

# A STUDY ON CLASSIFYING THE FORM OF MOBILE PHONES WITH “EIDETIC REDUCTION METHOD”

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## ABSTRACT:

This research suggests the method to analyze form called “eidetic reduction” to be applied for the classification of the forms of mobile phones. This approach is to recognize the essential forms or archetypes underlying the things that have been transformed and distorted by structures, colors, and materials. Considering the mobile phone to be a hexahedron, the form analysis method of “eidetic reduction” is to distinguish the archetype in terms the relation of folded edges and curved edges between the surfaces. Analyzing the forms of 288 mobile phones in current European markets, we can grasp the design form changes by different manufacturers on the basis of the most frequently applied archetypes, and the form identities of different manufacturers can be compared and analyzed. Also, by providing a perspective to the development of the archetypes which have not been applied to mobile phone design yet, differentiated forms for new design can be investigated.

**keywords:** Design Morphology, Mobile Phone Form, Analysis Methodology

# 1. INTRODUCTION

## 1.1 BACKGROUND AND OBJECTIVE OF THE RESEARCH

Form is the most basic issue in industrial design. As the structure of modern society becomes more complicated and the field of industrial design more diversified, people are actively conducting the research on design from the viewpoints of philosophy, history, culture, and business administration as well as form. This interdisciplinary research involves the application of science on design, and it starts from an object which has been designed in a certain “form”, or it is based on the final result of a design process.

This research aims to suggest standards and methods for classifying the forms of mobile phones. And it is very important to analyze products with a classification scheme. As manufacturers are unable to secure a monopolistic position, they have to compete with a number of other products in the market. To remain superiority in the competition, we need to understand and analyze the status of the product under the current market situation, and establish a design strategy for future markets while creating design road maps and trends maps. Grouping and analysis by a product classification plays an important role on activities of the in market forecasts. Specifically, as the mobile phone in modern society becomes the basic communication tool between human beings and the proper analysis of mobile phone designs leads to good designs, it is very necessary to research the form which is the most basic element in mobile phone designs.

## 1.2 THE BOUNDARY FOR THE RESEARCH

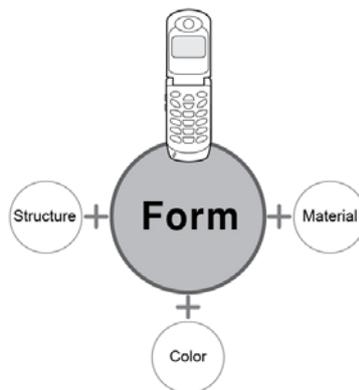


Figure 1: Research boundary

This research focuses on “the external form” of mobile phone product design. By defining the most influential element of design, among shape, color, material and structure of physical elements to be “form”, the additional influential elements can be color, material, and structure. The mobile phones analyzed will be limited to the products manufactured from 2003 to 2006 for the purpose of grasping the recent design trends of and shape changes in mobile phones.

## 1.3 THE METHOD FOR THE RESEARCH

This of the research is to define a standard for classifying mobile phone forms and analyze mobile phone products in form of the standard.

First, the method of the classification is called “eidetic reduction”, a method adopted after considering various theories in philosophy, science, and aesthetics on standards for classifying forms. Applying eidetic reduction, the form of a mobile phone can be reduced to a hexahedron based archetype, by adopting the assumption that the relation between two surfaces of a hexahedron is transformed in terms of folded edges and curved edges.

The adoption of this assumption is to introduce two dimensional mathematical equations defining the relation between the perfect square and the circle (super circle) to the understanding of the three-dimensional hexahedron. Analyzing the phenomenon in terms of the folded edge and the curved edge supports logical comparisons on the size relation of the curved surface between two surfaces of a hexahedron. Also, I verified the accuracy of the method by applying it in experiments to accurately classifying mobile phones.

Second, to practice “eidetic reduction”, I classified 288 products that 4 manufacturers released in European markets from 2003 to 2006 in term of their archetypes. Using the Classification to archetype extract the characteristics of forms applied in mobile phone designs in diachronic and synchronic analyses, and the similarities and differences between the mobile phones of different manufacturers have been deduced. Also, I suggested the potential application of the unapplied archetypes for new forms of mobile phones.

## 2. FORM ANALYSIS ON MOBILE PHONE DESIGN THROUGH EIDETIC REDUCTION

### 2.1 SUGGESTING THE VIEWPOINT

Compared to natural forms, artificial forms are extremely simple. When designers design certain objects, they express these objects with purified lines after abstracting from the concrete concepts. Though the form of a product is likely to be recognized as a complicated form that can not be easily interpreted, This phenomenon does not originate from the complexity of the basic form, but

it is because the basic form is not easily recognized after it has been transformed with functional elements and become complicated with surficial elements such as materials and colors. The complexity of a form is not the property of form itself, but it reflects the status in which function/structure and color/material are complexly applied.

The problem of recognizing complex form in design is like the problem of interpreting complex phenomena in cultural and natural sciences. Today, the world of science introduces the new paradigm of “Science of Complexity”. The terminology of “complexity” is used when considering the phenomena of the natural world, which change in accordance with simple regulations even if they look complicated and which can be simulated with simple mathematical equations. The complexity science is to find simple orders hidden in complex phenomena which seen impossible to interpret.

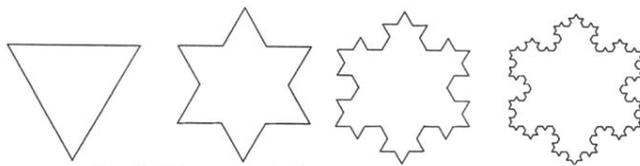


Figure 2: The formation of the pattern in compliance with the fractal structure

<sup>1</sup>In Gestalt psychology, for human beings to visually recognize an object, they form a visual field structure perception in terms of simple forms. Such recognition in terms of simple forms is called “the law of good gestalt”

Here, <sup>2</sup>Gestalt is the phenomenon in which human beings recognize the overall form first and then recognize the details through that. An observer invents minimum energy in recognizing the simplest structures which are pure and neutral, and not affected by the observes’ expectation, perception or desire.

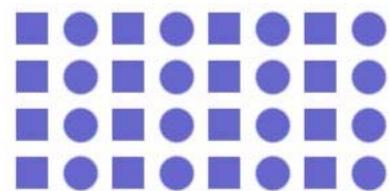


Figure 3: A case- the law of similarity

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<sup>1</sup> R. Arnheim/Kim Jae-eun (translator), *Artistic psychology*, Ewha womans univ. press, 1989, p. 416.

<sup>2</sup> Harvey Richard Schiffman, *Sensation and Perception*(4th ed), John Wiley & Sons, INC. 1996. p. 6, pp. 163-192. Margaret W. Matlin, Hugh J. Foley, *Sensation and Perception*(3th ed), Allen and Bacon, 1992. pp. 122-160 K. Koffka, *Pinciples of Gestalt Psychology*, Harcourt, Brace and Company, 1935; Wolfgang Köhler, *Gestalt Psychology*, Liveright Publishing Corporation, 1947.

The problem of understanding essential form has been examined artists from various aesthetic viewpoints. Cezanne was to grasp the essential subject while reducing the complex forms of inanimate objects into the basic figures of cylinders, cones, and archetypes. With the concept that complex forms are composed of basic figures, he applied figural interpretation on not only artificial objects, but also natural objects and human beings.



Figure 4: A figure painting and a still life painted by Cezanne

“Eidetic reduction” is a term used in phenomenology which is one of the fields of philosophy, and It refers to the method of intuiting the pure nature of eidos by reducing certain objects to their essential subject. Intuition means to recognize the essential structure of an object that has been transformed from an essence, and involves reducing from distorted forms to pure ones. To rightly understand form in design, we need to understand the same concept of eidetic reduction. In every complex phenomenon there is internal order. There is steady regulation operating behind the complexity of the form that surficially appears. Design is a forming activity, and it has to have an internal order, as a forming activity forms forming elements by forming a theory. Designers developing a design conduct a forming activity to create internal orders, whether consciously or unconsciously. Therefore, the interpretation of the designed form of a product can be fundamental interpretation that involves removing the functional and surficial elements analyzing the essential forms that contain embody certain hidden internal order.

## 2.2 RECOGNITION STANDARDS

### 1) Recognition standards on overall form by applying three dimensional concept of a super circle

To reduce the form of a mobile phone into its archetype by eidetic reduction, conceptual assumption of form changes should be made by applying the mathematical theory of two dimensional form changes to three dimensional forms.

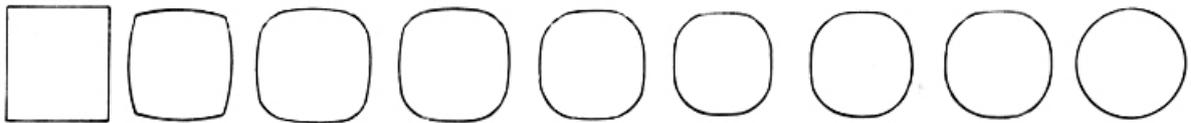


Figure 5: Form change from a perfect square to a Circle

The form change from a perfect square to a circle is effected with the change of the “N” value on the “Y” axis as the line on each corner gradually come to be curved and the vertex rounded. This indicates that the forms of rectangle and circle are recognized as having an organic relation through one formula. From the forming viewpoint, a transformed form from an certain fixed viewpoint includes the dynamic possibilities of it being reduced into a perfect square or a circle by different forces.

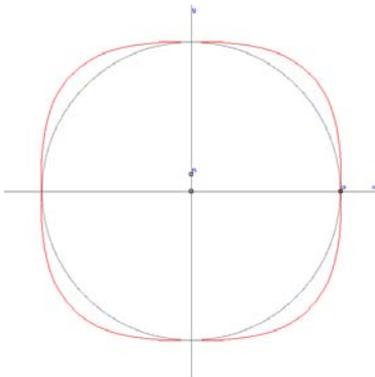


Figure 6: Form change from a perfect square to a Circle in compliance with Super circle;

$$x = a \cos^n(\theta), \quad y = a \sin^n(\theta)$$

When we apply the concept of the two dimensional form change of a super circle on a hexahedron and add three dimensional transformations, this might bring figural changes as those shown in Figure 7. This generates three dimensional form changes with changes in the basic form of the constructional elements of vertex, edge, or face. When examining the changing shape of a

section (Figure 7), the change can similarly be seen as involving gradual changes from a perfect square to a circle.

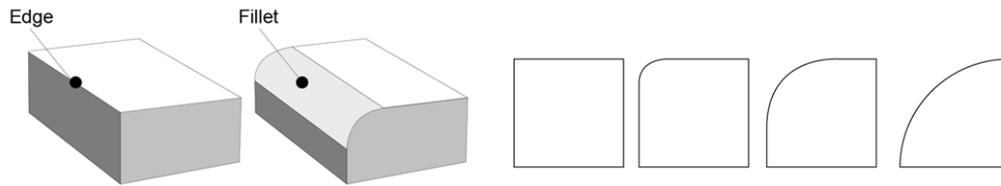


Figure 7: formation by the fillet and form changes of sections

Figure 8 shows modeling samples where the two dimensional concept of super circle is applied to three dimensional forms. The upper part shows the form changes applied with one dimension of the X axis, and the lower part shows the form changes applied with three dimensional changes in the X, Y, and Z axes. When differentiating the “N” value of the super circle applied on each surface and controlling the fillet values applied to each corner, we can analogize various forms into existence.

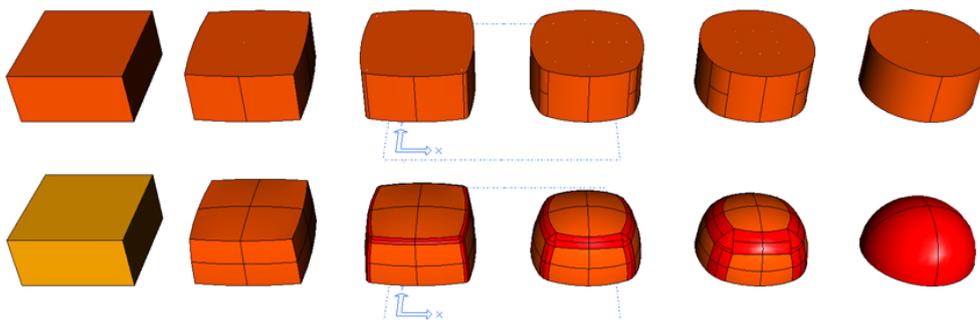


Figure 8: form changes by applying super circles to three dimensional surfaces

In conclusion, through the research above, forms from hexahedrons to spheres are not fixed, but embody the property of dynamic changes that have internal connections. Through this, forms with various curved surfaces can be reduced into a hexahedron. When this is applied to mobile phone designs, forms of mobile phones containing various curves can all be reduced to hexahedrons.

## 2) Standard on reductively recognizing edges by the different fillet values

Fillets are applied to the edges between two surfaces, Applying different fillet values to three edges creates the flow of curved surface (figure 9). A has the same fillet value applied to three edges, B has the same fillet value on two edges, and C has different fillet values on three edges.

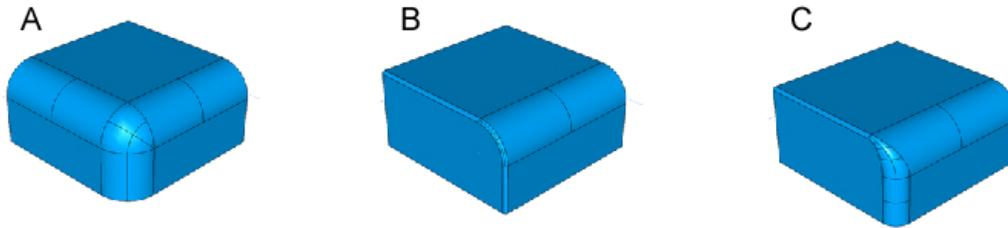


Figure 9: form of curved surfaces which three edges have

Fillets on the edges of two or three surfaces define the visual relationship between the surfaces to give a folded impression are curved impression. Comparing A and C in Figure 10, A gives the impression that one surface is bent by external force, but C gives the strong impression that one surface is folded by external force. Even though the value is small on the curved surface of B, it gives the impression of being.

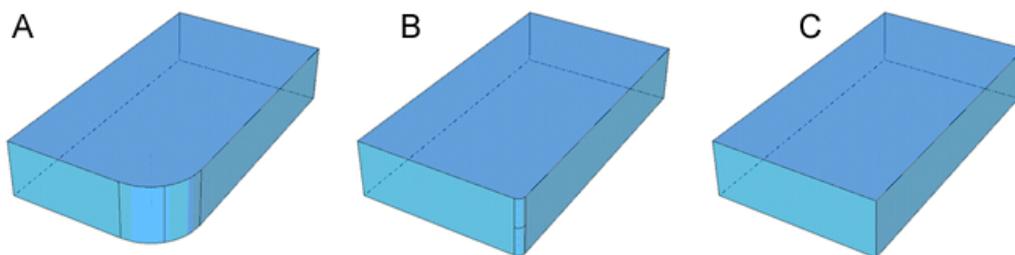


Figure 10: difference in impression by the size of curved surfaces in three edges

Therefore, changes between two surfaces are understood by being eidetically reduced into being folded or being curved.

### 3) Standard on reductively recognizing chamfer surface

In this research, Surfaces created with a chamfer is regarded as the same as surfaces created with a fillet. First the surface created with a chamfer or a fillet is a middle surface. This research is not to grasp the forms of middle surfaces, but to understand the relation between surfaces in terms of being folded or being curved within the overall form. Second, Products manufactured by injection molding isn't likely to have a perfect line on the section created with a chamfer. Unlike the chamfer of simple and firm metallic surfaces, chamfers in mobile phone designs use a straight line in small forms, but when it is applied to overall forms, curved lines are mainly used while considering the problems of constriction on a mold injection and an optical illusion where the straight line looks curved.

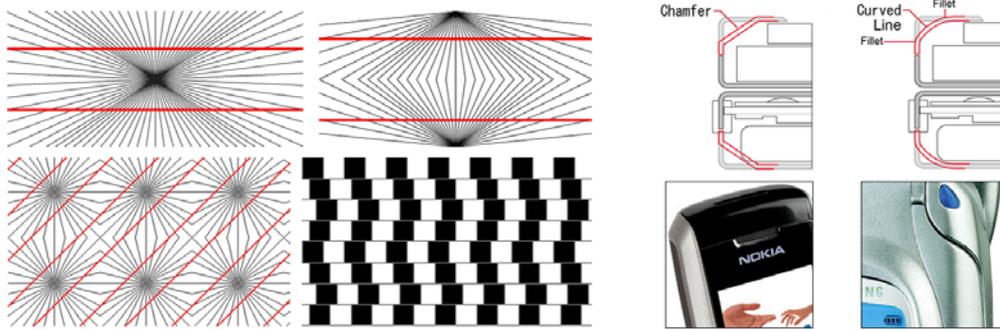


Figure 11: chamfer finishing and optical illusion of a straight line being curved by environment

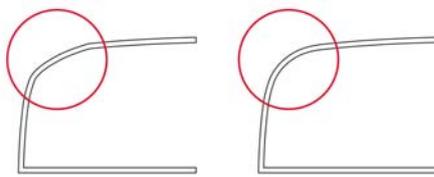


Figure 12: the middle surface created by a chamfer and a fillet is reduced to a curved surface.

### 2.3 APPLICATION METHOD

The archetypes of mobile phones can be extracted by using the following two synthetic standards for eidetic reduction.

1. All mobile phones can be reduced from hexahedrons to the basic archetypes
2. Changes between all surfaces can be reduced to a fold or a curve on an archetype.

As for the first standard, the form of a mobile phone can be reduced from a hexahedron to an archetype by applying the changing property of a super circle on each surface. The second standard is to interpret the relation between the surfaces of a hexahedron in terms of the relative size of the fillet.

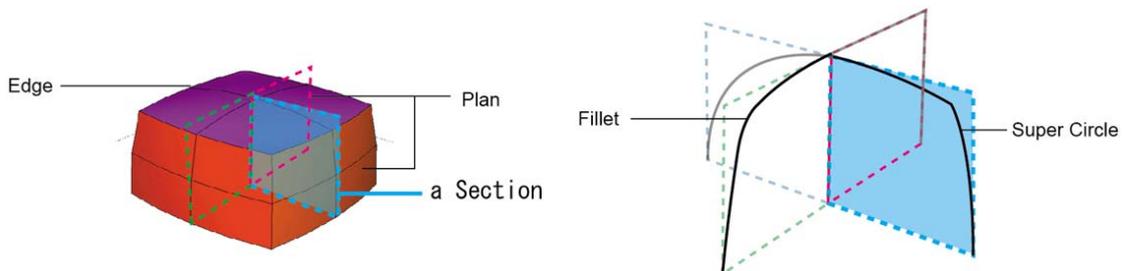


Figure 13: application of eidetic reduction being applied to a section of a solid

Applying the method above, as can be seen in figures 14 and 15, a hexahedron comes to be the various archetypes of distinguishable forms with different fillet values applied to their edges.

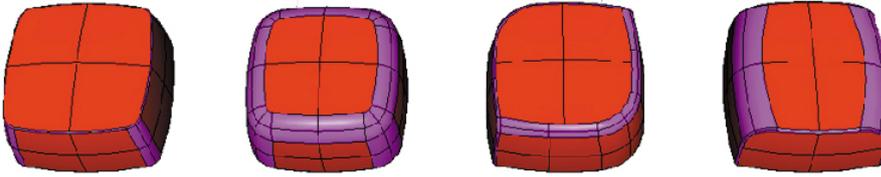


Figure 14: solid forms created by method of eidetic reduction

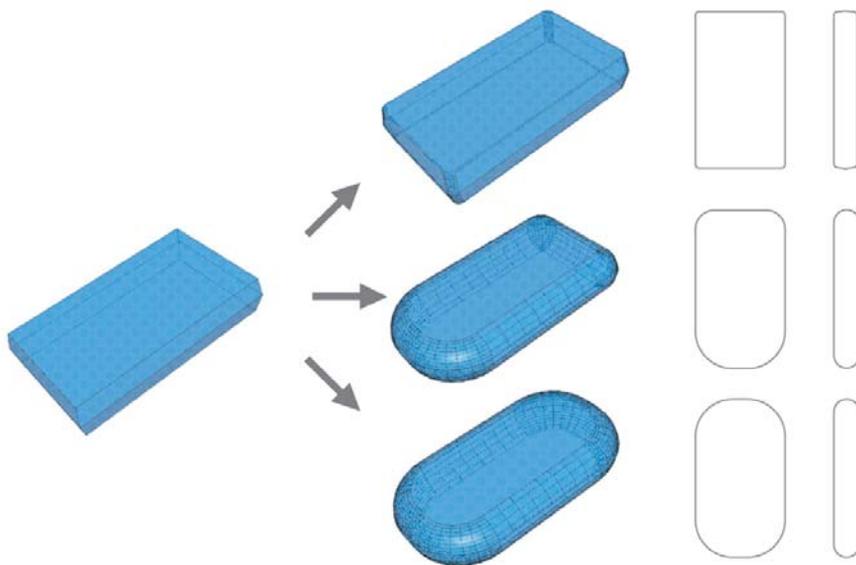


Figure 15: two and three dimensional form changes of parallelepipedon (rectangular volume) by the different fillet values

Figure 16 shows the concrete application of eidetic reduction method to extract the archetype of a mobile phone.

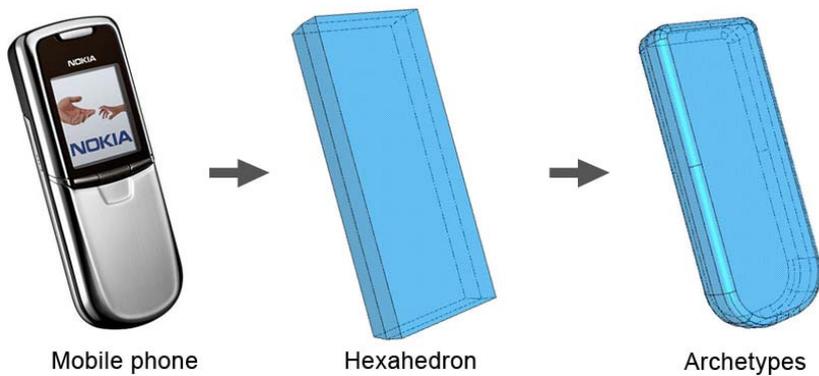


Figure 16: archetype extracting process through eidetic reduction

## 2.4 VERIFICATION

This experiment verified accuracy of the method of eidetic reduction to classify the forms of mobile phones, The impression of a surface being folded or being curved can be different for different observers, and it might be hard to decide whether a surface is folded or curved. A experiment was performed with the method shown below.

Experiment on the edge of mobile phones being classified into being folded and being curved	
Experiment type	1 to 1 interview between interviewer and interviewee
Experiment purpose	Confirm that 12 edges of mobile phone are classified into being folded and being curved
Experiment method	<p>Explain the following standards to 10 interviewees.</p> <p>① all mobile phones reduce hexahedrons to basic forms of archetypes.</p> <p>② all changes between all surfaces are reduced into archetypes of being folded and being curved.</p> <p>By observing 5 different mobile phones with suggested standards, observers will put "O" on curved impression and "X" on folded impression on the number section provided in each edge.</p>
Experiment duration	1 to 1 interview between interviewer and interviewee

Table 1: experiment plan

The result of the experiment shows that all 10 interviewees classified the edges of the mobile phones into being folded and being curved. The interviewees included 3 designers, 3 structure developers, 1 software engineer, and 3 marketers. I confirmed that designers or design related researchers as the main users are easily able to classify the forms with the standards.

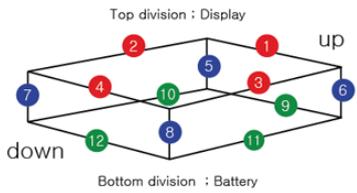


Figure 17: observation on edge part of mobile phones by an interviewee

Mobile phones tested in the experiment



The number section provided in each edge



	A												B												C												D												E											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
a	o	o	o	o																																																								
b	o	o	o	o																																																								
c	o	o	o	o																																																								
d	o	o	o	o																																																								
e	o	o	o	o																																																								
f	o	o	o	o																																																								
g	o	o	o	o																																																								
h	o	o	o	o																																																								
i	o	o	o	o																																																								
j	o	o	o	o																																																								

Table 2: experiment results

## 2.5 DETAIL CLASSIFICATION.

The property of physical form changes by the method of eidetic reduction is possible with detailed analysis while preparing the 2<sup>nd</sup> classification standard on forms within the classified samples after classifying the archetypes first.

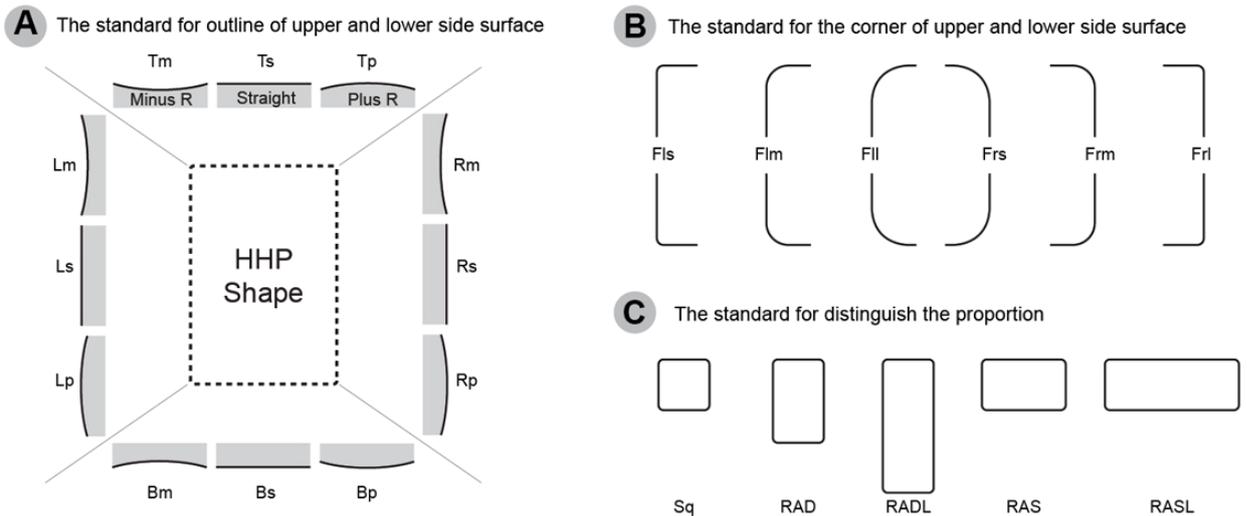


Figure 18: 2<sup>nd</sup> classification standard on forms

With the two standards provided in the preceding research for eidetic reduction, detailed analysis can be performed by integrating each outline containing plus round, minus round, transformed

round, and straight line with the integration of chamfer/fillet and integration in the standard of a straight line by the concept of transformation in a super circle while applying them with the standard of 2<sup>nd</sup> detailed classification. Mobile phones classified with the archetype can be classified or divided with the multiple applications by one of the standard of A, B, and C provided above. A is concerned about the outline of the upper and lower side surfaces, and is judged in terms of minus round, straight round, plus round, or transformed round containing a combination of minus round and plus round. B is concerned about the relative size of the curved surface of each corner of the upper and lower side surfaces, and this can be used to evaluate the sizes of the curved surfaces of the upper part and the lower part of a mobile phone, and whether the two parts are of a symmetrical shape. C is the standard for distinguishing the proportions of left/right and top/bottom, and for deciding the proportions of extension toward right/left and up/down. The mobile phones classified under the archetype of R4\_01, when performing detailed classification by the curved line on a side surface, will be arranged as shown in figure 19.

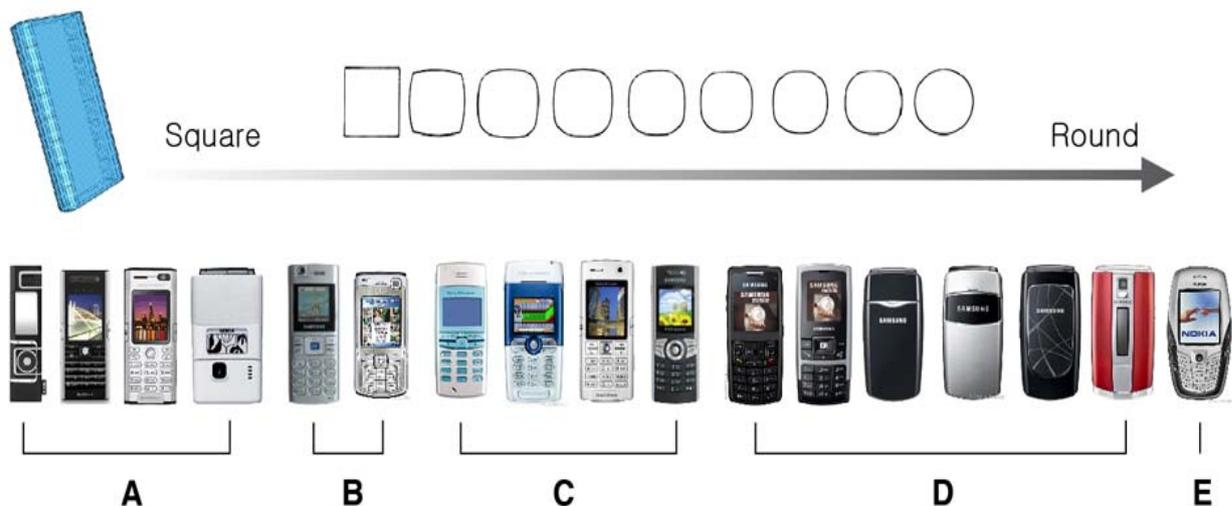


Figure 19: The classification standards on outlines of upper and lower side surface

By applying the classification standards on the outlines of the upper and lower side surfaces, I reclassified them toward the direction where the size of a straight line and that of a curved line are relatively increasing. An item in outline of a perfect square, B a curved line at the lower part, and C curved lines at the upper and lower part. An item in D has curved lines on all 4 surfaces, and E extremely curved lines on all 4 surfaces. As the classification above is a detailed classification, the archetype containing the curved flow of the left and right surfaces will be maintained regardless of the outline changes from A to E.

### 3 PRACTICAL ANALYSIS

#### 3.1 EXTRACTION ON ARCHETYPES OF MOBILE PHONE DESIGNS

The following table shows the archetypes extracted by eidetic reduction from a total of 288 mobile phones (52 from 'N' company, 69 from 'M' company, 66 from "S" company and 41 from "SE" company) released in European markets during the 4 years from 2003 to 2006.

Archetype	Applied forms	Archetype	Applied forms	Archetype	Applied forms
R0		R4_02		R8_04	
R1_01		R4_03		R8_05	
R2_01		R4_04		R8_06	
R2_02		R5_01		R8_07	
R2_03		R5_02		R8_08	
R2_04		R6_01		R9_01	
R2_05		R6_02		R10_01	
R2_06		R6_03		R10_02	
R2_07		R6_04		R10_03	
R2_08		R6_05		R10_04	
R3_01		R6_06		R11_01	
R3_02		R7_01		R12	
R3_03		R8_01			
R3_04		R8_02			
R4_01		R8_03			

Table 3: archetype analysis table through eidetic reduction

### 3.2 ANALYSIS ON MOST FREQUENTLY APPLIED ARCHETYPES

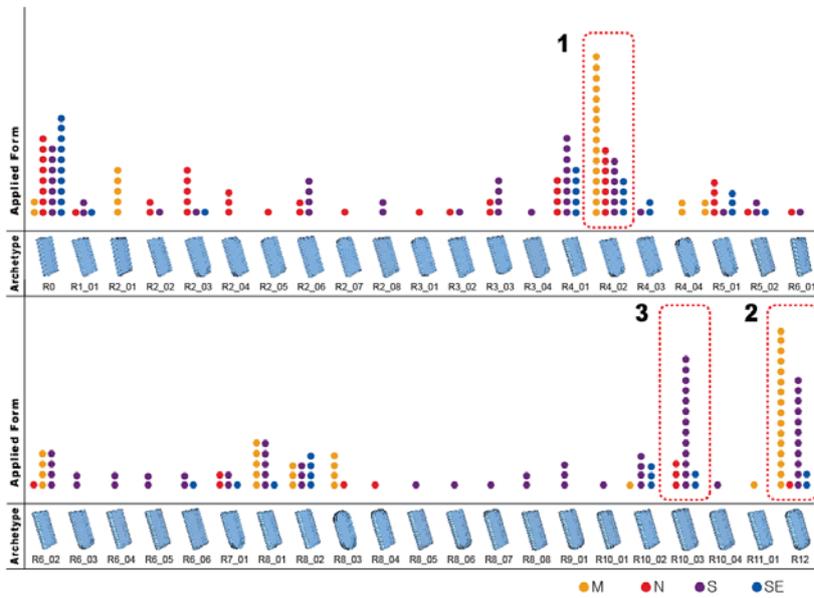


Table 4: archetype analysis graph through eidetic reduction

The graph above shows that the most frequently applied archetype of mobile phone is R4\_02 and accounts for 11.4% of all the mobile phones. Also R12 accounts for approximately 10.4%, and R10\_03 about 10%, of all the mobile phones. These three archetypes accounts for approximately 34.4% of all the mobile phones. As a matter of fact, as shown below, the mobile phones using archetypes R4\_02, R12, and R10\_03 are familiar forms to us.



Figure 20: Mobile phone being reduced to archetype

These three archetypes share the common characteristics of having big corners on the bottom curved surface at edges 8 and 9 and upper edges 1 and 9. Considering the increasing and decreasing relation of numbers on curved surface of three forms, based on a curved line of the

upper section and the lower section of R4\_02, it can be the transformation of forms created by controlling the size of curved surface going together with the side surface.

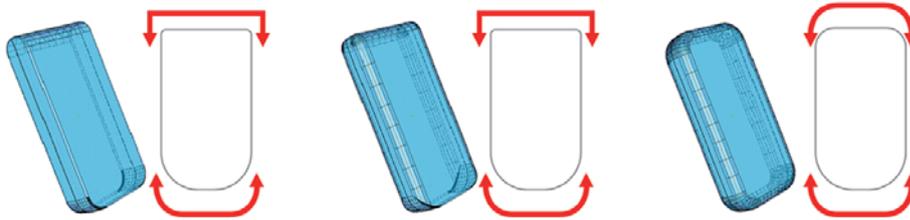


Figure 21: similarity of forms in most frequently applied archetypes

### 3.3 ANALYSIS ON CHANGES OF APPLICABLE FORMS FROM MANUFACTURERS

Based on the analysis above, when relocating the year of manufacture of the mobile phones from each manufacturer onto the Y axis, through diachronic and synchronic analysis, the change in the archetypes of the mobile designs of a certain manufacturer in each quarter of a year can be analyzed. Table 5 below shows the time frames of mobile phones from “S” company released the European region from 2003 to 2006. The forms of A and C were not applied in the first 2~3 years of the period, but they pursued the difference in design through the researches on forms that were not pursued before. B and D are the designs which the company steadily applied the same archetype for 4 years, and has high stability on structures and forms.

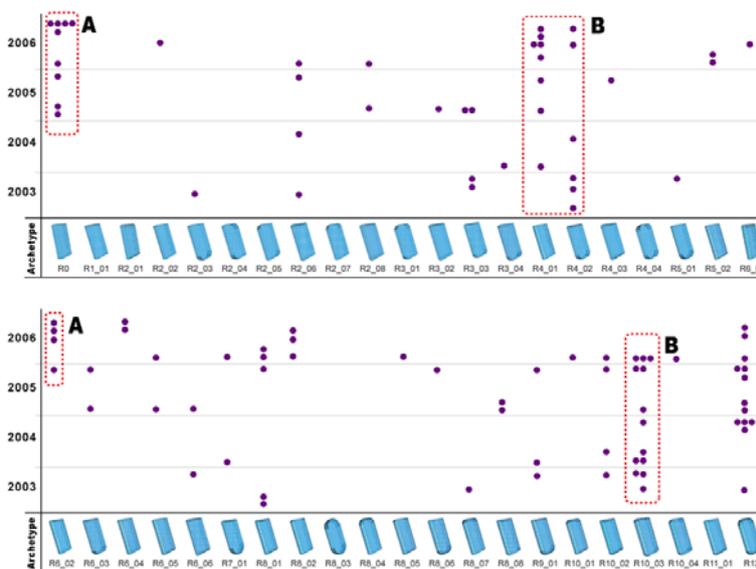


Table 5: archetype analysis graph on mobile phones manufactured by Korean “S” company for 4 years

The mobile phones on Table 6 show big differences in not only colors and materials but also in forms, as new products from “S” company the applying archetype of R0 for these in A zone and the archetype of R10\_03 for these in the D zone. By launching 6 new models in 2006 with new designs in a form area where no models had been launched before, the company seems to have completed an image innovation of its products, and imposed design restraints on manufacturers which product lineups based on the archetype of R0. Based on these examples and through comparisons and analyses of the archetypes of mobile phones from other manufacturers, image innovation of products can be strategically planned.

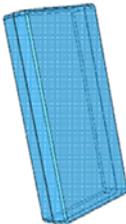
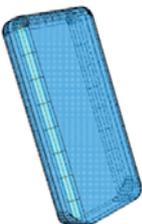
			
			
New models of 2006 based on archetype of R0		New models of 2006 based on archetype of R10_03	
		Previous models of 2006 based on archetype of R10_03	

Table 6: archetypes and mobile phones manufactured in 2006 by “S” company

### 3.4 EXPLORATION ON NEW DESIGNS AND PRACTICAL METHODS

As we calculate the possible numbers when each edge of a hexahedron is a folded edge or a curved edge, the numbers for all the archetypes of mobile phones are figured out. Mobile phones are designed to have different front and back surfaces. Item ① and ② of groups A and B matched by rotation result in different forms.

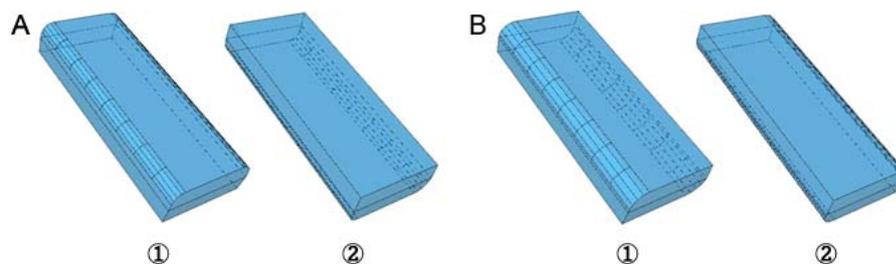


Figure 22: forms matched by rotation

Following is the result of possible numbers calculated by the numeric formula.

Curved edge	Formula	Value
0	${}^{12}C_0 = 12! / (0! * 12!)$	1
1	${}^{12}C_1 = 12! / (1! * 11!)$	12
2	${}^{12}C_2 = 12! / (2! * 10!)$	66
3	${}^{12}C_3 = 12! / (3! * 9!)$	220
4	${}^{12}C_4 = 12! / (4! * 8!)$	495
5	${}^{12}C_5 = 12! / (5! * 7!)$	792
6	${}^{12}C_6 = 12! / (6! * 6!)$	924
7	${}^{12}C_7 = 12! / (7! * 5!)$	792
8	${}^{12}C_8 = 12! / (8! * 4!)$	495
9	${}^{12}C_9 = 12! / (9! * 3!)$	220
10	${}^{12}C_{10} = 12! / (10! * 2!)$	66
11	${}^{12}C_{11} = 12! / (11! * 1!)$	12
12	${}^{12}C_{12} = 12! / (12! * 0!)$	1
<b>Total</b>		<b>4,096</b>

Table 7: possible numbers which curved surface has

“!” (Factorial) of the numerical formula below means the multiplication of natural numbers which is smaller or equals to subject number.

(assuming that  $0! = 1$ ) Ex)  $10! = 1 * 2 * \dots * 9 * 10 = 3,628,800$

② “ ${}^mC_n$ ” of the numerical formula below means the number of combination of picking up N from the mutually different M object. The order when picking up N will be ignored.

$${}^mC_n = m! / (n! * (m-n)!)$$

By the numerical formula above, as for the archetypes of mobile phones, the number of different forms is 4,096. This is the classifiable number of forms of mobile phones. The research above the classified 288 mobile phones introduced in European markets in the last 4 years under 42 archetypes. This, in other words, means that there are still more than 4000 archetypes which have not been applied to mobile phone designs yet. Therefore, I came to the conclusion that exploration of forms for new designs is possible through the research on archetypes. By developing these archetypes on the basis of the research perspective, differentiated forms for new design can be investigated.

## 4. CONCLUSION

This research suggests the method of eidetic reduction to analyze systematically the important element of the form of the mobile phone for the purpose of constructing a classification standard based on the hexahedron folded or curved surfaces. This method overcomes the narrow classification by hinge structures and enables more specific classification. And this provides chances to find more accurate way to analyze design trends and to develop design languages of mobile phone. This makes it more possible to interpret the concrete form rather than the relying on methods that use languages containing the possibility of errors or inaccurate meaning or classification, especially when the standard changes every year. Also, it contributes comparisons and analyses of the similarities and differences between classified forms.

However, there were compulsions of trends which forms were excessively simplified and understood at the process of executing and preparing the standard of analysis. Therefore, by using the method of eidetic reduction, currently I perform the succeeding researches for constructing the standard of secondary analysis and detailed classification on the classified archetypes, and the needed parts will be complimented. Also, it is true that the method of archetype analysis by eidetic method can not be the absolute solution. By the intention and the purpose of the analysis when using analysis method on language images, hinge structures, and user groups together, I think the research will be more effective with the mutually complementing processes.

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