IV

THE STRUCTURE OF DESIGN AND DESIGN METHODS

4-1. Overview

4-2. The Structure of Design

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4. The Structure of Design and Design Methods

4-1. Overview

In preceding chapter 3, it was tried to understand how the characteristics of culture can be identified. As a way of understanding cultural characteristics, the possibility of use of cultural variables was explored. Since the goal of this study is to understand 'cultural effects' on 'design' in general, in terms of methods only, now it can be said to have accomplished half of the goal (because methods for cultural part has been done in the preceding chapter). Naturally, it is now needed to step forward to studying another remaining half, which is 'design.'

This chapter will try to explore design methods for different attributes of design. More specifically, in this chapter it is tried to answer three questions: "how design is structured and what are basic attributes of design?"; "What are design methods appropriate for each attributes of design?"; "What is the sample case for demonstrating design method developed for specific attribute of design?"

At first, the structure of design is examined with the focus on the composition of design attributes. The basic attributes which consist of design are identified by literature study on existing theories regarding design attribute. Once attributes of design are identified, it continues to examine how those design attributes related each other in terms of structural point of view.

Then, the focus is placed on exploring design methods for each design attribute. According to the nature of each design attribute, most appropriate one among design methods available now is selected. Those methods will be used in the main experiment for understanding user’s behavior toward design.
Along with review of design methods for design attributes, three cases are introduced for demonstrating some selected design methods from each design attribute. The sample cases include 'development of object-oriented interaction idea generator', 'aesthetic effects on user-interface design', and 'video ethnographic approach for understanding passengers' behavior in train.'

The structure of the study in this chapter is summarized in diagram as shown in Figure 4-1:

Figure 4-1: The Overview of Structure of Chapter 4.
4-2. The Structure of Design

This section examines the structure of design: that is, what are the most fundamental attributes of design; how they are related together to form certain specific design? At first, the concept of design attributes are introduced and defined, and then existing theories of design attributes are reviewed and summarized to generate a set of design attributes. Mutual relationship between design attributes will be explored to draw on the structure of design.

4-2-1. The Concept of Design Attributes

The term 'attribute' originated from Latin 'attributus' is defined in Webster dictionary as 'an inherent characteristics.' This generic meaning of 'attribute' was adopted first in marketing field for the purpose of researching consumer attitudes on product by Lancaster. Lancaster understood that people do not acquire products for the sake of the products themselves, but for utility that is produced by characteristics of the products – attributes. He defined attributes as “the objective physical aspects of a product.” However, this definition excludes subjective and psychological characteristics that are also very important from the point of view of consumers. A more contemporary approach to attributes is made by Grunet: “any aspect of the product itself or its use that can be used to compare product alternatives. Each alternative can (but need not) be

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characterized by all attributes, i.e. using one attribute does not preclude using another.\(^67\)

In marketing point of view, an attribute is the aspect of a product that can be used for comparison. Marketing researchers have been using the concept of attribute for evaluation of consumer attitude: they first combine different attributes of products making into different product design, show them to consumers, and evaluate the relative importance of attributes of product influencing consumers’ preference attitudes.

Design also can borrow the concept of attribute from marketing point of view. Design attributes can be defined as ‘multiple aspects of design that can be used to analyze design and compare different design alternatives.’ Design attributes are fundamental dimensions to compose design as a whole. Design attributes can be very concrete and physical such as color, shape, texture, material, and so on, or they can be abstract like emotional feeling and symbolic meaning. However design attributes must have the same level of abstraction in order to keep mutual equivalences between each attribute. There may exist different levels of design attributes but they cannot be equally named as ‘design attributes’. Those less comprehensive attributes can be called ‘sub-attributes’ or ‘characteristics’ by Johnson’s terms.\(^68\) In fact, design attributes are structured hierarchically. For example, the design attribute ‘functionality’ can have sub-attributes such as ‘robustness of structure’, ‘durability’, or ‘speed’. Attributes with sub-attributes have the relationships of means and ends. In other words, sub-attributes are means to accomplishing attributes and attributes are ends to sub-attributes. This hierarchical view


of design attributes is illustrated in following Figure 4-2:

![Diagram of Hierarchical Structure of Design Attributes]

*Figure 4-2: Hierarchical Structure of Design Attributes*

In this sense, any design can be viewed a composite of design attributes and an activity of ‘designing’ can be regarded as nothing but an activity of controlling multiple design attributes. Designer may emphasize design attribute ‘A’ while he may de-emphasize design attribute ‘B’ and ‘C’. Designers consciously identify what combination of design attributes would be most appealing to users and what change of design attributes would be most sensitive to users’ satisfaction.

What finally handed over to end-users is also a composite of design attributes against

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which users may have different degree of satisfaction and feeling. Users may not be exclusively aware of the exact combination of design attributes but their responsive attitudes toward design (like or dislike) are caused because of specific way of combination of design attributes. The good design can be achieved when designer’s combination of design attributes is the same as user’s perceived combination of design attributes. This view of design attributes can be diagrammed as Figure 4-3:

![Design as a composite of multiple design attributes and Designer as Its Creator.](image)

Design attributes give designers many significant advantages. At first, designer can use design attributes as a guideline for finding design problems and setting up design process. In the beginning of design project, it is very crucial to get a right problem definition done and to establish correct design process so that all design problems can be covered in the design process as much as possible. As shown in the definition of
design attributes, design attributes cover all fundamental aspects of design and can be used as checklist to evaluate whether all of necessary design data are collected, problems are found, and all of design attributes are covered in the design process.

Secondly, design attributes can be implemented to model and establish design concept. As mentioned earlier, designer can control the relationship between design attributes by allocating different relative importance to different design attributes: e.g. giving more importance on affective side and less importance on functionality. Designer can also generate all different variations of design alternatives by combining design attributes in different way like in ‘Morphological Chart’ method developed by Zwicky.70 Designer can manipulate the whole picture of design concept by playing with design attributes.

Lastly, designer can use design attributes as criteria for evaluation. The function of comparability of design attributes described in the preceding section refers to this function as design criteria. It is quite natural to use design attribute as design criteria because design attributes are used in defining problems, and after all, design evaluation is to select best design solution to solve design problems. Design attributes are kind of filter through which only satisfactory design alternatives can pass as the final design solution.

These three functions of design attributes work throughout the all stages of design process. In other words, design attributes play different roles over three stages of design process: ‘analysis of design problem’, ‘synthesizing design concepts’, and ‘evaluating

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Design attributes can be used as kind of milestone in every turning point of stages of design process. These functions of design attributes over design process are diagrammed in Figure 4.

![Figure 4-4: Role of Design Attributes over Design Process.](image)

As seen above diagram of Figure 4-4, large amount of design data are converged into design problems; in turn, the number of design alternatives are diverged from design problems; design alternatives, eventually, are converged again into final design. Design attributes work as a milestone to control the three stage of process of convergence, divergence, and convergence.\(^72\)

For this significance of design attributes, design researchers generated diverse version of design attributes. These existing theories of design attributes will be reviewed in next session.

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4-2-2. The Review of Existing Theoretical Models of Design Attributes

Actually, the research of design attributes is conducted not just only by designers but also market researchers, product managers, product planners, and so on. Even though the focus, the methods, and the interests of researching design attributes differ from each other, the purposes are more or less similar: that is, to identify fundamental aspects of product and compare products by use of attributes. Here, in this section, some representative theoretical models developed in design field and other related fields are introduced for determining common design attributes.

1) General Properties Model by Jay Doblin\(^73\)

The American design theorist and educator, Jay Doblin developed so-called ‘General Properties Model’ for using as a checklist for design evaluation. In his model, Doblin arranged systematically the all the attributes designer should consider in design development. He listed up total 34 different most elementary attributes, then regrouped them into 14 sub-attributes, and eventually identified five design attributes as shown in Table 4-1. The five design attributes include ‘Human factors attributes’, ‘Technical attributes’, ‘System attributes’, ‘Symbolic attributes’, and ‘Aesthetic attributes.’ These are explained in detail as follows:

- Human factors attributes: All the attributes which are related to product performance in the user's point of view. They include usability, safety, and

operationability.

- Technical attributes: All performance attributes related to technical point of view. These include functional efficiency, reliability, manufacturability, and etc.

- System attributes: All attributes in the environmental context of design. These include adaptability to environment, flexibility in use, fitness to system context, and marketability.

- Symbolic attribute: All attributes as a symbolic sign to communicate in social context. They include fitness to social requirements, fitness to user’s requirement such as age, gender, personality, and lifestyle, social status, and genuineness.

- Aesthetic attributes: All attributes related to product aesthetic. These include appearance, appropriate graphical quality, orderly layout, and fitness to visual environment.

Later, Doblin developed this model further into so-called ‘USA’ model. USA is the name of attribute model Doblin coined and it stands for ‘Utility’, ‘Social Status’, and ‘Aesthetic’. Utility refers to attributes related product performance, functionality, and usability that can be objectively measured; Social Status refers to symbolic attributes that communicate user’s social status. Examples of this design attributes are semantic appropriateness, fitness to social status, connotative sign etc. Usually, this has difficulties to be evaluated; Aesthetic means formal attributes that include appearance, color, shape, and so on.

Doblin model is very useful in many cases but some of them seem to be too old to fit in present design paradigm: virtual product or ‘bit-based product’.
Table 4-1: Generic Properties Model by Jay Dobkin

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<thead>
<tr>
<th>Have high intrinsic quality</th>
<th>Have good performance</th>
<th>Have good human factors</th>
<th>Be easy to use</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Be easy to operate</td>
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<td>Have good technical factors</td>
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<td>Be efficient</td>
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<td>Be economical</td>
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<td>Have good systems fit</td>
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<td>Be good environmentally</td>
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<td>Fit market system</td>
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<td>Have good appearance</td>
<td>Have appropriate symbols</td>
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<td>Fit social requirements</td>
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<td>Be socially appropriate</td>
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<td>Be genuine</td>
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<td>Have good form</td>
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<td>Be orderly</td>
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<td>Fit visual environment</td>
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<td>Be well made</td>
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2) Man-Tool-Work-Environment System by Bruce Archer\textsuperscript{74}

The leading first-generation design methodologist Bruce Archer systematically identified nine design factors by investigating the system relationship between man, tool, work and environment as shown Figure 4-5. Those factors were generated by

\textsuperscript{74} Archer, L. B. 'Systematic Method for Designers.' In N. Cross ed. Developments in Design Methodology, Wiley, Chichester, 1984, pp. 60-62.
considering what factors are important in each relationship between man, tool, work, and environment. Those design factors are 'Aesthetics', 'Motivation', 'Function', 'Ergonomics', 'Mechanism', 'Structure', 'Production', 'Economics', and 'Presentation.' He also regrouped those factors into 'Use', 'Sale', and 'Manufacture' by analyzing what relevances those factors have. It is shown in Table 4-2.

![Diagram](image)

*Figure 4-5: System of Man-Tool-Work-Environment by Bruce Archer.*

**Table 4-2: Design Factors and Their Relations with Use, Sale, and Manufacture**

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<tr>
<th>Class of Design Factors</th>
<th>Use</th>
<th>Sale</th>
<th>Manufacture</th>
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<td>Aesthetics</td>
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<td>Motivation</td>
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<td>Function</td>
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<td>Ergonomics</td>
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<td>Mechanism</td>
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<td>Structure</td>
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<td>Production</td>
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<td>Economics</td>
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<tr>
<td>Presentation</td>
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</tbody>
</table>
3) Product Value Theory by Hirabayashi

Japanese product science researcher, Hirabayashi conducted research regarding attributes in terms of product. He divided attributes into three distinctive categories that include ‘1st Dimensional Product attributes’, ‘2nd Dimensional Product attributes’, and ‘3rd Dimensional Product attributes.’ These are reviewed in more detail as follows:

- 1st Dimensional Product attributes: refers to ‘Tool Attributes.’ This is the material value which usually appears in market-driven situation. It includes some hardware and software for satisfying ‘known needs’.

- 2nd Dimensional Product Attributes: includes ‘Affective Attributes’ such as ‘Useware’ focusing on usability, and ‘Feelware’ focusing on emotional side. These attributes are not prepared just for satisfying already-known needs but for creating new needs which consumers are not even aware of.

- 3rd Dimensional Product attributes: refers to ‘Social Attributes’ which deal with ‘Cultureware.’ Hirabayashi viewed that Cultureware is most ultimate attribute. It takes long time and has socially significant meaning.

As words like 1st, 2nd and 3rd shown in the name of attributes, three categories are related sequentially with means and ends relations. In other words, accomplishment of 1st dimensional product attributes leads to next higher stage of product attributes, and in turn, satisfaction of 2nd product attributes also initiates another final stage of product attribute. In other words, at first people pursue ‘tool (material) attributes’ and then after

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fulfilling this attribute they advance to next level of higher 'affective attributes', and finally arriving at 'socio-cultural attributes.'

These hierarchical relationships are summarized in Figure 4-6 as follows:

![Diagram of hierarchical relationships]

*Figure 4-6: Product Attributes in the Model of Product Value Theory.*

4) Means-Ends Chain by Gutman

Another attribute model with the hierarchical characteristics was proposed by market researcher J. A. Gutman. According to his theory, a product corresponds to a complete meaning of structure in the consumer's mind. Its elements form hierarchy consisting of different levels of abstraction: 'Concrete attributes', 'Abstract attributes', 'Functional consequences', 'Psychosocial consequences', 'Instrumental values', and 'Terminal values.' The concrete attributes of a product are the most concrete level in the hierarchical chain. They are most tangible properties of the product, directly observed

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by the users and manipulated by the designers. They include dimension, material, shape, and structure etc. Consumers are not typically regarded as evaluating products at this level.

After experiencing this level of physical concrete attributes, consumers are joined to form a set of abstract, subjective and intangible attributes. This level of attributes is the perceived ones and different depending on consumers' value system. They include affective, semantic, and cognitive attributes. The meanings of attributes are given by their consequences.

Functional consequences refer to practical benefits and performance outputs while psychosocial consequences are feelings and social considerations. Consequences are either positive, i.e. benefits, or negative, i.e. perceived risks.

Consequences are followed in the continuum of increasing abstraction by instrumental and terminal values, which are mental representations of the consumer's most fundamental goals. Terminal values are concerned preferred end-states of existence (i.e. happiness, security, accomplishment), and instrumental values are related to modes of behaviors (i.e. honest, courageous) which are instrumental in achieving these end states.

These six attributes can be regrouped into two categories again: 'Product knowledge' and 'Self knowledge.' The three most concrete levels of the means-ends chain belong to product knowledge and the three upper most abstract levels to self-knowledge. Depending on the consumer's product knowledge, the means-ends chains are not always complete, i.e. they do not reach to the level of terminal values.

A similar hierarchical structure of attributes was presented by Lefkoff-Hagius and
Mason.\textsuperscript{77} They divided attributes into three categories: 'Characteristic attributes', 'Beneficial attributes', and 'Image attributes.' Characteristic attributes are related to the physical properties of a product, Beneficial attributes refer to benefits or risks that the product may cause, and, finally, Image attributes are properties of the product that have an ability to define the product owner's relations to other people or self.

Like Gutman's Means-Ends Chain model, these three attributes are close linked each other. Experiencing Characteristic attributes leads to perception of Beneficial attributes, and depending on benefits consumer gets, specific Image attributes are formed.

Gutman's model is illustrated in Figure 4-7 as follows:

\begin{figure}[h]
    \centering
    \includegraphics[width=\textwidth]{figure4-7}
    \caption{Means-Ends Chain Model of Attributes by Gutman}
\end{figure}

5) Function Complex by Victor Papanek

American Designer, Victor Papanek who is better known as social movementist, suggested ‘Function Complex’ as shown Figure 4-8. The term ‘Function’ in ‘Function Complex’ by which he meant is different from conventional meaning of function which means the opposite meaning of aesthetic or ‘working’ instead of ‘pleasing.’ He argued that the function is all the modes of action by which a design fulfils its purpose and ‘aesthetic’ is also just one inherent part of function.

In his Function Complex, he listed up six attributes forming hexagon of which function is located in the center. These six attributes are introduced in more detail in the following.

![Function Complex Diagram]

Figure 4-8: The Function Complex by Victor Papanek.

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• Method: This attribute refers to the interaction of tools, processes, and materials. It describes the method in which tools, process, and materials are used for final design. In this attribute, Papanek argues the honest use of tools, processes, and materials criticizing the fake use of them: e.g. the steel beam in a house, painted a fake wood grain; the molded plastic bottle designed to look like expensive blown glass. In other words, tools, processes, and materials should be used as they are originally intended to be.

• Use: This attribute describes the issue of “Does it work?” In this sense, this attribute is similar to the ‘functionality’ in other models of design attributes. The design should fulfill efficiently the purposes as much as it can. Again, Papanek is highly cynical about distortion of original use of product: for example, cigarette lighter shaped like tailfin of automobile.

• Need: It deals with the issue of somewhat philosophical question of ‘what are people’s real needs?’ Design should be able to identify what people really need and to fulfill effectively their needs. However sometimes, as Papanek argued, people’s natural needs are overwhelmed by carefully manipulated ‘wants’ by egocentric design.

• Telesis: The term, ‘telesis’ is not a word ordinarily used so that Papanek himself cited the definition from the dictionary: ‘the deliberate, purposeful utilization of the processes of nature and society to obtain particular goals.’ If it is rephrased in the sense of design, it describes the reflection of the times and social conditions (in the content of design) that have given rise to the content of it.

• Association: This attribute is semantic aspect of design which creates specific...
association. Should TV set have associational values of 'furniture' (a lacquered wood-grain chest looking) or 'technical equipment' (black box with high-tech looking)?

- Aesthetics: This last attribute in Function Complex is the rather well-known aspect of design, such as form, color, proportion, layout etc. that arouse move, please people and are beautiful specific affective value like pleasure, delight, or sadness. However it is argued that aesthetic should be created with the contextual relations of other attributes in Function Complex.

6) Four Faces of Attractiveness by Mike Baxter

English design educator, Mike Baxter viewed the 'attractiveness' as ultimate purpose what customers are seeking for from design. And he pointed out four determinants of attractiveness: 'Functional (That looks like it works well!)', 'Symbolic (That's my kind of product!)', 'Visual Form (That looks good!)', and 'Prior Knowledge (Yes, that's the one!).' (Figure 4-9)

- Functional attractiveness: The attribute of design that makes products perform well their intended purpose. For people with no prior knowledge of a product, visual appearance is also very important for making product look like it will perform its function well. This attribute can inspire the confidence that prior use would otherwise provide.

- Symbolic attractiveness: This attribute becomes critical where appearance-value

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is an important (or all of) the reason for purchasing a product. Here the symbolic attribute of product is very important. Purchasing is inspired by the extent to which the product reflects the customer's self image and the statement that they wish the product make in the eye of others. These can be embodied by making design express more sort of symbolic statement. Examples might include, "This is a very respectable but slightly risky product and I am not old as my daughter thinks I am." This kind of statements and the images people conjure are developed and articulated by reinforcing symbolic attributes.

![Image of a face with thought bubbles: "That is my kind of product!" and "That looks good!" on the left and "Yes, That is the one!" on the right. A small black-and-white photo of a face is in the center of the thought bubbles.]

*Figure 4-9: The Four Faces of Attractiveness.*

- Inherent attractiveness of visual form: This attribute is most elusive and intangible quality at the root of visual appearance: its elegance, its beauty, its intrinsic aesthetic appeal. This is the embodiment of the perceptual, social and cultural determinants of the attractiveness of products.
• Prior knowledge attractiveness: This attribute deals with system issue, which means that design should be viewed and dealt with as one component in the systematic context of other components including user’s familiarity, visual identity with its predecessor, harmony with brand and company identity. Even if it is unique and completely new product, user must be still able to recognize what kind of product it is by providing users with its contextual hint.

Baxter’s model of Four Faces of Attractiveness shares many points with Doblin’s USA model: (Functional attractiveness with Utility, Symbolic attractiveness with Social Status, Formal attractiveness with Aesthetics).

4-2-2. Summarization of Design Attributes and Their Structural Relations

1) Summarization of Design Attributes

This section summarizes the theoretical models of design attributes reviewed in the preceding section and their structural relations.

Six models of design attributes reviewed share some similarities and have also some differences from each other. Mutual similarities and differences may be caused from the different academic backgrounds (designer, product scientists, and market researcher) or may be from some personal disposition (idealistic, criticizing, practical or theoretical).

At first, all the models are put together, and compared to find out similarities and differences. Then, it is tried to find out some common denominators so that they can be regrouped. The common denominators, meta-design attributes are again analyzed to see if there is any pattern of structural relations between them. Table 4-3 shows the list
The complexity shown in the list-up of different models of design attributes seems to make it not easy to find common denominators because clustering components can be done by various points of views: it may be grouped by the purpose of attributes, by temporal positions in the development process, by level of abstractions, or by even
authors’ professional backgrounds. Here the purpose of design attributes is used as criterion for evaluating whether design attributes belong to the same category or not. In other words, for what purpose do the design attributes exist? What are ultimate results design attributes would generate? According to this criterion, design attributes can be broadly categorized into three: namely ‘Functional’, ‘Aesthetic’, and ‘Symbolic.’ (Table 4-4)

Table 4-4: Categorization of Design Attributes

<table>
<thead>
<tr>
<th>Name of Model</th>
<th>Design Attributes</th>
<th>Functional</th>
<th>Aesthetic</th>
<th>Symbolic</th>
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<td>General Properties Model</td>
<td>Human Factors</td>
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<td>Telesis</td>
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As seen in Table 4-4, broad categorization made it inevitable to have some blurring
categorization: some attributes belong to both of aesthetic and symbolic. In addition, some attributes cannot be categorized in clear-cut mode and, in those cases, attributes were categorized in relative weights. However, even with these difficulties and limits, design attributes can be said to be comprehensively categorized into the three parameters of ‘Functional’, ‘Aesthetic’, and ‘Symbolic.’ These three categories are described in more detail in the following:

- **Functional attributes**: This is most fundamental 1st dimensional attributes which design is supposed to fulfill as existential purpose and user meets at first stage of interaction with design. This attribute can be measured objectively and quantified. This is most tangible and concrete so that designer can fairly easily simulate by drawing or mock-up. Problems can be clearly defined and the extent to which problems are solved by solution can be analytically evaluated. Engineers get involved heavily in these attributes. Without fulfillment of these attributes users hardly progress to next level of interaction with design. Usually people experience these attributes physically and homogeneously among them.

- **Aesthetic attributes**: Following functional attributes users get to experience aesthetic attributes. Attributes become more abstract and intangible, and cannot be evaluated only objectively and quantitatively. Designers can still simulate these attributes without serious difficulty by using drawing and semantic map. Problems cannot be clearly defined and pre-structured: a solution generated first and problems found later. Evaluation becomes difficult because this cannot be done mechanically or by designers but only consumers need to be involved. Stylistic designers and marketers are mainly
involved in designing these design attributes. People feel these attributes psychologically and cannot be shared with others: heterogeneous experience.

- Symbolic attributes: After long experience of the functional and aesthetic attributes, people get symbolic attributes in unconscious level. These attributes are most abstract and intangible, and cannot be consciously evaluated: these are just gradually formed. These are shared social norm and value. Simulation of this level of attributes cannot be done physically or individually. It can be done only contextually and holistically. Currently designers do not have appropriate tools for simulating symbolic attributes: scenario gives some potential. Evaluation can be done only in long term and macro level. Interdisciplinary team of conceptual designers, anthropologists, semiotician, and system analyst are major professions to deal with these level of attributes. People cannot feel these attributes by themselves but social and cultural encounter. These structural relations between three categories of attributes can be illustrated as in Figure 4-10.

![Figure 4-10: Three Design Attributes over Different Dimensions](image-url)
2) Hierarchical Structural Relations between Design Attributes

Three categories of design attributes also are mutually connected in means-end chain. As found out in the model of Gutman and Hirabayash, they are located in different hierarchical levels and the fulfillment of one level of attributes leads to next level, and without experiencing lower level of attributes, upper level of attributes seldom occurs. (Figure 4-11)

![Figure 4-11: Means-Ends Chain Relations among Three Design Attributes](image)

As seen in Figure 4-11, when people get a certain product, at first they use the product as functional object which exists for some functional performance: car for
driving, computer for information processing, spoon for eating, and so on. While interacting with product, if the existential function is not working properly, it hardly gets through to next stage of aesthetic appreciation: i.e. if car fails to drive as effectively as people expected, people usually stop there and do not proceed to their higher value appreciation. People can tell exactly the reason why they like or dislike the functional object: "I don't like my car because it only run 70 miles per hour at maximum speed."

Once people satisfied with product's basic functional attributes (means), they begin to form higher level of value (ends). They begin to give some his personal meaning to various aesthetic attributes and regard product not just as functional object but as affection conveyer: from "My car drives very fast!" to "My car is sexy!" In this affectionizing process, many other factors such as user's personality, lifestyle, and value system get involved. People can express their affective appreciation but cannot tell specifically the reason: "I feel 'sexy' about my car but I cannot tell why."

Now peoples' personal values regarding aesthetic attributes (means this time) begin to interact with socio-cultural context. All the personal values gradually emerge as socially shared value through positive and negative sanctions: "The design of your car really goes well with you" or "You as man look awkward to drive such a small pink car." Some symbolic values are kept long enough to become unconscious culture and others are kept too short to remain just as 'fashion' or 'fad'. This symbolic value is so abstract and taken for granted that people, sometimes, cannot be even aware of its existence. If we ask what style is Japanese cultural style, Japanese may not be able to articulate precisely. Only foreigners can see their style because foreigners come from a country with different social symbolic value system.
3) Design Attributes over the Product Lifecycle

Every product has lifecycle like man has their lifetime. Product passes through the series of stages (‘introduction’, ‘growing’, ‘mature’, and ‘decline’) in form and functional activity with the successive recurrences of a specified primary stage.

Three categories of design attributes play critical roles over product lifecycle as shown in Figure 4-12.

![Figure 4-12: Design Attributes over Product Life Cycle](image)

Above diagram just roughly shows how different types of attributes play different roles over the product lifecycle. In the introduction stage, when a product, for example, the radio is first introduced, people view the product as a functional object, ‘something to listen to’ and no archetype of radio is not yet formed. At first part of this stage, a product may be regarded as ‘some social status’ product. Early adopters who possess the radio unseen before are proud of having some gadget. However soon the product faces functional issues such as, in case of radio, “how clearly you can hear” or “how many
broadcasting stations your radio can access.

As product getting widely supplied, soon the competitive advantages of functional attributes become obsolete. People begin to talk about image of radio, 'cute radio', 'dynamic radio' or 'sports looking radio.' People become keenly conscious of his style and semantic properties of product. Product becomes message conveyer of owner: you can tell what type of affective value he or she has. However no aesthetic styles are yet predominant and are struggling fiercely to survive.

As product gets through long period, people begin to have consensus about product reflecting present socio-cultural values. The diversity of aesthetic attributes gets converged into few symbolic archetypes and they become iconic cultural object. People have some stereotypical image of the radio in cultural context. People no longer concern the functional performance or affective image but focus on symbolic or cultural stories accumulated deep into a product.

However, nowadays, paradigm is rapidly changing and so is the structure of design attributes. In the past, functional object and aesthetic attributes were clearly distinctive as seen in the famous slogan of “form follows function” by Louis Sullivan in the end of 19th century. All the functionality of product was crystal-clear: e.g. for rotating mechanical parts, control part is also rotating. In that case, aesthetic was nothing but ‘applying art’, that is, at first all the functional parts are finished, aesthetic attributes are simply applied later.

But, nowadays, tiny microchips replaced all the mechanical part and product becomes 'black box.' In this case of black box product, functional and aesthetic attributes are mixed up together and are not distinguished clearly. There is no clear logical connection between functional and aesthetic attributes. Moreover, in most cases of today's products,
functional excellencies in product become quickly equalized and no-differentiation factor. Relative importance is now placed on more aesthetic and symbolic attributes. (Figure 4-13)

4) Design Attributes and Design Process

Design attributes also play important role in design process. Depending on from what attribute design process is started and in what attribute design process is finished, there may be various types of design processes. (Figure 4-14)

For example if design process starts from functional attributes by analyzing mechanical parts of existing products and finishes up in developing well performing functional product, it is mainly engineering design. Design methods applied in this type of design process include ‘value engineering’, ‘stress analysis’ or ‘quality function deployment.’ (No. 1 design process in Figure 4-14)
Next, another type of design process is to start from functional attributes, and to finish at aesthetic attributes (No. 2 design process in Figure 4-14). For example, some designer can go around department store, pick up, and bring it back to their office. He may analyze the functionality, form, and color of product. Then he creates many idea sketches and finishes his design process with the nice stylish rendering. This type of design process may be called styling design process, which now most of practical designers are implementing for design development. However, this type of design process is increasingly obsolete as design paradigm changes.

Finally, the last type of design process begins from symbolic attributes and ends at symbolic attributes (No. 3 design process in Figure 4-14). A designer, or a group of interdisciplinary team of designer, social scientist, or anthropologist cautiously tracks various symptoms of symbolic signs in society, and uses them to understand why
specific aesthetic and functional attributes are in trend. Then they create some product
design which can satisfy symbolic social values they found in initial stage. However
design process is not over yet and they actually design new symbolic values as a final
goal. They design new human behavior, new story, or new experience. This kind of
design process is called ‘Human-Centered’ design process. Design starts from ‘human’
and ends with ‘human.’ This design process will be discussed later in this chapter in
more detail.

5) Design Attributes and Human Being

Three types of design attributes are more or less product-oriented. In other words,
they were developed with the concern of ‘thing’, not human being: whatever the thing is,
product or design. This is quite natural because the concept of ‘attributes’ was originally
developed in the view of product in marketing field (refer to the preceding section of
‘The Concept of Design Attributes’ in this chapter). However, it is no sense to think
design attributes without human being. After all, it is human being who will use design
attributes. This section explores the relation between design attributes and human being.

Every design attributes has different relationship with different aspect of human being.
(Figure 4-15) Human interacts with functional attributes mainly through human
physical body and conscious level of mind. For example, human being feels functional
comfortableness if he grips easily the steering wheel of car or he can easily access the
control button in machine. He can explicitly express the functional comfortableness
because the feeling is located in conscious level of human mind. If people are asked
about some functional comfortableness of some machine, almost all the answers would
be the same. Answers are objectively the same because no matter what kinds of value
system people have, the physical responses from functional attributes (e.g. hard to lift
things) are the same. And people can objectively talk about it. This is the area of body
and left-brain.

Figure 4-15: Design Attributes and Human Being.

When people interact with aesthetic attributes of design, they no longer physically
touch but feel, and try to put some meaning comparing with his personal value system.
After people got various stimuli through organs they personify the aesthetic stimuli in
the area of pre-conscious level. People know that they like or dislike but cannot
exclusively elaborate why they have such specific affective feelings. This is the area of
limited sense of affection or Japanese term, ‘KANSEI’, and right brain.

Further down, human’s personified value gradually begins to submerge deep into
unconscious level. People even are not aware of it and they can only show by behaviors
and some socio-cultural signs. This is the area of human behavior.
With this model of design attributes discussed so far, next section will deal with what types of design methods are appropriate for each area.

4-3. Design Methods for Multi-Attributes of Design

There are diverse design methods available since designers began to apply design methods for various design problems from 'the first generation-design methodology'\(^{80}\) There are arrays of design methods from which designers can choose. However, those design methods were originally developed for specific types of design problems and design attributes. It is not too much to say that finding right design methods is almost as important as the design solution. There is no 'panacea' in design methods.

Furthermore, the shift of design paradigm makes designer change his design methods too. Increasingly, conventional design methods become ineffective to new design problems. Figure 4-16 shows how design methods are changed in new design paradigm. For the functional attributes in machine age, the field of ergonomics was best tool for solving physiological problems. The reason for that is because all the problems related to the functional problems related to machine was physical: "Can people reach to control buttons?" "What is the most appropriate strength for human in the task of lifting? Designers rushed to import 'Anthropometrics' and 'Human Engineering' to design. American Designer Heny Dreyfuss was one of pioneers to introduce ergonomic concept in design.\(^{81}\)

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\(^{80}\) Cross, N. 'Developments in Design Methodology,' John Wiley & Sons, New York, 1984

\(^{81}\) Dreyfuss, Henry, 'Design for People,' The Viking Press, New York, 1974
However, things are different now. All the functional attributes related to information product (or 'bit-based product') are cognitive problems. People no longer feel physical difficulties in pressing computer keyboard or holding mobile phone. Now issues become how to understand the use of product (including software): "What are the most appropriate number of chunks for short-term memory?" or "What are the most appropriate task structure for learning software?"

Figure 4-16: Comparison of Design Methods between Machine Age and Information Age Regarding Design Attributes.

Design methods for aesthetic attributes are no longer exception. In the Machine age, people's value systems were pretty much predictable. People mostly have their value system according to demographic variables: 'age', 'sex', 'education', or 'income.' If consumer is man, his favorite style would be very masculine style (black, linear, or dynamic), and female consumer would select feminine style (pinkish, cute, or soft). So simple questionnaires with standard question like "what color is your most favorite
one?” or interview was fairly enough to study people’s perception of aesthetic attributes. However, people no longer behave and feel as they were supposed to do in the past. The more serious problem is that people cannot explicitly express their feeling in simple paper questionnaire because, as explained in the earlier section, most of those values are kept in pre-conscious level. Now we need fundamentally different design methods for studying people’s affective value.

Finally, understanding people’s symbolic behavior is even more difficult because people are not even aware of their symbolic values. However, in machine age, designers heavily relied on macro-scale trend survey such as annual consensus survey or annual lifestyle survey which produces only self-evident facts. Designers need some efficient method to understand human socio-cultural behavior. Nowadays cultural anthropologists are heavily involved in design because understanding culture is originally what they supposed to do.

In the following three sections, new design methods for three categories of design attributes will be reviewed.

4-3-1. Design Methods for Functional Aspect: Usability

As mentioned in the preceding section, the functionality in product has been rapidly changing along with the emergence of information product, because information product has capability of information handling like human processing information. In order for information product to have true sense of ‘extension of human being’, the way of information handling in product should be as similar as in human being. This can make human being have true sense of both-way interaction rather than one-way control as in machine. Now the functionality in product no longer means just ‘structural
durability' in product itself, or 'physical comfortableness' in human side. The issue is “how to enhance the functional attributes so that users can easily understand, learn, memorize the way of interacting with product.” This new issue gave birth to new concepts such as ‘usability’, ‘user-interface design’, ‘interaction design’, and ‘user-centered design.’ Among those new concepts, usability is the one that is more directly corresponding with functionality in information product. Other concepts such as user-interface design, interaction design, and user-centered design are dealing with above issue of ‘how to understand’ but they are too broad and comprehensive to be seen one of design attributes. They are whole new academic field and include ‘usability’ as one of their research topics.

1) The Concept of Usability

ISO 9241 defines usability as “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.” This definition is rather too complex to succinctly understand the concept of usability. The concept of usability has various definitions according to different views: the user-oriented view of mental effort and attitude; the user-performance view of the ease of use or acceptability; the context-oriented view of interaction between user, task, tools and environment; the quality of use view of overall system property; the semantic view of ‘easy to use’; the feature based view of usability in subject’s mind; contextual view of the factor of interaction; the product oriented view of ergonomic product attributes.\(^2\) One of the leading researchers in usability, Jacob

Nielsen also defines the usability as a composite of multiple dimensions: "usability is not a single, one-dimensional property and it has multiple components of 'learnability', 'efficiency', 'memorability', 'errors', 'satisfaction'." Shackel defines usability in rather long sentence as "usability of a system or equipment is the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfill the specified range of tasks, within the specified range of environmental scenarios," or in short "the capability to be used by humans easily and effectively."

2) Dimensions in Usability

These complex definitions show that, within the usability, there are again many dimensions: in the preceding definitions of usability, there are some common keywords like 'easily' or 'effectively.' Many usability-related researchers generated lists of usability dimensions which are mainly used as criteria or guidelines of usability evaluation. Those dimensions are summarized and briefly described as follows:

- Learnability: Easy to learn so that the user can rapidly start getting some work done with the system.
- Effectiveness: Effective to use so that users achieve specified goal with the accuracy and completeness.
- Efficiency: Efficient to use so that users expand the least amount of resources in

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relation to the accuracy and completeness.

- Memorability: Easy to remember, so that the casual user is able to return to the system after some period of not having used it, without having to learn everything all over again.

- Errors: A low error rate, so that users make few errors during the use of the system, and so that if they do make errors, they can easily recover from them.

- Satisfaction: Pleasant to use, so that users are subjectively satisfied when using it: they like it.

- Flexibility: Flexible to tasks so that users can easily adapt to tasks that system is not initially meant for.

While these dimensions of usability are developed more for evaluation, usability guidelines have been extensively dealt with in usability field more for generating usability solution by various researchers. Different usability guidelines are summarized in Table 4-5\(^5\) and briefly explained:

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- Consistency: Interface solutions holding to the same principles over a set of

individual cases or situations.

- **User Control**: The user's subjective feeling of engagement and direct manipulation, instead of merely giving the system instructions to act.

- **Appropriate Presentation**: Providing users with all necessary information including visual, audio, and tactile.

- **Error Handling and Recovery**: The ability to immediately notice and the possibility to undo erroneous action.

- **Memory-Load Reduction**: Providing only necessary information so that users' cognitive memory is not overloaded.

- **Task Match**: Providing exact information that the user needs, no more—no less in the order the user prefers to utilize it.

- **Flexibility**: The user's ability to adapt to the tasks that the system does not originally intend to have.

- **Guidance and Help**: The system's provision of appropriate help when users having difficulties.

3) **Design Methods for Usability**

Design methods for researching usability covers various methods from conventional methods like questionnaire or interview to highly analytical cognitive modeling. Design methods for usability can be categorized into different dimensions: the stage of its application (requirement stage, design & test stage, product release stage), location of study (laboratory or field study), types of data (subjective or objective), and types of measurement (qualitative or quantitative). Typical methods for researching usability includes, interview, observation, focus group, questionnaire, guidelines, prototypes,
heuristics, cognitive walkthrough, protocol analysis, cognitive modeling, and usability testing. These methods are plotted on the map with the axes of stage of design process, and quantitative vs. qualitative as shown in Figure 4-17.

![Diagram of Design Methods for Usability over Design Process]

*Figure 4-17: Design Methods for Usability over Design Process*

The design methods plotted on the map of Figure 4-17 are briefly described in the following. Interviews and questionnaires are excluded for too-well-known methods and Exploratory usability test, Assessment usability test, and Validation usability test are explained all together under Usability testing, for they are only different variation of usability testing.

- Observation: Observation is very useful method in the early of design process for understanding users' uninterrupted behavior on site. Researcher can get rich data regarding not only users but also their situational context. In additions, along with
observation, researchers usually have interviews with users for asking more comprehensive questions like "What are your main purpose of using this product?" However, observation can be done with only few samples and analyzing observed data needs highly qualitative skills. Figure 4-18 shows the sample of observation done for user playing with MP3 player. User shows some behavioral pattern of using product. This method will be more extensively dealt with in later section of user-observation.

![Figure 4-18: Observation for Understanding User's Behavior of Playing MP3.](image)

- Focus Group: This method is widely used method in marketing field for consumers' qualitative opinions on product. Group of 5-10 people are brought in the room with the one-way mirror through which focus group session can be observed and recorded. Moderator runs the focus group session and is responsible for maintaining the focus of the group and initiating the issues researchers want to know. However focus group only is not enough to get insight of users behavior and it is usually used as explanatory purpose for complementing other method.
For example, a session of focus group can be run for understanding the observed data by asking backgrounds for specific behaviors.

- Task Analysis: Task analysis is one of the key methods used in user-interface field to identify problems in user’s performing tasks. User’s goal to use the product is analyzed in terms of tasks required for achieving the goal and each task is again analyzed in terms of a sequence of action for performing task. Usually, it takes the form of table where the rows consist of actions and columns comprise of different components related to action such as user, related product component, problems occurred, and potential solutions. The list of problem found from task analysis can be transformed into user-requirements in the early stage of design problems. It can be also used as means to select the tasks for usability testing in later stage of design process.

- Usability Testing (Exploratory, Assessment, and Validation): Usability testing is perhaps the most distinguishable method used in usability research from others. Usability testing is the process that employs participants who are representative of the target population to evaluate the degree to which a product meets specific usability criteria. Usually users are brought in the laboratory with one way mirror through which all the user’s behaviors are observed and video-recorded. Users are given a set of actual tasks and perform those tasks with actual product or prototypes of varying degree of reality. Depending on the stage of design process usability testing is conducted, usability testing is again divided into ‘exploratory’, ‘assessment’ and ‘validation’ usability testing.

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Exploratory usability testing is done early stage of design process for identifying users mental model on tasks and discussing design ideas. Exploratory tests usually dictate extensive interaction between the participant and the test monitor to establish the efficacy of preliminary design concepts. To users, paper mock-up or idea sketch of computer screen (in case of software) is given, and the user would attempt to perform representative tasks. Or if it is too early to perform tasks, then the user can simply ‘walk through’ or review the product and answer questions under the guidance of a test monitor. The sample picture of exploratory usability testing is shown in Figure 4-19.

Figure 4-19: Sample Picture of Exploratory Usability Testing.\(^{87}\)

Assessment test is the most typical type of usability test conducted. Assessment tests are conducted in the middle of design process cycle, usually after the fundamental or high-level design concept has been established. User

will perform the tasks on highly realistic mock-up or computer simulated product rather than simply making comments on usability issues. The test monitor will lessen his interaction with the participants since there is less emphasis on thought process and more on actual behaviors. Data collected will be mainly quantitative data like time taken for performing task or the number of errors made during the performance of tasks. Final type of usability testing is validation usability testing. It is usually conducted either late in the development cycle or during the product-release and, as the name suggests, it is intended to certify the product's usability. Users perform tasks on realistic prototype or real product. Users are, in most cases, left alone in the laboratory to perform task without any interaction with test monitor. Most of data is quantitative data from logging of all the video tape-observation. Figure 4-20 is the sample picture of video screen recording of user performing task.

![Figure 4-20: Sample Picture of Video Screen of User Performing Task.](image)

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- Protocol Analysis: Protocol analysis is usually conducted with usability testing. User performs a task as part of a user scenario and vocalizes his or her thoughts, feelings, and opinions while interacting with the product. This method is also called ‘thinking aloud’ in the field of usability testing. With this method, researcher is able to capture preference and performance information simultaneously, rather than having to remember to ask questions about preference later. This method can also help some participants to focus and concentrate. They fall into a rhythm of working and speaking throughout the test. In addition, researcher is able to constantly receive early clues about misconceptions and confusion before they manifest as incorrect behaviors. However, this method has the disadvantage of being quite unnatural and distracting, since ‘talking alone’ is very different from their own interaction style.

- Heuristic Evaluation: This method employs a team of usability experts to identify problems in the design against a list of usability principles or heuristics. Usability heuristics are general guidelines to guide experts’ evaluation: e.g. ‘simple and natural dialogue’, ‘minimize user memory load’, ‘provide feedback’, ‘provide short cuts’, ‘prevent errors’, ‘be consistent’, ‘speak the user’s language’, or ‘good error message’. Usually experts evaluate by themselves and then compare findings. It is rather simple method but have some difficulties to find appropriate experts and experts’ evaluations don’t necessarily reflect real target users.

- Cognitive Modeling: Cognitive modeling is a technique that makes predictions about how a human activity, performed as a sequence of steps, will be performed. GOMS (Goals, Operations, Methods, Selection rules) is the one of most
representative methods in this type. However this method requires highly specialized knowledge and experiences. Also for some tasks having long sequences of actions and tasks, it takes too much time and efforts.

4) A Case Study – Development of Object-Oriented Interaction Idea Generator

In research of usability, focus has been mainly placed on the aspect of evaluation such as usability testing – how easily users can perform the tasks. However evaluation is the just one stage of design process. The other important stage is idea generation stage, searching for various design solution alternatives for given design problems. Traditionally designers have been to known as ‘idea experts’: they can quickly create ideas and visualize them, which are unique capability of designers. For idea generation designers have been mainly using ‘paper and pencil’ for simulating how product will look like. For this reason, drawing has been one of the most important skills designers should have.

However, idea generation by drawing is useful only for physical products that were used to be most cases in Machine age. Now, in information product, products are no longer physical or static: they are dynamic, constantly changing the states of product over the time when users interact with product. Consequently, drawing for simulating how it will look in static, physical product can be hardly used for idea generation of information products. Idea generation on interaction of information requires two essential elements: it should be able to simulate dynamic interaction; it should also be able to test immediately generated ideas to check the results.

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There are currently many authoring tools available such as VisualBasic™, Toolbook™, Hypercard™ and Director™ which can be used to simulate dynamic interaction. More recently prototyping programs for more specific purpose of product design became available: Rapid™ and Altia™. However those programs require too much knowledge on computer programming and they only focus on the aspect of simulation, lacking of testing function.

Computer software, PROTOBJECT, acronym of ‘Prototyping Object’ was developed for solving two main problems mentioned above: simulating dynamic interactive aspect of information product and testing immediately the ideas. PROTOBJECT, object-oriented virtual prototyping tool allows general designers to easily simulate interactive ideas, test them right away, and revise them. Interactive idea developed can be stored as an object in library so that they can be easily retrieved on demand and merged for creating new interactive objects. Created objects are simply dragged over the interface area of product image and interaction is immediately simulated.

PROTOBJECT consists of four basic modules: ‘Object Browser’, ‘Logic Linker’, ‘Visual Composer’, and ‘Tester.’ Object Browser manages and stores basic interface objects such as ‘push’, ‘rotate’, or ‘display.’ As the number of interface objects grows up, it can save meta-objects which are made by combining basic interface objects. Logic Linker allows designer to pick up some basic object interfaces from Object Browser and combine them to compose the flow of certain interface design. He can combine basic units by just drag and drop. In the module of ‘Visual Composer’, designer connects the interface he created in the module of Logic Linker with product where interface will be applied. Finally, in the module of ‘Tester’, prototype made in the module of ‘Visual Composer’ is tested to check if desirable interface is designed or not. In other words,
designer search for his objects of interface, drag them to Logic Linker and combine them, connect them with product, and simulate interface in Tester. The structure of PROTOBJECT with the relations between modules is shown in Figure 4-21.

![Diagram showing the structure of PROTOBJECT with Four Modules](image)

Figure 4-21: Structure of PROTOBJECT with Four Modules.

Each module is explained with the sample computer screen of each module from the following. Figure 4-22 shows the sample screen of Object Browser module. Small rectangular boxes are objects of basic interface. In the upper part of box, title of object is displayed. Object browser stores all the objects among which the user can drag any objects to Logic Linker for composing some interaction design. After finishing composition of new interaction design, the newly created interaction design can be saved again in Object Browser by dragging from Logic Linker and dropping to Object Browser. By this way, Object Browser keeps growing with the increasing number of objects and becomes database of interaction design.
Figure 4-22: Sample Screen of Object Browser

Figure 4-23: Sample Screen of Logic Linker.

As shown in Figure 4-23, objects dragged from Object Browser is linked together by
line for composing new interaction design. This newly composed interaction design will be applied for the product in Visual Composer Module. (Figure 4-24) The area where newly composed interaction design in Logic Linker is determined and new interaction design will be dragged on. In Figure 4-24, product where new interaction design will be applied is TV screen. The area for application is defined by making rectangular box on the TV screen.

Figure 4-24: Sample Screen of Visual Composer.

Next, finally, newly created interaction design is simulated to see if it is working well as designer intended. (Figure 4-25) If it is not, he can go back Logic Linker to change the relations between objects or return to Object Browser to add more objects to interaction design. If designer satisfies with the tested result he can put together interaction design, give name of new object, and save it back to Object Browser as shown in Figure 4-26. Designer can always retrieve this interaction design again later to
change the interaction design.

Figure 4-25: Sample Screen of Tester Module (Prototype Being Simulated)

Figure 4-26: Sample Screen of Resaving Newly Created Interaction Design.
4-3-2. Design Methods for Aesthetic Attributes: *Kansei*

In the past, machine age, the term 'aesthetic' implies only the forms, surfaces and visual or tactile boundaries of artifacts. In that sense, it was in the domain of *ontology*, the discipline concerned with what exists independent of its observation. In additions, as mentioned earlier, peoples' predictable behaviors according to their demographics also contributed to regarding aesthetic as fairly superficial thing. However, in the age of information product, aesthetic attributes are concerned with how products participate in human affairs, how they support meaningfulness, motivation and the centeredness of humans in their own world and by their own criteria. They becomes the domain of *epistemology*, the discipline concerned with how we know, and *hermeneutics*, the discipline of interpretation. They are not rational and determinable by objective criteria but symbolic and derived from individual understanding.

In 'functional attributes' discussed in the preceding section, issues are related to 'sense' that is fairly objective and quantifiably measurable. People say that something makes sense when they understand the role it plays in a particular context, when they have a satisfactory explanation of what it does. However aesthetic attributes are concerned with 'meaning' instead of sense. The meaning of something is the sum of total of all the contexts within which someone is capable of imagining some sense for it.89

The meaning of things, or mental representation has been the main concern of the discipline, 'Semiotics.' People convey ideas about things that are not materially in their presence only by calling forth an appropriate mental representation. The manner in

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which such representations are interpreted by participants in a communication system to create shared meaning can be fully understood only within the interdisciplinary context of semiotics. Mihai Nardin defines semiotics as “the general theory and practice of signs (whose scope includes) everything that is interpreted by human beings as a sign, and defines the circumstances under which interpreting something as a sign allows for its better understanding, or for an improved use of it.”90 In the mean time, a sign is defined by Charles S. Peirce as, “something that stands for someone or something in some respect or capacity.”91 The sign itself is the product of a three-way relation between representamen (that which represents), the sign’s object (that which is represented), and its mental interpretant (the situated intelligence that performs the necessary substitution of signifier for signified). (Figure 4-27)

![Diagram of Peirce's Triad Structure of Sign and Its Elements]

Figure 4-27: Peirce's Definition of Triad Structure of Sign and Its Elements

The triadic structure of the sign permits the sign process (semiosis) to be considered


as three levels. *Syntactic* addresses the internal structure of the *representamen* itself, particularly in terms of the relationships among its parts. *Semantics* addresses the tacit relation between *representamen* and *sign object* (that is intended meaning of sign). *Pragmatics* considers the effect of the *syntactic* and *semantic* aspects in relation to a particular interpreter in their personal psychological context. As shown in Figure 4-27, since each person is the product of a unique social, cultural, and experiential history, the manner in which the sign *object* is recalled by the *representamen* will be different (however slightly) for each *interpretant*.

This model of semiotic structure also implies that a same objective phenomenal *object* (aesthetic attributes) can be interpreted quite differently depending on people (*interpretant*) who read the meaning (*representamen*) differently. This model was borrowed in the design field and consequently gave birth to ‘Product Semantics’ in 1984. However, some designers welcomed a more playful use of product forms, permitting visual metaphors, similes and allegories previously banned. Some considered it an invitation to apply graphics and ornamentation to the surfaces of otherwise anonymous boxes, regardless of what they contained. Others, particularly in the business world, embraced it as a way of adding a new kind of value to a product that promised to increase sales or improve the manipulation of consumer satisfaction, turning product semantics into a kind of visual ‘double speak’.

In the mean time, Japan approached to this issue (*personal meaningful relation with object*) in another different dimension – ‘*Kansei Engineering.*’ *Kansei* is a Japanese word which does not have exact English equivalence. Some translate *Kansei* as

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93 Krippendorff, Klaus, op. cit. p. 3.
'Emotion', 'Sensitive', or 'Affective' in English but none of these exactly conveys the meaning of Kansei. The term, emotion has negative connotation as 'illogical', 'impairing rational decision making', or 'a disorganized response' while those are not true in Kansei. The term, 'affect' refers to "the user feeling good, warm, happy or the opposite as a result of interacting... (it is) independent of operational aspects and to be about plain feeling." However Kansei is more complex than plain feeling. Even with this difficulty of the concept of Kansei, Kansei Engineering has been regarded one of most promising approaches to tackle with people's meaning to object and interaction with it. Even though Kansei Engineering is not fully established field yet it is reviewed as one potential method to address the issue of design method for aesthetic attributes.

1) The Concept of Kansei

Even Japanese have difficulties to define exclusively the term 'Kansei.' Akira Harda tried to define the word Kansei by collecting definitions from the researchers who are involved in an interdisciplin ary research project. The extensive statistical method was applied to find fundamental dimensions from the collected various definitions of Kansei. The result has brought five dimensions of the meaning of Kansei.\(^\text{96}\)

a) Kansei is a subjective and unexplainable function.

b) Kansei, besides its innate nature, consists of the cognitive expression of acquired knowledge and experience.


\(^{95}\) Kirakowsky, J. 'The Software Usability Measurement Inventory: Background and Usage.' Recited from Keinonen, Turkka, op. cit. p. 50.

c) Kansei is the interaction of intuition and intelligent activity.

d) Kansei is the ability of reacting and evaluating external features intuitively.

e) Kansei is a mental function creating images.

Brief review of the definition with five dimensions of Kansei implies that it is not single, one dimensional property and has multiple components of 'subjective', 'expression of internal knowledge', 'intuition & intelligent', 'intuitive reaction against external features', and 'reflected image.' By putting together these five key dimensions the concept of Kansei can be modeled like Figure 4-28.

![Diagram of the Process of Formation of Kansei and Its Structure](image)

*Figure 4-28: The Process of Formation of Kansei and Its Structure.*

At first, person gets the external stimulus of features through human organs; then, compares it with his knowledge & experience acquired for long time; creates subjective image by interacting between intuition and intelligence; and shows intuitive reaction.
The external features can be not only visual but also auditory, tactile, or olfactory but here in this section, they are interpreted in the limited sense of visual features of aesthetic attributes.

Figure 4-28 shows the need of multi-disciplinary approach for Kansei because it embraces whole information process of human being: design, discipline concerned with creation of various external features; cognitive science or neural science, discipline concerned with mechanism of information processing; social psychology, discipline concerned with the people's knowledge and experience; cognitive psychology, discipline concerned with image and psychology; anthropology, discipline concerned with peoples' behavior (reaction). (Figure 4-29)

![Diagram showing multi-disciplines for Kansei Research.](image)

*Figure 4-29: Multi-disciplines for Kansei Research.*

These multi-disciplines for Kansei research can be categorized again into two: those concerned externally expressed Kansei and those concerned internally kept Kansei.
External Kansei research starts from human Kansei behavior and tries to dig out Kansei in human mind while Internal Kansei starts from Kansei inside human mind and tries to interpret external behavior. Design methods for Kansei Engineering are reviewed in this framework.

2) Design Methods for Kansei

Designers have been approaching to Kansei research in various ways. Among two types of Kansei research, external and internal, designers have been mainly focusing on external Kansei research: i.e. designers are more concerned externally expressed Kansei like verbal expression or image preference. In additions, recently, designers begin to join more scientific approach such as eye-tracking method for understanding people's patterns of Kansei. One from each field is reviewed in this section.

- Conjoint Analysis

Designer's first approach to Kansei research was linguistic image study. After showing different image pictures, respondents are asked a series of bi-polar adjectives. And the responses are gone through statistical analysis such as factor analysis to build semantic map for understanding relative semantic position of images. Among designers, this method is widely known as 'Semantic Differential Method' created by Charles Osgood. This method saved designers who have not been having any method to measure subjective meanings people have in their minds. However, this method has serious problem in converting verbal image into concrete forms. The main output from semantic differential method is profile chart (or called

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snake diagram for its shape like snake) of lines connecting points over bi-polar adjectives or semantic map on which verbal adjectives or images are located in bi-axes. However, these types of outputs are not able to help designers in connecting abstract verbal output into concrete form.

Conjoint Analysis was introduced to solve these problems found in Semantic Differential Method. Conjoint Analysis provides designers with how much relative importance people put in features and levels of product. By this means, designers can figure out how much contribution each feature and level of product makes to the verbal image. For example, feature of 'color' is most important factor for making people feel 'elegant' and, within the feature of 'color', for instance, 'yellow' is most contributing level. This way of analysis gives designers tool to realize the Kansei image into concrete form.

Nagamachi, Japanese researcher was one of the first researchers to apply Conjoint Analysis for design. He used 'Multiple Regression Analysis' for calculating relative importance of features and utility functions of levels of product. He even wrote computer program to lead respondents from evaluation of verbal adjective scales to automatic generation of form. In fact, he is the one of first people to name 'Kansei Engineering.' He defined Kansei Engineering as “Kansei engineering is the discipline which systematically analyzes and evaluates the Kansei people desires from artifacts and realizes the Kansei into final physical design.” In his definition, the concept of Kansei engineering is mainly focused on transforming verbal Kansei into visual form. For this type of Kansei engineering, there have been some criticisms saying that it relies on only people's verbal opinion and is limited.

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98 Nagamachi, Mitsuo, 'Kansei Engineering,' KAIBUNDO, Japan, 1989.
only around visual sense of *Kansei*. Even with these criticisms, these types of approaches have been helping in many respects for understanding people’s *Kansei* and visualizing them into forms.

The early example of this type of approach can be found in Harda’s application for ‘designing cassette tape.’ At first, he analyzed cassette tape with features (shape components) and levels: ‘window space (large, middle, small)’, ‘window position (top/bottom, center, left/right)’, ‘shape of window (large round, small round, no-round)’, ‘case structure (two direction, one direction, all around)’, ‘case color (colored, metallic color, non-chromatic)’, ‘hub shape (big, middle, small)’, and ‘point color (none, half, all).’ Then, through *Orthogonal Array* method, he generated 18 different variations of cassette tapes that have balanced number of features and levels. (Figure 4-30)

![Figure 4-30: 18 Different Cassette Tapes Generated by Orthogonal Array.](image)

Then, against every cassette tapes, respondents were asked to evaluate their preferences over 5 point Likert scale. The data of respondents’ answers were processed

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statistically through 'Quantification T' methods (Japanese statistical method similar to Conjoint Analysis) to find out utility function scores of every feature. (Figure 4-31) With utility function scores of every feature, he combined features to generate different alternative variations of cassette tapes, and among them he could select three cassette tape designs with top three highest utility function scores. (Figure 4-32)

![Figure 4-31: Utility Function Scores of Features of Cassette Tapes.](image)

![Figure 4-32: Finally Selected Three Designs with Highest Top 3 Utility Function Scores.](image)

- User's Interest Pattern Analysis: Mouse Tracking

Recently, another line of approaches to understand user's External Kansei has been introduced in the design field. Unlike verbal semantic approach reviewed in the
preceding section, this approach attempts to catch directly user’s interest pattern. The advantage of this approach lies in the point that users don’t have to express their opinion verbally or consciously evaluate their Kansei over linguistic scales. Users’ natural Kansei in mind are apt to be easily changed or distorted in the process of verbalizing their Kansei because the meaning of linguistic word may not be the same to all users. For example, imagine that users, A and B are shown some image and are asked how closely they think the image to adjective scale ‘elegant.’ To user A, the word ‘elegant’ may mean some very ‘light’ or ‘soft’ material while user B imagine ‘highly refined personality of women’ from the word ‘elegant.’ However, in case of direct observation of users’ interest pattern, users don’t have any mental load to verbally express their Kansei or to evaluate. All they have to do is just to behave as they do normally. This kind of direct observation of user’s interest pattern becomes available thanks to recent technological development like eye tracking, gaze tracking, or mouse tracking.

These types of approaches in design were undertaken as early as in the end of 1980s. Particularly, N. Hammer’s works are relevant to this approach. He used the ‘corneal reflection method’ where invisible infrared beam was mainly used to catch subject’s sight line. The main advantage of this system is that it is very comfortable for the subject as it does not require special helmets to be worn or the head to be positioned as with most systems of this kind.160

Figure 4-33 shows one example of results from his work. Hammer used jigsaw as product for experiment and asked different questions such as “which saw is easy

to handle?" or "which saw has a masculine touch?" Depending on types of question, subjects' eye movement showed different patterns and they were used to understand their Kansel.\textsuperscript{101}

![Figure 4.33: Eye Movement Patterns on Jigsaw](image)

Another way of catching user's interest pattern is to use the traces user left as a result of their behavior. For example, we can understand people's path by looking at the road made on the grass or people's social behavior from the positions of table and chairs as people left from restaurant. Mouse tracking is one of these types of approaches to understand user's behavior in interaction with computer.

Mouse tracking method refers to the record of all the traces in which user clicked mouse in the way of interacting computer. Mouse tracking method is particularly useful in understanding user's tacit behavior. Unlike user's interaction behavior with other physical product, it is hard to see any physical movement of human body in user's interaction with computer: what can be observed is only slight movement of hands and fingers for clicking or using keyboard. In that situation, mouse tracking is the best way to track where the user clicked (showed interest) and how long he stayed (how much interest user had). Mouse tracking program was developed to understand user's Kansei interest in using website. \(^{102}\) (Figure 4-34)

![Diagram](image)

**Figure 4-34: Mouse Recorder Controller and Visualized Image of Mouse Track.**

Once program is executed, 'mouse recorder controller' appears as shown in left-upper corner of Figure 4-34. From the controller, one press of the 'record' control button would record all the mouse track in the buffer of PC thereafter, and user presses the

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‘save’ control button whenever he wants to stop recording, which will result in saving mouse tracking data into file. Stored mouse tracking data can be easily retrieved by pressing ‘view’ button and all the results will be shown visually as shown in Figure 4-34.

Types of data recorded by this program are as follows:

- Mouse trace (all or parts)
- Mouse operation (left/right click, drag, scroll)
- Time taken (recorded in second and re-recorded from the new click or event)
- Total distance of trace

![Figure 4-35: Mouse Traces in Different Tasks.](image)

Figure 4-35 shows the example of application of mouse tracking program. The visualized patterns of mouse traces are shown different according to tasks. For task 1, the pattern is widely dispersed and for task 2, users used scroll bar more frequently
implying that website is too long to view in once. In task 2, mouse traces were shown heavily concentrated on upper menu implying users' narrow search pattern while in task 2, heavy congestion is shown in long-spread pattern implying wide interests.

Another type of analysis can be done using mouse tracking. Comparison between correct way of operation and actual traces users made provides designer with useful information on how, where, and what problem users have. (Figure 4-36)

![Diagram showing correct path and actual paths of Users A, B, and C.](image)

*Figure 4-36: Comparison between Correct Path and Users' Actual Paths.*

As shown in above Figure 4-36, user's behavioral patterns are quite different from each other and from correct path of operation. Users' different perceptions can be identified by different congesting areas (marked with boxes). This becomes clearer by overlapping mouse trace over actual screen image. (Figure 4-37) Various other different analyses can be possible with visualized mouse trace image.
3) Case Study: Effects of Aesthetic Attributes on User-Interface\textsuperscript{103}

The case study was undertaken to understand the effects of aesthetic attributes on user-interface. The study set the hypotheses as follows:

- A particular user-interface design of product can be represented in terms of aesthetic attributes.
- There are underlying rules to make good user-interface design in aesthetic attributes.
- Rules can be applied to identify the way of combining aesthetic attributes for

forming sound user-interface design.

The objective of the study is to set guideline of user-interface design by identifying the extent to which each aesthetic attribute contributes to usability by having users evaluate user-interface designs through computer-simulated products. Process of evaluation, as shown Figure 4-38, consists of 6 stages: defining representative sets of aesthetic attributes, designing models for evaluation, computer simulation, selecting evaluators, evaluation, and finally analysis.

![Diagram of Evaluation Process]

*Figure 4-38: Process of Evaluation.*

At the first stage, theories of aesthetic were examined to draw out essential aesthetic attributes for evaluation: form, color, graphics, and dynamics. Each attribute was subdivided in further detailed elements: size and shape for form, value and temperature for color, texture and pattern for graphic, light or flickering and movement for dynamics. Then aesthetic attributes were rearranged for defining features and levels of Conjoint
Analysis which will be used for identifying effects of aesthetic attributes on user-interface design. Features and levels for Conjoint Analysis were defined as shown in Table 4-6. Total 25 representative sets of combination of aesthetic attributes were generated by orthogonal array method of Conjoint Analysis.

Table 4-6: Features and Levels for Conjoint Analysis.

<table>
<thead>
<tr>
<th>Features</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>Single, Two, Three, Four different sizes</td>
</tr>
<tr>
<td>Shape</td>
<td>Circle, Rectangle, Two, Three, Four different shapes</td>
</tr>
<tr>
<td>Color</td>
<td>Basic gray</td>
</tr>
<tr>
<td></td>
<td>Three different grays</td>
</tr>
<tr>
<td></td>
<td>Basic gray and red</td>
</tr>
<tr>
<td></td>
<td>Basic gray and blue</td>
</tr>
<tr>
<td></td>
<td>Basic gray, red and blue</td>
</tr>
<tr>
<td>Graphic (Icon)</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Dynamic (light)</td>
<td>Yes, No</td>
</tr>
</tbody>
</table>

At the second stage, microwave oven was selected for applying 25 sets of aesthetic attributes for evaluation. Aesthetic attributes were applied only to control panels of microwave oven while other parts are remained same. The reason is that in microwave oven, control panel is the most critical differentiating determinant in user interface design. 25 representative control panels of microwave oven were generated as shown in Figure 4-39.
Figure 4-39: 25 Types of Control Panels of Microwave Ovens for Evaluation.

At the third stage, computer program UIA (User-Interface Simulation system of
Aesthetic attributes) was developed for simulating microwave ovens, recording data, analyzing, and managing experiment.

Then, at the fourth stage, 25 subjects (evaluators) were recruited. Questionnaire of true and false questions on basic knowledge of microwave oven was prepared in order to select evaluators who have similar capabilities and to minimize the individual differences.

At the fifth stage, actual experiments were conducted. For warming up and allowing the evaluators to adapt to computer-simulated products, each evaluator was given a task to set the time in computer-simulated electronic clock. After the warming up session, evaluators were given two tasks: automatic cooking and manual cooking. Figure 4-40 shows the screen of task given to the evaluators, and Figure 4-41 for a screen for analysis which shows operational path, time taken for performing tasks, the number of control buttons used, success or failure of task, and plot of actual operational path.

Figure 4-40: A Screen of Task to Evaluator.
At the sixth stage, the evaluated results were analyzed and conclusions were drawn. Time taken for performing tasks was used for input data of Conjoint Analysis for finding out how much influence each of attributes had on the usability. The analysis of data from experiment is shown in Table 4-7.

### Table 4-7: Effects of Aesthetic Attributes on User-Interface Design

<table>
<thead>
<tr>
<th>Aesthetic Attributes</th>
<th>Effects (%)</th>
<th>Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>36.18</td>
<td>Three kinds of different sizes</td>
</tr>
<tr>
<td>Shape</td>
<td>20.44</td>
<td>2-3 different shapes for differentiating functions</td>
</tr>
<tr>
<td>Color</td>
<td>33.39</td>
<td>Single basic color with another accent color for important part</td>
</tr>
<tr>
<td>Graphic</td>
<td>8.02</td>
<td>Meaningful guideline not found</td>
</tr>
<tr>
<td>Dynamics</td>
<td>1.97</td>
<td>Meaningful guideline not found</td>
</tr>
</tbody>
</table>
Table 4-7 is explained and summarized as follows:

- Size was shown to be most influencing attributes and it was followed subsequently by color, shape, graphic, and dynamics. Attributes of graphic and dynamics were found to have little influence on usability.
- The more the different kinds of sizes are, the more positive influence of size exerts on user-interface design.
- Two kinds of different shapes were shown to be the most positive in usability.
- More than three different values of colors and juxtaposition of red and blue were analyzed to show negative effects to usability. It is found that colors should be strictly applied only to parts which need to attract users’ eyes.
- Graphic and dynamics were analyzed to show contradictory results according to types of tasks, implying that effects of these attributes are not consistent and are very small enough to be negligible.

The case study shows the possibility to link aesthetic attributes to functional (usability) attributes by using computer supported experiment. However, this exploratory study needs further researches on some respects for more successful and practical application: There should be more systematic way of identifying aesthetic attributes and they should be studied in parallel with the layout of control panel and other factors of user-interface design. It also needs to be considered in much wider social context.
4-3-3. Design Methods for Symbolic Attributes: User Observation

As discussed in the earlier section, symbolic attributes in design have two distinctive characteristics: one is its 'sharedness' and the other is 'sub-consciousness.' At first, symbolic design attributes work at socio-cultural context so that they are shared among members of society and culture. It is no longer some value that individual keeps in his mind. Once a person is born, he is brought to society where he will face milliards of symbolic values of society and will acquire those as growing up by positive and negative sanctions. He may spontaneously learn that the color 'red' means 'danger' or the shape of 'linear' is for 'men.' Some of those symbolic values may be kept long without any change becoming 'tradition', and others may be disappeared ephemerally, becoming mere 'fad.' This process of birth and death of symbolic attributes is so dynamic even though there may be some differences in the speed of lifecycle depending on cultural value (as we discussed the cultural variable of 'subjugate' and 'control', or 'being', 'becoming' and 'doing' in chapter 2).

Mantovani suggested three-level model of social contexts.104 (Figure 4-42) Similar to the structural layers of culture reviewed in chapter 2, the model has hierarchical relations between levels: that is, lower levels must be at least partially satisfied before going up to next higher levels. In his model, level 1 is 'artifact level' where user mainly interacts with tools for performing task, and level 2 is 'situations level' where peoples' opportunities and interests interact together to achieve goal: everyday life. Finally level 3 consists of 'social context level' where social symbolic norm is major concern. If the

model of design attributes defined in earlier section (functional (usability), aesthetic (Kansei), and symbolic (user observation) attributes) is applied in this model, the position of symbolic attributes becomes clear. Usability of functional attributes is major concern in the level of artifact (how to interact the tool), Kansei value of aesthetic attributes is quite situational (how to perceive the situation in everyday life), and symbolic attributes belong to domain of social context (what to be socially-shared symbolic value).

![Diagram](image)

Figure 4-42: Three-Level Model of Social Context and Design Attributes

Another characteristic of symbolic attributes lies in its 'sub-consciousness.' People have been acquiring this symbolic attribute so gradually and spontaneously that they are almost unaware of them and take for granted. Usability problems can be explicitly expressed, Kansei can be tacitly expressed but symbolic attributes are latent in subconscious level. Symbolic attributes can be known only in relational context and
peoples’ natural activities and macro-trend. It is this ‘latencyness’ of symbolic attributes that requires the design methods different from other conventional methods. People’s latent needs of symbolic attributes simply cannot be understood by opinion-oriented questionnaires or focus group methods. That is why the design method of ‘user observation’ comes into being. The concept of user observation follows in next section.

1) The Concept of User Observation

In fact, people are very bad at articulating what they take for granted. They may not even be aware of their existences until they are exposed to different context where they are no longer something taken for granted. For example, a person who has been living where the color ‘red’ as ‘power-on’ has no doubt of this meaning before he goes to the other culture where the color ‘green’ stands for ‘power-on.’ He never realizes that is their own particular symbolic attribute, different from others. If designer asks people what are their particular values on symbolic attributes they are never able to tell. What they can tell is only by showing their behavior of ‘pressing red button for power-on’, since behavior is the outward result expressed from complex interaction process of conscious and sub-conscious levels.

Patton articulated the values of observing human behavior in several respects.105 First, by directly observing human activities, researcher is better able to understand the context within which behaviors are occurred. Understanding behavioral context is essential to a holistic perspective. Analogy can be drawn from the story of ‘seven blind men and elephant.’ Each blind man can describe exactly only the part of elephant but

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cannot imagine the whole picture of elephant. If designer just concentrate on user and artifact separately without viewing whole context, he will never able to build correct picture.

A second strength of direct observation is that researcher has the opportunity to see things that may routinely escape conscious awareness among people. Because all social systems involve routines, people in those routines may take them so much for granted that they cease to be aware of important nuances that are apparent only to an observer who has not become fully immersed in those routines.

Third, firsthand experience with users’ activities in context allows an observer to be open, discovery oriented, and inductive in approach. This is the case because the observer, by being on-site, has less need to rely on prior conceptualization of the activity.

A fourth value of direct observational approaches is that the evaluator can learn about things people may be unwilling to talk about in an interview. Interviewees may be unwilling to provide information on sensitive topics.

Finally, getting close to activities through firsthand experience permits the observer to access personal knowledge and direct experience as resources to aid in understanding and interpreting the symbolic meaning from activities.

Lonard and Rayport also neatly compared the traditional user-research, inquiry and observation as shown in Table 4-8. They also listed up four major advantages to get from observation: triggers of use, interactions with the user’s environment, intangible attributes of the product, and unarticulated user needs.106

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Table 4-8: Comparison between Inquiry and Observation. (Leonard D. & Rayport, J.F. op. cit. p. 111)

<table>
<thead>
<tr>
<th>Inquiry</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>People can't ask for what they don't know is technically possible.</td>
<td>Well-chosen observers have deep knowledge of corporate capabilities, including the extent of the company's technical expertise.</td>
</tr>
<tr>
<td>People are generally highly unreliable reporters of their own behavior</td>
<td>Observers rely on real actions rather than reported behavior.</td>
</tr>
<tr>
<td>People tend to give answers they think are expected or desired.</td>
<td>People are not asked to respond to verbal stimuli; they give nonverbal cues of their feelings and responses through body language, in addition to spontaneous, unsolicited comments.</td>
</tr>
<tr>
<td>People are less likely to recall their feelings about intangible characteristics of products and services when they aren't in the process of using them.</td>
<td>Using the actual product or a prototype, or engaging in the actual activity for which an innovation is being designed, stimulates comments about such intangibles as smells or emotions associated with product's use.</td>
</tr>
<tr>
<td>People's imaginations-and hence their desires-are bounded by their experience; they accept inadequacies and deficiencies in their environment as normal.</td>
<td>Trained, technically sophisticated observers can see solutions to unarticulated needs.</td>
</tr>
<tr>
<td>Questions are often biased and reflect inquirers' unrecognized assumptions.</td>
<td>Observation is open-ended and varied; trained observers tend to cancel out one another's observational biases.</td>
</tr>
<tr>
<td>Questioning interrupts the usual flow of people's natural activity.</td>
<td>Observation, while almost never totally unobtrusive, interrupts normal activities less than questioning does.</td>
</tr>
<tr>
<td>Questioning stifles opportunities for users to suggest innovations.</td>
<td>Observers in the field often identify user innovations that can be duplicated and improved for the rest of the market.</td>
</tr>
</tbody>
</table>

With the advantages of direct observation of people's activities, the concept of 'user-observation' can be referred to 'all the methods which involve in observing directly users' activities in context (or 'situated action' in Suchman's term)\(^\text{107}\) so that their latent needs can be understood.' Around middle of 1980's, the concept of user-observation was introduced in design community, and, since then, designers have been actively involving the application of user-observation method. User-observation

methods became very popular partly because 'user-centered design' or 'human-centered design' is introduced as a new design paradigm in recent years: making user central priority among consideration of product development, and fitting design to users, not the other way around. Application of user-observation for design has brought in cultural anthropologists as key member into interdisciplinary design team.

2) Design Methods for User-Observation

Observational research is not a single thing. There are many variations of user-observation methods. User-observation methods can be categorized by five variables: 'role of observer', 'portrayal of the evaluator role to others', 'portrayal of the purpose of the observation to others', and 'duration of the observation.' (Figure 4-43) The first and most fundamental distinction that differentiates observational strategies concerns the extent to which the observer will be a participant in the setting studied. This is not really simple choice between participation and nonparticipation. The extent of participation is a continuum that varies from complete immersion in the setting as full participant to complete separation from the setting as spectator. There is a great deal of variation along the continuum between these two extremes.

Second dimension of user-observation is the extent to which observers role is portrayed: overt or covert observation. A major concern about the validity and reliability of observational data concerns the effects of the observer on what is observed. The basic notion here is that people may behave quite differently when they know they are being observed compared with how they would behave if they were not aware of being

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observed: *Hawthorne effect*. Thus, the argument goes, covert observation are more likely to capture what is really happening than are overt observations when the people in the setting are aware they are being studied. However, there, the moral and ethical issues become involved. Just as participation is not an either-or proposition in observational research, so the question of how explicit to be about observations and the purpose of research is not an either-or proposition. The extent to which participants in a program under study are informed that they are being observed and are told the purpose of the research varies from full disclosure to no disclosure, with a great deal of variation along the middle of this continuum.

![Figure 4-43: Dimensions of Observation (Environment is added by author)](image)

Another important dimension along which observational studies vary is the length of time devoted to data gathering. In the anthropological tradition of field research, a participant observer would expect to spend six months at a minimum, and often years, living in the culture being observed. However, the purpose of user-observation as a design research is more modest: generating user’s behavior pattern and get insight.
Additionally, to be useful, all information should be timely. Design development cannot wait for years. Thus the duration of observation will be depend to considerable extent on the time and resources available in relation to the information needs of evaluation users.

The last dimension, observational focus is a major factor affecting each of other three dimensions reviewed above. The scope of an evaluation can be broad, encompassing virtually all aspects of the setting, or it can be narrow, involving a look at only some small part of what is happening. Particularly, the focus of observation, what to observe is very significant dimension because it is the frameworks of observation and analysis of observed data. There are two well-known frameworks of observation: AEIOU by Doblin Group, and one developed by Zeisel.

First, AEIOU is the framework developed by Doblin Group, one of the first forerunners of user-observation in design field. AEIOU is the acronym standing for 'Activity', 'Environment', 'Interaction', 'Object', and 'Users.' Activity is the primary activity and the associated activities done by users (e.g. primary: talking, associated: taking notes, interpreting, eliciting information, etc.). Environments describe the character and function of environment where activities happen (e.g. examination room, doctor’s space, patient’s space etc.). Interactions refer to the character and function of routine and special interactions between people, people and objects, over time and across distance (e.g. doctor & patient, doctor & insurance form, doctor & clinic form etc.). Objects are list of the objects involved in users’ activities including the primary objects and associated objects (e.g. primary: pen, chart, forms, associated: table, chair,

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examination table, form holders etc.). Finally, users describe who they are, what their roles are and relationships, across distance and time (doctor, patient, insurance companies, nurse etc.)

In the mean time, Zeisel listed up six ‘elements in environmental behavior observation’ including ‘who is’, ‘doing what’, ‘with whom’, ‘in what relationship’, ‘in what context’, and ‘where.’ They refer respectively to ‘actor’, ‘act’, ‘significant others’, ‘relationships (aural, visual, tactile, olfactory, symbolic)’ ‘socio-cultural context (situation, culture)’, ‘physical setting (props, spatial relations). Figure 4-44 is the one sample picture showing Zeisel’s observation frameworks.\[111\]

\[Image of a diagram showing the elements of observation framework\]

Figure 4-44: A Sample Picture Showing Zeisel’s Observation Framework.

Some representative design methods for user-observation will be reviewed in the following.

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- Video Ethnography

An emerging and useful development in design research is the application of social science methods to the study of people interacting with products, other people, and environments. Ethnography, the primary method used by anthropologists, entails observing people going about their daily activities and noting interesting behaviors.

Video ethnography refers to the method that applies video technology as a medium for getting insights on people's behaviors and needs by experiential sampling and the cultural inventory. Video ethnography has the value of the depth and richness of new insights that are transferable to the design process. It identifies key design directions, objectives and opportunities where designers can achieve the greatest impact. Particularly, video ethnographic approaches have become widely popular among designers as video technology develops wide variety of highly sophisticated video cameras in affordable prices.

Rick Robinson, founder of E-lab. (Chicago-based design consulting firm specializing user-observation) listed five advantages of video as design research tools: It is a continuous record of behavior, rather than a selective one; Video can be re-analyzed from several points of view, with different questions in mind; Viewing behaviors repeatedly reveals subtle detail and nuance; It captures significant interactions and the preceding behaviors; Videotape is a clear communication medium that can be shared, and all observations can be verified.$^{112}$

Lucy Suchman of the Xerox Palo Alto Research Center (PARC) pioneered the use of video ethnographic methods for design teams, specifically to the ease of use of a

new Xerox copier. Suchman had a variety of users attempt specific tasks with the copier. She videotaped the interactions for later analysis and she had the users articulate what they were thinking. A number of insights developed from this work which changed the design team's basic assumptions about the system. Since this successful application of video ethnographic method for design, she implemented the video ethnography for variety of projects like "Workplace Project." Table 4-9 is a sample transcript of the videotape from copier project, which shows her analytic framework.

Table 4-9: Sample Transcript of the Video Tapes from Xerox Copier Project

<table>
<thead>
<tr>
<th>The User</th>
<th>The Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not available to the machine</td>
<td>Available to the machine</td>
</tr>
<tr>
<td>Available to the machine</td>
<td>Design rationale</td>
</tr>
<tr>
<td>A: &quot;To access the BDA, pull the latch labeled Bound Document Aid&quot; (Both A and B turn to the machine)</td>
<td>Display A</td>
</tr>
<tr>
<td>(Points) Right there.</td>
<td>Display B</td>
</tr>
<tr>
<td></td>
<td>Instructions for copying bound document: Accessing the Bound Document Aid.</td>
</tr>
</tbody>
</table>

There are no established processes of video ethnography yet but, from author's empirical point of view, the process can be consisted of five stages: 'planning', 'pilot visit', 'observation', 'analysis', and 'communication.' (Figure 4-45)

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At first, in planning stage, the variables of observation are determined: the role of observer, the portrayal of observer, duration of observer and so on, shown in Figure 4-43. Overall time schedule is decided. Then, in the stage of pilot visit, observer visits the site for ‘sniffing air’ to get a feel for the space and the types of activities which occur within it. Also pilot visit makes it possible to establish technical decision regarding what types of observation and recording techniques would be appropriate. Observer should get permission for observation if necessary. Then, he can define the strategy for the follow-up detailed observation. Pilot visit is followed by conducting of actual observation(s). There are some different types of observation within video ethnography such as ‘shadow tracking’, ‘fixed camera’, ‘user-view tracking’ and so on. Observer should also decide the observation frameworks like AEIOU according to
which observation and recording are made. In the stage of analysis, videotapes are analyzed with the help of software to identify particularities and reoccurrences from video clips. Then they are analyzed into regularities and behavioral patterns which would be structuralized for modeling what observed. Finally all the findings are synthesized and transformed into design brief with various format: scenarios, series video clips, structural diagrams, behavioral prototyping, and design recommendations. This method of video ethnography will be demonstrated in detail later in the section of case study.

- Town Watching

Town watching is the design method to understand the trend in particular period by observing various images and symbolic signs of street. In town watching, town or street is viewed as a ‘mirror’ reflecting people’s lifestyle and present trend.

Town watching was originally developed in Japan, as a method of reading consumers’ unmet needs for new product planning. The strong advantage of town watching lies in its availability at any time. You don’t have to ask permission to observe, you don’t have to recruit subjects, or you don’t have to pay anything for observing. You can simply go out there and observe the street. While video ethnography focuses on concrete scope of observation (people interacting with product or people in office), and on people’s behavior in rather short term duration, the town watching is oriented for reading rather comprehensive atmosphere on street in long term duration.

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There are some variations in town watching methods: ‘fixed point method’, ‘comparison method’, and ‘detective method’. Fixed method is to have the focused observation in certain place, for example, most popular shopping center. This method focuses on observing different changes during specific period of time in place: e.g. how people’s behavior would be changed according to daytime and night.

Comparison method is useful to understand changes occurred in long-term duration. Observer can select certain street and compare the street, for example, in every month. There may be new stores coming and some stores gone, or items on displays would be seasonally changed. Usually pictures of panoramic view of street are taken regularly and pasted up on the wall for comparing them and reading changes.

As its name implies, detective method is to observe some people behaviors by following their routine activities. Observer carefully selects the target people whom he thinks are closest to his target consumer. He follows them and record what they do, how they spend time, where they visit and so on. Those observed data are re-described into scenario of their typical lifestyle. Later, researcher follows the scenario again for intensive observation. However, this method can cause some problems of ethics and morality. After observing people, observer should explain what they observed and seek for after-permission. Observer can take advantage of after-permission as interview so that he can understand the background of what he observed. Figure 4-46 shows the part of sample pictures taken from town watching which was undertaken to understand ‘music market for teen ages’\textsuperscript{116}: various places,

users and behaviors related to music activity. Later those pictures are rearranged into patterns so that observer can understand the underlying dimensions of observed data.

![Figure 4-46: Sample Pictures Taken from Town Watching for 'Teens' Music'](image)

However, even with this rather simplicity in use of town watching method, it requires well-structured plan and frameworks for its effective application. Recently, computer is actively used to make database of pictures taken from town watching. That database can be accessed through Internet, and users are allowed to surf freely those image pictures, click them if they are interested in, or they can make their story of typical everyday life by composing selected pictures. All the interaction data between user and database are saved on log file of server. The data are periodically retrieved and analyzed for finding the changes and trends.

- Scenario-Based Design\textsuperscript{117}

Scenario-based design refers to design method that applies the story-telling characteristics of scenario for the purpose of representing relationships between user, object, event, and context so that designer can get the insight from holistic

\textsuperscript{117} Lee, K.P., 'Scenario-Based Design Method for Education with the Focus on Case Study,' Proceeding of Spring Conference, Korean Society of Design Science, 2000
understanding of situation. Strictly speaking, scenario-based design itself cannot be categorized in user-observation techniques. This method is rather complementary method for user-observation method. Scenario is used for recomposing observed data from user-observation into whole integrated story by connecting fragmental observed scenes. Scenario becomes very useful tool to simulate the new design concept which is required to be represented in terms of story of users, products, and events. Designers can no longer rely on simple drawing and physical mock-up for modeling their final design solutions. New design situation is dynamic and holistic, and is constantly changing along the time dimension, which makes it impossible for 'static dead media' such as drawing or mock-up to represent design concept.

Table 4-10: Comparison of Design Representation Types

<table>
<thead>
<tr>
<th>Simulation methods</th>
<th>Users</th>
<th>Events</th>
<th>Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenarios</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Sketches &amp; Drawings</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Story boards</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>User Interface Maps</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Paper Prototypes</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Interactive Prototypes</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Physical 3D Models</td>
<td>●</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Computer Modeling</td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

There are many advantages in using scenario-based design. At first, as mentioned above, scenario can simulate more diverse elements such as users, event, design object while designer's conventional tool like drawing or mock-up, at best, can model

118 Welker, K. et al. ‘Design Scenarios,' Innovation, IDSA, Fall, 1997, pp. 24-27
only static element of designed object. (Table 4-10) Secondly, scenario way of
description can help designers to understand ‘causal relations’ between diverse
elements. This advantage can make designers understand not only the result itself but
also ‘why is that’ so that designers can get the means to identify design needs and the
background of design solutions. Finally, users can easily participate scenario-based
design. Designers can ask users to describe their behavior, lifestyle, or daily life as
scenario format from which designers can get insight of users needs and their specific
situation. Everybody can be nice ‘story teller’ about his life.

The process of scenario-based design is introduced here to real case for
demonstrating the advantages and identifying limits of scenario-based design. The
case is the educational project of junior class 'product design program' at department
of industrial design, KAIST.119 (Figure 4-47)

![Diagram: The process of Scenario-Based Design]

Figure 4-47: The process of Scenario-Based Design

The problem statement given to students was 'to design new millennium project
using scenario-based design'.

Process consists of four major steps as shown Figure 4-47. At first, users' typical situations are understood through user observation and, then, describe them as scenario for extracting users' needs. Next, partial solutions are generated for needs and finally all the partial solutions are integrated into whole scenario.

The first step of scenario-based design is to understand user's current situation around design problem. Issues of this step include how users behave in design problem, in what situation users behavior is done, how they interact each other. The most important task in this stage is to identify 'particularities' in users' behaviors. Techniques used in this step include several techniques such as video ethnography, disposable camera method where users take pictures of themselves making visual diary, and depth interview for understanding underlying reasons of their behaviors. Additionally, users can write their own scenarios describing their typical lives. Figure 4-48 is the some sample clips from videotapes taken during user observation of children hygiene behavior.

![Figure 4-48: Sample Clip of Users' Hygiene Behavior Observed by Video Ethnography](image)

In the second step of scenario-based design, regularities and patterns of user behavior are identified based on diverse data gathered in the first stage. Typical
patterns of users' behaviors are used for writing users profiles and problem scenarios. Keywords, insights, or pictures found in the step of 'understanding users' are categorized and clustered by their frequencies and relationships between them. Clusters are transformed into users' behavior patterns and, in turn, patterns are used for identifying users' representative profile. Finally, users' patterns and profiles are integrated together into scenario. Figure 4-49 shows comic type of sample scenario. In this comic strips some of users' hygiene behavior pattern are described from which particularities, problems, or provocative issues can be generated.

Figure 4-49: Sample of Comic Type of Scenario for Identifying Problems.

In the third step of scenario-based design, problems are issued through analyzing scenario described at preceding step and identifying needs and problems. A particular scene is selected to identify problems and their causal relationships, which, in turn, problems are stated. In this step, insightful problem statement is more important than
instant solution. Diverse creative and essential design solutions can be generated from the list of requirements generated from problem statements. Some of problem statements are shown in Figure 4-49.

Finally, diverse creative solutions are generated from problem statement identified from preceding step. Those partial solutions are integrated into holistic solution scenario. (Figure 4-50) At first, partial solutions regarding problem scenarios are generated by various creative problem solving techniques such as brainstorming or visualization techniques.

![Figure 4-50: Final Solution Scenario of Children Hygiene](image)

Partial solutions are transformed into partial solution scenes which will be
integrated into total solution scenario. Depending on the way of combining different partial scenarios, various solution scenarios can be generated. Those solution scenarios themselves can be used also as base for identifying another problems. This cycle of problem scenario and solution scenario is continued until satisfactory solution is generated. Solution scenario can be represented by different styles: textual sentence, comics, storyboard, picture story or optimally movie. Nowadays, this way of representing design solutions by scenario is applied for product design and software design as well where time dimension and relationships between elements are critical.

Recently, this scenario-based design method is also applied in usability testing and HCI as a way of describing users' usability problems. However, it still needs lots of time and efforts to analyze observed scenes and to generate solutions. Computer application is one of potential solutions. Particularly, network has very strong potential for users can participate to create scenario through network.

- Computer Aided Tool for Analyzing Video Data.

As argued in early section, a video ethnographic approach for user-observation are definitely very effective ways for understanding user's situated action. However, in spite of the advantages of video data it is really difficult and laborious to manage and analyze video data into meaningful findings. A researcher should spend really long and boring time in front of VCR, watching, rewinding, fast forwarding, logging, and writing down findings. After analysis of data, he frequently needs to search for

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related videotapes and go back to video clips, which requires long time and many efforts. In addition, the discontinuity over the process of viewing, logging, writing, and interpreting makes original meaning of data easily distorted. For the successful application of video ethnography, there is a need of some efficient tool to identify, annotate and manage video data. Some tools are already developed for this purpose and commercially available: CAVEAT™ developed by E-lab121, The Observer™ by Dutch company Noldus Information Technology122, MacSHAPA™ developed by Sanderson, and VESDA™ developed by Harrison123. All of these programs share in common in the fact that they are tools developed for analyzing and structuring video data. However, primary purposes and backgrounds for those programs are little bit different from each other, some for identifying needs, some for measuring behavior, some for HCI. CAVEAT is the only software developed in design context. However it lacks systematic point of view and it only works for the stage of user needs identification without having any links with remaining stages of design process.124

'VIDEOW' a computer program for analyzing video data from video ethnography was developed in Design Planning Laboratory at Korea Advanced Institute of Science and Technology. VIDEOW allows designer to very easily watch,


clip, mark, search, annotate, store, log, and edit video data collected from video ethnography right on the computer screen. This concurrency allows designer to have comprehensive contextual understanding of user behavior. It is used as not only analyzing tool but also synthesizing tool by providing designers with systematic tool to get insight on design ideas. Functions of VIDEOW are introduced in more detail with the sample computer screens.

Overall interface of VIDEOW is shown in Figure 4-51. As shown in Figure 4-51, it consists of five small windows for various functions: ‘viewer’, ‘note pad’, ‘marker’, ‘note palette,’ and ‘activity chart.’

![Diagram of VIDEOW interface]

*Figure 4-51: Interface of VIDEOW*

Designer uses Viewer to play video data which has similar interface to conventional VCR: play, stop, pause, rewind, and forward. He tries to find out some
particularities or problems from video data while watching it. If he finds some scenes interesting enough to need further analysis or note taking, he can stop and press 'stamp' button to save the clip into Marker as shown in Figure 4-52. In the Marker, designer can draw any mark like an arrow or input any text on the part that needs attention and further explanation. The thickness and color of drawing line and font of text also can be easily changed for the visibility on different color backgrounds of video clip. Then, in Note Pad, designer can input more detail notes on insight or findings from video clip according to observation frameworks like AEIOU (Activity, Environment, Interaction, Object, Users, other note and remarks).

Figure 4-52: Enlarged Part of Marker and Note Pad of VIDEOW

More frequently used notes such as 'press', 'rotate' or 'push' can be saved in Note
Palette so that designer can just drag the word from and drop to Note Pad without need to input repeatedly. Once designer finished inputting note in Note Pad, he can press ‘update’ button in left-upper corner of Note Pad. Then notes designer took on Note Pad are automatically saved in the table format of ‘Activity Chart’ as shown in Figure 4-53. Activity Chart includes all the notes written in Note Pad with video clip for which notes were taken. Notes are arranged according to frameworks same as on Note Pad. Also in the far left column, time of video clip is recorded. Designer can look at all the interesting video scenes with their note explanations in one table.

![Figure 4-53: Table Format of Activity Chart](image)

What is really good in this activity chart is that designer can re-play again any video clips by just simple clicking on video clip in Activity chart. From video clip
designer clicked, video is replayed again and analyzed in more detail. Of course, all the notes can be edited and video clips can be added and deleted on demand.

After inputting all the notes and creating Activity chart, it is the turn to analyze and find any patterns in video data. This can be also easily accomplished by ‘sorting’ function in the program. (Figure 4-54) Designer can sort any video clips and their related notes according to any frameworks. For example, if designer wants to collect all the video clips and notes of user ‘women driver’ and activity of ‘push pedal’, he just input those two words on Note Pad and press ‘search’ button. Then all the video clips with ‘women driver pushing pedal’ will be retrieved. Designer can select any number of frameworks for various aspects of data. By doing this sorting task, designer can easily find ‘pattern’ of user behavior with quantified data.

![Sorted Video Clips by the Function of 'Sorting.'](image)

Figure 4-54: Sorted Video Clips by the Function of 'Sorting.'

This patternizing function is one of the most important functions in VIDEOW. Once video data is analyzed all the analyzed video data can be saved in plain file so
that designer can export data for further statistical analysis to other statistical software like SAS or SPSS or for graphic editing for making scenario. Eventually, this leads to the establishment of video database which designer always can access easily.

This program is not necessarily limited in the application only for video ethnography. It can be also used for more micro study like usability testing where detail data on interaction between user and control panel is more important.

3) Case Study: Application of Ethnography for the User Research in Designing Korean-type High Speed Train

This section introduces the real case of ethnographic approach for demonstrating design method of user-observation. The case ethnographic research is to study user activities in natural situations in train ("Saemaul” train, first class Korean train). At first, data on passengers’ activities in Saemaul-train were collected. Then, activity model on frequent and particular activities are produced from analyzing data. By asking ‘why’ to user activities, hidden needs and ideas for the design solution were generated.

The actual process of the case study is as follows. (Figure 4-55) First, pilot test of participant observation was conducted. This contains mainly note taking and little of picture taking. This pilot test takes an important role in establishing research framework in the next step. Research framework contains ‘technical framework’ about how to apply various ethnographic techniques and ‘themetic framework’ about what to focus.

Technical framework of present ethnographic Research was decided by some criteria as project newness and degree of limitedness of worksite. By the first criterion, degree of newness of project goal, designing an interior of Korean Express train can be considered fairly new but not entirely. It is because the end goal (high-speed train) is new in Korea, but the existing train is also somewhat similar to high-speed train. By the second criterion, degree of limitedness of worksite, this project can become under perfect site-oriented project. Therefore, video ethnography had to be a major technique to apply. As a supplementary research, participant observation was also conducted to get statistical data related to numbers of people doing a kind of activities. Participant observer also took zoomed-in pictures of physical environment that are hardly caught by the fixed video camera. Interviews or other interactive techniques were not included in accordance with objectiveness of this project.

Regarding thematic framework of the project, since a passenger train consists of an interior and a corridor, two fixed cameras were needed to record people's activities in the two spaces. The activity can be divided into two kinds; chronological activity flow,
which means a person's activity flow from the point he got on the train to the point he get off the train, and synchronous activity, which means kinds of activities people doing at the same time in the one passenger train. Chronological activity flow data was effectively obtained by video ethnography and statistical data about synchronous activity was obtained by counting people doing a kind of activity by participant observer. The synchronous activity was observed around the components of physical environment, which are seat, foot rest, table, curtain, leg supporter, hanger, light, window, baggage lack and so on. Some sample pictures and notes taken in pilot visit shown in Figure 4-56.

<table>
<thead>
<tr>
<th>Scene #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
</tr>
<tr>
<td>Activity</td>
</tr>
<tr>
<td>Interact</td>
</tr>
<tr>
<td>Objects</td>
</tr>
<tr>
<td>Environment</td>
</tr>
<tr>
<td>Particularly</td>
</tr>
</tbody>
</table>

Figure 4-56: Sample Pictures and Notes Taken in Pilot Visit.

Second, the main step of ethnography, which is data collection, was conducted. Assumed that main user group of Express train will be businessmen, and they mainly use train in daytime during weekdays. Thus, data collection was conducted and repeated,
if necessary, with the basic unit of a round trip from Taejon-Seoul route (3 hours) during weekdays. Figure 4-57 shows sample video clips of a passenger who boarded in Taejon station with his friend. 18 video clips are some particularly interesting scenes that were selected from 45 minutes-long videotape for further detail analysis.

![Figure 4-57: Sample Video Clips of One Passenger with His Friend.](image)

Third, collected data was analyzed with some idea generation. User activities were analyzed by AEIOU framework. In other words, user activity should be told as a situation in which who (user) did what (activity & interaction) with what (object) in where (Environment). Then, if there is some question about why, assumed answer or particular remarks about it should be written down. These descriptions of the scene are used as sources to be developed to design ideas.

Especially, chronological activity flow was analyzed by software named "Observer" developed by Noldus Information Technology that is often used in the field of behavioral science. Chronological activities of several people in the train can effectively
be analyzed by multi-user analysis provided by the software. Figure 4-58 shows one sample screen of analysis of video data as follows:

![Sample Screen of Analysis of Video Data by Observer Program](image)

*Figure 4-58: Sample Screen of Analysis of Video Data by Observer Program.*

After having analyzed data, some patterns were discovered and some general directions were generated based on patterns found. Ideas were arranged by 'symbolic perception', 'general design direction', 'detail design ideas', and 'some other speculative ideas.' Those categories have some hierarchical continuum between them from concrete idea to abstract users' perception on some concept. Some examples of those ideas are shown in Table 4-11. And some example of design concept is also shown in Figure 4-59. The further detailed concept has not yet developed in present moment.
Table 4-11: A Sample of Idea sheet

| Symbolic Perception                          | Transporting rather than enjoyable trip  
|                                            | -nowhere to go when passengers got bored.  
|                                            | -unnecessary interaction is never happened  
| General Design Direction                    | Provide interaction with visible & amenable corridor  
|                                            | Supply some light entertainment while traveling  
| Detail design ideas                         | Clarify feedback system for toilet  
|                                            | Put a trashcan near seat  
|                                            | Emphasize information display  
|                                            | Visible table  
|                                            | Hanger per a row of seat  
|                                            | Supporter for walking passenger while train running  
|                                            | Left-Right tilting function of seats  
| Other speculative ideas                     | Separated space for family with active children  

Figure 4-59: Some Sample Ideas Developed from Analysis.

In this project, two criteria were identified through reviewing and categorizing
design project in which ethnographic research is conducted. It is also established a guideline how to apply ethnography in accordance with characteristics of the project. Then, the case study shows the concrete example of a process of an ethnographic research. Because the express train project is still progressing, analyzed data can not be included in this case study (only partly for the purpose of demonstration). After developing prototype, another round of user-observation is required for making sure if the concept is working as intended. However the second round of user-observation would be more micro-level of usability testing.

4-4. Findings and Implication.

The structure of design has been discussed in this chapter with the focus on identifying design attributes, design methods for them, and the introduction of demonstrating cases. The findings from this chapter and their implications to further remaining chapters of this study are summarized in the following. Implications from each finding are written in italic font.

• The Structure of Design

• Design consists of design attributes referring to multiple aspects of design that can be used to analyze design and compare different design alternatives. Three fundamental design attributes identified include ‘functional’, ‘aesthetic’, and ‘symbolic.’

*Three design attributes should be included in the main experiment in design side in order to compare design and culture.*

• Three design attributes of ‘functional’, ‘aesthetic’, and ‘symbolic’ are related each other as means-ends relationships. In modern design paradigm, they are concentrated respectively on ‘usability’, ‘Kansei’, and ‘user-observation.’

*In the main experiment, measurement of ‘usability’, ‘Kansei’, and ‘users’
behavior should be included and their mutual relationships should be identified in terms of means-ends relationship.

- The Design Methods for Multi-Design Attributes.
  - Usability testing, conjoint analysis, and user-observation were found to be effective design methods for studying three design attributes: functional (usability), aesthetic (Kansei), and symbolic (user-observation)

  Usability testing, conjoint analysis, and user-observation should be implemented in the main experiment for identifying subjects' characteristics regarding three design attributes.

- Case studies demonstrated the effectiveness of computer application for design methods.

  Computer application for usability testing, simulating products, and conducting surveys should be actively sought for.

With findings and implications described above, next chapter will focus on designing experiment and conducting pilot experiment. Figure 4-60 summarizes diagrammatically the findings and implications in this chapter as follows:
Figure 4-60: Summarization of Findings and Implications of Chapter 4.