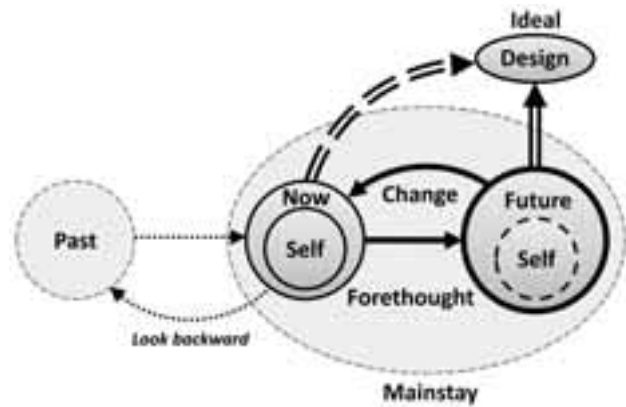
design, the issue of the origin of the design idea has been discussed on the basis of the knowledge of studying design cognition by focusing on concept synthesizing process in design [39]. The abstraction process in design to create a new idea, which is the ideal one, is driven by the forethought of a promise or by foresight. We propose a peculiar feature of design, namely, 'a design has a definite source in the future'.

3.3. Idealization of Design Schema

We have classified the ability of abstraction in design into two types, namely, 'abstraction in essence' (human-driven abstraction) and 'abstraction in simplified representation' (generalization). The former implies a strong motif of designing, and its process aims at achieving real abstraction. 'Abstraction in essence' involves the entireness. The latter one implies our usual rational activities. Most designed objects were produced based on the latter abstraction, which comprised some external goals but without any internal drive or criteria. If we conduct a study on designs formulated using the latter abstraction, we would never be able to capture the real abstraction and ideal design.

To identify the typical human-driven abstractions in design, we have surveyed examples presented in discussions in design studies. Coyne et al. perceived design as the situated problems in order to scope it on the basis of connection model, and they estimated the design schema in the case of house building [40]. Every design scheme is structurally based on a concrete problem. For example, a design scheme for a house can be constructed with many rooms, such as living room, bedroom, bathroom, and kitchen. In other words, a house can be represented as a composition of these rooms. They suggested that the design schema could be found in the situated functions and used to form the structures of these rooms. Their proposed example is limited in the case of physical constructions such as buildings. To develop the idea

18 What is "What's the Design"?
Special Issue of Japanese Society for the Science of Design
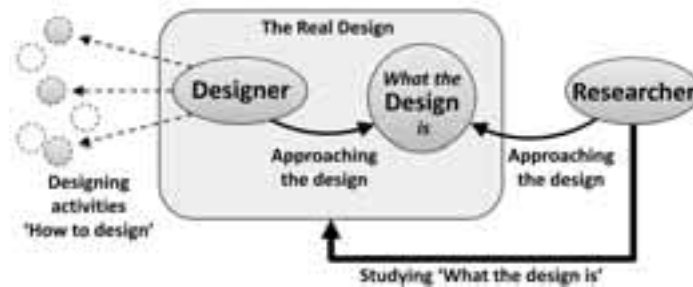vol.16-2 no.62 2009

Fig.6. Study approaches to the ideal design

of a design schema, we consider that the schema should be free from the functional limitation of existing objects. The design schema should represent an ideal meaning of a house for a self. This can be accrued by a human-driven abstraction process for a house.

Moreover, to formulate a design space that corresponds with an ideal design schema, it is necessary to explore the meaning of a new relationship between the self and the objects [41]. Therefore, identifying an abstract image is needed for formulating the ideal design in an ideal situation. We have situated the real design by enlarging Visser's view [27] for studying what the real 'ideal design' is.

4. The 'ideal design'–as a conclusion

In order to identify the concept of a 'design', we first examined the motivations of design focusing on the internal perspective. We further discussed the abstraction process, which appears to stimulate creative design, especially from the perspective of the internal criteria. The internal criteria are considered to arise during a self conscious process in a commitment with the world via intrinsic motivation (namely 'drive') while having an inner perspective. One of the types of the abstraction process, which is human-driven abstraction, leads to designers being preoccupied with recognizing the world from an internal perspective. Abstraction is not a goal or purpose for the designers but a motif and drive for creative acts.

Second, we claimed another important feature to distinguish design creativity from art (from pictorial recognitions), that is, an ideal design. Needless to say, practice is necessary to research as well as learn any creative activity. Design, too, is not an exception. Visser claimed that to understand the nature of design, it is important to observe real design activities. Then, it can be said that a clue is covered in any kind of design act. Even if we observe a design of mannerisms, we consider that the core of the design is not provided. We consider that the

factors of the process of ideal design enable a process to transcend problem solving. Forming internal criteria provides the answer for the argument presented by Visser stating 'design involves more than problem solving' and 'characterizing design as problem solving does not capture its essence!' Thus, we develop Visser's claim and state that 'to understand design, it is necessary to observe real designs', but we emphasize that we should study it 'particularly at the level of ideal design'. Studying an ideal design as a real design activity leads us to understand the indwelling features of a creative design.

Finally, we propose an exemplar for an ideal design. An ideal design is something that aroused from within us, which is supported by our ideal criteria. It involves the presence of the abstraction process in an ideal environment. Moreover, it produces what a design should be like from the perspective of 'future' and 'to be', which can be recognized only by human beings. At the beginning of this study we cited the definition of design that would make change the situation to pleasant one. Finally, we note that changing is not the aim of design but it will be only appeared as the results of ideal design. Given this, we show our potential to answer the challenging question of 'What design is'.

References

1. Ward, T. B., Finke, R. A., & Smith, S. M. (1995). Creativity and the Mind : Discovering the Genius Within. New York : Plenum.
2. Ward, T. B., Smith, S. M. & Vaid, J. (1997) *Creative thought,* Washington DC, American psychological association.
3. Takala, T. (1993) A neuropsychologically-based approach to creativity, in : J. S. Gero & M. L. Maher (Eds) *Modelling creativity and knowledge-based creative design.* Hillsdale, New Jersey, Lawrence Erlbaum, 111–138.
4. Csikszentmihalyi, M. (1988) Society, culture, and person : A systems view of creativity, in : R. J. Sternberg (Ed.) *The nature of creativity.* Cambridge, Cambridge University Press, 243–270.

What is "What's the Design"?
Special Issue of Japanese Society for the Science of Design
vol.16-2 no.62 2009

19

5. Thagard, P. (1997) Coherent and creative conceptual combinations, in : T. B. Ward, S. M. Smith & J. Vaid (Eds) *Creative thought.* American Psychological Association, 129–141.

6. Lubart, T. (1994) Creativity, in : R. J. Stenberg (Ed.) *Thinking and problem solving.* Academic Press, 289–332.

7. Gero, J. (2009) Computational explorations of design creativity. *His keynote to speech at ICoRD'09. Bangalore, India.*

8. Simon, H. A. (1996) *Sciences of the artificial third edition,* Cambridge, MA, MIT Press.

9. Cross, N. (1984) *Developments in design methodology,* John Wiley & Sons Ltd.

10. Thomas, J. C. & Carroll, J. M. (1979) The psychological study of design. *Design studies,* 1(1), 5–11.

11. Nakashima, H. (2009) Methodology and a discipline for synthetic research – What is synthesiology ? – , Synthesiology English Edition, 1(4), 282–290, AIST.

12. Taura, T. & Nagai, Y. (2008) Design insight-a key for studying design creativity, paper presented at the *NSF 08.*

13. Cross, N. (2006) *Designerly ways of knowing,* Birkhauser.

14. Friedman, K. (2003) Theory construction in design research : Criteria : Approaches, and methods. *design studies,* 24,507–522.

15. Coyne, R. D., Rosenman, M. A., Radford, A. D., Balachandran, M. & Gero, J. S. (1990) *Knowledge-based design systems,* Addison-Wesley Publishing Company, Inc.

16. Amabile, T. M. (1985) Motivation and creativity : Effects of motivational orientation on creative writers. *Journal of Personality and Social Psychology,* 48(2), 393–399.

17. Amabile, T. M. (1982) Children's artistic creativity : Detrimental effects of competition in a field setting *Personality and Social Psychology Bulletin* 8, 573–578.

18. Loewenstein, G. (1994) The psychology of curiosity : A review and reinterpretation. *Psychological Bulletin,* 116(1), 75–98.

19. Schon, D. A. (1983) *The reflective practitioner : How professionals think in action,* NY, Basic Books.

20. Akin, O. (1986) *Psychology of architectural design,* London, Pion Ltd.

21. Avison, D. E., Lau, F., Myers, M. D. & Nielsen, P. A. (1999) Action research. *Communications of the ACM,* 42(1), 94–97.

22. Rust, C. (2004) Design enquiry : Tacit knowledge and invention in science. *Design Issues,* 20(4), 76–85.

23. Goldschmidt, G. (1999) Visual analogy, a strategy for design reasoning and learning, in : C. Eastman, W. Mccacken & W. Newsletter (Eds) *Design knowing and learning : Cognition in design education.* Avebury), 53–74.

24. Cross, N. (2001) Strategic knowledge exercised by outstanding designers. IN J. Gero & K. Hori (Eds.) *Strategic knowledge and concept formation 3, Key center of design computing and cognition.* University of Sydney, Australia.

25. Candy, L and Edmonds, E A (2002) Interaction in art and technology, Crossings : Electronic Journal of Art and Technology, 2 (1).

26. Bilda, Z., Edmonds, E. & Candy, L. (2008) Designing for creative engagement *Design studies,* 29(6), 525–540.

27. Visser, W. (2006) *The cognitive artifacts of designing,* Lawrence Erlbaum Associates.

28. Sarkar, P. & Chakrabarti, A. (2009) Analyzing creativity methods. IN A. Chakrabarti (Ed.) *Research into Design, ICoRD'09.* Bangalore,India 3–10.

29. Ulrich, K. T. (2007) *Design creation of artifacts in society.*

30. Krippendorff, K. (2006) *The semantic turn : A new foundation for design,* New York, Taylor and Francis.

31. Norman, D. (2006) Ad hoc personas & empathetic focus, in : J. Pruitt & T. Adlin (Eds) *The persona lifecycle : Keeping people in mind during product design.* Amsterdam, Netherlands, Morgan Kaufmann Press ; Elsevier, 154–157.

32. Erlhoff, M. (2009) *Design dictionary,* Birkhauser (Architectural).

33. Rosenman, M. A. & Gero, J. S. (1993) Creativity in design using a design prototype approach, in : J. S. Gero & M. L. Maher (Eds) *Modelling creativity and knowledge-based creative design.* Hillsdale, New Jersey, Lawrence Erlbaum), 111–138.

34. Taura, T. and Nagai Y. (2005) Primitives and Principles of Synthetic Process for Creative Design, J. S. Gero & M. L. Maher (Eds), Proceedings of Computational and Cognitive Models of Creative Design VI,177–194 .

35. Nagai, Y., Taura, T., Edmonds, E., Candy, L. & Okada, R. (2006) Study of concept synthesis in design creativity - role of action concept in design creative process. *Design Research Society International Conference 'WonderGround', on CD-ROM,* Lisbon.

36. Gentner, D. (1983) Structure-mappong : A theoretical framework for analogy. *Cognitve Science,* 7, 155–170.

37. Sano, K. (to appear) A method of represent to appear processes of a creative activity from a inner perspective. (In Japanese)

38. Takashina, S. & Nakahara, Y. (1972) *The critical base of contemporary art,* Japan, Kodansha.

39. Taura, T. (2005) Concept forming process and criativity in design. *Special Issue of JSSD,* 12(3), 28–35. (In Japanese)

40. Coyne, R. D., Newton, S. & Sudweeks, F. (1993) A connectionist view of creative design reasoning, in : J. S. Gero & M. L. Maher (Eds) *Modelling creativity and knowledge-based creative design.* Hillsdale, New Jersey, Lawrence Erlbaum), 111–138.

41. Georgiev, G. V., Taura, T., Chakrabarti, A. & Nagai, Y. (2008) Method of design through structuring of meanings. *ASME International Design Engineering Technical Conferences (IDETC) and Computers and Information in Engineering Conference (CIE).* New York.

20

What is "What's the Design"?
Special Issue of Japanese Society for the Science of Design
vol.16-2 no.62 2009