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STUDY ON USER INVOLVEMENT IN HARDWARE, SOFTWARE, AND SERVICE-INTEGRATED-TYPE DESIGN DEVELOPMENT

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ABSTRACT

This study aims to clarify the significance of hardware, software, and service-integrated-type design development in business. Design management should be considered as a framework and method of co-creation of product/service development, created by both industry and users together. Technological seeds in the industry are made visible early when disruptive innovation is made in order to succeed as a business. Recently, the number of cases that depend on offering experience value to users with KANSEI closer to the market and users is increasing. There are few examples of market creation-type businesses that are succeeding in ICT industries, with the result that innovation is sustained. The concept of legacy-free product/service development and user involvement in the early stages of the innovation process that is the result of hardware, software, and service-integrated-type design development needs to be considered.

Keywords: *Hardware, Software, Service, User involvement, Innovation*

1. INTRODUCTION

This study examines hardware, software, and service-integrated-type design development for business development covering services in the auto and electronics manufacturing fields,

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typical in Japan, which have increased in importance and effectiveness in recent years. A design platform construction methodology for the relationship between companies and users for hardware, software, and service-integrated-type design development will be evaluated with respect to cooperation focusing on the integrated knowledge represented by Web 2.0 and crowdsourcing based on design management. We will also examine greater democratizing innovation in progressing innovations on the user side with design innovation and user-designed user innovations (i.e., open-source innovations and crowdsourcing) for functions, mechanisms, and new product development for design activities through hardware, software, and service-integrated-type design development.

2. BACKGROUND

2.1. Limits on Innovations Due To Changes in Industry Structure and Sustainable Technologies

Vertically integrated design and manufacturing systems is an effective area in the auto industry where it has matured over the last 100 years. Although the latest technologies have undergone commoditization and been introduced repeatedly along with technology innovations in the electronics industry, performance-, quality-, and price-oriented commoditization will give rise to satisfaction if performance and function create expected value for the user employing PCs, cell phones, and other commercial devices. Market maturation and commoditization are creating the economic phenomenon of oversupply. In horizontally integrated models, the battle for superiority in price competitiveness, not technological ability, is taking precedence in commoditization. Pushing commoditization will lead to the elimination of function, quality, and brand differentiation and will result in gaps in processes such as "ease of obtaining," "claim responsiveness," and other service areas. Differentiation on the service side immediately creates homogeneity, requiring new differentiation on the service side.

The spiral phenomenon of differentiation and homogenization will increase greatly in the future, but may lead to success of companies advancing strategically and integrally without differentiation on the hardware, software, or service side occurring separately. Hardware, software, and service-integrated-type design development is required as a result.

Users still expect factors of automobiles other than price, quality, and function, so design will be an effective strategy whether or not this spreads through developed countries. Sustainable innovation has supported mature technologies, while commercialization combining hardware, software, and services on the sensitive side, which differs in dimension from current performance, is effective. Meanwhile, in the electronics field, horizontal integration is already spreading in the semiconductor industry, and non-fabrication semiconductor manufacturers outsourcing production is universal. There already seems to be vertically integrated movement after horizontal specialization with horizontal specialization in the parts industry, and the upper level of commercialized ICT products shows remarkable horizontal integration.

There are many instances where new technology does not lead to product or service development, market development, or business launch due to a lack of wisdom or strategic

thinking at the extremes of product development in Japanese companies, which were the first to demonstrate strength in vertical integration. "Japan's impressive onsite abilities and aesthetic sense will not be useful or lead to abundance if it is not oriented to changes in industrial manufacturing, the backdrop of new business model creation" (Ministry of Economy, Trade and Industry, Industrial Structure Council, Fundamental Problem Study Task Force White Paper, Shock of Knowledge Reclassification – Substance of Modern Industrial Structure Changes, 2008) [1].

2.2. Progress of the Innovation Concept

There have been many discussions on the technological side concerning technological innovation, and there are indications that its original meaning has changed with the creation of new societal values and reforms. These reforms incorporate completely new concepts and create new value for current products and mechanisms as well as creating a moving user experience and tremendous societal changes. This concept includes new value creation according to changes in management, process innovations, and other changes in awareness and mechanisms.

Existing technologies generally mature after innovation. Companies seek stability by improving on matured technologies. While user needs can be met using these improved technologies, there are mid- to long-term delays in technology innovation. Even so, many companies that succeeded using business models combining products and services have appeared in recent years, particularly in the United States. While they may be used for technology applications and for introducing and maturing the latest external technologies to maximize management efficiency, business perspectives differ. Apple is focusing on design in its corporate strategy. User KANSEI is stimulated and imagination fired by establishing a brand together with creating new lifestyles. Full micromanagement of the development process is typical of the hardware, software, and service aspects by very sensitive managers. Products and services thus provided offer experience beyond user expectations [2]. A value chain is formed, and further user KANSEI is created by having users act as transmission devices or relays.

2.3. Innovation and Design Management

Companies are tending to focus on higher function and multifunction product development to respond to the advanced needs of customers. Most new technology for this is "sustainable technology" to improve product performance, and the continuous effort to improve performance in a sustainable environment where analysis and plans for markets and technology environments are possible is called "sustainable innovation" [1]. There are many examples of companies with technical superiority that fail due to market competition because of poor awareness of non-technical factors such as design.

Sustainable innovation involves continuous effort to improve performance for the development of high-function products responding to the needs of customers. Thus, sustainable market growth means that further improvements in performance and specifications will be underappreciated when high product function and performance reach saturation and are of necessity, and when sufficient performance is reached. Start-up companies that succeed in low price, individual response, usability, and other dimensions

apart from performance will be created when performance competitiveness does not lead to market superiority. Product commoditization in the IT industry is also the backdrop (Figure 1).

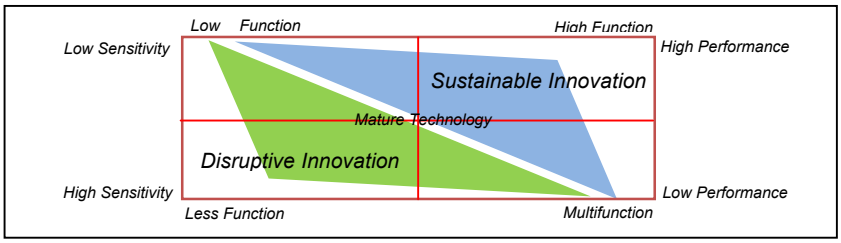

Figure 1: Sustainable Innovation and Disruptive Innovation

According to M. Christensen, disruptive innovation is not technological progress that is well beyond the needs of the customer and likely to be beyond sustainable innovation, but is where matured technology is skillfully used to create new markets [3]. There are many instances where companies quickly visualize the benefits not just of a technology but also what it means for the customer, and they fully utilize marketing when disruptive innovation succeeds as a business. This may also be a business model design through design activities if perspectives change. Design management and activities for maximizing people, assets, financial resources, information, and time in corporate activities, which center on design and improve the economic effect, also comprise design in innovation.

3. OPENNESS & DEMOCRATIZATION OF INNOVATION

Innovations in conventional companies relied on corporate legacy (corporate culture, human resources, accumulation of skills, etc.). Companies generally made their own efforts in new business and new product development. Open innovations using external management resources have recently appeared that are not based on independent new business or new market development. Open innovation is the polar opposite of conventional closed innovation and is based on the fluidity of personnel with advanced skills and experience, fast market introduction of products and services and shorter times, and utilization of the management resources (technical, personnel, and organizational) of other companies and organizations through mergers & acquisitions and strategic partnerships; it is a management strategy for completely new strategic businesses and business models (Figure 2).

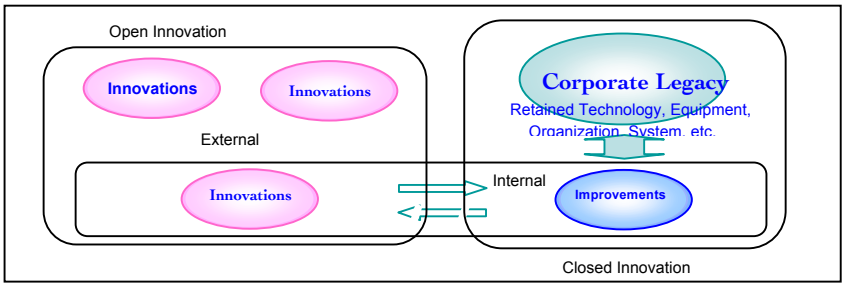

Figure 2: Innovation Openness

Research and development investment has increased globally but its efficiency has dropped, a trend most pronounced in Japan. According to the Ministry of Economy, Trade and Industry, the ratio of research and development investment and total added value in the industrial sector after 5 years has fallen rapidly in research and development efficiency [4] (Figure 3). There has been an increasing shift to a technological strategy using the technology needed to respond quickly and appropriately to customer needs in line with the movement to retain competitive advantage, and this needs to greatly expand externally because of the centralization of resources in core research and development after the bubble economy burst in Japan [4] (Figure 4). This is not only to simply obtain or supplement technology that a company does not possess, but also to create cooperative value that improves the synergy effect externally.

Eric von Hippel focuses on lead users and describes the appearance of a user-centered innovation system base where the movement of self-developed and improved products is free and general users' interest in these solutions is demonstrated by full replacement of manufacturing-led innovation systems, according to certain conditions, with these playing a supplementary role. The democratization of innovation progressing in this fashion is a user-led process [5].

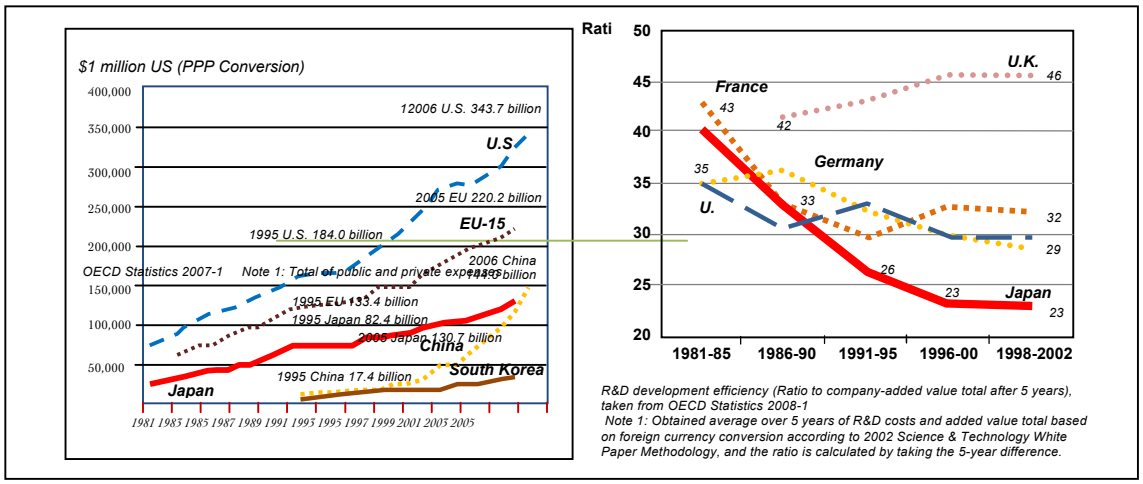

Figure 3: Changes in Research & Development Cost and Efficiency

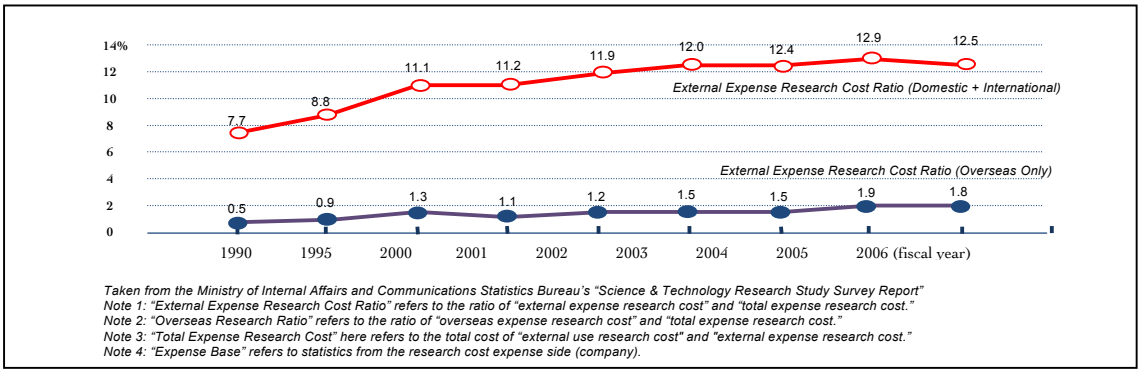

Figure 4: External Expended Research Cost Rate as Total Expended Research Cost in Companies (Expense Base)

3.1. User-involved Business and Product Development for Network Use

Outsourcing to external companies has conventionally been at the forefront when companies use external ideas, but the number of cases in which opportunities for direct user participation are used for product and service development processes has recently been increasing. Google, which purchased YouTube in a stock swap for $1.65 billion in 2006, wanted to conduct joint operations with the YouTube community. So, the potential for users to participate and for network-type design development based on the relationship with the user will increase according to shared knowledge and value judgments; i.e., group knowledge and crowdsourcing. Eric von Hippel defines innovation democratization as "the condition where the skills and environment for creating recipient user innovations, not the manufacturers that create products and services, improve" [5].

Methods of developing products and services have changed greatly with open innovations, outsourcing, and crowdsourcing. Open-hardware systems and modularity have created horizontal specialization, while a user-generated structure was created for LINUX (OS) and Mozilla (software) open sourcing and crowdsourcing. Functions of designer as facilitator that connects companies integrating these and users may also be attractive. The roles played by design function in user participation businesses are becoming more important. Web 2.0 network utilization technology makes this possible. Information and functions are out of the hands of the manufacturer and are assembled and processed by users because the Web functions as a platform. This accumulation is generally critical for Web 2.0 in forming massive "collective intelligence" because many users participate and transmit information. This cyberspace can achieve intelligent, creative results while developing artistic and cultural appeal [6] [7] (Figure 5).

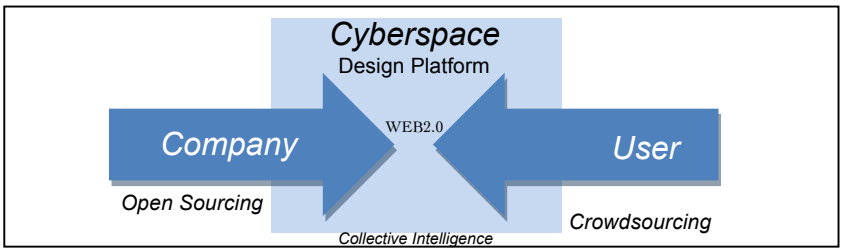

Figure 5: Open Sourcing and Crowdsourcing

User focus is on user innovation designed for development processes through the expansion of information and communication technology (ICT) in the development of products and services. Collective intelligence is used in product & service planning and development processes, and user-oriented network design development is enabled in the design development process. Jointly published homepages by Muji and Cuusoo in Japan are examples where products and services are developed by user-oriented processes.

User-directed product development systems, not just simple company/user collaborations, are gradually being realized. Open and user innovations today are parallel and are functioning and progressing mutually, equating to predetermined harmony. User innovation may also resonate with the inner stirrings of new business models together with design-inspired innovations [8].

4. DESIGN PLATFORM

4.1. Patterns and Design Management of Customer Participation Product Development

There have been many attempts to create platforms for design, and platforms using virtual prototyping via the Internet have recently appeared. There are many examples where these are used as a process participation marketing method rather than a hypothesis verification marketing method. Targeting new markets and new-genre product development in particular is very difficult for the reasons cited earlier, so it fundamentally functions as a platform in low-tech mature product fields.

Its function as a facilitator is a design management secret in customer participation product development. Full optimization of individual needs is enabled by resident participation workshops introduced in urban planning based on these democratic methods. The presence of facilitators is critical in this situation. Facilitators in resident participation urban planning maintain a neutral position in urban planning and other debates while promoting discussion, advancing debate based on superior knowledge, collecting information, and ultimately offering penetrating debate for consensus formation leading to proposals.

Although it is difficult to determine who will oversee and direct collective intelligence in product and service business development in certain processes, facilitator functions are essential. Open participation in consensus formation by interested parties is not necessarily beneficial, but may be a necessary framework for cultivating common value judgments obtained through time-consuming processes. This is similar not only to urban planning, but also to hardware, software, and service-integrated-type product and service development processes.

There are various user participation methods in new product and service development and provisioning, and user participation is achieved based on collective intelligence, while development patterns where companies and users team up to generate new business are being created. In order to understand the importance of design platform construction, the four types of structure shown below were created based on the results of interviews mainly with US, Japanese, European, and South Korean company design department personnel as well as on previous interviews. [9] Although these are restricted conditions, user participation and analysis as the first step in verification are needed (Figure 6).

Figure 6: Four Customer Participation Product Development Types

The conclusion is that design platforms should be constructed based on customer participation in product development and design organizational functions strengthened. Concepts and ideas, as well as product form and lifestyle, are visualized in user-directed/customer-directed product development, and it is thus desirable that the design

organization play the role of facilitator to achieve the potential needs of lead users and general users. To achieve this, it is essential to develop and maintain infrastructure systems using the Web. Product development can be achieved at the same level as the user from the user's perspective.

4.2. Success of Customer-directed Product Development through User Organizations (Japan & US Electronics Companies)

An example of interaction between users utilizing networks is partial introduction through information terminal devices. The effect of existing product improvements and enhancements, based on exchanges between blogs and e-conferences, and new product planning and development are reflected through the cooperation of voluntary network organizations. The success of iTunes on iPod is an example where user tricks and modification methods often create new functions and services [2].

4.3. User Involvement Product Development Using the Web

In conventional product development processes, the design department raises concepts and makes product planning proposals to R&D, planning, and sales departments and functional organizations, and the design department designs for mass production through a process expressing form and color. The manufacturing department then oversees mass production technology, and manufactured products are sent to the market as products by the sales promotion of the sales and sales promotion departments. Opinions of customers are fed back each time from the distribution industry's buyers and users and are reflected in subsequent product development.

Many processes are considered for user-directed and user-/customer-directed product development, but this differs from conventional product development in that the potential for product development based on the customer's customers and not the company's customers is hidden, resulting in a completely opposite ideal to conventional product development. At the same time, participation by small businesses in customer participation product development using the Web is enabled through the spread of the Internet where there is company-directed product development. Examples of these processes are shown below (Figure 7).

1. Ideas create successive ideas as opinions and these ideas appear again and again in publicly declared and announced plans via the Net from the planning stage, different from conventional company-directed product planning.
2. Ideas that appear converge via Web-based contests and meetings.
3. Customer demands for specifications, design, and price converge on the Web.
4. Purchasers are called for and manufacturers are sought as the minimum production lots are reached.
5. Mass production and direct sales start, expanding to sales channel sales outside the Net when the opportunity arises. Product development where ideas that were conventionally abandoned at the idea level are assured at level of the minimum lot, and existing distribution concepts such as the potential for commoditization thus change fundamentally.

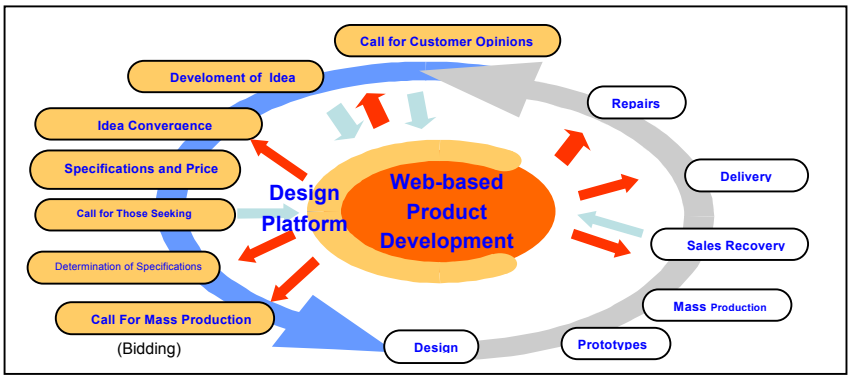

Figure 7: Typical Example of User Involvement Product Development

In order to realize these product development, hardware and software for Web-based digital sketch system, CG, animation, 3-D, CAD, CAM, CAE and RP have been developed one after another. Especially technology such as next-generation description language XVL (eXtensible Visual word description Language) which allows ultra-lightweight 3-D expression operating in Internet environment required for implementation of design evaluation using 3-D virtual prototyping is effective to Web-used user involvement product development. [10]

5. SUMMARY AND FURTHER WORK

5.1. Hardware, Software, and Service-integrated-type Design Development

In design activities, visualization of each plan and strategy including concept, business strategy, research development, market analysis, development of ideas, business roadmap, merchandizing strategy and advertising strategy contributes to accelerate business achievement. In hardware, software, and service-integrated-type design development, these visualization technologies will function as principal pillar of design activities and will accelerate innovation in businesses.

This study showed that function and framework of design activities by hardware, software, and service-integrated-type design development, design innovation for new product development and user-participated user innovation are connected by Internet technologies and trigger new product and service development. It can be said that open innovation and democratizing innovation by these user-led product development is new value system, which is fundamentally different from traditional corporate product and service development.

Internet supporting-technologies and development of description language which allows convenient exchange of 3-D data in Internet environment enabled design development centered on business to shift to cooperative creation with users. One reason behind this is that technology infrastructure such as electronic planning system, digital design system and rapid prototyping is getting completed. Additionally, it is predicted that user-led development of product and service will be disseminated in future, and it is important to see that only then will be a chance for design activity to demonstrate its function. It can be said that designers take on important role as interface connecting users and businesses.

5.2 Future Developments

When developing and providing new products and services, methodology for enabling users' participation as collective intelligence, creating new business model by collaboration with users and producing new value has not been established yet. Also there are not so many businesses capable of providing products and service to create users' experience value. A concept of user-participated development process that has been expanded theoretically since 1980s has been extended so generally that it includes utility of collective intelligence application, the concept created afterward.

The importance of hardware, software, and service-integrated-type design development is not something that can be achieved simply with the advancement of design activity, but results on the business side have been achieved with design innovations due to changes in designer functions in in-house design departments. In addition, results are being achieved in facilitator functions in network design development combining user collaboration with the design development process through discovering potential needs in development, which creates value. As a result, success of businesses integrating hardware, software, and services from the viewpoint of the relationship between contents and services (including solutions) that are related to products (hardware and software) can be expected.

Demonstrating specialization, skill, vision creation, hypothesis establishment, and verification functions is extremely important for in-house design departments of electronics and auto industries in responding to new and challenging problems. Products and services through hardware, software, and service-integrated-type design development are expected to play a role in developing new added-value creation businesses in the future.

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[9] Interview investigation was conducted from 2006 to 2009 to 22 companies.: 13 electronics companies (8 companies of Japan, 3 companies of Europe and 2 companies of Republic of Korea) , 9 automotive companies (8 companies of Japan, 3 companies of Europe and 2 companies of U.S.A.)

[10] Digital Styling Design Systems such as Digital Sketching: 3D Digitizer, 3D curve sketching system etc. and Rapid Prototyping as 3D Printer, Stereolithography Machine, Paper Lamination

System, Fused Deposition Modeling (FDM) system and Ink-jet Machine are usable. Digital Documentation System such as XVL Viewer, XVL Converter and XVL Studio, by Web3D XVL data. via Internet is also usable.

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