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Enlargement of the Design Domain and Front-loading of Design Decision-Making in a Product Development Process

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ABSTRACT:

This paper presents a subject on enlargement of design domain as well as front loading of design decision-making of electronics industry in Japan and Europe. It also tries to introduce the method of production and operation management into design management. This research is carried out in collaboration with the partnership researchers in Europe.
Although there is no significant difference in design development process between Japanese and European companies, there are some differences in the design domain. Managing design decision-making leads the concept of front-loading of design decision-making in a product development process from the degree in a planning stage to elaborate influences of a process afterwards, which is usually accompanied by a risk. The front-loading of design decision-making performs risk reduction and enlarges the domain of design division in Japanese industry.
Keywords: Design management, Design domain, Front-loading of design decision-making

1. BACKGROUND AND METHOD OF THIS RESEARCH

In recent years, the industrial structure has changed greatly in Japan. The role in which the design plays in the alteration of an industrial structure is large. At present, IT and networking are progressing after the age of hardware, when the manufacturing enterprise bore the major industry's workload, and the role which a service industry plays became larger, changing the function that a design performs greatly. This is especially so in the field of IT related digital equipment, where the hardware ratio as an object of a design development has decreased relatively, and the software segment has increased. Now, it has rapidly shifted to hardware and software fusion type design development. In the alteration of such an industrial structure, design management must aim at a transition of knowledge with the necessity that business activity will be managed strategically and qualitatively by a design.

Generally, since business activity is always changing, the present condition is that a verification is not fully made of whether having obtained a success was due to strategy or not. Furthermore, at present such examples of success and failure are buried beneath reality, without being verified scientifically. Especially in the case of design activities in a company, as they have many trade secrets, there are very few opportunities to release them to public. In fact, whether the design management was performed as the general solution or as the special solution which took hold on the particular situation of a company has not been verified.

This research based on the interview investigation, is carried out by the authors in collaboration with the partnership researchers in Europe, and in it, the domain of design activities and an alteration of the object field are explored through the interview investigation of the design division in 13 companies of Japanese and European electronics industries.[*1] The interview investigation to Japan-Europe 13 companies is related with the design decision-making in a product development process such as,

1. Domain of design division
2. Design development process
3. Design decision-making person in charge
4. Participants of design decision-making meeting
5. Design decision-making list item
6. Methodology and tool for design decision-making

Moreover, difference between Japan and Europe about the strategic role that the design division plays in a company management is clarified. Since the design process in a company is changing together with the alteration of an industrial structure in a product development process, management of decision-making in connection with a design is mainly considered. By introducing the method of production management practice, and positively introducing "adjustment" and a "maturing" in the product development process in which Japan excelled, the conventional design domain and field are extended, and the effectiveness of the hardware and software fusion type design activities is pointed out. (Fig.1)

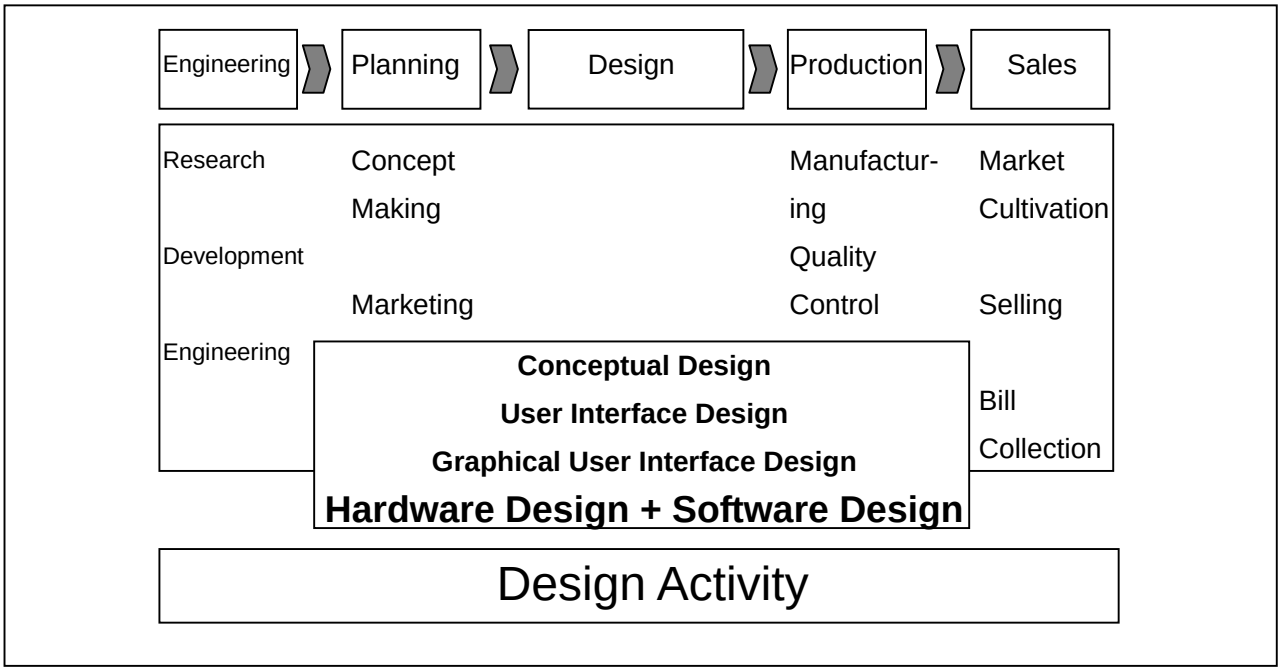

Fig.1 Hardware-Software Fusion Design Activity

2. CHANGE OF DESIGN ACTIVITIES AND DOMAIN

2.1. ALTERATION OF A DESIGN DOMAIN

Within the companies of electronics industries, as a design domain in the narrow sense, the concept of design work =modeling has been established for a long time. Now, such a design domain is already becoming out of fashion. The design domain is being enlarged positively by adopting a peripheral field and different kinds of product designs. The design domain expansion of the design division in a company is classified into 2: (1) design object domain (the product and services), (2) design activity domain (process of product developments, such as plan, design, production and sale, as design activities in a broad sense). The field for a design of the designer in a company is expanded year by year, and has spread to not only a finished product but also parts, the component, the system, and even to the services.

2.2. ENLARGEMENT OF A DESIGN DOMAIN

In the manufacturing business, the product development process is especially important in its extensive activities, also the minute differences are observed between Japanese and European companies due to the difference in the system and the climate. Particularly in Japan, service

industrializing is noticeable even in the manufacturing business, and it is impossible for the design division to attain the strategic activity only by concentrating on a product design domain. The meaning of "design" is expanded and is used as "planning," "producing," "coordinating," "editing," "making a solution," etc. (Fig. 2) It can be said that the expansion of this field is making the specialty of Japanese design ambiguous. On the other hand, in a European Company, a design division is positioned as an expert group of modeling, and in many cases an external consultant is taking charge of such activity domains. (Fig.3)

Company	Planning	Producing	Coordinating	Editing	Making a solution
J-1	○	○	○	○	○
J-2	○	○	○	○	○
J-3	○		○		
J-4	○		○	○	○
J-5	○	○	○	○	○
J-6	○		○	○	○
J-7	○		○		
J-8	○	○	○	○	○
%	100%	50%	100%	75%	75%

Fig.2 Design Domain of Japanese Electronics Industries

Company	Planning	Producing	Coordinating	Editing	Making a solution
E-1	○		○		
E-2	○		○		
E-3	○		○		
E-4	○		○		
E-5	○		○		○
%	100%	0%	100%	0%	20%

Fig.3 Design Domain of European Electronics Industries

According to “the research study about the evaluation of a design introduction effect” in 2003 by The Ministry of Economy, Trade and Industry of Japan,[*2] the field of design is positioned into two, a narrow sense of "modeling and direction for embodying a concept," and a broad sense of “plan, design and direction for embodying a concept." In addition to the brand construction and manufacturing which utilized the design in business activity, activity of distribution, services, management concept, etc. will be required as a design object domain. Furthermore, the result of the questionnaire for 100 companies which won ‘Good Design Award’ in the ‘Director General Special Prize for Medium and Small Companies’ in the past ten years shows that the effectiveness of a design setup is generally perceived not only by economical effectiveness but also effectiveness in product development power, in an image brand side, and of the consciousness and the climate side of a company. [*3] (Fig.4)

As for the limit of the design activities with which a design division (designer) deals, "market research," "the concept making," "the design of goods," "engineering," "the prototyping," etc. are ranked within the high order. 40% of above mentioned companies’ designers are engaged in the “market research,” more than 50% in "the concept making." It can be said that this shows that design activities and the design domain are focused on the early stages of a business activity and a product development process. It also shows that the content concerned with design decision-making is not in the narrow sense of design domain, but on the contrary, the preceding section in a project and a concept stage is important. In Europe, this kind of preceding section is not considered to be performed by the design division of company. (Fig.4)

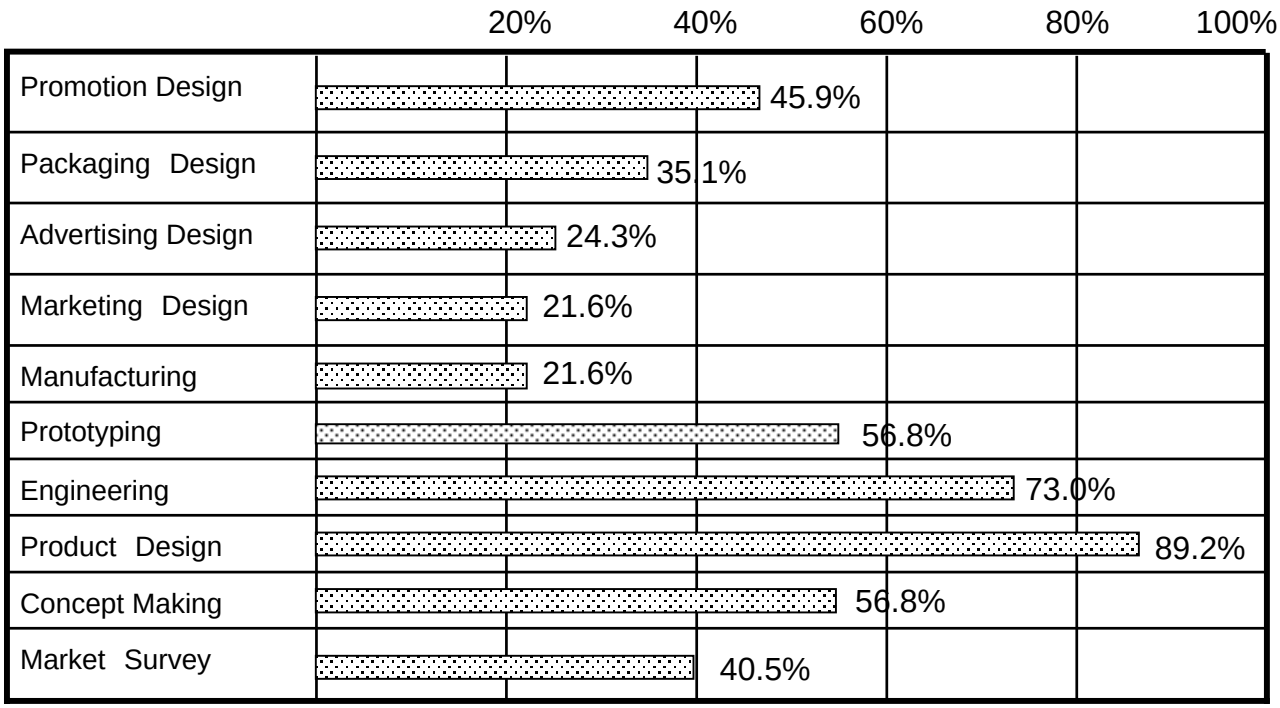

Fig.4 Field of Activities in which Design Division involved

3. DESIGN DECISION-MAKING IN PRODUCT DEVELOPMENT

3.1. INTRODUCTION OF THE PRODUCTION MANAGEMENT PRACTICE

Design decision-making demands to be performed not by management service of former type decision accumulation, but by decision in economic merit and the estimation mechanism as a dynamic model. For this reason design decision-making is changing greatly. In Japanese companies, in regards to details, the initial concept stage of a product development is considered to be more important. In relation to this, the design division of the electronics industry in Japan is also emphasizing the earlier solution type of design process. This comes from aiming to reduce a development risk. In production and operation management, there is a concept that repetitive reduction by shifting the solution attempts and resource charge to earlier stages of a development, leads to shorten the period of a time. If this idea is applied to a design development process, it will be an effective measure not only in the solution but also in the point that the front-loading of the design decision-making in R&D, project (concept), and engineering stage contribute greatly to the improvement of design quality. (Fig.5)

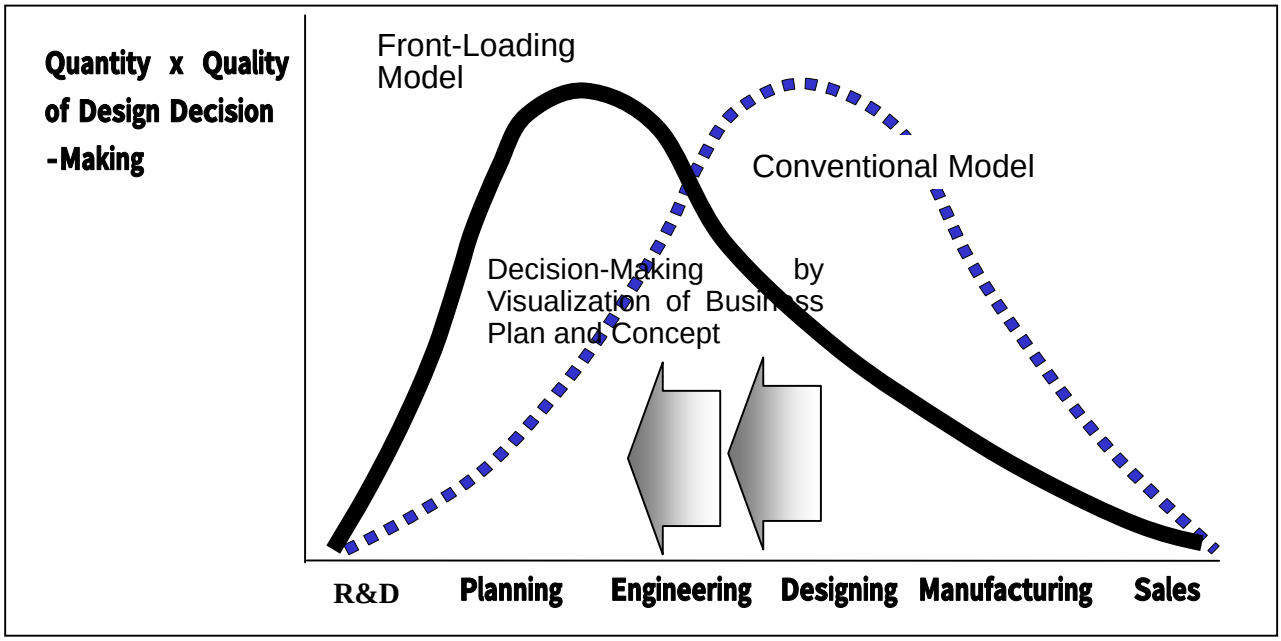

Fig.5 Front-loading of Design Decision-Making

3.2. DIFFERENCE IN STRUCTURE OF DECISION IN JAPANESE AND EUROPEAN PRODUCT DESIGN

The design development process is not a part of the product development process for the above-mentioned cause, and since Japan-Europe coexistence is carried out in many parts, the structure of decision-making depends on the product development process, the development organization and its structure. Between the Western company that has a project manager system and the Japanese company, which although having each function, such as planning, technology (development and engineering), design, manufacturing and sales division, the business goal is accomplished by all sections mixed together, accumulating and adjusting mutually, there are great differences in the influence to the decision-making in connection with the product development of a design division and an external design consultant. (Fig. 6, Fig.7)

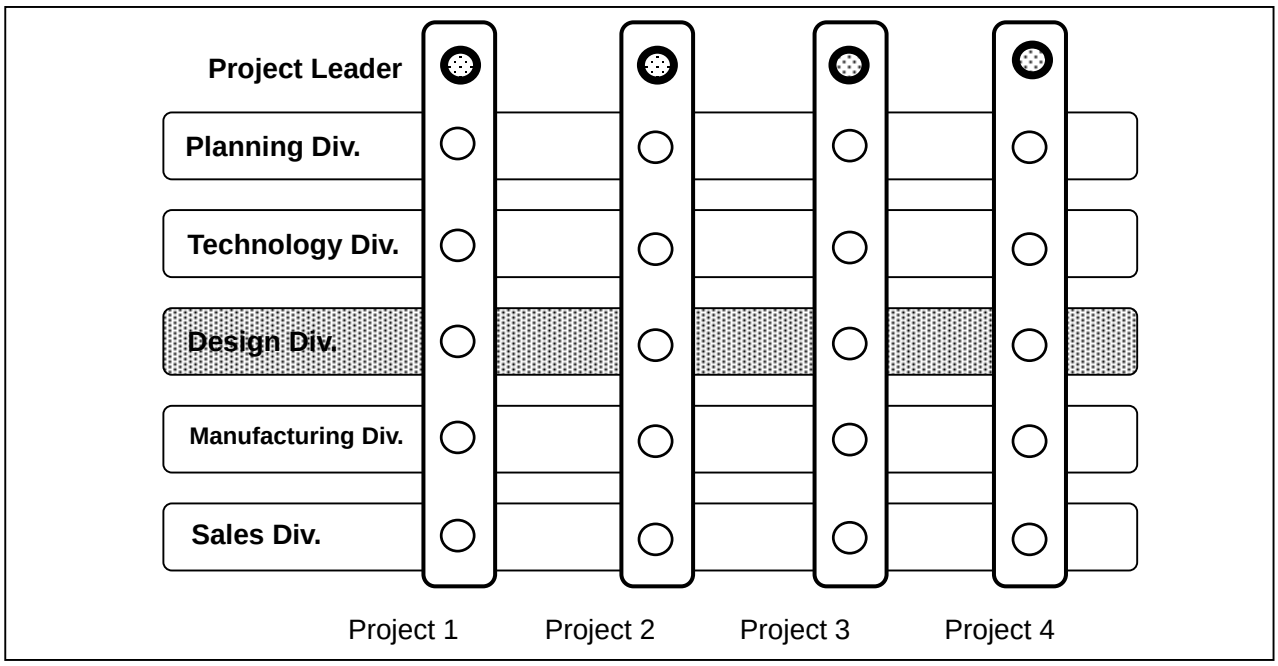

Fig.6 Project Manager System in European Electronics Companies

It should be understood that this is not caused by the difference of view to the design activities, but is brought on by the difference in interpreting privilege and authority of the work by a section or a person in charge in a company. In Japanese companies, though they treasure capacity, the ability of an organization as a group activity surpasses that of an individual and is thought to be more important depending on the case. The cooperativeness as a member of the group is required of a designer at the same time as the capability as an individual. Moreover, the service activities done beyond an organization sometimes receives a high estimation. Such a business culture and climate have supported the enlargement of Japanese companies' designers' design domain. In

European companies, the job security and the job assignment are finely specified and the designers are fundamentally not allowed to invade mutually. Therefore, enlargement of a design domain means not only an enlargement of the target product but to be allowed to act at the domain in which other divisions are doing exclusive management.

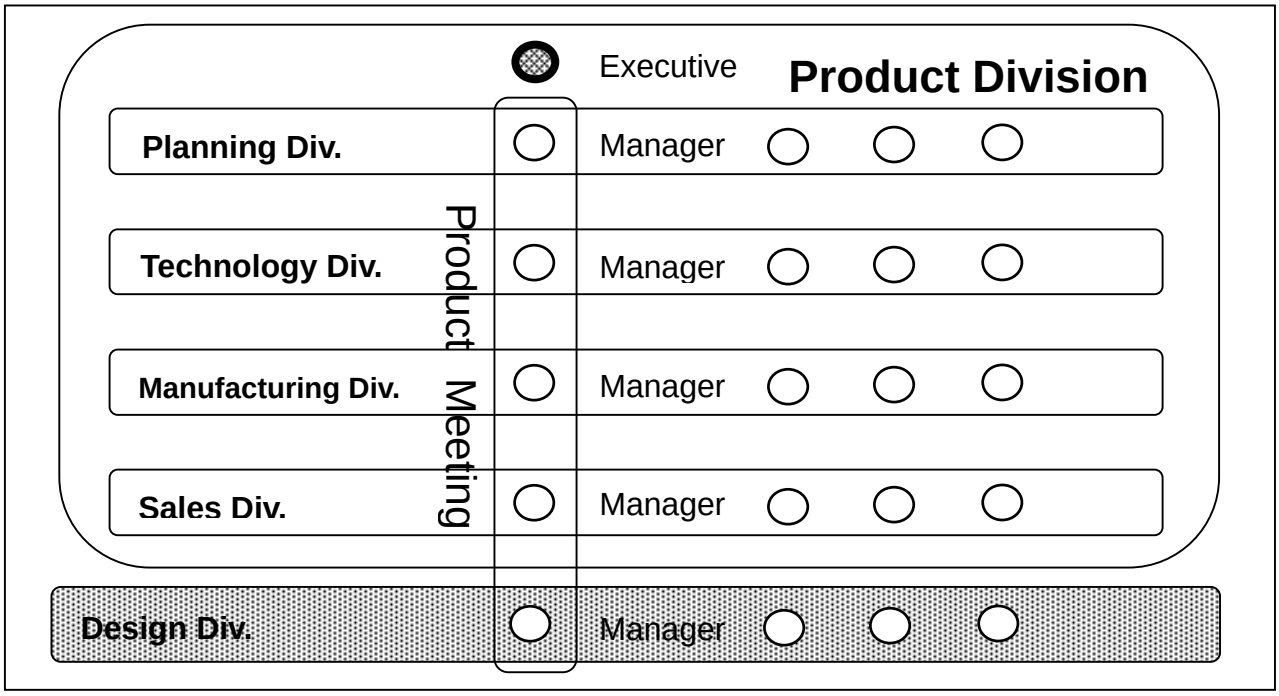

Fig.7 Design Decision-Making in Japanese Electronics Companies

4. DESIGN MANAGEMENT BY CROSS SECTIONAL ORGANIZATION ACTIVITY FUNCTION IN A DESIGN DEVELOPMENT

4.1 HARDWARE AND SOFTWARE FUSION TYPE DESIGN DEVELOPMENT

When carrying out front-loading of design decision-making, it is understood in a company that the decision-making, in connection with a hardware and software fusion type design development, is not completed just fixing on form, color, and pattern of hardware. The design decision-making in connection with software is becoming impossible to be done independently by a design division. As it is a project and the spec determination in itself, advanced judgments of management are needed.

If the design activities in a company can achieve a cross sectional organization function, the contribution to the management of a design can be expected to rise higher. Especially in the process of the above-mentioned software development, planning at an early stage and early spec

determination are generally becoming a required condition because product developments are restricted than those of hardware (appearance, a unit, electric circuit), and it takes a longer verification period. (Fig. 8)

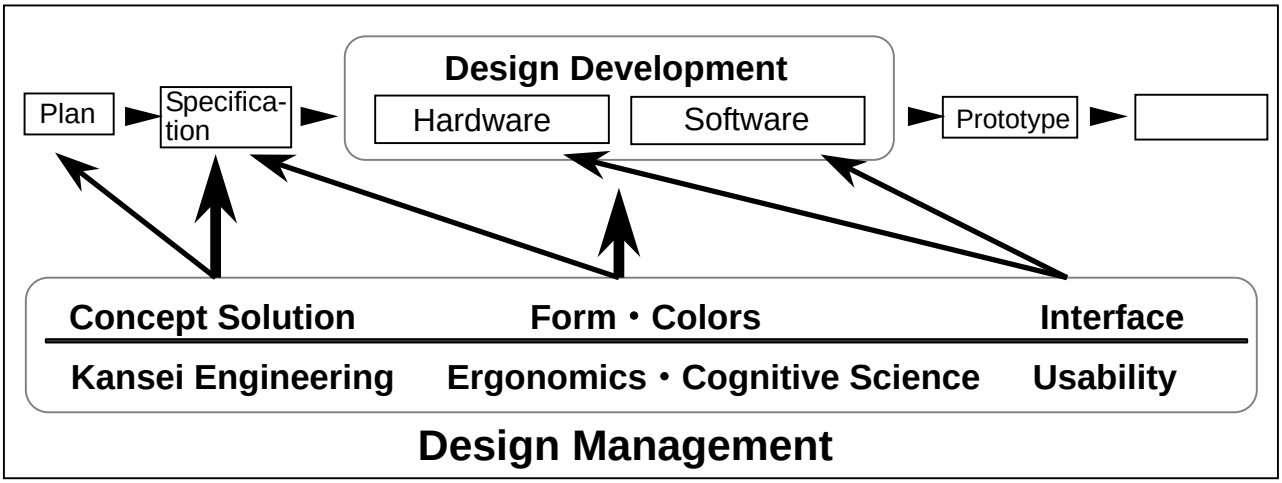

Fig.8 Design Management in a Process of Product Development

4.2 ROLE OF THE DIVISION IN A COMPANY

As for the decision-making in a business strategy level, since it is deeply concerned with a business strategy, a mid-term plan, and the roadmap of a research and development, the use of a designer has increased in recent years as a special capability in which they strategically adjust both markets (needs) and technique (seeds). Unlike the overseas example where the cross sectional function is given to the project manager, the management and decision by consensus of two or more divisions is common in Japanese companies, so the design decision-making combined with the product development process is indispensable. Estimates show coming out that the solution type design activities in a company which promote the regulation and consensus between organizations by the practice of a design are more effective than depending on the product manager as an individual. (Fig. 7)

In companies of the Japanese electronics industry, there are many examples in which a design division exhibits a coordination function and plays the role of a bridge to a management project or the research and development division. (Fig.9) The vision and concept which the design division visualized are used as a leading tool in business planning. This coincides with front-loading of the above-mentioned design decision-making, and shows that the decision of a design is deeply concerned with the determination of a business plan, product planning, a research and development, and a technological strategy. As a concrete design activity, in each stage of a business concept, a business strategy, a roadmap of a research and development, a market analysis, an idea development, an idea aggregation, and products lineup plan, composition chart

of each business plan and strategy is made, or the future life style is visualized by an image sketch. As for the contribution of design activities to the management, according to the design management survey carried out by ‘Japan Management Association Consulting’ in the 2004, the contribution degree of the design in a business profit was highly evaluated from the replies of 169 respondents (a candidate 1, 500 companies) as 73%. *[4]

Company	R&D	Planning	Engineer-ing	Design	Manufactur-ing	Sale
J-1	○	○	○	○	○	○
J-2	○	○	○	○	○	○
J-3		○	○	○		
J-4	○	○	○	○	○	
J-5	○	○	○	○	○	○
J-6	○	○	○	○	○	
J-7	○	○	○	○		
J-8	○	○	○	○	○	
%	88%	100%	100%	100%	75%	38%

Fig.9 Coordination Function of Design Division in Japanese Electronics Companies

4.3 PRECEDING DESIGN DEVELOPMENT

According to this survey, in the field of an automobile, transportation equipment, electrical household appliances and precision instruments, companies where the preceding design development is carried out stated that 7% of "the preceding design development is performed to all the goods," 39% of "the preceding design development is performed only to strategically important goods," and thus corresponds to about half of the companies. As for the practice situation of preceding design development and the contribution to the design business profit, companies that are carrying out the preceding design development evaluate that the contribution degree to a profit is high, which shows their respect for a preceding design development.*[4] This is considered to be a changed form of front-loading of the design decision-making. It is not the design decision-making of developing products but the merchandise planning and concrete image of the product which is going to be developed, are made to visualize the design activity of a preceding design development, and urge design decision-making in a broad sense. As a result, the new technology development in a company, new market cultivation, and a new product development are promoted,

and it has become a big foundation which establishes the relative predominance in competition between companies. In cooperation with other divisions in connection with product development and design, the collaboration from the early vision and concept stage of a design are certainly progressing mainly in the technology divisions, and is greatly reflected in the enterprise mid-term plan. Moreover, many design operations are already done through the network as a concurrent engineering, and the quick solution of a technology development or a technical task used as seeds is practiced.

The design division of Philips Electronics N.V., Netherlands, proposes a future life style and life system in the WEB site which has been opened for quite a long time. The object which the company aims at is visualized, and is leading other companies. In "The Home of the Near Future", which has been going on since 1999, an argument of 'why smart house was not realized' is presented from the point of view of the relationship between a technology development and life style.[*5] It can be said that the content represents the development philosophy of the company in business including the design rather than the design proposal.

Front-loading of design decision-making does not mean just making a decision by preparing the selection choice on a design, but it also includes clarifying the Mission Statement and Concept Definition in the first stage of a product development project by means of a design and an orientation.

5. CHANGE OF PROFIT PROFILE OF ELECTRONICS INDUSTRY

In both Japan and Europe, it is difficult for the design division in a company to take cross section leadership in a product development process, but it is important to exhibit the division coordinate function in a company. In a design division, it is becoming important to collaborate or to coordinate not only with the departments within a company but with other companies, even those of different, unrelated groups.

Thus, front-loading of design decision-making has raised many other problems. Particularly in Japanese electronics industries, seen from a manufacturer's point of view, profitability and added value have shifted to the different parts of industrious structure; materials and parts division and sale and maintenance division. As a design division in a company of a manufacturing enterprise, it can be a serious problem in the future. Primarily, the value which a product design created was originally drawing a bell curve with a peak at the field of manufacturing and assembling. However, because of commodity product and open system, manufacturing and assembling business is turning into an industry with the least added value and is consequently, represented by what is called smile curve. In such industry, front-loading of design decision-making has a big advantage in which the design division in a company expands a design domain, and expands the range of design value. (Fig. 10)

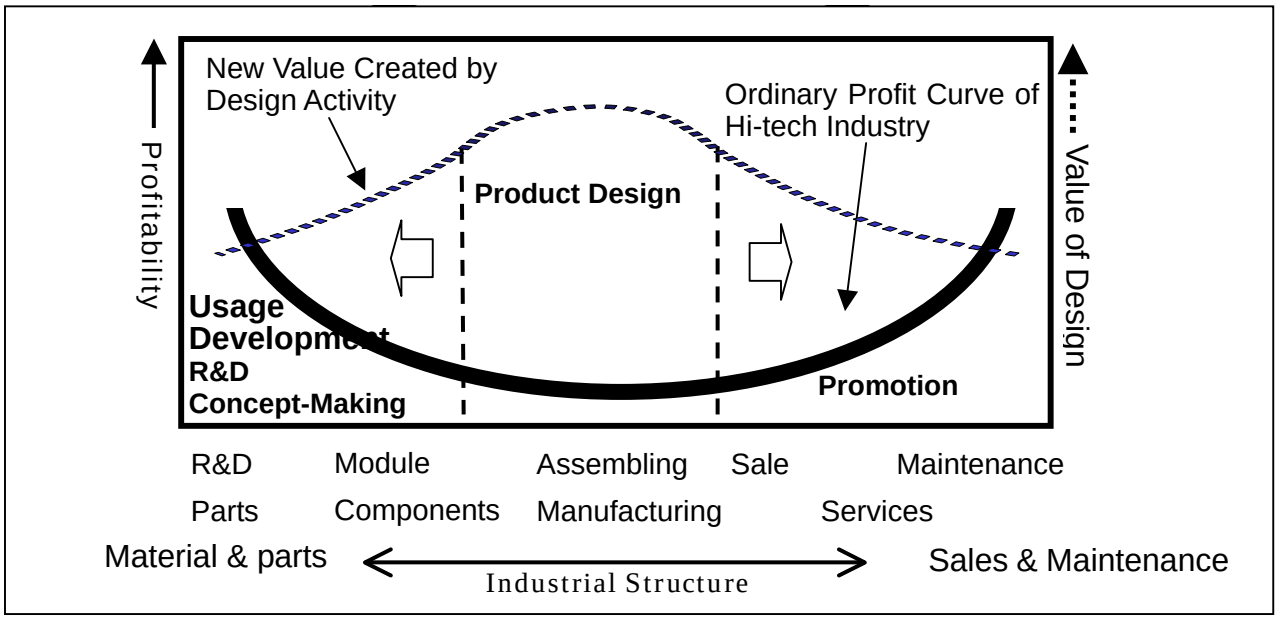

Fig.10 Hill-Curve Created by Design Value

In a hardware and software fusion type design development which is especially outstanding in the IT industry, it is important to include material, parts, and software development in a domain of a design, and to perform front-loading of design decision-making, exceeding a company or a type of business, at a development phase of a product and services. When promoting hardware and software fusion type design activities (Fig. 1), it is recommended that front-loading decision, the method of production and operations management is introduced into design management. It is considered to be effective to manage differentiation and an integration of design decision-making strategically. When seen from the viewpoint of production and operations management, a product development process exceeds the framework of an individual firm. It means making the design domain of a design division correspond to a hardware and software fusion product development, and to trespass on the limited project and development stage of a different type of business in other industries. In the Japanese electronics industry, front-loading of the design decision-making in a product development process enables to regain the business domain which once flowed out of a company on account of the change in the industrial structure, and to make the industry exert its worth.

6. FRONT-LOADING OF DESIGN DECISION-MAKING

6.1 INCREASE IN EFFICIENCY BY FRONT-LOADING OF DESIGN DECISION-MAKING

It has been a concern that the expansion of design activity domain may cause a fall in the performance on design division management. On the contrary, however, front-loading of

decision-making makes it possible to find and solve problems at an early stage possible. Therefore instead of the decline in a physical performance, the improvement in an intellectual performance, in sensitivity and in quality is attained. As a result, the investment in connection with design is smaller. The investment in design activities is generally considered as cost (expense) in many cases, although it is originally the investment in the business itself, and should be recognized as investment that produces value. However, if considered as an investment to earn added value, the break-even point of initial investment and a return will be obtained at an early stage in many cases.

While the investment in a market is spent mainly on technology development and production equipment, the investment in design is mainly invested in people. So compared with a technology development and production equipment, the amount of money spent is much smaller. However, as for the effectiveness, it produces a qualitative effect, such as brand effect, as well as the business profit which is an economical quantities effect. When the investment in design is judged not only by economical / physical value as it has been done so far, but by an overall judgment which also includes sensitivity value and information value, its efficiency is understood as well as that the effect comes out in such a short period of time.

Front-loading of design decision-making excels not only in the disinvestment performance side in a company, but it brings an earlier management decision in all stages of a business strategy and a business project, from planning to the implementation. It can be said that front-loading of design decision-making contributes greatly to the communication inside and outside a company when it practices a business philosophy and a business domain.

6.2 FRONT-LOADING OF DESIGN DECISION-MAKING AND IMPROVEMENT IN PRODUCT RACE

In a manufacturing enterprise, it is well known that a company concentrates its strength in shortening a product development cycle, in order to develop the new products earlier and to timely introduce them to markets. In an intense market race, front-loading of decision-making is becoming more and more important to gain a strategic advantage position and to secure competitive power. The design division is involved in each process from the material and parts division to sale and maintenance division. Before design was only one production process of a product development process, but now, the design division participates in parallel in each process with the engineering division (research, development, engineering, production, and quality management), the planning division, the sales division, etc. Nowadays, if design work cuts itself loose, a product development cannot be done.

In a product development process, if digital-data usage became seamless by going over the limits of one company, the design data which the design division inputted will go around the world in an instant. When this happens, the content and timing of design decision-making will diffuse, which

becomes a new problem. While the design activities as a total solution progresses, such fragmentation goes on, and specialization and integration are repeated. In such situations, layers of each decision-making level in connection with a design are needed. If the production and operations management practice is applied to the design management practice, the decision of the design at the time of a product development will depend mutually, and it is also required to react and update to the latest condition. In future design management, such flexibility and consistency represented by a brand and the production of a vision are demanded.

7. CONSIDERATION

Based on the interview investigation in Japanese and European electronics company design divisions and the past questionnaire result, and with an enlargement and change of the domain, management of the decision-making in connection with a design making has been attempted to be made into the composition chart and to be systematized. There are changes of design activities in a company accompanying an industrial structure alteration, and changes of quality and quantity in decision-making. Both changes are found to have been accelerated in these past several years, with IT-inaction progressing. As described at the beginning, it is rather difficult for a company to conduct such systematization under synchronization with reality. So, in this research, the following facts are made clear: the fact that the enlargement of the design domain which front-loading of design decision-making effects has given the design division many new opportunities potentially as organization activities in a company, and that the coordination function by a design division is raising the design value in a company.

In the material and parts division of the product development process in electronics industry, there is a movement of horizontal-integration from vertical integration beyond a business domain. Moreover, in the sales and maintenance division, the price decline continues in the intense marketing battle, and the product becomes a commodity. Meanwhile, the added value which a design brings to a company also cannot help changing. It has become clear that a function of cross sectional control is also important in the expanded design activities.

How much a design division is committing to the decision of a product development process differs greatly, according to the function of a design division in a company, a systematic positioning, and how the manager of a company understands a design. Recently, the design division of automobile and electronics industries, in so-called leading industries of Japan, has been trying hard to expand opportunities to commit the decision in connection with such management. It has also become clear through the past questionnaires and the interview investigation that the manager is recognizing that the investment in the design is the source of making profit efficiently.

A lot of research has been conducted about the positioning of the design division in a company. However, an organization is a dynamic model and is always changing. A possibility that today's organization will continue to exist tomorrow is not necessarily high. Moreover, it is difficult to say whether the successful form of organization and management service in one company is

adaptable in other companies. Since an organization exists and is functioning on a climate and a strategy particular to the company, there is always a limitation in such a case study. In a design management today, what is more important is systematized strategy, not the past experience.

It is effective to apply front-loading of design decision-making to the design management as a foundation common to such problems. Front loading of design decision-making leads to the quick solution of the problems in the sales and maintenance division, as well as to the shortening of a development period. In this research, the justice of these is stated by adapting to the case of design activity.

By the interview investigation to companies, it was concluded that front-loading of the decision-making in design activities has a big influence on an enlargement of a design domain and the design quality enhancement, and it also improves business profit. Conventionally, from the sensitivity side of a design, creativity and aesthetic sense are considered to be in the world of tacit knowledge. However, it is necessary to know it formally by trying such systematization.

The front-loading of knowledge enables acquired from past experience to be utilized cumulatively, and it also has a power to make perpendicular progress at the time of the start. The front-loading of sensitivity has not yet been started. When front-loading of design decision-making is considered from a sensitivity point of view, it can be said that it is important to lead the project and research development which induces the beautiful products in the first stage of product development, in parts and material division. In this sense, it is required that it be considered one of the aims of front-loading of decision for a design division in a company in order to take leadership and to carry out the design management of hardware and software fusion type production. (Fig. 8)

8. CONCLUSIONS

Within the alteration of the design development process in a product development process it can be said that compared with digitization of a tool, alteration is smaller in an evolution and conclusion of an idea, when visualizing the composition chart and systematization. The design division in a company which has abandoned the conventional design activities and enlarged its domain is pressed for re-differentiation and enhancement of specialty in exchange for it. Moreover, the macro viewpoint with management ability represented by the coordination capability is urgently needed regardless of whether the design division likes it or not.

For this reason, the concept and the domain of a design, the privilege and responsibility for decision-making are all getting larger, and integrating these strategically has now become a challenge. In spite of having demerits with efficiency, Japanese companies which make decisions on a consensus base have shortened the development cycle by abolishing the backtrack process after decision-making. On the other hand, it can be said that the problems have been left unloaded in respect of continuous creativity of an original design. Though there are examples of the companies which have changed the design by altering the constitution of decision-making

intentionally, the long-term verification has not been fully made.

As described in this research, differentiation (specialization) and an integration of design activities progresses at the same time paralleled when making a decision. In a product development process, the precision and the degree to elaborate in a project or a concept stage influence the next process. In this sense, since the management service of the accumulated type decision, which has laid up each process, is accompanied by a risk, the reduction of a development load and risk should be aimed at, by discovering problems at an early stage and solving them.

In order to solve problems at an early stage, though an application of the past experience and the other example is effective, clarification of a vision or a concept is the most important, and the exact representation of it. Needless to say, the proposal of a subject, fully utilizing the visualization capability of the design division enables a sharing of the subject among each section in a company including a manager, and leads to an earlier solution and decision making.

From the side of the management, the greatest problem in doing front-loading of design decision-making lies in the fact that it is difficult to grasp the wholesome image of daily-accumulated design activities. This occurs because design decision-making is moved forward at each step of a product development process. When the decision which differs in size and strength daily goes from a parts and material division to a sale and maintenance division, the performance of a design division may fall conversely. As a result of expanding a design domain, it becomes impossible for the design division alone to make the design decision, as judgment on a management level is demanded. So the divisions of project, research and development which are staff departments in a design division are required to be strengthened. Moreover, a staff department needs to be merged not only with people from a design background but also with experts other than designers. In this way, it becomes effective for a staff department to complement relationship not only with a line department but also with the staff department in the company. Cooperation with an external design consultant is effective, and it is also required to deepen the specialty of the designers in a company as well as widen their horizons of specialty.

It can be seen that it is as if the front-loading of design decision-making has responded to the change of the industrial structure, but the fact is that a design division should offer the Grand Design in a business concept level stage, and to urge to make front-loading decision. This research was at first aimed to apply and develop the methods of production and operation management to the design management. However when it is committed to an industrial structure and the Grand Design of an industrial establishment, the value of a design will lead to obtaining a new break-through.

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   Panasonic Design Company, Sharp Corporation, SANYO Electric Company Limited, Mitsubishi Electric Corporation, Toshiba Corporation, Hitachi, Limited, Sony Corporation, FUJITSU Limited.

   European electronics companies (five companies):
   Thomson Corporation, Philips Electronics N.V, Bosch und Siemens Hausgeraete GmbH, AB Electrolux, Nokia Corporation

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