Markets, Globalization & Development Review

Volume 4
Number 2 *Design Thinking*

Article 4

2019

How Is Design Thinking Applied at R & D Stage in the Japanese Electronics Industry?

Yasufumi Morinaga
Kyoto Sangyo University

How Is Design Thinking Applied at R & D Stage in the Japanese Electronics Industry?

Abstract

This paper clarifies how design thinking is applied at the research and development stage in the Japanese electronics industry through the Survey on Research Activities of Private Firms by the Ministry of Education, Culture, Sports, Science and Technology. Specifically, three questions are explored. Firstly, to what extent are the companies utilizing design thinking at the research and development stage? Secondly, which aspects of design thinking are they focusing on? Thirdly, is there a difference in how design thinking is used in different product fields? The paper concludes that the utilization degree of design thinking is generally not so high. Especially, designer's role of opinion adjustment by taking advantage of their visualization ability is hardly utilized. In addition, there is a difference in the usage of design thinking based on different product field. Especially, in the electronic parts and devices industry, consciousness to utilize design thinking is relatively high. On the contrary, in precision machinery industry, the priority of design thinking in the use of designers is relatively low.

Keywords

the Japanese electronics industry, design thinking, opinion adjustment, creation of originality, problem finding concerning usability

Cover Page Footnote

This work was supported by JSPS KAKENHI Grant Number 18K01775.

How Is Design Thinking Applied at R & D Stage in The Japanese Electronics Industry?

Introduction

The present study clarifies how design thinking is applied at the research and development stage in the Japanese electronics industry.

Several companies in Japan have employed in-house designers to facilitate innovation activities, which follow: research and development, product development, and commercialization.[1] Design management studies in the past have focused mainly on finding how in-house designers act at the product development stage (Morinaga 2010, 2016; Akiike and Yoshioka (Kobayashi) 2015, 2018). Therefore, designers' behavior at the research and development stage prior to product development is unclear.

Designers are known for their special abilities called "Design Thinking," such as insight, abduction, and trial-and-error problem-solving capabilities (Brown 2009). In fact, such abilities are regarded as suitable for research and development activities rather than product development activities, because, as going upstream of the innovation process, unresolved problems increase and the scope of trial and error becomes larger (Ulrich and Eppinger 2015). Moreover, since the innovative ideas created through abduction often require a major overhaul of the product interface and layout of parts, beginning work at the product development stage may often be too late (Yoshida 2007).

Theoretically, the effect of using design thinking at the research and development stage is beneficial. In addition, the intense rise in competitive environment has increased the importance of creativity and innovation. Therefore, many companies are making aggressive efforts toward design thinking, but it has not been studied so far. To what extent are the Japanese companies utilizing design thinking in the research and development stage? Which aspects of design thinking are they focusing on? Furthermore, is there a difference in how design thinking is used in different product fields? The present study focuses on the Japanese electronics industry to explore these questions.

[1]The earliest research and development are activities that create excellent ideas and technologies that form the foundation of new products and the product development that follow are activities that link these ideas and technologies to concrete product forms. Commercialization include activities that produce and sell the developed products for a profit (Konno and Takai 2010).

About the Survey

The present study clarifies how design thinking is applied at the stage of research and development in the Japanese electronics industry through a survey on research activities of private firms (SRAPF) by the Ministry of Education, Culture, Sports, Science and Technology. The electronics industry was chosen for this study because most of the electronics companies have separate design departments and many designers are involved in research and development activities.

The SRAPF uses government statistics for studying the real-life research and development activities in Japanese companies. The research includes companies with a capital of 100 million yen or more with in-house research activities. Although the SRAPF has been conducted every year since 1968, it was not until the 2008 edition that the trend in the activities of the design department came to be included in the survey (Hasegawa 2011). Then, the 2010 and 2011 editions have also included the trend in the activities of the design department. Most of the official statistics in Japan had not focused on designers' activities at the research and development stage yet. Therefore, these surveys contribute significantly to research.

However, three points must be noted when using the data provided by these surveys. The first is the difference in the nature of the data between the 2008 edition and the other editions. The data contained in the 2008 edition indicate the trends from 2005 to 2007, such as "During the research and development projects undertaken from 2005 to 2007, what is the ratio of those that involve designers in the pursuit of value creation?" On the other hand, the data included in both the 2010 and 2011 editions indicate only for a single year.

Second, there is a difference in the overall contents of questions surveyed between the 2008 edition and the others. Common question items are used in both the 2010 and 2011 editions, but are quite different from those of the 2008 edition.

The third is the difference in the methods of industry classification. In the 2008 edition, the electronics industry is classified into machinery industry, electrical machinery industry,[2] information and communication electronics equipment industry, electronic parts and devices industry, and precision machinery industry. However, in both the 2010 and the 2011 editions, seven categories instead of five are included in the electronics industry: general-purpose machinery and equipment manufacturing industry, production machinery and equipment manufacturing industry,

[2] The electrical machinery industry includes the electronics and electrical measuring equipment industry and other electrical machinery industries.

industrial machinery and equipment manufacturing industry, electrical machinery and equipment manufacturing industry, [3] information and communication electronics equipment manufacturing industry, electronic parts and devices and electronic circuits manufacturing industry, and other manufacturing industries (see Appendix for more details) .

Owing to the several differences between the 2008 edition and the other editions, it is not possible to combine them. Therefore, it is necessary to determine which among them is more suitable for the present study. The 2008 edition was chosen for the richer data in comparison with other editions, which allows for a more detailed analysis, although it is slightly dated in comparison to the other two surveys.

Measurement Method of Involvement of Designers

A total of 183 electrical companies responded to the 2008 edition. They were categorized further as follows: 69 companies in machinery industry, 49 companies in electrical machinery industry, 27 companies in information and communication electronics equipment industry, 17 companies in electronic parts and devices industry, and 21 companies precision machinery industry.

In addition, companies were surveyed regarding the purpose of involving the designers in the research and development projects and the number of projects that involved participation of the designers. Specifically, regarding the purpose of involvement, the companies are required to select all the applicable items from the following 10 alternatives: “To make own products and services differentiate from other companies (hereinafter referred to as differentiation)”; “to give amazing experiences to customers (hereinafter referred to as creation of impressiveness)”; “to provide easy-to-use to products and services (hereinafter referred to as creation of ease of use)”; “to add value to products and services (hereinafter referred to as value creation)”; “to provide originality to products and services (hereinafter referred to as creation of originality)”; “to establish a consistent corporate image (hereinafter referred to as establishment of corporate image)”; “to increase the value of corporate brand (hereinafter referred to as corporate brand value enhancement)”; “to reduce costs relating to products and services (hereinafter referred to as cost reduction)”; “to coordinate among the different opinions of the members engaged in research and development activities (hereinafter referred to as opinion adjustment)”; “to

[3] The industrial machinery and equipment manufacturing industry includes the electronics and electrical measuring equipment manufacturing industry and other electrical machinery and equipment manufacturing industries.

discover problems concerning usability of products and services (hereinafter referred to as problem finding concerning usability)".

Regarding the percentage of projects involving designers, companies were asked to choose from the following: "0% to less than 20%", "20% to less than 40%", "40% to less than 60%", "60% to less than 80%" and "80% to 100%".

From these data, the present study calculates the degree of involvement of designers in research and development activities for each purpose. The method of calculation is as follows: First, for each purpose, the value is obtained by multiplying the respective proportion of projects involving designers by the number of the companies responding to the corresponding proportion. Next, the total value is obtained by adding all these values obtained. Finally, the weighted average is obtained by dividing the total value by the total number of companies for each purpose. This average is taken as the proxy for the degree of involvement and is calculated for every purpose for the whole industry and by every category. However, since the proportion of projects with designers involved is not continuous data, the median of each level is used for scoring. For example, in the case of "0% to less than 20 %", 10 % is used as the proportion of projects with designers in them.

Results

Table 1 presents the results. First, when considering the degree of involvement for the entire electric industry, the weighted average of all purposes is 27.6%, implying that the involvement of designers in research and development projects is about 30%, on average (i.e., designers are involved in 3 out of 10 research and development projects).

However, there is some variation by single purpose. In particular, scores for the involvement purposes, such as "creation of ease of use", "differentiation," and "value creation" are relatively high. In contrast, scores for the purposes such as "opinion adjustment", "creation of impressiveness", and "establishment of corporate image" are relatively low. Furthermore, variation by category inside the industry can be noted. The precision machinery industry is the highest with 34.8%, followed by the machine industry with 29.5%, the information and communication electronics equipment industry with 27.7%, and the electrical machinery industry with 25.2%, respectively. On the contrary, the degree of involvement in the electronic parts and devices industry is the lowest with 18.5%.

Table 1. Degree of involvement of designers in research and development activities for each purpose

	machinery industry	electrical machinery industry	information and communication electronics equipment industry	electronic parts and devices industry	precision machinery industry	entire electronics industry
	n=69	n=49	n=27	n=17	n=21	n=183
differentiation	35.2	31.2	36.1	21.3	38.6	33.4
creation of impressiveness	22.8	20.5	27.1	14.3	25.3	22.3
creation of ease of use	36.0	34.9	33.0	20.0	47.1	35.2
value creation	32.5	27.7	33.0	24.1	35.3	30.8
creation of originality	30.0	22.6	26.8	18.0	30.0	26.4
establishment of corporate image	26.6	19.8	23.6	14.3	36.7	24.3
corporate brand value enhancement	27.7	21.3	25.2	18.6	33.8	25.3
cost reduction	30.6	28.8	25.4	27.3	36.0	29.7
opinion adjustment	22.0	18.6	20.4	21.4	27.5	21.3
problem finding concerning usability	30.0	24.8	26.9	22.0	34.0	27.9
average of all items	29.5	25.2	27.7	18.5	34.8	27.6

(%)

Notes: (1) Data was created from the 2008 edition of SRAPF. (2) Figures are rounded off to the second decimal place.

Subsequently, when considering the purpose-specific involvement for each industry category, certain features can be seen. In the four categories outside the electronic parts and devices industry, “creation of ease of use” and “differentiation” are the most frequent reasons to involve designers. On the other hand, different from other categories, “cost reduction”, “value creation”, and “problem finding concerning usability” score high in the electronic parts and devices industry. In addition, in the electrical machinery industry, “cost reduction” is the third highest, and in the machinery industry and information communication electronics equipment industry, “value creation” is the third highest.

In the machinery, electrical machinery, and information communication electronics equipment industries, “opinion adjustment”

ranks lowest in designer involvement, and it is second lowest in the precision machinery industry. In the electronic parts and devices and precision machine industries, “creation of impression” ranks the lowest, and it is second or third lowest in the machinery industry and the electric machinery industry. Other than in the precision machinery industry, “establishment of corporate image” is generally low, and in the electronic parts and devices industry and the precision machinery industry, “creation of originality” is the third lowest.

Discussion

Based on these findings, the degree of design thinking applied at the stage of research and development in the Japanese electronics industry is discussed. The study needs to consider what elements can be included in the concept of “design thinking”, which can be classified into the capabilities related to imagination such as insight and abduction; the ability to visualize the conversion of invisible things such as words and concepts into visuals; the ability to solve problems through trial-and-error method.

These capabilities can be regarded as strongly connected with some of the purposes surveyed in the 2008 edition of SRAPF. In particular, capabilities related to imagination such as insight and abduction are related to the “creation of originality”, the capabilities of visualization connected with “opinion adjustment”, and trial-and-error type of problem-solving capabilities related to “problem finding concerning usability”. Visualization by designers makes it easy to share images of products and services between the project members, which is useful for opinion adjustment (Isono 2014). In addition, trial and error is essential for easy problem solution (Brown 2009). Therefore, by drawing pictures or making a rough model with clay or cardboard quickly and repeatedly, designers can help to observe the scene in which the prototype is used, find problems, and improve continuously.

Based on these assumptions, the following sections discuss how design thinking is applied at the stage of research and development in the Japanese electronics industry as a whole, and how the application differs by categorization of this industry.

Focusing on the Entire Electronics Industry

First, regarding the degree of utilization of design thinking by considering the aim of involving the designers into projects for the entire electrical industry, purposes of “opinion adjustment”, “creation of originality” and “problem finding concerning usability”, which are the representatives of design thinking, rank the lowest (the last out of 10 items), the sixth and the

fifth, respectively. Therefore, these results show that the degree of utilization of design thinking is generally low. In-depth analyses reveal three implications.

First, since the purposes such as “creation of ease of use”, “differentiation” and “cost reduction” rank relatively high, it appears that the traditional roles of designers are still outstanding. It is well known that the equivalent of “creation of ease of use”, that is, User Interface (UI), has played an important role in the design department since the 1980s (Norman 1988). Traditionally, design has always referred to as the shape and color of a product, which for long time has been considered as product differentiators (Kotler and Rath 1984; Levitt 1983). Therefore, the research and development stage emphasizes the traditional roles of designers as well.

Second, the purposes such as “creation of impressiveness”, “establishment of corporate image” and “corporate brand value enhancement” rank relatively low, indicating that the Japanese companies are not highly interested. Given that “creation of impressiveness” is considered equivalent of emphasis on User Experience (UX), it suggests that there had not been a switch from UI to UX yet at the time of the survey. However, considering that the iPhone was launched in 2007, after which UX became increasingly popular, it is possible that the importance of UX was not recognized yet. Second, low concern for “establishment of corporate image” and “corporate brand value enhancement” indicates that the companies are less conscious about using design as a tool for building a corporate image and brand. This inclination may not be limited to the electrical industry alone, but is likely to be a characteristic of Japanese companies as a whole (Morinaga 2010). Japanese companies are considered as lacking consistency in designing, which is supposed to contribute to corporate image building and branding strength. It appeared true even during the survey.

Third, since “opinion adjustment” is positioned the lowest among the purposes for the involvement of designers in the electrical industry, as argued by several earlier studies, the research and development stage hardly appears to benefit from the role of opinion adjustment of the designers by applying their visualization ability. For example, Kiffin and Gardien (2009) and Leonard-Burton (1995) insist that since the visuals are primitive and strong communication tools, they function very well to help communication and coordination especially when the direction of the concept or the project is not determined, or the participating members are highly heterogeneous. In addition, in recent years, such facilitation capability of designers has become highly evaluated and expected (Shimizu

2017). However, at the time of the survey, this capability of designers was not actively utilized.

Focusing on Each Category of the Industry

This section focuses on the purpose-specific involvement of designers inside each category of the electronics industry and discusses how design thinking is used by each category and what the differences among the categories are.

First, in the machinery industry, “creation of originality” and “problem finding concerning usability” share the fifth place and “opinion adjustment” is the lowest. Second, in the electrical machinery industry, “problem finding concerning usability” and “creation of originality” are in the fifth and sixth place, respectively, and “opinion adjustment” ranks the lowest. Third, in the information and communication electronics and equipment industry, “problem finding concerning usability” and “creation of originality” are ranked fifth and sixth, respectively, and "opinion adjustment" is the lowest.

Although there are some variations in ranking for each purpose, the result for these three categories is similar to that of the electrical industry as a whole. In particular, the roles of “creation of originality” and “problem finding concerning usability” are utilized following the traditional roles of designers in the purposes such as “creation of ease of use” and “differentiation”, whereas “opinion adjustment” is not at all used. This result indicates that while the designers are expected to play a role in suggesting unique ideas or problem solving by the trial-and-error method in the aforementioned categories, the intention to use a designer as a facilitator is very low.

However, the electronic parts and devices industry as well as precision machinery industry differ in these aspects from the others. Considering the electronic parts and devices industry, it is found that “problem finding concerning usability” is ranked third, “opinion adjustment” ranked fourth, and “creation of originality” being the lowest. In other words, the designers are fairly expected to assume the facilitating roles and help find the possible usage problems through trial and error as members of the project. This result indicates that the consciousness to use design thinking when involving designers in research and development projects is relatively high, although the average degree of utilizing designers for all the purposes is generally seen less in this category (this category has the lowest average score for all the items). The relatively low resistance to the newly found functions such as design thinking might be related with the little persistence on the designers’ traditional roles in the research and development stage, since they have not been actively used as yet. However, not all the abilities

related to design thinking are in active use. “Creation of originality” ranks the lowest among all the purposes for involvement, and there is little requirement for designers to propose unique ideas.

Then, in the precision machinery industry that demonstrates the highest degree of utilization of designers among all the categories (this category has the highest average score for all the items) , “problem finding concerning usability” only ranks the sixth , “opinion adjustment” the ninth, and “creation of originality” the lowest. This result shows that the priority of design thinking in the use of designers is relatively low, although the inclination for general use is high. Compared with the use of design thinking such as having designers as facilitators or soliciting unique ideas, the traditional roles of designers, including “creation of ease of use”, “differentiation”, “establishment of corporate image”, “cost reduction”, and “corporate brand value enhancement” are overwhelmingly emphasized yet in the stage of research and development.

Future Studies

The present study clarifies how design thinking is applied at the stage of research and development in the Japanese electronics industry. Consequently, it can be seen that the degree of utilization of design thinking is generally not so high. However, since the survey on which the present study is based was conducted in the mid-2000s, it is likely that design thinking had not yet penetrated deep enough into the society. Therefore, new surveys are mandated in the future to update the data. Once sufficient data are accumulated and time series analysis become possible, the trend of how Japanese companies regard and utilize the design thinking in their research and development will be further clarified.

For reference, qualitative and fragmentary data obtained after the late 2000s show certain changes taking place in each category. In the electrical machinery industry, designers’ use of “creation of originality” should be increasing. This is because innovative ideas and concepts are becoming more important than technologies due to the decreasing rate of technological innovation in this category. In fact, the designers in one home appliance company reinvented the product of electric iron in a way of bringing more convenience to the consumers, based on user observation method (Nikkei Design 2010).

In the machinery industry and information and communication electronics equipment industry, it is likely that the opportunities for designers to act as coordinators among the participants’ different opinions are increasing. The reason is that products in these categories have become increasingly large-scaled and complex in recent years, which requires more

and diversified members to participate in the product development and in turn makes communications between more difficult. In fact, one company which received an order from a large cancer treatment facility for a heavy-ion radiotherapy system describes such a case (AXIS 2010). Because of the high number of participants (equipment and system development experts, medical professionals, and hospital construction experts), it was for a long time impossible to reach a consensus about what the system should be like. However, by adding the designers and making them visualize the alternative images that the participants have towards the system, a common language connecting the experts was created, which made it possible to summarize the concept and direction of the system.

In the electronic parts and devices industry, “creation of originality”, which previously was barely utilized, is now being seen more often. In recent years, profits and sales in this category have risen through application development, overcoming the limitations in price competition and sales expanding efforts. Therefore, creative ideas are needed to open new markets, and this task falls to designers. For instance, in one surveillance camera device company, a designer proposed the idea of mounting a camera on a balloon drone and it was commercialized successfully (Nikkei Design 2017).

Similarly, the previously underutilized “creativity of originality” is gaining ground in the precision machine industry. Because cameras and watches are seen as products related to social status, designers are still expected to perform traditional roles, such as enhancing a corporation’s image and brand value. However, since these are mature products, designers are now being expected to create more unique products. For example, a camera manufacturer accepted its designers’ suggestions to commercialize a unique compact camera that shoots six patterns at once (Nikkei Design 2016). This improved the quality and the user experience for photos posted on SNS.

References

Akiike, Atsushi and Toru Yoshioka (Kobayashi) (2015), "Engineers Who Can Produce Technology, Engineers Who Can Produce Design: Empirical Research on Effects on Design Creation in Digital Camera", *Hitotsubashi Business Review*, 64-78. https://doi.org/10.1111/j.1467-8691.2010.00560.x

Akiike, Atsushi and Toru Yoshioka (Kobayashi) (2018), "Technical Change at The Time of Design Management: A Case Study of The Digital Camera", *Akamon Management Review*, 17 (3), 1-20.

AXIS(2010) Taiwa to Keiken no Tumikasane, *AXIS,* 34-36.

Brown, Tim (2009), Change by Design, Harper Collins Publishers.

Esslinger, Hartmut (2010), A Fine Line: How Design Strategies Are Shaping the Future of Business, John Wiley & Sons.

Hasegawa, Koichi (2011), "Present State of Japanese Company's Design Management: From the Survey on Research Activities of Private Firms", *Journal of Intellectual Property Association of Japan,* 8 (1), 32-39.

Isono, Makoto (2014), The Role of Design in New Product Concept Development, Maruzen.

Kotler, Philip and Rath G. Alexander (1984), "Design: A Powerful but Neglected Strategic Tool", *The Journal of Business Strategy,* 16-21. https://doi.org/10.1108/eb039054

Kyffin, Steven and Paul Gardien (2009), "Navigating the Innovation Matrix: An Approach to Design-led Innovation", *International Journal of Design,* 3 (1), 57-69.

Konno, Tomoyuki and Fumiko Takai (2010), Core Text Innovation Management, Shinseisya.

Leonard-Burton, Dorothy (1995), Wellsprings of Knowledge: Building and Sustaining the Source of Innovation, Harvard Business School Press.

Levitt, Theodore (1983), The Marketing Imagination, The Free Press. Ministry of Education, Culture, Sports, Science and Technology "Survey on Research Activities of the Private Firms" (2008 edition, 2010 edition and 2011 edition).

Morinaga, Yasufumi (2010), Product Development Emphasized on Design: Intersection of Product Development and Brand Building, Hakutoh Shobo.

Morinaga, Yasufumi (2016), Textbook of Design Management Written by a Business Scholar, Dobunkan Publishing.

Nikkei Design (2010), “Atarimae no Design wo Utagaukoto de Jyuyo wo Horiokoshita”, *Nikkei Design*, 28-29.

Nikkei Design (2016), “Canon ni Manabu, Designer no Iyoku wo Ageruniha”, Nikkei Design, 18-20.

Nikkei Design (2017), “Design shikou Jidai no Design Bumon”, *Nikkei Design*, March, 43.

Norman, Donald A. (1988), The Psychology of Everyday Things, Basic Books.

Shimizu, Junko (2017) Graphic Recorder: Textbook for Graphic Recording to Visualize Discussion, BNN Corporation.

Ulrich, Karl T. and Steven D. Eppinger (2015), Product Design and Development, Irwin McGraw Hill.

Yoshida, Michio (2007), "Design Strategy of Samsung Electronics", *Hitotsubashi Business Review,* 36-46.

Appendix

The classification and breakdown of the electric industry in the 2008 edition, the 2010 edition and the 2011 edition of the SRAPF are as follows.

2008 edition	Breakdown	2010 and 2011 edition
Machinery Industry	Metal Processing Machines, Machines for Special Industries, Machine Tools for Office Services, Other Machinery	General-purpose Machinery and Equipment Manufacturing Industry
		Production Machinery and Equipment Manufacturing Industry
		Industrial Machinery and Equipment Manufacturing Industry
Electronics and Electrical Measuring Equipment Industry		Electronics and Electrical Measuring Equipment Manufacturing Industry
Other Electrical Machinery Industries	Industrial Electrical Machines, Consumer Electrical Machines, Electronic Calculators	Other Electrical Machinery and Equipment Manufacturing Industries
Information and Communication Electronics Equipment Industry		Information and Communication Electronics Equipment Manufacturing Industry
Electronic Parts and Device Industry		Electronic Parts and Device and Electronic Circuit Manufacturing Industry
Precision Machinery Industry	Medical Equipment, Optical Equipment :Lens, Clock, Others	Other Manufacturing Industries