The Significance of After-Market Strategy in FANUC: Case Study of Platform Leadership Strategy

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1. Introduction

The capital goods industry is the key to innovation. This is because technological innovation has been codified in the machine tool industry. Rosenberg (1976), who historically analyzed the machine tool industry, noted that the technical bottleneck machine claims to determine the direction of technology's evolution. A technology imbalance can be resolved by focusing on technological development and improve the bottleneck.

The machine tool industry has also continued to innovate, and small- and medium-sized enterprises have continued to survive with the spread of the Numerical Controller (NC), which will enable companies to have their own machining technology. In addition to domestic companies, this has expanded machine tool companies in Taiwan, South Korea, and China. In 2009, Japan slipped as the world's largest machine tool manufacturer, after maintaining this status for 27 consecutive

years. On the other hand, as large companies can be difficult to differentiate, a movement exists for the NC device's unique internal development.

In case studies of IT companies in the United States, Gawer and Cusumano (2002) presented a "Platform Leadership Strategy," and Iansiti and Levien (2004) proposed their "keystone strategy." Hayashi (2014b) analyzed the machine tool industry using these frameworks, and from this perspective, considered FANUC, one of the world's top NC device companies, as the "keystone," and it applied to the machine tool industry as an "ecosystem." The Platform Leadership Strategy has until recently been primarily adapted in the IT and retail industries. However, Hayashi (2014b) considered that this strategy can adapt to the manufacturing industry, and from that perspective, the FANUC's strategy was analyzed in 4 lever. Hayashi (2016b) also analyzed FANUC's robot business from the same viewpoint.

Hayashi (2015) extends the previous machine tool ecosystem analysis. As a Platform Leadership Strategy, FANUC spreads the range of "relationships with external complementors." Hayashi (2015) analyzed the relationship between competitors and potential customers, and noted a complementary relationship. Hayashi (2016a) conducted a field survey by interviewing Taiwan's machine tool companies, and in Taiwan's machine tool industry, this illustrated that the FANUC platform leadership strategy is working.

This paper, based on these analyses, will focus on FANUC's after-sales service strategy. Generally, after-sales service has a noticeably high profitability. However, FANUC's purpose is to strengthen their after-sales services, such as overseas customer sales. As a result, FANUC's after-sales service, used to maintain customers' diversity, is beneficial in the maintenance of the machine tool industry's ecosystem, which this paper will prove.

2. Overview of Previous Research

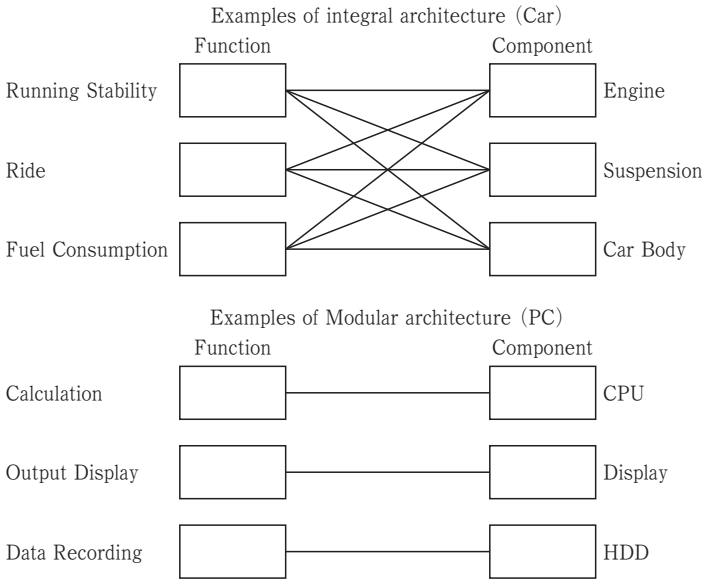
Abernathy (1978) provided the headwaters for companies' innovation research by studying the auto industry, and proposed a "dominant design." Dominant design, to serve as an example of any product, is the industry's dominant product design. For example, the Ford T automobile model is a dominant design, or the car's basic shape. The author insisted that if it is dominant design, but intends to improve productivity, then a productivity dilemma exists in product specification innovation.

Henderson and Clark (1990) pointed out the importance of product architecture from their study of copy machines and semiconductor manufacturing equipment. Product architecture is a design concept regarding how to establish each product component's dependencies on each other. Many subsequent researchers proceeded to adapt to a variety of industrial product architecture.

Ulrich (1995) divided this into two types of product architecture: integral and modular. Integral involves the product's tangled function and structure, and is a state in which parts are rigidly connected with their own interface. The typical industry resembles the automotive industry. Designers of each component are required to adjust mutual designs, to influence their respective parts. On the other hand, "modular" involves simple mutual relationships, and the parts' interface is standardized, which separates independence. One typical industry is the personal computer industry in which each component functions independently and it is possible to increase the variety of products by selecting combination of components.

Baldwin and Clark (2000) studied the personal computer industry, and pointed out modularity's benefits, as follows: ① simplification, ② standardization, and ③ independence. They argued that when the industry includes modular components, if the "design rules" between modules are observed, trial and error tests can be freely conducted, and innovation can happen.

(Figure 1) Classification example



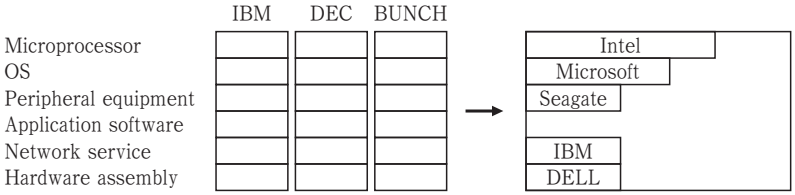
Source: Ulrich (1995), Clark and Fujimoto (1991).

Christensen (1997) studied the Hard Disc Drive (HDD) industry, and proposed "the innovator's dilemma." Specifically, the more often we hear about current major customers' needs, when technological change has occurred, company correspondence slows to new technology.

Fine (1998) and Christensen et al. (2004) thought that the industry tends to evolve from an "integral" to a "modular" industry. They were generally positing that, if the market's required performance level is stable, the dominant strategy becomes modular, and the product is generalized. Chesbrough (2003) proposed the open architecture strategy's superiority, and noted that with the introduction of the "modular" architecture, each company can focus its management resources on its specialty, which will lead to increasing superiority in the entire network.

Clark and Fujimoto (1991) studied and compared 20 Japan and Western

（Figure 2）The Changing image of the Modular Industrial Structure



Source: Fine（1998）.

companies' international competitiveness in the automotive industry. As Hayashi（2013）displayed a survey list for each industry, Clark and Fujimoto（1991）used, as the case study's skeleton, various industry studies that have been performed. They noted, in their analysis of organizations' ability development, the importance of "companies' participation in development," for Japanese companies. Thereafter, Asanuma（1997）illustrated that the source of the automotive industry's strength lies in certain modules from major parts suppliers.

Gawer and Cusumano（2002）proposed the platform leadership strategy. Platform leadership is the company's ability to drive innovation around a particular platform technology at a broad industry level. The authors studied such IT companies as Intel, and as a result, the industrial structure is open-modular, competition also occurs in intense environments, and it is possible to maintain the company's profitability. These companies are directed to use the following "four levers," to induce innovation among the industry's complementary products.

The Four Levers of Platform Leadership

① Scope of the firm: this lever addresses the firm's internal functions, and what it encourages others to do externally. It is better for firms to develop an extensive in-house capability to create their own complements, or to allow the

market to produce complements.

② Product technology (architecture, interfaces, intellectual property): This lever addresses decisions that platform leaders must make regarding the architecture of their product and the broader platform. They must decide the degree of modularity, the degree of the interfaces' openness to the platform, and how much information regarding the platform and its interfaces to disclose to outside firms or competitors.

③ Relationships with external complementors: This lever determines how collaborative, versus competitive, the relationship should be between the platform leader and the complementors. Platform leaders must also be concerned with achieving a consensus with their partners, and how to handle potential conflicts of interest, such as when the platform leader decides to directly enter complementary markets, and turns former partners into competitors.

④ Internal organization: This lever addresses internal organizational structure to more effectively manage external and internal conflicts of interest. The correct internal structure can help platform producers manage external and internal conflicts of interest. Most platform leaders do not have the capabilities or resources to create complete systems by making all the complements themselves, and must collaborate. Platform leaders' and complementary innovators' combined efforts increase the potential size of the pie for everyone.

Iansiti and Levien (2004) proposed that a business ecosystem concept exists in the industry. Keystones in biological ecosystems exercise a system-wide role, despite having only a small part of their ecosystems' mass. Keystones provide a stable platform for the entire ecosystem, and although they leave the vast majority of value creation to others in the ecosystem, what they do create is crucial to the

community's survival. The ecosystem's health is measured using the following three indicators: productivity, robustness, and niche creation. For example, Microsoft functions as only a small part of the computing ecosystem, as both its revenue and number of employees represent approximately 0.05 percent of the ecosystem's total figures. However, Microsoft's market cap has typically ranged between 20 and 40 percent of software providers' combined market cap. Keystones can create value for their ecosystems in numerous ways.

Dujarric and Hagiu (2009) studied the case of Japan's failure from a business ecosystem perspective, and analyzed the ecosystems of Japan's animation, software, and mobile phone industries. Japanese animation exists despite the fact that with advanced technology, it does not have a significant influence in the world. Further, the Japanese mobile phone industry has also had advanced technology, but its "i-mode" could not be exported. They insisted that there was no business ecosystem perspective, and these industries were "Galapagos".

Teece (1986) claimed that complementary goods and assets are important to become an innovation leader and to monopolize. Complementary goods assets include software, consumables and distribution channels for the computer hardware. Companies cannot provide value and market only their products, as it is possible to increase their value with a combination of complementary goods assets.

Osanai and Sakakibara (2012) discussed a case study of Komatsu as part of product architecture. Komatsu is Japan's top construction machinery company, and they focus on and analyze aftermarket strategy, which has gone unnoticed until recently. They use their knowledge of the IT and electronics industries' product architecture and analyze Komatsu as a producer of goods. However, the target of their analysis, Komatsu's strategy, does not cover the entire industry ecosystem.

3. Machine tools of industrial structure

This paper analyzes the machinery industry, which generally provides support to the manufacturing industry. Specifically, the machine tool is referred to as the "machine-making machine" or "mother machine." The Japan Machinery Federation (JMF) aggregates the scale of Japan's machinery industry, and according to its statistics, Japan's machinery industry production in 2015 encompassed approximately 73 trillion yen (USD 660 billion). Its primary output is automotive, as 44% is transportation equipment, and 20% is occupied by general machinery, such as machine tools or industrial machinery. Approximately half of its general machinery is used in the production of transportation equipment.

(Figure 3) Japan's Machinery Industry

Production (Trillion yen)

(Product/Year)	2014	2015	Weight
Japanese machinery and engineering	70.3	72.6	100%
General machinery	13.8	14.4	20%
Electrical machinery	7.3	7.7	11%
Transportation equipment	31.5	31.8	44%
Precision machinery	1.4	1.4	2%
Other	16.3	17.1	24%

General machinery, including machine tools, industrial machinery, etc.
Electrical machinery, including electrical equipment, electronics, etc.
transportation equipment, including automobiles, rail cars, shipbuilding, aircraft, etc.
precision machinery, including cameras, measuring equipment, etc.
Source: The Japan Machinery Federation

According to Hayashi (2014a), general machinery, other than metal machine tools, contains a variety of products. The primary products are construction machinery, refrigeration machines, and semiconductor manufacturing equipment, among others. Metal machine tools and robots, have also been used to produce these products, in addition to automobiles. Therefore, the metal machine tools'

accuracy also determines the accuracy of these products. The metal machine tool industry is important in more than scale.

（Figure 4）The breakdown of Japan's general machinery

（Trillion yen）

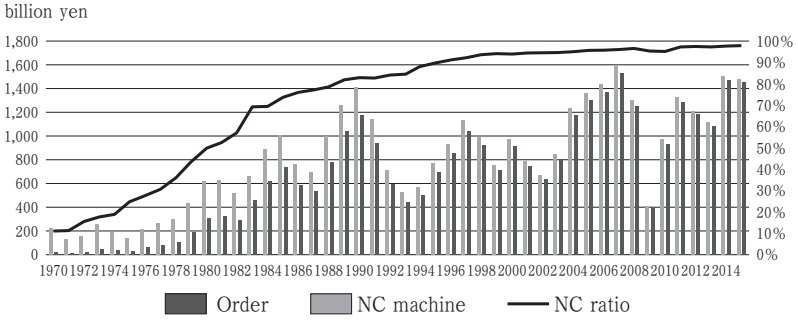
(Product/Year)	2013	2014	Weight
General machinery	13.4	13.8	100%
Construction machinery, etc.	1.7	1.8	13%
Metal machine tools	0.9	1.3	9%
Robot	0.5	0.6	5%
Refrigeration machines, etc.	1.9	1.9	13%
Semiconductor manufacturing equipment, etc.	1.5	1.6	13%
Other	6.9	6.7	49%

Souce: The Japan Machinery Federation

A key component of machine tools is the numerical controller, or NC. Its device controls are under a program control that uses signal commands by numerical value, such as the tool's position and feed rate relative to the workpiece. The United States developed the first NC machine tools in 1951. However, the NC machine could not respond to the complex processing required by aircraft manufacturers. Therefore, the spread of NC machine tools was delayed in the United States. On the other hand, machining for small businesses was often in demand in Japan, and earlier promoted the spread of the NC machine tool. As a result, Japan was the world's largest machine tool producer for 27 years, from 1982 to 2008. According to the Japan Machine Tool Builders' Association, or JMTBA, the Japanese machine tool industry's current market size approximates 1 trillion yen. Its NC ratio has exceeded 90%.

On the other hand, it has become possible for anyone to create a certain level of machine tool by purchasing an NC device. For example, China's NC machine tool production volume has expanded due to their importing NC devices. Chinese production was 1.4 million units in 2000, and approximated 6 million units in 2005, 14

(Figure 5) Machine tool order trends in Japan



Source: JMTBA

million units in 2009, and 20 million units in 2013. China has been the world's largest machine tool producer since 2009. Regarding machine tool market share in 2015, China was first place with 28%, second place was Japan with 17%, third place was Germany with 15%, fourth place was Italy with 7%, fifth place was South Korea with 6%, sixth place was the United States with 6%, and seventh place was Taiwan with 6%. Countries other than China and the United States have an export

(Figure 6) Machine Tools: Country Share

(Mil.: US$)

	CY 2015	Production	Weight	Consumers	Weight	Net Export
1	China	22,100	28%	27,500	35%	-5,400
2	Japan	13,490	17%	5,805	7%	7,685
3	Germany	12,422	15%	6,360	8%	6,062
4	Italy	5,306	7%	3,136	4%	2,170
5	South Korea	4,758	6%	3,823	5%	935
6	USA	4,600	6%	7,361	9%	-2,761
7	Taiwan	4,030	5%	1,564	2%	2,466
8	Switzerland	3,052	4%	1,038	1%	2,014
9	Spain	1,003	1%	595	1%	408
10	Austria	938	1%	637	1%	301
	Other	8,491	11%	21,151	27%	-12,660
	Total	80,190	100%	78,970	100%	-

Source: Gardner Research

surplus.

If Korean and Taiwanese companies buy NC equipment from Japanese companies, they can also create a certain level of machine tools. European companies in such countries as Germany, which produces high-end NC machine tools, also have a monopoly on non-NC ultra-high-end machinery. Machinery using NCs can create extensive machinery, but this is not possible with a special process. A general misunderstanding exists in that NC machine tools are not necessarily high-end, and are used in most mid-range machines, but there are instances when they are not used in both high-end and low end machines.

(Figure 7) Machine Tools: NC machine production in each country

Units						Value				
	Year	Total	NC	non-NC	raito		Total	NC	non-NC	raito
Germany	2013	43,672	30,016	13,656	69%	mil.Euros	7,941	7,042	899	89%
						Unit price(000)	182	235	66	-
Switzerland	2013	15,336	3,752	11,584	24%	mil.CHF	2,453	998	1,455	41%
						Unit price(000)	160	266	126	-
UK	2012	-	-	-	-	mil.GBP	39,641	24,675	14,966	62%
Japan	2015	101,566	89,288	12,278	88%	bil.Yen	1,253	1,136	117	91%
						Unit price(mil.)	12.3	12.7	9.5	-
South Korea	2013	-	-	-	-	bil.Won	1,222	1,186	36	97%
Taiwan	2012	318,357	49,493	268,864	16%	mil.TWD	134,893	101,593	33,300	75%
						Unit price(000)	423.7	2,052.7	123.9	-
China	2011	860,000	255,000	605,000	30%	-	-	-	-	-
India	2012	12,995	9,326	3,669	72%	mil.INR	32,974	25,298	7,677	77%
						Unit price(000)	2,537	2,713	2,092	-

Source: JMTBA, VDW, Office for National Statistics, UCIMU, Swissmem, KOMMA, TAMI, China Customs, IMTMA.

Japanese machine tool companies' strength lies in generic processing for automotive and electrical machinery. The Japanese, in other words, are strong in middle-end mass production applications. However, South Korean and Taiwanese companies have also been involved. Additionally, China has adapted to produce the majority of its middle-end machinery. Regarding the general price image, if the average number of Taiwan and Korean machinery manufactured is 100, 140-150 are

(Figure 8) Machine Tools: Country-Specific Role

	Main Areas	Main Player	Accuracy	Price Range	Volume
High-End	Munitions Medical care	Western	High	High	Few
Middle-End	General machinery Automobile Electronics	Japan, Taiwan, and South Korea.	Slightly Higher	Medium	Slightly Higher
Low-End	Daily necessities General goods	Chinese	Low	Low	Intensive

Source: Created from the Japan Machine Tool Builders' Association (2012)

made in Europe, 120 are made in Japan, and 70 are made in China.

Japan had 92 machine tool companies in 2013. This number has not changed significantly from the past, and has been stable. Fifteen companies report capital of more than 100 billion yen (16%). Thirty-five companies report capital of 1 billion yen or more (38%). Only 7 companies had employees with more than 3,000 people (8%). Further, 40 companies had more than 300 employees (43%). Small- and medium-sized companies are the core of Japan's machine tool industry, and many of these companies have each developed a highly original machine, such as grinding or dedicated machines. These companies, by purchasing NC devices from FANUC, are specializing in the development of the machine itself.

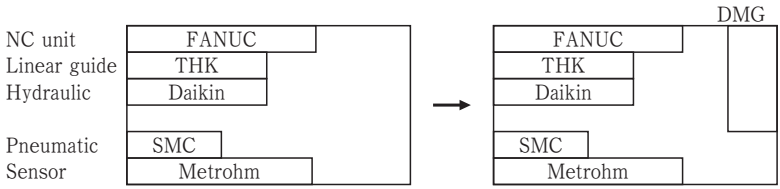
Japan's leading machine tool companies have become difficult to differentiate. Therefore, the top three Japanese companies are evolving their own NC devices. The top company, Yamazaki Mazak, jointly developed an NC device from its own specifications with Mitsubishi Electric in 1982. Second, Mori Seiki Co., Ltd. has increased the NC device's ratio using its own specifications by more than half since 2010. Third, Okuma Corporation has been making OSP, an internal NC device, since 1963. Major companies are promoting vertical integration, but on the other hand, small- and medium-sized companies have evolved the NC device from FANUC.

（Figure 9）Japan's Machine Tool Market Share

	(Year)	2011	CY 2013	CY 2013
	Company name	Sales (mil.$)	MC share	NC lathe share
1	Yamazaki Mazak	2,525	26.0%	28.6%
2	Mori Seiki	1,409	25.2%	26.3%
3	Okuma	1,181	14.1%	23.6%
-	Other	-	34.7%	21.5%

Source: Nikkei, 2014.7.28, Gardner Publications

（Figure 10）The Machine Tool's Industrial Structural Image



4. FANUC's Platform Leadership Strategy

FANUC is a company that represents Japan. Its sales in FY 2015 have approximated 623 billion yen, operating income is 215 billion yen, and its operating profit margin approximates 35%. At the end of May 2016, FANUC's market capitalization is approximately 3.4 trillion yen, or twenty-second place among all Japanese companies; when limited by manufacturer, FANUC is the eighth, following Toyota, Honda, Nissan, Keyence, Canon, Sony, and Denso.

FANUC is a leading manufacturer of NC equipment and industrial robots. The machine tool's key component is the NC device, and particularly a device for controlling the tool's position and feed rate. FANUC has supplied for the customer one NC unit and an average of five servo motor sets, as the NC device moves the servo motor. As of June 2016, FANUC has cumulatively produced 16 million servo motor units, and 3.5 million NC device units. The FA, Factory Automation department

represents the NC device's sales, and the FY 2015 sales ratio is 27%.

(Figure 11) FANUC's Sales Breakdown and Sales Matrix

(bil.Yen)

Department	FY 2014	FY 2015	Weight
FA	207	170	27%
ROBOT	157	188	30%
ROBOMCHINE	292	183	29%
Service	75	82	13%
Sales	730	623	100%

Region	FY 2014	FY 2015	Weight
Japan	124	119	2%
Asia	392	265	4%
Europe	88	94	2%
Americas	124	143	2%
Other	3	3	0%
Sales	730	623	10%

Source: Company financial statements

2016.10～12	Japan	Asia	Europe	Americas	Other	Total
FA	11%	18%	3%	1%	0%	32%
ROBOT	4%	8%	7%	16%	1%	35%
ROBOMCHINE	4%	8%	3%	2%	0%	16%
Service	4%	1%	4%	6%	0%	15%
total	22%	34%	16%	25%	1%	98%

Source: Estimated from the IR data

FANUC's NC device share is the best worldwide, and while there is no exact number, there is a share of the exhibition in each country. FANUC's share in Japan is 55%, the United States is 58%, and Europe is 44%. FANUC's share of the exhibition in China is on average slightly less than 50%. China's top machine tool company, Shenyag Machine Tool, has purchased 60% of its NC from FANUC. As competition in China is tough in the non-NC machine tool industry, each company is promoting the development of a machine tool with NC. Conversely, because FANUC is supplying the NC devices, small- and medium-sized companies have survived.

South Korea's machine tool industry focuses on two NC lathe models and machining centers, and they have accomplished a high-mix, low-volume production.

The country's Hyundai WIA and Doosan Infracore companies have a high market share. FANUC also supplies more than 80% of the two companies' NC devices. On the other hand, Taiwan's machine tool companies have distributed its production across approximately 700 companies. Many medium-sized Taiwanese machine tool manufacturers have owner-managers, and Taiwan-made machines are widely exported to China and the United States. Taiwan's top manufacturer, Dongtai Seiki Co., Ltd., has also purchased approximately 90% of their NC devices from FANUC, demonstrating that FANUC's NC devices have become the standard adopted in Taiwan.

(Figure 12) FANUC's NC Share

EMO 2015		IMTS 2016		Nikkei 2012.7.30	
Euro	Share	Americas	Share	Japan	Share
FANUC	44%	FANUC	58%	FANUC	55%
A	24%	D	12%	Siemens	22%
B	10%	E	3%	Mitsubishi	17%
C	7%	F	9%	Other	6%
Other	15%	Other	18%		

Source: EMO, 2015; IMTS, 2016; Nikkei, 2012.7.30

FANUC is the world's top manufacturing company for robots that use NC devices. A normal articulated robot uses a single NC unit, and six servo motors. FANUC and Yaskawa Electric Corporation are the only leading companies that provide in-house production of the robots' servo motor; FANUC's FY 2015 robot sales ratio is 30%. Additionally, FANUC has also produced other machines, such as machine tools and injection molding machines, which do not conflict with its customers. The FY 2015 sales ratio for these robomachines is 29%. As of June 2016, FANUC cumulatively produced 400,000 robot units, 210,000 machine tools, and 51,000 injection molding machines. NCs are incorporated in these machines; in other words, FANUC's NCs have been used in almost all its products.

FANUC's industrial robot share is the best worldwide. FANUC's share in Japan is 12%, the United States is 83%, and Europe is 62%. Specifically, market share in Europe and the United States is high, although market share in Japan is low because Japanese companies' customers tend to prefer custom specifications. Additionally, Japanese companies' customers are accustomed to handling the robot; further, large companies, such as Toyota, have independently decided the robot's specifications, which are then manufactured. However, FANUC has sold the only robot that has been standardized for their specifications. Therefore, Toyota has not adopted the FANUC robot on a full-scale basis.

(Figure 13) FANUC's ROBOT Share

EMO 2015		IMTS 2016		Nikkei 2012.7.27		Nikkei 2012.7.27	
Euro	Share	Americas	Share	Japan	Share	Global	Share
FANUC	62%	FANUC	83%	Yasukawa	12%	FANUC	17%
A	11%	D	5%	Kawasaki	11%	KUKA	11%
B	7%	E	3%	Panasonic	11%	ABB	11%
C	5%	F	2%	FANUC	10%	Yasukawa	11%
Other	15%	Other	7%	Fujikoshi	5%	Kawasaki	5%

Source: EMO, 2015; IMTS, 2016; Nikkei, 2012.7.27

Generally, independent system integrators have established industrial robots for the production lines of small- and medium-sized enterprises. System integrators have conducted detailed production line design, robot installation, software design, and embedded control software, etc., System integrators customize the customer. An independent system integrator consists of approximately 1,000 companies in China. They must assure the final user of diversity.

FANUC is listening to the needs of system integrators and are making a standardized robot, which itself will be produced by a robot. FANUC describes it as follows: "The automated assembly systems, with a large number of FANUC intelligent ROBOTs, assemble other ROBOTs, which go through a continuous run-

ning test, and inspection in the testing area." The ROBOT Factory has a capacity to produce 5,000 robots in a month. Hayashi (2016b) thought as follows that approximately 30% of the robots can use the factory assembly process, and currently, the remaining 70% cannot produce only robots. On the other hand, FANUC robots are standardized and approximately 80% of the robot assembly process is automated. Similarly, the company expects to automate approximately 90% of this process in 2016. Naturally, FANUC has produced their robots' NC devices and servo motors. Owing to standardization, NC devices and robots are inexpensive, and are less likely to malfunction after the customer's purchase.

Hayashi (2014b) applied the framework of Gawer and Cusumano (2002) to FANUC's NC device. Hayashi (2016b) also extended this to the robot industry.

① Scope of the firm: FANUC has produced a standardized robot using its own robot, and has also manufactured its primary NC device and servo motor components. FANUC has left the final customer correspondence to machine tool companies in the NC industry. Similarly, FANUC has left the final customer correspondence to the system integrators in the robot industry.

② Product technology: FANUC is listening to the customer's needs, and are incorporating standardization as a function. Hayashi (2014b) has highlighted that FANUC's NC display was to mirror the personal computer's display, and its operation method involves the customer's ability to customize. FANUC also normalized the NC device and its robot and, as a result, both their failure rate and product price are low.

③ Relationships with external complementors: FANUC has adapted the Intel MPU to the NC device for the first time. FANUC will collaborate with Cisco to develop an open architecture system to prevent issues with the industrial robot. The maintenance of Customer of the customer; specifically, the final

user performs worldwide, to support the customer.

④ Internal organization: FANUC has placed approximately one-third of its employees in the development department. It has similarly arranged approximately one-third of its service organization. FANUC does not provide much support for particular users. Rather, FANUC has thoroughly promoted product standardization.

5. Significance of FANUC's maintenance system

FANUC's major companies are small- and medium-sized companies in Japan and Asia. These companies are free to customize the NC's display. Therefore, end users do not know whether it is a FANUC product. According to interviews with Japanese and Taiwanese machine tool companies, customers choose the FANUC NC device due to the after-sales service force. Generally, an estimated 30% of the added value of the machine tool is said to be the technical services used to maintain its performance. However, South Korean and Taiwanese companies have a relatively small parts inventory, and tend to leave repairs to an agency. On the other hand, Japanese companies tend to locate a commonplace repair service. For Japanese final users, this request level is necessary for a higher quality of after-sales service.

FANUC intends to focus on after-sales service, as FANUC products and equipment are used in customers' final manufacturing sites. FANUC homepage explains this as follows: "Under the slogan, 'Reliable, Predictable, Easy to Repair,' FANUC strives to enhance operability in manufacturing sites throughout the world." The Repair Factory has over 460 pieces of testing equipment, and can perform more than 13,000 types of repairs. Moreover, the Maintenance Parts Warehouse stores over 17,000 different types of 2 million parts, including parts that are no discontinued. FANUC has service offices worldwide, in over 252 locations in 46

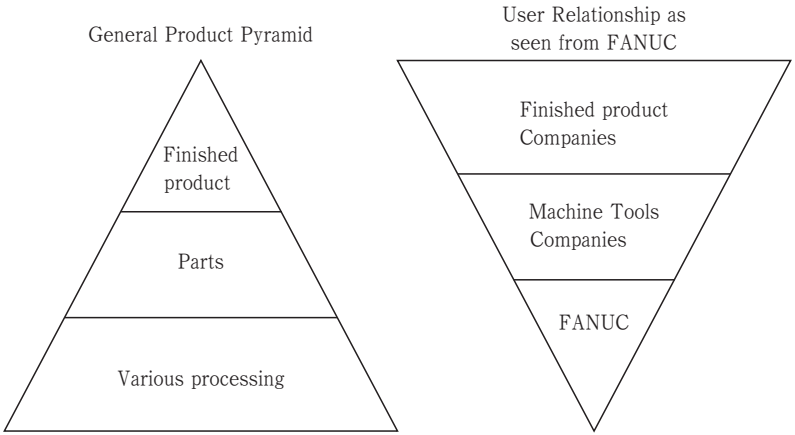
countries. In contrast, Mitsubishi Electric, FANUC's competitors, only have offices in 27 locations. Out of 1,600 FANUC employees, a ratio of 1 in 3.5 people are in charge of service. When a customer's NC unit fails, FANUC replaces the normal NC device and performs the repair. When the production line is stopped for one minute in a typical automotive factory, the loss is 2 million yen. FANUC's correspondence greatly benefits the customer.

The machine tool industry is affected by the business cycle, as it depends on customers' capital investment. Additionally, fixed costs are substantial, as small machine tool companies develop the NC's software. Globalization involves larger fixed costs for maintenance systems and user education. However, by adopting FANUC's NC, companies can reduce fixed costs, and it will be possible for them to export their products. Maintenance, as a percentage of FANUC's sales, remains at 15%, as FANUC has a high profitability in equipment sales, and does not rely on maintenance. FANUC should focus on after-sales service to maintain the machine tool industry's ecosystem, which will enhance the machine tool's structural stability to maintain the machine tool industry's ecosystem.

Additionally, South Korean and Taiwanese machine tool companies are expanding their sales. These are in the field, and competing less with Japan's small- and medium-sized machine tool companies. Japan's leading companies have produced a machine that can undertake a variety of general-purpose processing tasks, but these machines are a part of the processing and can be inexpensive. From FANUC's perspective, Korean and Taiwanese companies have pioneered a new-end customer. Originally, Japan's machine tool companies have focused on the development of low-price products in focused functionality for the small- and medium-sized processing industry. FANUC has prompted the development of a new niche machine for the entire industry, involving the maintenance of diversity in both companies and technology. FANUC's perspective is that, the user, or specifically,

a machine tool company, broadens end use. These structures are noted using the inverted pyramid in Figure 14:

(Figure 14) User relationship from FANUC's perspective



Source: Hayashi (2016b).

FANUC can develop using the NC module without being bound to the trend of end users' needs, as they have built superiority as an industry. FANUC has the world's top market share in robotics. However, due to strong customer needs, FANUC has a low market share in Japan, but due to high versatility, FANUC has a high market share abroad. This high market share has also been evaluated in the global after-sales service system, as western companies tend to capture after-sales service and business. For example, the business models for copy machine company Xerox and razor manufacturer Gillette, famously profit in maintenance. In contrast, FANUC's after-sales service exists for the purposes of user support. As FANUC has established a global service organization, its customers' machine tool companies can sell their products overseas. Specifically, FANUC's after-sales service involves maintaining machine tool industry's ecosystem.

6. Summary

This paper, based on the previous product architecture studies, analyzed FANUC's platform leadership and after-sales service strategy. As the company is in the process of modularizing its machine tools' NC, by purchasing a key component, it could first produce machine tools at a constant level. FANUC supports customers by strengthening its after-sales service, and as a result, it has effectively operated its support system to maintain the machine tool industry's business ecosystem. FANUC, as a keystone of the machine tool industry, will support small- and medium-sized machine tool companies, and maintain diversity. Consequently, FANUC has achieved a maximum benefit from market expansion, making it possible to verify the current situation, in which it is possible to create a niche ecosystem with structural stability and robust maintenance.

Regarding future challenges, I will use the financial data from FANUC and other machine tool companies to analyze the health of a quantitative business ecosystem indicator. Additionally, while Osanai and Sakakibara (2012) analyzed Komatsu's aftermarket construction machinery strategy, the impact of this strategy on the agency's management was not analyzed in detail. Other machinery industries, such as construction machinery, may also want to use this knowledge.

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