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# Electronic technology and Parts Procurement: A Case of the Automobile Industry

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### 1. Introduction

With the advancement of electronic technology, the use of open networks, such as the internet, has been advocated, and transactions like parts procurement through auctions have received much attention in the recent years. Under such circumstances, there were even some theories, which argued that parts procurement for the automobile industry as a whole would be eventually take the form of auctions (bidding) using the internet. However, as we will discuss later, in reality, parts procurement through the internet is less than 10% in the Japanese auto industry as of 2002. What was the reason behind the significant gap from the prediction?

In anticipating the conclusion, "almighty internet procurement theories," such as the above, completely overlooked the fact that firms were influenced by factors like characteristics of parts, type of transaction system, and the content of the information to be exchanged, in selecting the information technology.

Regardless of the industry, whether it be automobile or other, it is difficult to predict the kind of electronic procurement system that would be introduced without analyzing its product architecture (basic design idea). To begin with, current automobiles are basically types of products in which the parts design for each product need to be mutually adjusted and optimized, in order to guarantee the performance of the entire product. Therefore, it is an "integral architecture" product (Fujimoto et al., 2001). When we look at the parts to be supplied, only less than 10% are generic parts that have been standardized for inter-firm use. Unlike the desktop computer, the automobile is not an "open modular architecture" product where a complete product can be made by gathering many generic parts with a standard interface. When this difference is ignored, it leads to the mistake of applying the simple "almighty internet procurement theories."

We also cannot ignore the influence that the different transaction systems have in choosing the type of information technology. For instance, in the case of Japanese firms, the parts manufacturers are in charge of the detailed design, and through the black box parts practice (also known as "design-in"), the parts are collaboratively developed with the auto manufacturer. In this case, the competition between the parts manufacturers isn't simply based on price bidding, but rather, a capability-building competition (known as the "development competition") based on a multi-faceted evaluation of the supplier. Further in the case of development competitions and design-in (such as the approved drawing system), heavy traffic of highly confidential 3D-CAD information is exchanged between the assembler and supplier. Given the bandwidth assurance and insufficient security of the current internet, there is unwillingness to exchange such information.

Therefore, at least for the time being, firms choose to use private lines or industrial standard networks (i.e. ANX or JNX, discussed later), which guarantee both security and bandwidth to an extent. Eventually, it is possible that the system will centralize on internet procurement, if the internet is improved and acquires these capabilities. However, for the time being, the use of the internet will be limited to generic parts or very simple single parts (10-20% of total parts procurement at most), whereas private lines or industrial standard networks will be used for specifically designed part which make up the majority.

As we have seen, the selection of a certain parts transaction system for a part tends to affect choice of the mode of information system that might best fit the transaction information between the firms. Conversely, once a particular type of information is chosen, the mode of information exchanges, patterns of competitions between suppliers and transaction systems would also be changed. In this way, inter-firm information systems, transaction patterns, and architectures of the parts would co-evolve through dynamic interactions among them.

Through such framework of analysis and perspective, in this paper, we will take up the development of inter-firm information systems in the auto industry, and make a concrete analysis on the characteristics of information systems, such as firm-specific networks, industrial standard networks and the internet. Next, by showing the mutual relationship of the characteristics of parts architecture, transaction systems and information networks, we will discuss their co-evolvement through the respective choices and their interactions.

## 2. Building a firm-specific network (private lines and commercial VAN)

In the Japanese auto industry, the inter-firm information system was built in the early 1990s. The sales information network between assembler and dealers, and the procurement information network between the assembler and its major first-tier suppliers was built by the mid-80s and end of the 1980s respectively. By the early 1990s, sales, production and procurement information became integrated and shared among the dealers, assemblers and suppliers.

Built under the initiative of each assembly firm, the inter-firm information networks established during this period were all private communication lines of the assembly firm. The communication line, the communication protocol and data format of these information networks were uniquely operated by each assembly firm. This was due to the fact that the information networks were basically built by gradually expanding the existing development design CAD system and order-related business applications, uniquely operated by each assembly firm within their own company, to their major business partners.

Since the firm-specific network was made through optimizing the existing information system of the assembly firm, it was convenient for continuing business partners, and the transmission of information took place safely and securely. However, it ignored the possibility of transactions with those outside or beyond the "keiretsu," or major affiliated business partners. As assembly firms began to have transactions with multiple parts manufacturers, it lead to the problem of "too many lines and terminals" phenomenon. This indicates a situation where a parts manufacturer must set up a private line and specific terminal for each application, in order to make transactions with multiple assembly firms. For instance, if a parts manufacturer has business transactions with 3 assembly firms and is connected on-line with each for 3 types of applications, CAD data, order EDI and BOM (Board of Materials), it needs a total of 9 separate private communication lines, leading to a complicated network and increased capital maintenance cost on the side of the parts manufacturer.

## 3. Building a standard network for the auto industry

### (1) What is JNX ?

In order to solve the above problems, the auto industry in each country faced the task of building an industrial standard network. The standard network of the American auto industry (Automotive

Network Exchange, or ANX) started to operate in the fall of 1998. This became the model for the Japanese Automotive Network Exchange (JNX) and European Automotive Network Exchange (ENX), which began to operate around the year 2000 in Japan and Europe respectively.

The goal of the auto industry's standard network was to standardize the network infrastructure within the auto industry. Therefore, it unified the communication protocols, before unique to each company, to TCP/IP, as well as making the communication line to a one common type of network. By standardizing the network infrastructure, companies were able to make transactions with various companies, even outside a particular business partner group, with one common communication line once they had joined the ANX or JNX.

Since the ANX and JNX are TCP/IP type networks like the internet, both the hardware and the software can be shared with the internet, but the users are limited to registered members. In this perspective, it can be distinguished from the internet where anyone can participate. To be more specific, the ANX and JNX have a screening system, which limits those who join to specified members whose "identity is known." Also by using an exclusive IP address, it is protected from being accessed by "unspecified individuals" (as in the case of the internet). Further, the ANX and JNX provide "bandwidth assurance (communication speed)," "security assurance (able to send safely)," and "reliability assurance (able to send with certainty)" which are not fully realized on the current internet. In order to do so, they have obligated the use of IP-sec and firewalls, and introduced a validation system for service providers.

However, we need to keep in mind that the ANX/JNX does not provide business applications and solutions themselves. If we were to divide the structure of an information system to communication infrastructure (lower layer) and business applications (upper layer), the target of the ANX/JNX is simply to standardize the communication infrastructure. The standardization process of the upper layer is in a separate realm from the ANX/JNX. In other words, this is an issue left in the hands of the users and service providers.

**(2) Current situation of the JNX**

The cumulative members of the JNX were approximately 350 companies (March 2002), 580 (June 2003), 820 (February 2004). JNX center, the management body, had expected the number to reach roughly 500 companies by the end of 2002, and hit 1000 during the year 2003, but these current data suggests the pace has actually been much slower.

The major reason behind this is that the transfer of the auto manufacturers' business applications to the JNX has not progressed. The biggest factor was that there was a delay in switching the business application to the JNX standard, TCP/IP. Particularly, the traditional EDI frequently used VAN. Since the communication protocols were in many cases not TCP/IP-based, it took a longer time to transfer to the JNX compared to CAD or Web.

In the recent years, the assembly firms have begun to accommodate these aspects, leading to more firms transferring their basic business applications, such as the CAD, EDI and Web, to the JNX. However, compared to this, the standardization of business applications or their exchange system has not progressed as much. The utilization rate of STEP, used for the exchange of CAD data, is still low, and very few firms have actually switched their order EDI to EDIFACT. In order to facilitate the JNX network environment to be more convenient, the standardization needs to progress more.

On the other hand, JNX center has recently introduced new services, such as Dial up access, Gateway access, which allows the access to JNX network from Internet, CAI(common application infrastructure). These services possible to use JNX network at low cost are targeted at small and medium parts manufacturers (i.e. Tier-2, Tier-3). Obviously, one main reason of the increasing of the JNX members during the year 2003 is the launch of the services above.

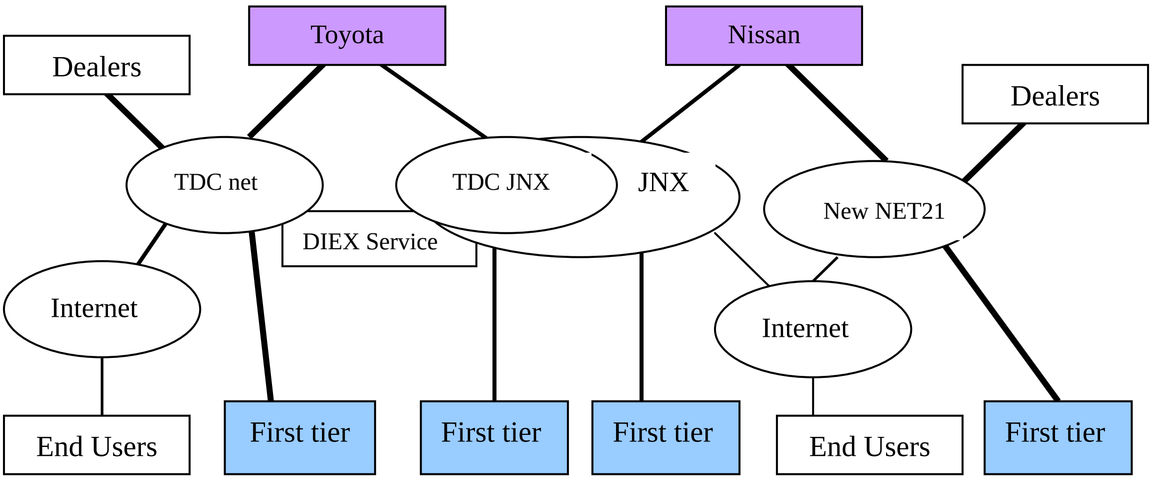
**(3) The co-existence of traditional networks and the JNX**

The goal of the JNX was to intensify the individual networks of group of firms to JNX through the standardization of the network infrastructure. Therefore, the aim of the JNX was to stop the use of traditional private lines and VAN, and to transfer all business applications to the JNX. However, in reality, there are hardly any firms who have consolidated their communication network with their business counterparts solely to the JNX. Rather, there is a situation of co-existence, where the firms continue to use the traditional firm-specific networks and have added the use of JNX (figure 1).

One reason is that the traditional private networks have dramatically improved in a short period of time. In other words, before, the private networks used private lines or VAN for each application, as mentioned earlier, but recently these have become consolidated. As a result, the overall negative effects, caused by “many lines and many terminals” phenomenon, have decreased, providing less advantages to transfer to the JNX.

In addition, there was a limitation to the security level of the JNX, making it less attractive, in terms of usefulness, when compared to the traditional private network. Further, although JNX focused on standardizing network infrastructure, in order to make the network easier to use, standardization at the level of business applications must advance at the same time. On the contrary, the business applications of the traditional private networks are easy to use, due to the long years of

Figure 1: Inter-firm Information System after building JNX




Note: DIEX indicates VPN service.

Source: Made in referring JNX homepage and Abe(2001).

repeated improvements, and it is also superior to the JNX in terms of reliability allowing the data to be sent with certainty. Therefore, there has been limited incentive for firms to sacrifice all of its current business applications and transfer to the JNX.

Further, the development of electronic technology such as the VPN (Virtual private network) has made it easier for the co-existence of private networks with JNX. In other words, JNX service providers use VPN technology and guarantee connection to both the private line and JNX, with just one line. So, there are parts manufacturers who have physically consolidated their communication lines to one line, with the co-existence of both the private line and JNX. Such parts manufacturers make transactions with their major business counterparts without using the JNX, while making transactions with others using the JNX, with a single communication line. In either case, you are also guaranteed connection to the internet with this single line.

In this way, the communication lines of inter-firm networks have rapidly intensified since the start of JNX. Some firms use VPN, and connect to the private line, JNX and internet by allocating each to a separate layer. For instance, in the process of development design to mass production, the private network, with higher certainty and security, is used for the information network with major business counterparts requiring minute and collaborative work. On the other hand, for transaction with other firms, there is a greater tendency to use JNX.

## 4. Trend of internet procurement (Covisint)

### (1) Outline of Covisint

With the rapid penetration of the internet from the mid-1990's, electronic commerce using the internet has become common. Even in the auto industry, the trend towards the so-called internet procurement, using the internet for parts procurement, has become active. Of these, Covisint is currently receiving the most attention. Covisint is an assembler leading consortium for e-commerce, which was started in December 2000 by the three companies GM, Ford, Daimler-Chrysler, along with Nissan and Renault.

Covisint aims to provide the application platform for inter-firm electronic commerce in the auto industry, using the ANX/JNX and internet. In this sense, Covisint can be distinguished as a network infrastructure from industrial standard networks or the internet. In other words, the Covisint lies in a different layer from ANX and JNX, and is not in direct competition with them.

Covisint provides services such as "procurement through the electronic market," "SCM business," and "collaborative development business." The procurement business takes place using electronic catalogue sales and on-line auctions. Regarding the SCM, the major services provided are tools, which allow sharing of information, such as state of inventory, state of delivery/distribution and demand forecast in the supply chain. Further, in reference to collaborative development, it provides tools (i.e.Virtual Project Workspace) necessary for real time development and collaborative designing.

### (2) Operation of Covisint: the reality

However, when we observe the reality, of the three main pillars mentioned above, Covisint's main business is the procurement function through the electronic market, and the SCM and collaborative design sections are still groping, so to say (Table 1). The SCM and collaborative design functions are basically operated through the firm-specific network, and therefore, the services provided by Covisint are in direct competition with the firm-specific network. Covisint's goal is to unify the firm-specific network of the assembly firms to Covisint, but it seems few assembly firms will actually decide to do so.

Therefore, Covisint's main business, currently, is the procurement of indirect and direct materials through the electronic market. Since the electronic market is highly open, parts purchased through catalog sales or auctions, are limited to generic parts or commodities in which the competition is based strictly on price. In the case of the automobile, such parts only make up 20%

Tabe 1 : Survey on Covisint Business

| | Q1 2001 | Q2 2001 | Q3 2001 |
|---|---|---|---|
| Auctions | Over 100 events<br>Over $ 1.0 billion | Over 420 events<br>Over $ 36.0 billion | Over 1,200 events<br>Over $ 48.0 billion |
| Catalogs | Over 200 catalogs<br>Over 2.5 million individual items<br>6,000 transactions | Over 200 catalogs<br>Over 2.5 million individual items<br>20,000 transactions | Over 200 catalogs<br>Over 2.5 million individual items<br>74,000 transactions |
| Supply Chain Management | — | 1,500 seats sold and in use | 2,300 seats sold and in use |
| Virtual Project Workspace | Over 200 seats sold and in use | Over 500 seats sold and in use | Over 500 seats sold and in use |
| Registration | Over 900 companies | Over 1,000 companies | Over4,100 companies |

Source: Made in referring to Covisint Connector Newsletter.

or less of the total parts required.

The other parts are mainly specifically designed parts (approved drawing parts or some provided drawing parts), and their prices can’t simply be decided by the price presented by the auctioning firm. A multi-dimensional capability evaluation reflecting the product development capability or technological capability, quality/delivery assurance capability, etc. of the parts manufacturer is necessary. Due to these reasons, these are not fit for net auction.

In actuality, when we observe the current situation of “net procurement” or how Covisint is being used, although there are a small group of American manufacturers who actively participate, most Japanese firms have been extremely cautious. So far, major Japanese auto firms such as Toyota and Honda have not adopted “net procurement” using the electronic market, and there is a strong tendency to estimate the percentage of parts possible for internet procurement to a very low figure. For instance, according to a Japanese firm that cooperated in our hearing investigation, they claimed only 3% of the parts could be considered for “net procurement”. One reason for being so careful is that electronic markets, including Covisint, do not provide any data that allow us to evaluate their reliability or capability level.

Our recent survey (UFJ Institute, 2004) also shows that the Japanese automobile companies are very cautious to “net procurement”. According to this survey, only 3.5% companies answered “yes” to the question whether you had carried out “net procurement” using e-marketplaces. The percentage of internet procurement costs to the total purchasing at those companies is only 1-3%.It is obvious that many Japanese automobile companies have a reluctance to do business with“invisible”partners through e-marketplaces.

Although the registered companies of Covisint have reached at over fifteen thousand companies at the end of the year 2003, the auction business of Covisint have not acquired the sales target planned at the start of Covisint. As a result of the poor performance at the parts auction business, Covisint has reduced 30% of the staff at the end of 2002. After all, Covisint announced at December of 2003 that the parts auction service division would be acquired by Freemarket.com.

As discussed so far, the JNX was proposed as the new industry standard network that would overcome the disadvantages of the traditional firm-specific lines for electronic procurement of auto parts in Japan. However, the use of private lines is firmly rooted, and private lines continue to be used together with JNX. Purchasing on the internet is currently still very limited for automobiles. As we have seen, we confirmed the co-existence of three different network technologies in the procurement of automobile parts. Next, the author will explain the basic theory behind this situation of co-existence.

## 5. Interaction of information networks, transaction systems and architectural characteristics

### (1) Characteristic of the information network systems

The standard framework for the comparative analysis of information network systems is as follows:

- Structure of the network
- Transmission capability
- Security (secrecy maintenance, prevention of unlawful measures)

Through these perspectives the matching of the data processing needs of the business and data processing capability of each network is analyzed and evaluated.

For instance, the internet currently has an “unlimited network” structure, which allows anyone to connect all over the world. Therefore, it demonstrates tremendous strength in cases of problem-solving (search) activities in which solution information (solution) are scattered throughout the world. However, compared to the private lines made for specific purposes, it falls short in the transmission capability of heavy information (wideband information), such as 3D-design. Due to the unlimited nature of the network, the security is not fully assured either. As a result, if the possessor of the solution can be specified in advance, private lines and networks with limited members tend to be selected due to the higher transmission capability and the increased security. For instance, collaborative development of complicated functional parts, are examples of such cases.

In addition, the frequency and the two-directional property of information transmission have influence on choosing a system. Either way, the basis for choosing an information system is selecting the one, which meets the conditions required by the architectural characteristics and transaction system, as much as possible, for the respective parts.

**(2) Characteristics in parts design architecture and information**

As discussed earlier, the automobile, as a whole, is said to be a product with "integral architecture," but when we look at each of its part, the degree of commonness, its functional completeness, unification of the inner structure, the degree of standardization of interface, etc. all have differences in their architectural characteristics. These differences in the architectural characteristics are precisely what influence the choices made for transaction systems and information systems.

Generally speaking, in the case of modular parts with standardized interface that is functionally complete, there is little necessity for mutual adjustment in terms of design. As a result, it is possible to use an information system with a comparatively small transmission volume. On the other hand, in the case of integral parts that require detailed design adjustments between the product's main body and other parts, there is a tendency for the incomplete design information (heavy 3D-CAD information, in recent years) to frequently flow back and forth in the process of custom designing. Therefore, an information system capable of transmitting comparatively large volume of information is needed.

**(3) Characteristics of transaction systems and information**

There are several stages for parts transaction, and a transaction system is chosen for each stage. Here, let us look at the following three as representative phases:

- supplier selection
- parts design
- order of mass production parts.

**(i) Supplier selection**: From the supplier side, this is the competition amongst suppliers to receive the orders. In the case of "special assignment orders," the supplier is chosen in the beginning, followed by the boiling down of order conditions, style and design. In "development competitions," it is a capability-building competition amongst multiple firms (usually a few in number). In this case, the evaluation is multi-dimensional, involving experimental design and experimental product information, requiring detailed exchange of information, similar to the level of "special assignment orders" between the assembly firm and the supplier candidates.

An "auction" is basically a price competition. The supplier candidates propose price information to the ordering firm who give order conditions and design information in advance. The information flowing through the network is much simpler compared to that of the development competition. In the case of "catalogue purchases" of parts, the firm simply looks at the catalogue information proposed by the seller, and orders by specifying the product number, and thus the burden of an individual transaction on the information system is small.

**(ii) Sharing of responsibility and collaboration for parts design**：In the cases of "approved design systems" and "provided drawing system" or the so-called collaborative development systems, incomplete design information like conceptual design, layout, style decision, test design, etc. need to be frequently exchanged back and forth between the auto firm and parts manufacturer, and the information system is required to have capabilities that meet these needs.

In the case of "provided drawing system", the basis is the detailed drawing made by the ordering firm. So the design proposal by the supplier side is only a VE proposal (improved proposal) according to the originally proposed design. As a result, the load on the information system is not very big. However, if it is a core part bearing significance in the product discrimination, we need to be cautious, since the VE proposal becomes highly important.

In the case of "commodities," the firm just places the order by specifying a product number from the catalogue developed by the supplier. Thus, a simple information system is enough to meet the needs.

**(iii) Ordering mass production parts**：When giving instructions for parts delivery of to the mass production line, individual information, such as product number, units, delivery time, delivery place are dispatched by coded information. So the load on the information system is small compared to the exchange of design information. However, there are differences according to the frequency of order (including unofficial announcements/information), frequency of change in order information, etc.

For instance, let us compare repeated orders and single orders. In the case of repeated orders, the load on the information system depends on whether it is a big lot (low frequency) or a small lot (high frequency), as in the Kanban system (just in time), and further, whether it is sufficient by "supplying in sequence" where the delivery is made in the order of production. In the case of "supplying in sequence," the information is liable to change frequently, due to the poor quality or malfunctions in the production line of the assembly firm. Then the volume of information exchanged will greatly increase. If advance order notices are sent out, either frequently or regularly, as unofficial information to the supplier, the burden on the information system will also increase.

At any rate, in mass production parts order, the individual information transmission is coded and simple, but since the number of information transmission becomes huge, the information system needs to be able to cope with this. Further, the choice remains to either having a specific format of transaction information (i.e. EDI) for each firm that is placing the order (i.e. "Kanban" of Toyota), or standardizing the format within the industry (Takeda, 2000).

## 6. Conclusion

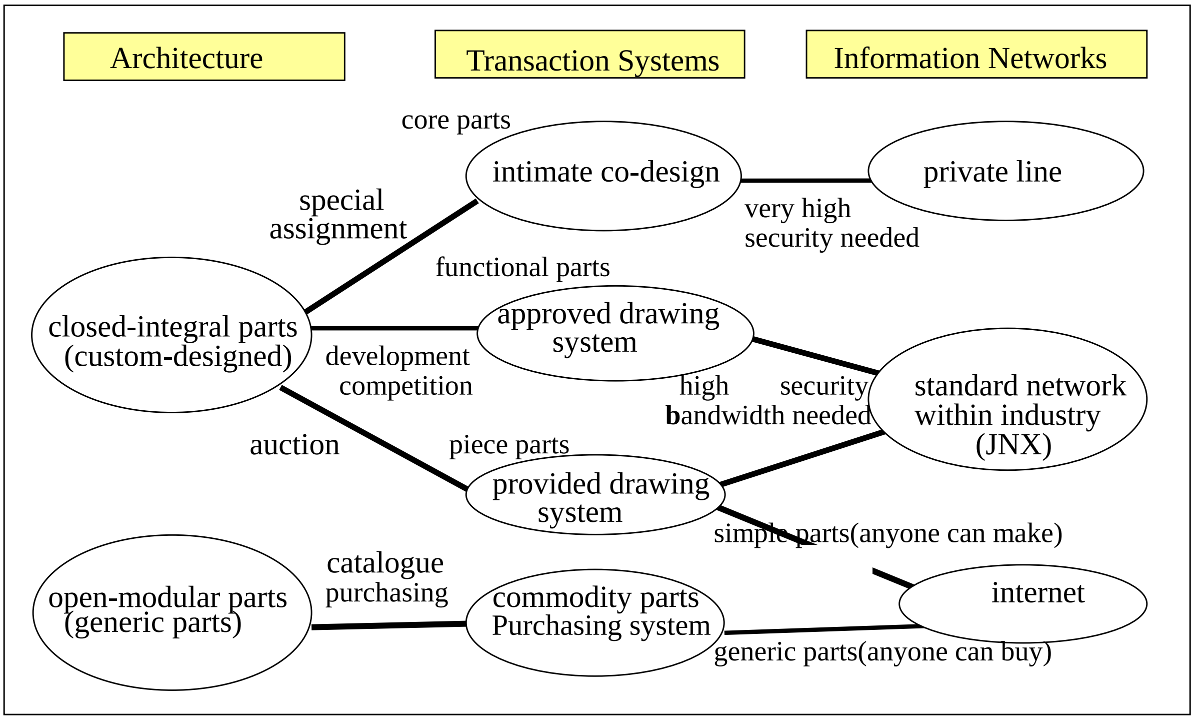
Based on these analyses, we will demonstrate the entire picture of the selection process for electronic procurement technology. More specifically, a good match (a fit or compatible combinations) exists for a certain combination of information system, transaction system and architectural characteristic (design ideas), and information networks are selected in the process of their mutual adaptation (Figure 2).

Statically speaking, there is a tendency for a compatible set of information system, transaction system, and parts architectural characteristic that fit well together to be chosen. On the other hand, dynamically speaking, if these become disassociated, the firm will try to restore their compatibility.

Especially, when a dynamic mutual adaptation is observed between the information system, transaction system and the parts design system, one important point is which factor tries to adapt to the other. Each system has its stickiness, and the mutual adaptation will not always be a smooth process.

In the case of the information system, initial investments and maintenance on legacy system or human resource investments on system-specific skills are considered to be embedded costs, which hinder the rapid switch of the information system.

Figure 2 Mutual Adjustments of Architectures, Transaction Systems and Networks




Similarly, in the transaction system, since the organizational capability or "relational skill" required for each transaction system is different (Asanuma, 1989) and takes time to build up (Fujimoto, 1999), it is not easy to switch the transaction system from one to another. The architecture of parts design also does not change easily once it has been fixed. In the case of automobiles, there has been no fundamental change in its architecture since the T-Ford (Fujimoto et al., 2001).

As discussed, information systems, transaction systems and parts design systems, all have stickiness due to factors like technology, market, economy and organization, and perform a "tug-of-war", so to say, in order to achieve mutual alignment. Through this process a specific information system is selected.

In the future, will the parts transaction information system converge into one system (for instance, the evolved form of the internet), or will multiple systems continue to co-exist? The opinions vary on this point, but nevertheless, this will be greatly influenced by the effects of the dynamic interactions. For example, there is a theory that the internet will evolve to satisfy all transaction needs, resulting in a convergence to the internet. This is a perspective, which places importance on the technological development of the information system. Another perspective is that with increased modularization and openness, there will be a trend towards the product architecture to adapt to the internet, resulting in an extensive increase in internet procurement of parts

On the other hand, in reality, there is yet another possibility. As a result of the bipolarization to internet procurement and limited network procurement (private lines and JNX), transaction systems and architectural characteristics may also reinforce the tendency towards bipolarization through a kind of mutual adaptation process. Thus, over the long term, two systems (limited network and unlimited network) could be locked in.

Either way, parts transaction information systems, transaction systems, and architectural characteristics should be seen to co-evolve as they mutually adapt to each other in a process-dependent way. Therefore, it is difficult to predict their exact future at this point in time.

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