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A Process of Forming a Single Competitive Factor in the Digital Camera Industry

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***Abstract*—**This paper considers a forming process of a single competitive factor in the digital camera industry from the viewpoint of product platform. To make product development easier for companies and to increase product introduction ratios, development efforts concentrate on improving and strengthening certain product attributes, and it is born in the process that the product platform is formed continuously. It is pointed out that the formation of this product platform raises product development efficiency of individual companies, but on the other hand, it has a trade-off relationship of causing unification of competitive factors in the whole industry. This research tries to analyze product specification data which were collected from the web page of digital camera companies. Specifically, this research collected all product specification data released in Japan from 1995 to 2003 and analyzed the composition of image sensor and optical lens; and it identified product platforms shared by multiple products and discussed their application. As a result, this research found that the product platformation was born in the development of the standard product for major market segmentation. Every major company has made product platforms of image sensors and optical lenses, and as a result, this research found that the competitive factors were unified in the entire industry throughout product platformation. In other words, this product platformation brought product development efficiency of individual firms; however, it also caused industrial competition factors to be unified in the industry.

***Keywords*—**Digital camera industry, product evolution trajectory, product platform, unification of competitive factors.

I. Introduction

THE purpose of this paper is to analyze the unification process of the competitive factors observed in the digital camera industry. This paper will consider the product characteristics based on product specification data of all models released in the Japanese digital camera industry for nine years (1995 to 2003) after dominant design was emerged, and analyze the transition of product attributes of each entry company and its product lines. In particular, it conducts a detailed analysis of product attributes of the nine major companies in Canon, Casio Computer, Fujifilm, Nikon, Olympus, Panasonic, Pentax, Ricoh and Sony.

Dominant design in consumer digital cameras is said to be "QV-10" released by Casio in 1995. When this model got a huge hit in the market, competitors launched similar products one after another, and the consumer digital camera market rapidly expanded. In the process of expansion of this market, this analyses what kind of technology and product were developed by entry firms. One product is made up of multiple attributes. Therefore, a company has multiple parameters that can be changed in products, but among them, it positively adds and strengthens product possibilities for technology development and product attributes highly requested from the market. Also, in order to make it easier for consumers to perceive, product strengths were often narrowed down to specific product functions and attributes. This paper considers the trajectory of product evolution after the appearance of dominant design of the digital camera industry and elucidates the process of unification of competitive factors in the industry. Also, this paper would like to consider why the unification of competitive factors occurs from the viewpoint of product attributes. Specifically, from the perspective of the product platform, it considers the company's product line. The product platform is the structure, in other words architecture, of the product. Based on this product platform, multiple products would be developed based on it. As this product platform has both merits and demerits, it would like to clarify the contents in the context of unification of competitive factors.

This paper uses the interview data of digital camera companies and secondary materials. First interview was with Matsushita Electric Industrial Semiconductor Company's DSC (Digital Still Camera) and and Mobile Camera LSI Category Manager and second interview was with the Corporate Technology Training Center's Technology Manager, and third interview was E-mail Interview to Digital Camera Set Maker's manager.

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II. Theoretical Reviews of Previous Researches

A. Researches on Unification of Competitive Factors

In the fields of innovation and product development theory, discussion has been made on unification of competitive factors. For example, the S-shaped technology curve [1] shows that technological progress of a certain product is represented in the quadrant. Its horizontal axis shows development efforts such as resources and time required for technical development and its vertical axis shows technical performance. The development effort here can be seen as synonymous as time, so it can be seen as representing the technological progress over time.

At the beginning of the technology development, trial and error is conducted with the aim of establishing the technology definition because knowledge making up the technology base is lacking. Eventually, as the technology base is established, bottlenecks in technology development become more likely to become apparent. Then, technology development will be focused, and it will resolve the bottleneck in one stroke. However, when reaching a certain level, the pace of technological progress would decrease. This phenomenon

would be seen as the technological S-shaped curve. In addition, it is understood that in a plurality of product fields, when a change in occurrence frequency of innovation of product technology and production technology is simultaneously captured and a mutual dependency relationship is observed, a common pattern of technological progress appears in each case. Reference [2] revealed this pattern through analysis of the American automobile industry. They investigated the frequency of major innovation with regard to product technology and production technology from the dawn of the industry to the stage of maturity. As a result, the relation of occurrence frequency revealed that the industry would change through three stages, such as fluid, transitional, and specific stages (A-U model). Among the dynamics of the innovation, knowledge on product concepts has accumulated; dominant design emerges among them. In the process of forming this dominant design [3], the model with a characteristic accepted by most customers survives from several products. Through this process, competing factors among competitors would be clarified. Thus, in the process of technological progress and innovation discussed by [1] and [2], these processes include the unification of competition dimensions. In the early stages of the industry, the role model of the product was born through the interaction between technology and market. This model clarified its product concept and value for customers. In other words, dominant design emerges through the interaction between products and markets in discussions on S-shaped curves, and product innovation and process innovation in the fluid stage of industry, it can be said that a unified value dimension is formed between competitors and customers. Therefore, after the transitional period, companies tend to grasp competition in a unified way.

Researches that attempt to capture the competitive environment by reducing the value dimension continue in several industries. One of them is the PIMS (Profit Impact of Market Strategies) by [4]. This research has constructed a "PIMS database" that contains about 3,000 business unit financial and strategic information about the relationship between strategic variables for each business division and performance. This research uses the concept of relative quality and discusses the relationship between it and market share and profitability. This relative quality could theoretically reduce multiple evaluation scales of products and services into a single evaluation dimension of "quality". PIMS research has made it possible to conduct research using enormous data by dropping multiple value dimensions of products and services into a single dimension called "relative quality". In these preceding researches above, while paying attention to the interaction between technology and products and the market, competitive factors were unified as a single competitive factor.

This paper takes product platform as analysis view of the point and, by analyzing the transition of the product attributes of each company and focusing on the product attributes, it tries to elucidate the process of unifying competitive factors in the industry.

B. Researches on Product Platform

As customer needs become complicated, and the market environment quickly changes, companies have to develop various products frequently. Among such competitive environments, it is necessary to develop products with flexibility [5]-[7]. To do so, instead of optimizing for individual product development with reusing modules [8], it is important to commonly use management resources between product lines and product projects [9]. The strategy of integrally managing these multiple product development projects is called platform strategy [10].

One of the merits of utilizing the product platform is the ability to introduce new products to the market with high frequency. According to [11], its effect is said to lead to an increase in market share. It is said that as the number of new product introductions increases, the market share increase ratio would increase. In addition, companies can obtain high market performance by introducing a large number of products. However, it is said that there are the following two trade-offs in the platform strategy [12]. First of all, there is a trade-off on platform utilization and the lifetime of a particular platform. By using one platform for a long time, while high profitability can be raised, the platform becomes technically obsolete, so the product's competitiveness would be reduced. Secondly, there are trade-offs between platform sharing and differentiation. The more company shares the platform with multiple products, the more it can develop product. On the other hand, it is pointed out that it is difficult to differentiate products if a specific platform is shared by multiple products.

Previous researches [9]-[11] have focused on product platform strategies within individual companies. Therefore, in this paper, by taking examples of industries where companies actively use product platforms to develop products and clarifying the product lines of major companies, it attempts to clarify the process by which competitive factors are unified in the whole industry.

III. Case Study: Changes of Product Attribute and Trajectory of Product Evolution in Digital Camera Industry

A. Outline of the Digital Camera Industry until 2003

"QV-10" released by Casio in 1995 was accepted by many customers. From the following year, many other companies also released consumer digital cameras with product attributes similar to "QV-10". After that, the consumer digital camera market expanded rapidly.

Shipment volume and shipment amount in Japan was about 1.5 million units and about 69.2 billion yen in 1999, and rose to about 8.43 million units and about 224.9 billion yen in 2003. As the market size increased, the number of entry companies increased from 13 companies in 1996 to 20 companies in 1997 and 23 companies in 2000. When the number of entrants increased, the number of product models of digital cameras released by one company also increased. In 1995, only seven companies introduced each model, but 27 models were released from 14 companies in 1996, and 112 models in 2003 [14].

B. Characteristics of "QV-10" and Types of Companies Entering the Digital Camera Industry

"QV-10", which became the beginning of the consumer digital camera market, has characteristics different from those of the previous digital cameras. As "QV-10" increased sales significantly, many companies will enter the digital camera industry. However, it is thought that many of the companies considered "QV-10" as a camera that digitized film cameras for consumers; because, it can be well understood by looking at which industry the digital camera companies has entered from. In this article, companies entering these digital camera industries are classified into three categories.

First category is film camera makers. Canon and Minolta, Nikon and Fujifilm, in the late 1980s, launched an electronic still video camera, were going to continue the research and development as one of the potential of the new camera. And, when "QV-10" was accepted in the market, they started developing many digital cameras for general consumers. That was because the product structure of digital cameras was technically highly similar to conventional film cameras and the possibility of substituting film cameras was high, it was considered that companies tried to develop the digital camera. Between 1995 and 2003, film camera manufacturers developed 344 models. As Fig. 1 shows, it accounted for more than half of the digital cameras released during that period, and they were major players in the digital camera industry.

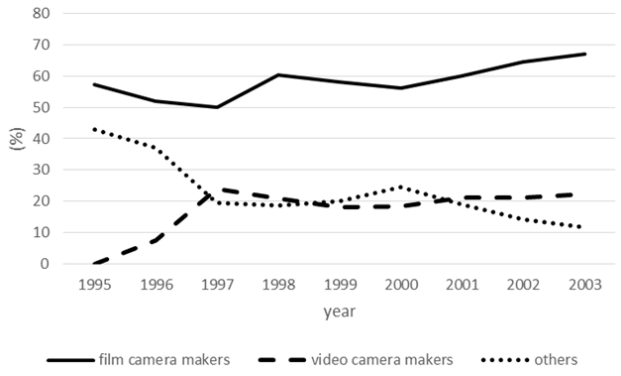

Fig. 1 Ratios of released models by industry of origin [14]

Secondly, it is a manufacturer that has developed video cameras. Sony and Sanyo, Panasonic and Sharp were developing in-house imaging devices and developing video cameras. The image sensor device is a key device that plays the eye of a digital camera. Compared to film cameras, digital cameras are more likely to electronic devices, and it seems that video camera manufacturers' entry into the digital camera industry has progressed. In 1988, Sony released Mavica "MVC-C1" which was an electronic still video camera, Sharp entered the digital camera industry in 1996, Sanyo and Panasonic also entered the digital camera industry in 1997. From 1995 to 2003, video camera manufacturers released 114 models, accounting for about 20% of the digital cameras released (Fig. 1) [14].

Third, it is other manufacturers, from electronics companies, toy companies, and home appliance companies, and so on. As far as it can be confirmed, 107 models were released from 22 companies by 2003. However, 19 of them could only release 4 models or less. The other three companies are Toshiba, Epson and Casio. Toshiba has released 20 models, Epson has done 12 digital cameras, but they withdrew from the market [14]. On the other hand, Casio has released 40 models. Casio is a company that has developed electronic products such as calculators, digital watches and electronic dictionaries. And, with the release of "QV-10", it has created a consumer digital camera market, and continues to release digital cameras after that.

As above, we have classified companies entering the digital camera industry into three categories. Among them, it was the film camera maker that accounted for more than half of the digital cameras to be released consistently, showing the largest presence in market share.

C. Changes in Product Attributes of Major Entrants

Next, this paper analyzes what kind of product development the major entry companies have made, focusing on imaging sensor devices and optical lenses which are the key devices for digital camera. Digital camera is a device that records captured still images as digital information. It consists of an image sensor that converts light into an electrical signal and an optical lens that optically forms an image of the subject to image sensor. Therefore, the devices which take the basic function of photographing images are image sensor devices and optical lenses, and their importance was particularly high in the fluid stage of the industry.

Although "QV-10" was equipped with 1/5 inches 0.25 mega pixel CCD, digital cameras had come to be equipped with image sensor with many pixels one after another. For example, in 1997, megapixel machines were released by Olympus, Fujifilm and Canon, and in 1998 they were also released from Nikon, Sony, Ricoh and Casio. In 1999, Nikon and Fujifilm released 2 mega pixel machines. 3 mega pixel machines in 2000, 4 mega and 5 mega pixel machines in 2001, 6 mega and 8 mega pixel machines in 2003 were on sale. In this way, film camera manufacturers were leading the advancement of multi-pixel imaging sensor device.

Of course, digital cameras equipped with these latest multipixel image sensor devices were products of high price range in the product line, but also in the digital camera of the popular price range, there was a tendency to increase the number of pixels. Then, they increased the number of pixels of the image sensor device mounted on the digital camera and stop mounting the image sensor device with a small number of pixels on the digital camera. For example, let's take a look Olympus digital camera. As shown in Fig. 2, duration periods of the 0.35 mega pixel CCD was 25 months (August 1996 - August 1997), these of the 0.81 mega pixel CCD was 23 months (October 1996 - September 1998), these of 1 mega pixel CCD was 57 months (September 1997 - June 2001), and these of the 2 mega pixel CCD was 51 months (April 1999 to July 2002). In addition, the "QV-10" was equipped with a single focus lens without optical zoom, but the digital zoom lens that was released later increased the mounting of optical zoom lenses. Fig. 3 shows the ratio of concentration of the

optical zoom lenses of major companies entering the market. Among the digital cameras released in 1995, only one model was equipped with an optical zoom lens, and the ratio of concentration was 0.25. The ratio of concentration in 1996 was 0. 2941, in 1997 it was 0.2333. That is, until then, the majority of digital cameras did not have optical zoom lenses. However, digital cameras with optical zoom lenses exceeded majority for the first time (concentration ratio 0.5385) in 1998, about 80% of digital cameras have been equipped with optical zoom lenses since 2000. That is, after 1998, optical zoom lenses were mounted on many models, and it turns out that a zoom lens has become standard in the industry.

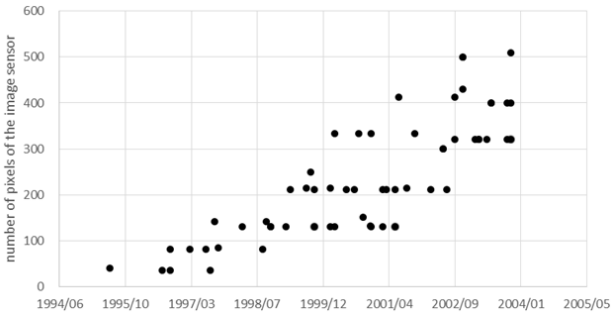

Fig. 2 Olympus image sensor

Optical zoom lens		1995	1996	1997	1998	1999	2000	2001	2002	2003	Overall
Canon	mounted	0	0	0	1	2	3	9	8	7	30
	not mounted	0	1	2	1	0	0	0	2	2	8
	concentration rate	0	0	0	0.5	1	1	1	0.8	0.777778	0.789474
Casio	mounted	0	0	0	1	2	3	4	2	3	15
	not mounted	1	4	4	2	1	2	3	5	3	25
	concentration rate	0	0	0	0.333333	0.666667	0.6	0.571429	0.285714	0.5	0.375
Fujifilm	mounted	1	0	2	0	2	6	6	7	7	31
	not mounted	0	2	2	3	5	2	6	4	1	25
	concentration rate	1	0	0.5	0	0.285714	0.75	0.5	0.636364	0.875	0.553571
Nikon	mounted	0	0	0	2	2	2	4	5	5	20
	not mounted	0	0	2	1	1	0	0	0	0	4
	concentration rate	0	0	0	0.666667	0.666667	1	1	1	1	0.833333
Olympus	mounted	0	0	2	2	5	10	7	8	11	45
	not mounted	1	3	3	3	2	2	3	1	0	18
	concentration rate	0	0	0.4	0.4	0.714286	0.833333	0.7	0.888889	1	0.714286
Panasonic	mounted	0	0	0	0	1	3	2	4	6	16
	not mounted	0	0	5	1	0	0	0	0	0	6
	concentration rate	0	0	0	0	1	1	1	1	1	0.727273
Pentax	mounted	0	0	0	0	0	2	2	4	6	14
	not mounted	0	0	1	0	0	0	0	1	0	2
	concentration rate	0	0	0	0	0	1	1	0.8	1	0.875
Ricoh	mounted	0	4	2	3	2	4	3	2	6	26
	not mounted	1	1	1	0	1	0	0	0	1	5
	concentration rate	0	0.8	0.666667	1	0.666667	1	1	1	0.857143	0.83871
Sony	mounted	0	1	1	5	5	9	11	9	8	49
	not mounted	0	1	3	1	1	1	2	4	7	20
	concentration rate	0	0.5	0.25	0.833333	0.833333	0.9	0.846154	0.692308	0.533333	0.710145
Overall	mounted	1	5	7	14	21	42	48	49	59	246
	not mounted	3	12	23	12	11	7	14	17	14	113
	concentration rate	0.25	0.294118	0.233333	0.538462	0.65625	0.857143	0.774194	0.742424	0.808219	0.685237

Fig. 3 Concentration ratios of the optical zoom lenses of major entry companies

It was also film camera manufacturers that actively introduced optical zoom lenses. Between 1995 and 2003, Pentax's optical zoom lens had a high ratio of concentration of 0.875, Ricoh's concentration ratio was 0.8387, and Nikon's concentration ratio was 0.8333. These companies had equipped optical zoom lenses into nearly all models since 2000.

For the design and manufacture of optical lenses, advanced technology accumulation was required. Since the number of pixels of the image sensor device exceeds one mega pixels, it became difficult to design the lens, high assembling accuracy was required, and there were few manufacturers capable of manufacturing the optical zoom lens. By the time that 2 mega pixels became mainstream in the industry, it was said that lens could not be manufactured without technical accumulation of optical lenses.

As there was the reason why film camera makers had enhanced the performance of the image sensor devices and increased the mounting of optical zoom lenses, most entry firms have recognized that digital cameras were alternative to film cameras. It is said that more than 3 mega pixel image sensor devices and mounting of optical zoom was standard for L size printing. Therefore, film camera manufacturers thought that basic functions as camera to record high-quality images were not sufficient for digital cameras at the time. In order to catch up with the photographing function level of the film camera, they tried to make it possible to take a high-quality photograph by carrying out the multi-pixel imaging device and mounting multiple optical zoom lenses. In addition, the video camera maker installed the latest imaging device manufactured in-house on a digital camera. Sony has released 2 mega pixel devices at the same time as Fujifilm and Nikon, and 4 and 5 mega pixel devices were on the market ahead of other companies. In addition, Sony has actively marketed digital cameras with optical zoom lenses since 1998, and Panasonic has installed optical zoom lenses on all digital cameras released since 1999. In other words, they had contributed to the

installation of optical zoom lenses in the industry.

D.Formation of Platforms and Trajectory of Product Evolution in the Digital Camera Industry

It was said that it was difficult to combine an image sensor device and an optical lens in the production of digital cameras. Therefore, when looking at the product attributes of each company, it is understood that while fixing the lenses, it forms a platform of the image sensor device and the optical lens that changes the number of pixels with the same sized image sensor device. The platformization of this image sensor device and the optical lens could lead to modularize the production process with high difficulty of digital camera production. Therefore, productivity can be improved while keeping design quality and production quality at a certain level. For example, Sony formed 19 platforms and developed 56 models and Olympus formed 14 platforms and developed 53 models. There is variation in the continuity of the platform. Sony had a platform for only two months that released three models, a platform that released seven models over 30 months, and a platform that released nine models for 26 months. Also, Olympus developed seven models from a platform that lasted 25 months, and developed five models over 32 months. In any case, Sony and Olympus continuously formed a plurality of platforms and developed numerous products based on them. All major companies have developed products with forming such platforms. In addition, major entry companies have been working on early platformization of this imaging sensor device and optical lens. As shown in Fig. 4, except for 1999, the platform conversion ratio exceeds 50%. Approximately 74% of the digital cameras in 2003 were developed based on the platform, and even during the period from 1995 to 2003, about 64% of the digital cameras released were developed based on the platform.

Product platform		1995	1996	1997	1998	1999	2000	2001	2002	2003	Overall
Canon	platformed machine	0	1	1	0	0	1	6	6	4	19
	no platform machine	0	0	1	3	2	2	2	4	5	19
	rate of platform machine	0	1	0.5	0	0	0.333333	0.75	0.6	0.444444	0.5
Casio	platformed machine	1	1	4	2	2	3	5	6	4	28
	no platform machine	0	3	0	1	1	2	2	1	2	12
	rate of platform machine	1	0.25	1	0.666667	0.666667	0.6	0.714286	0.857143	0.666667	0.7
Fujifilm	platformed machine	0	2	2	4	3	5	5	6	4	31
	no platform machine	1	0	2	3	4	4	7	6	3	30
	rate of platform machine	0	1	0.5	0.571429	0.428571	0.555556	0.416667	0.5	0.571429	0.508197
Nikon	platformed machine	0	0	0	2	0	0	2	3	3	10
	no platform machine	0	0	2	1	3	2	2	3	2	15
	rate of platform machine	0	0	0	0.666667	0	0	0.5	0.5	0.6	0.4
Olympus	platformed machine	0	3	4	5	4	11	6	6	11	50
	no platform machine	1	0	1	0	3	2	4	3	1	15
	rate of platform machine	0	1	0.8	1	0.571429	0.846154	0.6	0.666667	0.916667	0.769231
Panasonic	platformed machine	0	0	4	0	1	1	1	3	5	15
	no platform machine	0	0	1	1	0	2	1	1	1	7
	rate of platform machine	0	0	0.8	0	1	0.333333	0.5	0.75	0.833333	0.681818
Pentax	platformed machine	0	0	0	0	0	0	2	4	6	12
	no platform machine	0	0	1	0	0	2	0	1	0	4
	rate of platform machine	0	0	0	0	0	0	1	0.8	1	0.75
Ricoh	platformed machine	1	4	1	0	0	3	2	2	6	19
	no platform machine	0	1	2	3	3	1	1	0	1	12
	rate of platform machine	1	0.8	0.333333	0	0	0.75	0.666667	1	0.857143	0.612903
Sony	platformed machine	0	1	2	3	4	8	12	13	11	54
	no platform machine	0	1	2	3	2	2	2	2	4	18
	rate of platform machine	0	0.5	0.5	0.5	0.666667	0.8	0.857143	0.866667	0.733333	0.75
Overall	platformed machine	2	12	18	16	14	32	41	49	54	238
	no platform machine	2	5	12	15	18	19	21	21	19	132
	rate of platform machine	0.5	0.705882	0.6	0.516129	0.4375	0.627451	0.66129	0.7	0.739726	0.643243

Fig. 4 Ratios of product platform of major entry companies

As described above, each major company has formed a platform of imaging sensor device and optical lens, and has developed multiple products from one platform. Although the platform was used for various periods, it continued to be used for several products. In addition, since the dominant design came out, it had formed a platform immediately and coexisted with multiple platforms. Thus, the product line was enriched. However, utilizing the product platform can lead to fixed product attributes. The parameter that can be changed in the platform of the image sensor device and the optical lens is only the number of pixels of the image sensor, and it is impossible to change the size of the image sensor device and the optical lens. For this reason, for example, since the image sensor device and the lens module were parts having thickness in the component parts, the depth of the digital camera cannot be reduced. Specifically, Sony released three models, forming a platform of a combination of a 1/2.7 inches imaging device and an optical zoom lens with a focal length of 39 to 117 mm. Then, it provided two variations, 1.3 mega pixels and 2.1 mega pixels CCD. On the other hand, the depth of its product was 68.8 mm and 65.4 mm, although each shape of the body cases was completely different.

"QV-10" had the 0.25 mega pixel CCD mounted. Subsequently, each major company developed technology to mount an imaging element with a high number of pixels. Then, they introduced digital cameras equipped with megapixel CCD,

3 mega pixel CCD and 5 mega pixel CCD. Also in the installation of optical zoom lenses, the concentration level of all major companies except Casio had exceeded 0.5 since 2000. Nikon and Panasonic have optical zoom lenses in all the models released, and Pentax and Ricoh have optical zoom lenses in all models except one model. As a result, the ratio of concentration of the optical zoom lens from 1998 to 2001 in the digital camera industry was 0.7433. In other words, it is understood that the optical zoom lenses were positively mounted on the industry as a whole. And the existence of platform of the imaging sensor device and the optical lens made it possible to develop many digital cameras equipped with multipixel imaging sensor and optical zoom lens. Major entry companies began forming platforms right after the dominant design came on. When new devices, for example, an image sensor device appeared, they formed new platforms. Continuous formation of platforms and numerous product developments utilizing them were manifested as changes in product attributes such as increasing the number of pixels of the image sensor device and installing an optical zoom lens. This can be regarded as a trajectory of product evolution of the digital camera industry.

IV. Discussion: Unification Process of Competitive Factors in the Digital Camera Industry

In the previous section, this paper has clarified what kind of product evolution has been made by major companies in the digital camera industry based on product specification data. First of all, participating companies have been positively carrying out image sensor with increasing number of pixels and mounting optical zoom lenses. Film camera makers were actively installing optical zoom lenses in products, and video camera manufacturers have also pushed towards increasing the number of pixels of imaging sensor devices. It was found that the product attribute for enabling shooting of high quality images was strengthened. And in order to make it possible quickly, they formed the platform of the imaging sensor and the optical lens, and continuously formed and used product platforms. Therefore, it turned out that the percentage of product platforms rose every year.

One of the merits of forming the platform of the image sensor device and the optical lens is to facilitate the combination of the image sensor and the optical lens, which is a difficulty in digital camera production. They fixed the optical lens and combined the imaging sensor. At that time, if the size of the imaging device was fixed, only the number of pixels could be made variable. Then, although the optical lens and the size of the image sensor device were the same, it was possible to give variations only to the number of pixels of the image pickup device. This development method was used by all major entrants. Approximately 65% of the digital cameras released by those companies from 1995 to 2003 were developed based on the image sensor device and optical lens platform (Fig. 4).

Another advantage is that it allows for the introduction of high-frequency product markets. In the digital camera industry, the number of models also increased year by year. In 1995, only four models were released from major entrants, but increased to 30 models in 1997, 51 models in 2000 and 71 models in 2003. As [11] pointed out, by forming a product platform, new products can be introduced to the market with high frequency, and its effect leads to an increase in market share. In the case of the digital camera industry, Sony and Olympus, which have a high platform ratio of image sensor device and optical lens, also launch to the industry. Sony launched 72 models with the largest number of entrants. In addition, Olympus has released 65 models second largest after Sony. As a result, the market share of Sony and Olympus has increased. However, it is said that when companies form similar platforms, products become homogeneous and become commoditized. Forming platforms for imaging devices and optical lenses to increase development efficiency and increase the number of models is an advantage for individual companies to be able to continuously develop products. However, in the viewpoint of industry as a whole, it is not always just a positive aspect. In the digital camera industry, since they developed a digital camera under the product concept of alternative to film camera, the digital camera development has been focused on increasing the number of pixels of the image sensor device and installing the optical zoom lens so as to enable high quality image shooting. Then, they combined a specific optical lens with a specific size image sensor so that it becomes easier to increase the number of pixels of the image sensor device. Since all companies have formed platforms for imaging devices and optical lenses, the competitive factors such as increasing the number of pixels of the image sensor device were unified in the industry as a whole. In this way, the formation of the platform of the image sensor device and the optical lens, and the development efforts to increase the number of pixels of the image sensor device caused thereby the unification of the competitive factors in the digital camera industry.

It has been pointed out that there is a trade-off relationship between platform utilization and product differentiation [12]. In this paper, tradeoffs between utilization of platform and product differentiation were caught not only by individual companies' product differentiation but also by industry as a whole in digital camera industry. By analyzing the product attributes of major companies after the dominant design was introduced, it shows that it draws a uniform evolution trajectory throughout the industry.

V. Conclusion and Further Researches

In this paper, based on the product specification data of digital cameras released in Japan from 1995 to 2003, we examined the process of unification of the competitive factors observed in the digital camera industry. Since the advent of dominant design, participating companies developed their products based on that. In the case of the digital camera industry, many companies focused on development of high-quality images, and therefore developed a product platform of the image sensor and the optical lens which made it easy to increase the number of pixels of the image sensor device. Although they were able to develop a number of models, their products had homogeneous characteristics and they caused unification of competitive factors in the industry.

The product platformization could make product

development easier for entry companies and increase market introduction ratios. It caused that development efforts focused on improving and strengthening specific product specifications. Forming the product platform would increase product development efficiency of individual companies. On the other hand, it can be pointed out that there is a trade-off relationship of causing industrial competition factors to be unified in the industry.

Previous studies such as [11] and [13] which researched in the field of automobile industry have pointed out that forming product platforms within the enterprise could easily expand the product line. On the other hand, this paper analyzed the digital camera industry as a research subject and took up the whole industry, and cases where entry companies formed similar product platforms and competed for product development. This paper is focused not on individual companies, but on the trajectory of product evolution throughout the industry. As a result, it is suggested that the pursuit of efficient product development by individual enterprises has a trade-off relationship that unifies competitive factors in the whole industry. After that, products with new competitive factors that broke the unification of competitive factors shown in this paper were developed in the digital camera industry later. The future research will try to clarify, through case analysis, product development that has escaped from a unified competitive factor. In addition, next research attempt is to consider the product line strategy for new competitive factors in industry.

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