◆論　文

Advantages of the Firm without Center Technology:

A Case Study of Casio Computer

Keyword　center technology, product development, device procurement, new concept creation, Casio Computer

Lecturer, Faculty of Management, Chukyo University　Kiyohiro Yamazaki

Abstract

The purpose of this study is to examine how the firm without center technology to gain the competitive advantage. Many researchers insist the firm which has core competence gains the competitive advantage. In contrast, Leonard-Barton (1995) investigated the possession of the core technology prevents the firm from gaining the competitive advantage occasionally. However, many firms without center technology succeed in a variety of industries lately. Therefore, the logic of the firm without center technology needs to be examined in detail now, and this study takes Casio in the compact digital still camera industry in Japan as an object of study.

In this study, the center technology is defined as the technology which plays the basic function. The CCD and optical lens provide basic function of the digital camera. Moreover, the center technology is recognized as the center role of the product by product makers. Consequently, this study defines the center technology as knowledge and the production equipments of the CCD and optical lenses.

Casio does not hold these technologies. In this situation, Casio could develop slim and light digital camera EXILIM in 2002. Although this had only 1.3 mega pixels CCD and optical lenses without zoom, it developed under new concept "wearable camera". Casio increased its market share in the digital camera industry.

In the development process, Casio procured the center devices—the CCD and optical lens-from several device makers. At that moment, Casio was able to choose either advanced device or cheap device, and change the device makers when others provided more advanced and cheaper devices. Furthermore, Casio developed EXILIM under new product concept. It omitted the optical zoom and auto focus. Moreover, HCLi (Hyper CCD-Lens integration) and MCM (Multi Chip Module) were developed especially for EXILIM. Both devices saved space and contributed toward downsizing.

This study examines that the logic of the firm without center technology in forcing an economical advantage and an organizational advantage. The economical advantage means

that the firm can choose either advanced or cheap device out of several device makers, and change the alternatives cheaply and quickly. The uncertain technological environment forces the firms which have center technology encourage the technological development and pump money into development in order to follow the technological progress. Conversely, the firm without center technology is not under the necessity of investing the money in technological development.

Moreover, the organizational advantage means that the firm without center technology is not restricted by organizational inertia and cognitive restraint, and exercises the characteristic strength. First, the firm without core technology is free from cognitive restraint on the product concept and technology. Second, it could not differentiate the product in the same respect as the product of the firm with center technology. Since it would pursuit the differentiation on the different points, its decision-makings and organizational behaviors would differ from other firms and could create new competitive advantages.

Ⅰ. Introduction

Numerous attempts have been made by scholars (e.g., Wernerfelt, 1984; Barney, 1991) to demonstrate that management resources are different across individual firms, and each firm's resources are an advantageous source for competition. This approach, which is called RBV (Resource-Based View of the Firm), points out that management resources and their abilities differ from one firm to another, and this heterogeneity leads to the differentiation of products and services. In particular, Prahalad and Hamel (1990) paid attention to firm-specific management resources. They maintained that heterogeneity is important and argued that it is advantageous for competing firms. These resources should not be easily imitated by other companies for the heterogeneity of resources to exist. The resource that can be easily imitated and obtained by competitors is at once imitated by them (Barney, 1991). Therefore, ambiguous causality (Itami, 1987; McEvily and Chakravarthy, 2002), path dependency (Nelson and Winter, 1982), and a right to be protected legally and systematically (Rumelt, 1984) are required.

In addition, researchers have argued that resources should not be freely transferred to other firms (Dierickx and Cool, 1989; Peteraf, 1993). Ambiguous causality and path dependency make market dealings of resources difficult.

As mentioned above, researchers have discussed that the possession of the core resource hinders gainings of competitive advantage (Levitt and March, 1988) while management resources generate competitive advantage. Leonard-Barton (1995) paid attention to the core capability as a source of a competitive firm's advantage. However, this capability is not versatile. It can be a burden to the firm if it does not lead to corporate competitiveness. A firm's corporate activity would be stiffened; the core capability becomes a core rigidity.

A great deal of effort has been devoted to the fact that current firms having core resources and capabilities gain the competitive advantage. However, the reasons firms without core resources and capabilities have this strength have not been studied in academic research. That the firms with the core technology construct competitive advantage and that the possession of the core technology hinders the competitive advantage of firms

have been discussed. However, researchers have not sufficiently discussed the reasons firms without the core technology can enhance competition.

From the practical perspective, it can be pointed out that industries where the firm is without core technology can demonstrate strength in recent years. Firms lacking core technology obtain core devices when those devices outside firms are significantly modularized (Ulrich, 1995; Baldwin and Clark, 2000). The most important addition to be made to what we have said about the firm without core technology is the forming of the global innovation network (Dedrick, Kraemer and Linden, 2008; Linden, Kraemer and Dedrick, 2009). The firm could cooperate with several international partners for creating new value. Therefore, the firms without center technology could develop excellent products and gain their competitive advantage with using the global supply chain in industries that were dominated by firms with core technologies. This paper then constructs the structure where firms without core technologies become competitive. Casio Computer Co., Ltd. (referred to as "Casio" hereafter) in the compact digital camera industry will be the main focus of analysis. The paper clarifies the process in which Casio, despite lacking image sensor and optical system technologies, developed the competitive models EX-S1 and EX-Z1000.

For the purposes of this paper, a center technology is defined as a resource for designing and producing core devices. The elemental technology constituting a product is roughly divided into the center technology and peripheral technology[1] categories. The center technology[2] is a technology that satisfies two requirements. One requirement is a technology for working the "basic function" provided by a product. Secondary, when each firm enters the market, its center technology is recognized as the technology composing the primary part of the product, and center technology decided by the overall industry. The recognition subject is the set of manufacturers, and the timing for recognizing the center technology is an introduction stage in the industry. It is the technology that is developed continually and improves the function level. In contrast, the peripheral technology is defined as the technology concerning all devices except the center device.

Ⅱ. Case study

In this section, Casio in the compact digital camera industry is a case that illustrates how a firm without center technology gains a competitive advantage. The data for this case study is from interviews with Casio, other manufacturers in the set, and device makers (e.g. Panasonic and Canon) as well as from publications and announcements from several firms.

1. Possession of each firm's center technology

Since the QV-10 sale that Casio put on the market in 1995, the general consumer market rapidly emerged for Japan's digital camera industry. Taking a picture and recording that image are basic camera functions and an indispensable technology. Therefore, the image sensor and the optics system technologies are technologies that work a digital camera's basic functions. The image sensor and the optics system technologies are recognized by the set of manufacturers as the product's primary role because their development in terms of high-resolution has been one of the most important tasks for the set manufacturers since the development of the

Table 1: Possession of center technology by digital camera companies

	Image sensor technology	Optics system technology
Casio	×	×
Canon	○ (CMOS)	○
Olympus	×	○
Nikon	○ (CMOS)	○
Sony	○ (CCD)	○
Panasonic	○ (CCD)	○
Fujifilm	○ (CCD)	○
Sanyo	○ (CCD)	○

QV-10. Therefore, the center technology of the digital camera is defined as the image sensor and the optics system technologies. Table 1 shows the possession of the center technology by digital camera companies.

2. Case study of the EX-S1

When the EX-S1 was put on the market in May 2002, it became a big hit, and by the next month, it had experienced the highest number of sales in the industry. The market share of Casio rose from approximately 5% to 10% by putting the EXILIM on the market. The competitive advantage factor of the EX-S1 was that it equipped 1.3 megapixels CCD and single focus lenses. These characteristics were achieved by drastic decisions and new product concepts.

In the development of the EX-S1, there was a Casio-specific development process that did not involve either image sensor or optics system technologies. When each firm developed the digital camera, it thought about the digital camera as an alternative to a film camera, and increasing the number of pixels was a focus of the competition. In addition, sales of Casio models that lacked image sensor and optics system technologies were also less than those of other companies, and Casio's market share decreased. Casio believed that it was not able to spell out its own characteristics because it did not have those technologies, even if competing by the number of CCD pixels and optical zoom.

Consequently, Casio was driven by the necessity for producing an original feature, and it pursued a usage different from that of the film camera. The product concept that was considered was the possibility of taking pictures anytime and anywhere, which was a wearable camera. In April 2001, the product project team developed the goal of a card case that was 10mm thick. As a result, Casio did not persist in the development of the high-resolution image and decided that equipping their cameras with 1.3 million pixels CCDs and single focus lenses would result in products that were inferior to other companies' products.

Optical lenses and CCDs equipped in the EX-S1 were developed in cooperation with the device makers. When single focus lenses were equipped in the EX-S1, Casio designed the lens, and Pentax manufactured it. However, the optical zoom lens was purchased from an outside source as a lens module and equipped in Casio products other than the EX-S1 because advanced skills in lens design were needed as producing such lenses was difficult. For example, the lens made by Canon was equipped in the QV-4000 (which went on sale in August 2001) and the lens made by Pentax was equipped in the QV-R4 (released in July 2002) before and after the EX-S1.

Moreover, Casio worked with a CCD maker because Casio did not have the image

sensor technology and developed the CCD lens integration module HCLi (Hyper CCD-Lens integration). Casio was able to make the module thinner than the earlier version because the extra parts became unnecessary if the CCD and lens were integrated, as compared with the previous CCD chip and lens that were separately supplied. Meanwhile, the firms with center technology, such as Canon and Sony, equipped center devices developed in house with their products. Therefore Canon and Sony need to use their devices developed in house, while Casio could select the devices from several device makers at low cost.

In addition, to improve portability, optical zoom and automatic focus (AF) functions, which were assumed to be standard functions, were omitted. LSI technology named MCM (Multi Chip Module) that brought four chips (CPU, ASIC, SDRAM, and the flash memory) together in one layer was used for miniaturizing the exterior. A large-scale digital interface LCD of 1.6 inches was equipped with the digital camera, which was unprecedented at that time. As mentioned earlier, the thickness of 11.3 mm was achieved by the high-density surface-mounting technology and LSI design technology that had developed after Casio put its calculator and watch on the market in the 1970s.

3. Case study of the EX-Z1000

The EX-Z1000 was released in May 2006 and was equipped with a ten megapixel CCD, which was unprecedented in the compact digital camera industry. As a result, it accounted for 7.2% of the market share by the following month. At that time, other firms equipped from six to eight megapixel CCDs into their products. In 2006, the competitive factor of digital camera was a camera's multiple functions, such as the anti-shaking function and the high resolution.

Casio thought that the EX-Z1000 should not be equipped with these functions, and the charm of this product was that it had ten megapixels. This advancement became possible because Casio did not have the center technology for the development of the EX-Z1000. The noise increases as the number of CCD pixels rises, and image quality deteriorates. Therefore, the industry did not think there was a big advantage in a ten megapixel CCD. However, Casio did not persist with the high-resolution, and noise was allowed. Then, the EX-Z1000 became more attractive by raising its megapixels by ten and won popularity among consumers. Meanwhile, Canon and Sony could not permit the noise on the picture because it is important for them to enhance the high resolution.

At that time in 2006, Casio equipped its digital camera with between six to eight megapixel CCDs and put it on the market. For instance, even if the same six megapixel CCD was externally procured, the size and valid pixels were different. Seven megapixels and eight megapixels are also similar. The EX-Z1000 equipped with a ten megapixel CCD. Moreover, Casio switched from procured CCD to other CCD. Casio switched its CCD device maker, and the 12 megapixel CCD equipped in the EX-Z1200 (released in June 2007) was procured from a CCD manufacturer different from that of the EX-Z1000. By switching suppliers, Casio could release digital cameras equipped with 12 megapixel CCDs earlier than firms procuring ten megapixel CCDs.

Better portability and display performance were also achieved. The special lens had a small diameter and the camera was equipped

Table 2: Enlargement of the LCD

inch	1.8	2.0	2.5	2.7/2.8	3.0
Casio	95/4	99/9	96/3	05/8 (2.7)	
Canon	97/3	98/10	05/9		06/4
Olympus	96/10	98/10	05/9		05/11
Sony	96/10	99/3	97/8		05/11
Panasonic	97/3	97/12	00/2	06/8 (2.8)	06/8
Fujifilm	96/7	97/11	02/11		06/3
Sanyo	99/8	97/3	05/2		05/10

with decreased resolving power. The image quality decreased to improve the portability. The high luminance 2.8 inch wide LCD was included. Up to this point, Casio had aimed at the enlargement of the LCD before other companies did (Table 2). Casio has solid experience with a small LCD because since 1973 it has equipped this technology in several products, such as wristwatches, calculators, and electronic instruments. As a result, Casio accumulates the liquid crystal technology and uses for the digital camera.

III. The logic of a firm without the center technology

The previous section showed that in developing the EX-S1 and EX-Z1000, Casio easily procured center devices and at that time was developing products with characteristics different from those in any existing products. The logic is constructed in paying attention to the two advantages exhibited when a firm that does not have center technology develops a product with a high competitive advantage.

1. Two advantages of a firm without center technology

There are two advantages for firms that lack center technology. First, those firms have the flexibility that allows them to correspond quickly to environmental changes at low costs. This paper refers to this flexibility as an economic advantage. Second, there is originality that demonstrates a firm's own strong point without an organizational restriction called organizational advantage. This paper aims to clarify the mechanism of the strength of the firm without center technology by paying attention to these advantages.

The economic advantage pays attention to the financial side of the firm and indicates advantages on the inside of the firm when relationships with external sources are built. This advantage is in terms of lowering the firm's costs. However, the advantage to the firm without center technology is not only in terms of costs. Besides the reduction in costs, an advantage can be organizationally demonstrated. Organizational advantage pays attention to the systematic side of the firm and indicates the advantages of decision making and organizational behavior.

2. The economic advantage of firms without center technology

The firm without center technology increases the probability for constructing a competitive advantage because it can correspond to an environmental change at low cost. The firm should procure the center device for product development from outside the company and can choose a low-cost procurement method from the range of choices. This paper refers to this situation as a wide selection. Additionally, when the firm is presented with choices having costs lower than

those of the current existing choices, the firm can switch to these cheaper alternatives in a process known as switch easiness.

The firm without a center technology could lower its cost and risk by procuring the technology from outside rather than by developing it in-house. Therefore, there are a wide variety of choices for external procurement. Low cost alternatives can be selected from several options, which are two or more procurement methods and device makers. The wide selection means the technology is procured from joint development or the device that mounts the center technology is procured from device makers. In addition, firms can select how to obtain their center technology by comparing joint developments for the external procurement of the technology. Firms can also compare several external firms that can provide procurement of the device.

Switch easiness means that the cost and time of the change from present choices to other choices is low. The firm without center technology does not need to continue with a specific procurement method and device maker. Because the firm without center technology is not developing the center technology by itself, sunk costs and time for the change in procurement are low. The procurement method and the device maker can quickly be switched from several procurement methods and device makers to procure an inexpensive device and one with a high level of functionality for the product. When doing so, first-mover advantage (Lieberman and Montgomery, 1988) is obtained. Moreover, even if the other set of manufacturers proceed to furnish a new device, the firm without center technology can quickly follow that movement. The possibility of easily adjusting to the change of circumstances rises when obtaining a cheap device or the latest device from external sources and changing the product composition.

When the lens was procured, Casio was able to selected two methods in the EX-S1 development because Casio did not have an advanced optics system technology. Through joint development, Casio designed the single focus lens in-house and consigned the manufacturing to outside sources. Another method is purchasing the optical zoom lens with a difficult design as a lens module from outside sources. Casio procured this module from several lens manufacturers in the procurement of the optical zoom lens. In addition, Casio switched these procurement methods and device makers within one year.

Casio also selected CCD because it did not have the image sensor technology. It procured the module from joint development efforts. Casio had already put the model equipped with between two to four megapixel CCDs on the market before HCLi was developed. Those CCDs had been procured as a module from outside sources. Casio not only developed HCLi in cooperation with the CCD manufacturer, but also procured two to four megapixel CCDs when it switched its procurement method. The CCD module with its different size and number of pixels was procured for the six megapixel digital camera to the 12 megapixel digital camera before and after the EX-Z1000. Casio switched device makers and could equip the EX-Z1000 with the latest ten megapixel CCD.

3. The organizational advantage of firms without center technology

The advantage for the firm without center technology is not only in terms of a reduction of costs. This paper assumes an advantage that excludes cost. This advantage is

called as an organizational advantage. This advantage is not composed of organizational restrictions or original pursuits. First, the firm without center technology is free from receiving cognitional restriction in its decision making and organizational behavior. The firm does not experience organizational restriction. Second, even if the firm without center technology procures its center device from external sources and can compete equally with other firms, the procurement alone is not sufficient to create that firm's strength. The firm tries to develop originality in ways other than the center technology and differentiates its product features from those of other companies.

First, freedom from organizational restriction means a firm receives neither cognitional restriction concerning the product concept nor cognitional restriction concerning the technology through organizational restriction, such as organizational inertia (Hannan and Freeman, 1984). Cognitional restriction concerning the product concept means restricting the manner in which the product is conceptualized. While the firm needs to decide its target customers and product value, it sometimes fails to create proper product concepts. Because the performance improvement of the product is faster than the speed of the improvement in customer demand (Christensen, 1997), an unbridgeable gulf between both levels is caused. In addition, according to Abernathy (1978), the process innovation tends to increase while the product innovation decreases when a model is accepted by the customers and the product demand increases. As a result, basic attributes of the product are not fundamentally reconsidered, and new ways to develop the product are stifled within the firm with center technology.

However, the firm without center technology is not able to focus on a specific customer who alone positively evaluates the center device's function or to target a wide range of customers. The differentiation of the firm's product becomes difficult, and consequently, the firm does not persist in attaining the value offered by the center device in an existing product.

In addition, cognitional restriction concerning center technology is caused due to human resources, such as engineering, that achieve development and utilize material resources, such as equipment for experiments and manufacturing facilities. The engineer tends to concentrate on the technology developed by the firm and often fails to exploit the technology developed from the outside (Katz and Allen, 1982). The equipment for experiments and manufacturing facilities are particularly technical, and the organizational specification is high. Therefore, researchers argue that the cognitional restriction is caused due to the thought process of engineers' and the existence of such equipment, and the firm with center technology does not readily rethink the product.

In contrast, the firm without center technology needs not to concentrate on the developments of center technology development. Engineers do not persist in obtaining knowledge and know-how for only a specific technological field because they are not heavily involved with the center technology. Therefore, there is no resistance to the device procurement from outside the firm. Because the firm has neither the manufacturing facilities nor the equipment that are related to center technology, it is not restricted by material resources.

Second, the pursuit of originality is important. There is the tendency for a firm's

decision making and organizational behavior to depend on its technologies and resources. However, because the firm without center technology experiences difficulties when differentiating its product by the center technology, the firm needs to invent a unique feature. It then tries to begin competing on its own stage. On this stage, the firm without center technology pursues a product concept different from the existing product concept based on the center technology. New product development makes use of the peripheral technology. This pursuit of originality is based on the new product concept and peripheral technology.

When each firm enters the market, it has developed its product under a dominant product concept since the introduction stage. The firm with center technology tends to develop the product that makes the best use of its technology. However, the firm without center technology experiences difficulties when differentiating the product. Therefore, differentiation based on a concept that is different from the one belonging to the firm with center technology will be valued. That is, originality in a new product concept is to set the product concept that can demonstrate the product's own strong point.

This paper next looks at the pursuit of originality by use of peripheral technology. The firm without center technology relies on procurement from external sources for the center device. Because this procurement acquires a device that is the same as the one belonging to the firm with center technology, distinguishing a clear difference between the two products is difficult. The firm without center technology will think that it should differ technically from the other companies. The source of technical differentiation then stems from not the center technology but the peripheral technology. The pursuit of the product's originality will be improved by using the peripheral technology with the possibility of this technology becoming the firm's strong point.

Casio experienced difficulties when competing with other companies. It did not persist in developing and manufacturing its camera based on the concept of a replacement for the film camera by including a standard function, such as the optical zoom and AF. The LSI design technology and the LCD technology that Casio had been accumulating in another business division were exploited. Casio developed MCM and a large-scale digital interface LCD, which differentiated its products from those of competitors. Moreover, a flat and compact design was achieved in the development of the EX-Z1000.

Ⅳ. Conclusion and future research

This paper investigates the logic of the firm without center technology based on the analysis of Casio in the digital camera industry. In this case, this paper focused on two advantages: the economic and the organizational advantages.

First, the firm without center technology has a wide variety of selection concerning the procurement of the center device. There are two methods in Casio's case. One involves joint technology development with the device maker. For this method, Casio used the knowledge and equipment of the alliance firm and developed the center devices at a low cost. HCLi of EX-S1 was developed by this method. The other method is an external device purchased from the device makers as module procurement. In this method, competitive pressures influence device makers, and Casio could compare several device

makers and choose an inexpensive option. There is a possibility that the latest device can be quickly adopted. The EX-Z1000 was promptly equipped with ten megapixel CCDs. Additionally, Casio easily switched between two methods of procuring. It was able to switch cheaply and quickly among the device makers.

This paper referred to the other strength of the firm without center technology. This firm experiences difficulties in producing a big difference from other firms' products on the basis of center technology because this firm lacks the center technology. Therefore, the firm needs to try to offer the customer new value by creating a different concept and using its peripheral technology. The concept behind the EX-S1 was to take pictures anytime and anywhere (the wearable camera). Consumers were attracted by the allure of ten megapixels in the EX-1000.

In general, researchers have believed that the firm with the center technology gains the competitive advantage easily. Alternatively, they have argued on the strength of the firm without the center technology, as mentioned earlier in this paper.

Lastly, the limitations in this study and the problem with future studies are shown. Based on the analysis of the Casio case in the digital camera industry, this paper constructed logic concerning the advantages of the firm without center technology. However, the hypothesis was constructed based only on the Casio case. The hypothesis shows only a part of the reasoning that explains why the firm without center technology demonstrates competitive advantage. Therefore, further examination is indispensable. Constructing an argument for strength without center technology is necessary through future analysis of a number of firms across various industries.

Firms such as Canon, Nikon, Sony, and Panasonic were not compared with Casio, which was chosen to represent the firm without center technology. Future research needs to compare the difference between the logic of the firm with center technology and the logic of the firm without center technology.

Notes

1 This definition of center technology cannot necessarily be applied to all industries. There are industries in which the center technology does not apply. The apparel industry is one such example, and reexamining this issue is necessary. However, this definition is effective in the industry examined in this paper.

2 There is a difference between the center technology and the core technology. The core technology that Prahalad and Hamel (1990) and Leonard-Barton (1995) examined is a technology that is unique to the firm and has multiple uses with several products. Therefore, recognizing the center technology is different from differentiating the respective core technologies in each firm. The center technology in this paper is decided in accordance with product features and a specific technology in one product, regardless of the firm's intention. There-

Table 3: The theoretical position of this study

competitive advantage	possess center technology	not possess center technology
high	strength with center technology	strength without center technology
low	weakness with center technology	weakness without center technology

fore, the center technology is a unique technology that is decided by the overall industry. The performance level of the product's basic function does not often meet customer demand standards during the development or the introductory periods of the industry, and the biggest development task is for market expansion (Christensen, 1997). The product then becomes an improvement of the function level of the center technology. Therefore, if the definition of the core technology is used, it is highly likely that all firms entering the market have some technologies and discussing firms without technologies is difficult.

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