Title: A New Mode of Coordination of the Division of Labour: The Significance of the Physical Features of Product Models and of the Application of Information Technology

Abstract

The purpose of this paper is to examine the sources of strengths and weaknesses in competitiveness of Japanese firm organisations, which form a certain mode of coordination for the division of labour between or within firm organisations. Japanese firms also employ economic institutions (employment and financial systems), which support the mode of coordination. The key issue here are the physical features of the products, which determine whether or not Japanese firms have competitiveness. Firstly, regarding this issue, the reason why Japanese firms displayed strong competitiveness in electronic appliances will be examined. Also in this paper, the recent changes in the physical features of products, such as those of the information industry that seems to be the future leading industry, will be examined. Japanese firms are facing pressure to restructure the mode of coordination to gain competitiveness in this area of industry.

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Section : Issues and Structure of this Paper

After WW , Japanese firms have been displaying a prominent strength in certain areas of industry, such as electronic appliances and the car industries. One hypothetical scenario to explain the strength is that the prevalent mode of coordination for the division of labour of Japanese firms has been established through the influence of market forces, economic institutions, political, and social factors. Then, the environment, such as the market and technological conditions Japanese firms faced, in some sectors, were suitable for the mode of coordination for the division of labour, gaining them competitiveness in the international market. Also, economic institutions have been suitable for supporting a certain mode of coordination for the division of labour within or between Japanese firms. As a consequence, some sectors, such as electronic appliances and the car industry, developed as leading industries in Japan. On the other hand, the sector whose features did not fit the mode of coordination, did not succeed in gaining competitiveness.

However, with the rising presence of the computer and information industries, and technological changes in production sites, the degree of interface between intermediate goods (or components) is changing. As an overall trend, the modularisation of each component of the final product is being promoted. The physical feature of products in these new industries is different from the products of industries in which Japan had competitiveness. Thus the movement in the production site requires an alternative mode of coordination of the division of labour that differs from the mode Japanese firms established in past.

The detail of influence of these movements on the coordination of the division of labour, under the prevalence of information technology and the internet, will be examined in the following sections. In this paper, firstly, the relation between industries where Japanese firms have competitiveness and the interface of each component will be examined. As a new trend, the modularity of the design and production of components is observed. Then, implications concerning the mode of coordination of the division of labour influenced by the new trendwill be described to examine the sources of strength or weakness of certain industries in Japan.

Section : Leading Industries in Japan, Physical Features of Components of Product, and Organisational Mode of Firm

(1) Brief Description of the Historical Perspective on Economic Systems and Industries in Japan

Regarding the continuity of the socio-economic system between the wartime period and today, Noguchi (1995) indicated that the Japanese economic system after the

war has a similarity with the system during the war period in respect of general mobilisation for resources. He says the system only changed the priority from promoting war to economic growth. Okazaki and Okuno-Fujiwara (1993) also note that many of the important feature of the present economic system in Japan were generated in the process or the development of heavy and chemical industries, and in the wartime economy that started from the 1930s to the beginning of the 1940s. The main reforms of the economic system in the wartime period was, according to Okazaki (1997), 1st: The amendment of commercial law to separate ownership and management and to make managers devoted to increasing production without being constrained by the influence of stockholders. 2nd: The reform of the financial system to create a main banking system, and making the main bank commit to the management of the firm. 3rd: The reform of the employment system which attempts to place workers for a long time in the same firm and to form firm-specific human resources. These basic features of firm organisation and institutions surrounding the firm[i] remained after the war. Moreover, the bank also remained in its position as the main resource for financing firms. Thus the bank had an incentive to monitor the performance of the firm, and participated in the management of the firm when it faced a crisis. This movement also reflected the rise in the relative position of the role of the human resource that is firm-specific and takes a long time to nurture. Okazaki also added that the economy moved from a planned or controlled economy to a market economy. The interests of three stakeholders of the firm (managers, employees and the bank), concerned with the growth of the firm, were met, and this feature formed the micro-basis for rapid growth after WW .

Under this mode of economic system, several industries were developed, gained strong competitiveness in the world market, and played (and are still playing) a substantial role for the economy as leading industries. Itami (1998) maintained that there have been three waves of leading industries. The first wave started, according to Itami, in 1955 and ended in 1974. The main industries that led the economy in this period were iron & steel, chemicals, machines, electric goods and shipbuilding. The main actors of the second wave, which started in 1975 and ended in 1993, were the car and electronic appliances industries. The main actors of the third wave, that has just started, are expected to be the supportive industry that contributes to produce finished goods, and the integrative industry, such as the information and communication industries, and the software industry. However, facing the transition of leading industries today, from consumer electronics to the information industries, Japanese enterprises do not seem to have strong competitiveness in the world market, compared to the industries which led the economy in the 1st and 2nd waves. As will be examined later, these two industries have different product characteristics, and it seems that Japanese firms, which have a suitable mode of coordination of the division of labour within/between firms in the electronic appliances industry, face difficulty in gaining strong competitiveness in the information industry.

The purpose of this section is to examine the relationship between the source of competitiveness caused by the difference in the mode of coordination of the division

of labour within firms, the economic institutions that support the economic activities of the firm, and the difference in physical features of the product.

(2) The Leading Industries in Japan and Mode of Coordination within Firms in Japan

Itami (1998) shows the common features of successful industries in Japan. Firstly, accumulation of technology is generated from the production activities. This is so-called "learning by doing", where knowledge and experience are accumulated in the working place of production. Secondly, the development process of the technology is usually a continuous process, and it is rare to jump or change rapidly to technology that is totally different from the technology used before. Therefore, workers can grasp the trend of technological progress. Also it can be argued that the relative importance of basic research is not high compared to applied research. For example, VCRs, where Japanese firms displayed remarkable strength and established a dominant position in the world market. The technology for developing and producing VCRs was closely based on colour TVs and tape recorders, where Japanese firms had already performed well in the world market.[ii] Thirdly, the scope of the targeted goods, for example: car, VCR etc., is clear, narrow, and often existed in the market. Thus workers can easily set (or share) the goal. Lastly, those industries were blessed with thousands of technicians graduated from universities. Thus, as the feature of innovation of Japanese firms, they have strength in continuous improvement and upgrading. This is pointed out by Porter (1990):

> ..... They became innovative in process technology, pioneering just-in-time production and a host of other quality and productivity practices. This led to better product quality, repair records, and customer satisfaction ratings than foreign rivals. (Porter, M., 1990, p90)

This sort of innovation took place in firms of industries where Japan gained strong competitiveness in the world market such as electronic appliances and car etc.

On the other hand, regarding the industries where Japan failed to gain strong competitiveness, as Porter M. E. & Takeuchi H. (2000) point out, industries where basic and applied research is the core for competition, such as chemical, aerospace, software, and financial industries, were relatively weak in Japan. Moreover, industries where innovation in design is the core for competitiveness, such as the apparel industry, are also weak in Japan. They also point out that a lack of supply of human resources is observed in industries, such as software and financial trade, where specialists in a certain area are required.

Industries such as the electronic appliances and car industries etc., which have the features described above, have been successfully developed by Japanese firms that took a certain mode of coordination. This mode is characterised by horizontal coordination (for details, see argument by Aoki (1988)). And the coordination within the firm is supported by economic institutions. The institutions are: (1) the employment system, such as long-term employment, seniority wage systems, and

enterprise labour unions, and (2) the financial system, such as the main banking system and cross holdings of shares between firms. Though these systems are also employed by firms in other countries, it is more prominent in Japanese firms. Moreover, as Aoki (1988) indicate, intrinsic characteristics of Japanese firms are lifetime employment, seniority wages, and internal promotion. These are also adopted for blue-collar workers. These systems are connected to on-the-job training systems (OJT), the system for the formation of in-house (firm specific) skills. OJT can be practised under the premise of the worker's long-term employment, and these are maintained by a seniority wage system by providing the incentive to workers for investing in firm specific skills and holding royalties in the firm to which they belong. In other words, the employment system that guarantees long-term stability of the position of workers and the employment system is complemental with the financial system characterized by provision of stable financial resources for firms with a main banking system and interlocking shareholdings.

Under the economic system, horizontal coordination within firms is developed. For instance, employees experience several working positions through rotation, then, when they are promoted to upper management positions, they have an overall understanding of, eg. basic duties and the responsibilities of the various sections and divisions. Operations that involve several departments, are promoted through deep communication and information/knowledge sharing (including tacit knowledge) among the departments. This mode of firm organisation is defined as horizontal informational coordination, argued by Aoki. According to Aoki, this mode of organisational structure has been displaying strong competitiveness in the car and electronic appliances industries. He also says, however, that this mode does not have an advantage in chemical and information industries, such as personal computers or their components. These two categories of industry have different features on the composition of product and pattern of technological development (the difference will be examined later). In order to strengthen the competitiveness in these areas, Japanese firms, which intend to shift or expand their operation to these areas, are struggling to reorganise the firm structure.

Section : Movement to Modularity and the Mode of Coordination for the Division of Labour within Firm

(1) Comparison of Physical Features of Product between the Electronic Appliances Industry and Personal Computer Industry and Suitable Mode of Coordination within Firm [iii]

Regarding the mode of coordination for the division of labour within firm organisations, as Piore (1992) explain that the social division of labour, in the case that each entity does not produce the final product, each entity has to have a certain mode of communications with the other entities, and share and deepen the

knowledge to hold the cognitive meaning for producing the final product. Moreover the social division of labour can be coordinated in two different ways. Firstly, Smyth and Lo (2000) explains J-mode (stylised Japanese mode of firm organisation) in Aoki (1988)'s argument belongs to this type of the division of labour. Under the mode of firm organisation, task definition is unclear or flexible, and each worker or team keep deep communication with each other through rotation or co-working. The relationship or connection among them tends to be close and specific. Knowledge (or information) is created or shared horizontally. The system enables workers to share tacit knowledge. Secondly, on the other hand, the evolved mode of the U.S. mode of firm organisation presented by Aoki (1995) also seems to promote the social division of labour. With this evolved mode, the task of each worker or team is clearly defined and the information is shared through coded record. Each entity interprets the information independently in his/her own way and highly specialises in its profession. Under the system, workers share explicit knowledge. In the environment, each entity can work as a module and the relationship or composition of members can be varied frequently, and tends to be short.

The difference in the feature between the electronic appliances industry and the personal computer industry can also be found in the similar points in their structure of each of the products (or components) and in the characteristics of research and development for each entity involved in producing a certain final product. Table 1 presents the difference in physical, functional, and R&D structure between the two industries.

Concerning the electronic appliances industry, which has strong competitiveness and has been the leading industry in Japan, the interface between hardware components is strong and not standardised. In other words, the connectedness between components is specific and customised each other. Therefore it is rare, if at all possible, to replace just one part of a component with a different source of component. As a consequence of this, every component of an electronic appliances is designed to wear out at approximately the same time. Therefore the R&D team attempts to coordinate (or communicate) closely to combine the efforts of each member of the team involved in developing each component. Though different members of the team/department design different component of the new product, a deep coordination helps the components to fit together. In production, knowledge sharing

Table 1, Characteristics of IT Products in Comparison with Other Products: in Physical and Functional Structures, and in R&D

Products/Services	PC hardware	PC software	Automobiles	Electronic appliances
Location of comparative advantage*	US	US	Japan	Japan
Structure of products or services				
Assembled from components	Yes	Yes	Yes	Yes
Interface between components	Weak	Weak	Strong	Strong
Standardized interfaces between components	Yes	Yes	No	No
Upgrading component	Free	Free	Partially possible	Almost impossible
Need for balance between components	Little	Little	Medium	High
Characteristics of R&D				
Size of R&D investment	Medium	Small	Large	Medium
Gestation period	Medium	Short	Medium	Short
Pattern of R&D organization:				
Team / Individual	Individual	Individual	Team	Team
Centralised / Decentralised	Decentralised	Decentralised	Centralised	Medium

(Source): Oniki H.,(2000), Table 3-15

through deep communication is required between departments or between the parent and the subsidiary corporations. Once a model is developed/designed and a production management system is established, the main objective is to maintain a smooth stream of production from components to the final product. The deep communication and coordination is quite effective for minor improvements, such as minimising the damage from troubles in the production system and for cost reduction. Oniki (1999) maintains that this feature represents "depth in coordination" that is characterised by the degree to which coordinating workers understand each other and the amount of information which needs to flow between the workers engaged in the coordination. As Itoh (1993) explains, though economies of specialisation is lost (to some extent) by spending on coordination with other entities, if tasks are interrelated such that performing one task increases the returns from the other task, the effect of coordination dominates the economies of specialisation. In explaining the stylised Japanese firm organisation (J-mode), Aoki (1988) also says it is efficient in an environment where the changing process is incremental and is not rapid. In this case, the information value, which is created by learning and by horizontal adjustment at the operational level, outweighs the loss of efficiency caused by sacrificing specialisation of operation.

This mode has advantages in operating production lines that are composed of thousands of independent steps. In other words, it has advantages in process (or incremental) innovation. Therefore, since strong interface of components and incremental innovation are features of the electronic appliances industry, it seems that these features of the electronics industry require coordination based on the social division of labour that is coordinated by a close, fixed and specific relationship within a firm's units for research & development and for production, which even enables the sharing of tacit knowledge among the units. In this respect, the mode of coordination for the division of labour prevailing in Japanese firms is suitable for products composed of components having a strong interface with each other. Horizontal coordination between units of a firm realises deep communication and knowledge sharing between them and overcomes the problem raised by the specific relationships between the components.

On the other hand, regarding the personal computer industry, in which Japanese enterprises failed to get strong competitiveness in the initial period (in 1980s), the interface among the components of a product is flexible (or standardised). In other words, the connectedness between components is not specific and the components have not to be customised. Therefore, a portion of a product can be changed or replaced. This is because personal computer hardware is a physical product assembled from components such as a CPU, a hard disk, a keyboard, a display, and others, and the interface, through which a component is combined with other components of personal computer hardware, is standardised. Therefore, each component of personal computer hardware can be designed and produced independently of the others. Moreover, as Itami (1998) indicates, since computer technology changes discontinuously and evolves drastically, the core of competitiveness exists in the development process where new architecture is created and does not depend so much on the production process where incremental

improvement is generated. Therefore, forms of R&D organisation do not have to be team oriented but can be of an individual/independent and decentralised form.

In this sense, the feature of the personal computer industry does not seem to require the aspect of the horizontal coordination and specific relationship of entities for the social division of labour that has strength in integration of components (or inputs) and in incremental improvement of product through deep communication and deepening cognitive knowledge of the whole process. Rather, it requires the aspect of the social division of labour in which, while each entity obtains information regarding the whole operation, each of them specialises in its own operation (whether design or production) and each operation or the division of labour is clearly defined. This mode of coordination benefits more by merit of specialisation. Therefore, the mode is suitable for the industry, such as personal computer, in which core for competitiveness exists in the development process and innovation process is discontinuous and drastic. As in Table 1, the software industry, eg. software for "Windows", can also be categorised by the same features of the physical and technological development process as the personal computer industry. This mode of coordination for the division of labour differs from the mode in which Japanese firms displayed strong competitiveness. Rather, the coordination seems to correspond to that of stylised U.S. firm organisations, especially the one introduced in Aoki (1995) as the evolved forms, in which each entity has a clear division or boundary of the task while accessing the information of the whole firm.

Lastly, as the White Paper on International Trade (2001) explains, there is a large change in production process in electronic appliances industries. In production, many components for a final product are replaced by several chips and the product tends to be miniature. This changed the production method from the conveyor-belt system to cell system in which even one worker can finish the assembly. This results in the simplification of production process with better efficiency and the importance of operations for assembling to create added value is reduced. This movement also contributes to reducing the importance of process development, especially generated in the production site.[iv]

(2) Modularity of Development and Production Process

The above movement in physical features of the product in the personal computer industry is called "modularity", regarded as a strategy for organising complex products and process efficiently. Baldwin C.Y. & Clark K.B. (1997) explains that a modular system is composed of units (or modules) that are designed independently but still function as an integrated whole. In order to achieve modularity of design (of each part), according to them, "visible design rules" need to be established early (or ex-ante) in a design process as partitioning information that enables designers (or developers) of components to communicate. The visible design rule (or visible information) is defined as 1) "architecture" that specifies what modules form the system and how each module functions. 2) "interfaces" that specify interaction of

each module such as how they fit together, connect, and communicate. 3) "standard for testing" that investigates the conformity of modules to design rules and performance of a module relative to other modules. On the other hand, Baldwin & Clark also explain that each unit of design also has "hidden design parameters" (or hidden information) that is the unit's own decision and do not influence the design beyond its own module. Therefore, each unit can select the hidden information ex-post and often change without communication with other units of design.

Under the system, as far as each unit follows the visible design rules, the designer of each module is not constrained to develop an experimental module and test it. Therefore, in other words, each module does not need to sacrifice the benefit of specialisation by spending so much time on horizontal coordination as in the stylised Japanese mode of firm organisation. The more experiments are conducted and the more flexibility of design each unit has, Baldwin and Clark say, the more rapidly the industry develops by increasing the rate of innovation. Moreover, through concentrating on developing one module, each unit (or module supplier) can pursue its activity profoundly.▼ This is realised by the condition that enables module units to reduce the cost of adjusting each other. In other words, through the reduction of coordination costs by adjusting each modular unit with visible design rules, the merit of specialisation through the division of labour is enhanced.

The movement toward modularity is aiming for 1) dealing with sophistication and with higher specialisation of firm management, 2) dealing with diversification and rapid movement of market needs 3) dealing with drastic technological innovation 4) realisation of efficient production by slimming the operations and cost reduction, 5) concentration on core business of the firm, etc. Moreover, with the pressure from the demand toward modularity, technological development also contributes to advances in modularity. Baldwin & Clark (1997) explains firstly, breakthroughs in materials science and other areas made it easier for engineers or designers to obtain the product knowledge and specify design rules. Secondly, moreover, improvement of computer quality reduced the cost of capturing, processing, and storing the product knowledge and also reduced the cost of designing and testing different modules. Moreover, it seems that the recent development in information technology (or the internet) greatly contributed to sharing "visible design rules" among module suppliers, and helps to create an environment where module suppliers participate or compete widely.

(3) Modularity, Mode of Coordination for the Division of Labour within Firm, and Role of Information Technology

These movements toward modularity of design, development, and production of components seem to have a strong influence on coordination of the division of labour within firm organisations. As Kusunoki (2001) explains, the competitive strength of Japanese firms lays in integration of constituent units and repetition of the optimisation of the interface between them, which forms a lean production system. Under the system, with high integration of units, the design of units tends to be

interdependent with each other and requires deep communication between personnel involved in the project. Thus management of linkages, interfaces of components (or subsystems) and functional knowledge composing a certain product system are the heart of the strength of the organisational capabilities of Japanese firms.

On the other hand, the modularity of each unit and sharing visible design rules through a computer network does not need to consume time in face-to-face communication, and the relationship between units does not have to be fixed and specific. Rather, modularity promotes open architecture of constituent factors. For example, at the design and production site, the skills of workmen, which depended on the tacit knowledge to transmit and to acquire, can be accumulated in personal computers as digital data. For instance, producing a metal mould has depended on the skill of the workman. However, under the development of software technology and the quality of personal computers, engineers are able to accumulate most parts of the skill as digital data (or as explicit knowledge) and to design the mould through three-dimensional computer aided design (CAD) without drawing pictures on paper. Then the mould is transmitted to a machine tool and produces goods or components without making a metal model. (Oyama, 2000) This movement cuts costs and time for production and reduces asset specificity of investment. Now it is easier for the producer to take more orders than in the past. Moreover, each entity, such as a designer, engineer, supplier, and worker of the production site can share the information through the network without frequent face-to-face communication.

In this context, a module can be interpreted as each level of an entity, such as a firm, a unit in a firm, a worker, and a component etc. With this system, through the openness of innovative module units, radical innovation or discontinuous changes in product concept and functionality, where Japanese firms do not have strength, can be dealt with. Therefore, in order to be efficient in the trend of modularity, the organisational structure, in which each unit can highly specialise in its task while accessing and following the "visible rule" to coordinate each other, seems to be suitable. In this point, as is examined in Section -(1), the evolved mode of the U.S. firm organisation is suitable for operating in the development of modularity of design, development, and production. As a result, the competitive advantage of the stylised Japanese mode of firm organisation (in Aoki's argument) may decrease. Japanese firms face a turning point in the reorganisation of their coordination from a mode, which had displayed strong competitiveness in the past, to a mode that can take advantage of the modularity.

Section : Modularity, Role of the Information Technology, and Mode of Coordination for the Division of Labour between Firms

The modularity of design, development, and production is also promoted in the division of labour between firms in which each firm plays its role as a module. In this trend, the development of the information technology (IT) increases the merit of modularity of the division of labour between firms through reducing the transaction costs of trade between the firms and the network of the firms is getting wider and open. In this trend, the advantage of a closed network of firms, the Japanese subcontracting system, is decreasing. The technology seems to exert a strong pressure and influence on the restructuring of Japanese firm organisations.

(1) Modularity of Firms and the Role of Information Technology (IT)

The network system of Japanese firms set up in the 1970s and 1980s was a local and closed network that was connected within a firm or within a group of firms. Moreover, as the Computer Integrated Manufacturing (CIM) was, the network is the subject of central control in the hierarchical organisation and the rule was not a standardised one. (Kawamura, T., 1996) This system contributed to sophisticate the mode of coordination for the division of labour within/between firms in Japan characterized by horizontal coordination with deep and fixed (or long-term) relationship between entities. Under the mode of coordination, personnel are on the same wavelength and organise teams through sharing tacit knowledge through face-to-face communication, as well as explicit knowledge transmitted through the computer network, within the firm. Moreover, the relationship between firms, eg. the parent firm and subcontractors, led to the realisation of a strong collaboration for developing components and for an efficient production process. [vi]

However, in the 1990s, new informational technology, the "internet", promoted a paradigm shift from the information technology that already prevailed. The features of the network, which promoted the paradigm shift, by the new information technology, are: 1) an increase in the proportion of information that is transmitted through the network. 2) The network is opened globally. 3) Downsizing of instruments which process data, such as personal computers. Therefore, it encourages autonomous decentralisation of entities. 4) The interface, for connecting each entity, is standardised. 5) Importance of software is increasing. (Baldwin & Clark, 1997) Therefore, under the new paradigm, as the internet does, information is controlled by workstations or personal computers which are decentralised. The information is not controlled by large computers, and all information is open to users.

Many firms introduced this information technology and started using it as 1) a tool for transmission of information or for communication between the firm, 2) a means for sending information or messages of the firm, 3) media for commercial transactions or communication between firms or between the firm and the consumers. The information technology provides a foundation on which firms share information about product development, design, and production. Also, firms draw up a contract on selling or purchasing in the network. There appear some new forms of

coordination for transaction and new trends of design or production realised by the information technology.[vii]

The first is supply chain management (SCM) whose essence is to cut redundant operations existing over different firms and to reduce lead-time by establishing an organic network between operations of firms connected by the internet. For instance, firm A is a supplier of intermediate goods, and firm B is a purchaser of the intermediate goods from firm A. These two firms share the production plan of firm B, then firm A can make a plan for replenishing the intermediate goods efficiently. Then both firm A and B can reduce inventory and cut costs. This form of coordination has already been established by the "Kanban" system through long-term relationship between parent firms and suppliers in Japan. However, development of the information technology realises the form of coordination to be expanded widely (or on a global level) through the information network.[viii]

In the same context, secondly, the information technology reduces the cost for collecting information about the trade partner. In other words, transaction costs (in this case, the cost of searching) generated in the market are reduced by the open network established by the information technology. Moreover, considering the physical features of information industries, such as computer hardware and software, the interface between components is weak. Thus the investment does not have to be specific to a certain firm. Therefore, in this sense, the problems of asset specificity and connectedness, which are attributes of the transaction cost, are avoided. Then, the costs for agreeing and writing also seem to be reduced in market transactions. Concerning ex-post transaction costs, such as the monitoring cost for late delivery, since the cost of searching for a partner is reduced, each firm has the means to "exit" from the transaction.[ix] This seems to contribute to reduce the ex-post transaction cost. These factors accelerate firms towards an increased outsourcing of inputs (or intermediate goods) without being constrained by the scope of the subcontracting network that many firms in Japan already established. The movement to reorganise the purchasing network is under promotion and firms expand the source of inputs.

The progress by the information technology influence on management of firm organisation and the coordination for the division of labour, especially between firms, is changing. The overall trend is that the coordination for the division of labour between firms tends to be on a short-term (or project) basis, and more flexible. Therefore, the transactional relationships between firms change frequently in the market. This movement comes from reduction in transaction costs by the information technology. In other words, the technology reduced the cost of searching for the partner and agreeing or writing a contract, and these transactions can be conducted wherever the partners are in the world.[x] Under these circumstances, firms changed their policy toward concentrating on their own core operations and outsourcing the operations, goods, or material where they do not have a comparative advantage.

The experience of the U.S., where the economy has benefited from information technology, gives us an insight into the influence of the technology on firm management. Ishiguro (2000) explains that firms in the U.S. turned their weakness into strength through information technology. He explains that firms in the U.S. have a tradition of accumulating the formal knowledge (equivalent to "general knowledge" or "explicit knowledge") that can be described by documentation or by formula. U.S. firms clearly draw up the architecture (or framework) for operations, then modularise each operation as an independent and standardised unit. This system is supported by the clearly defined rights and job boundary of the individual worker, and by contract between the firm and the individual worker. However, this system often tended to make the organisation bureaucratic and led to inflexibility. As a result, U.S. firms, especially in the manufacturing sector, lost competitiveness in the 1980s.

However, Ishiguro continues, regarding the organisational characteristics of US firms, the architecture for the operational process is clearly drawn up where the individual job boundary is clear and standardised. These features of organisation are sustained by contract and expressed by formal knowledge. Operations of the organisation characterized by the system above can easily be organised or rationalised by information technology because operational process expressed by formal knowledge can be transmitted by the network. U.S. firms use internet (or email) for information sharing, while Japanese firms largely depend on face-to-face communication with suppliers of intermediate goods.

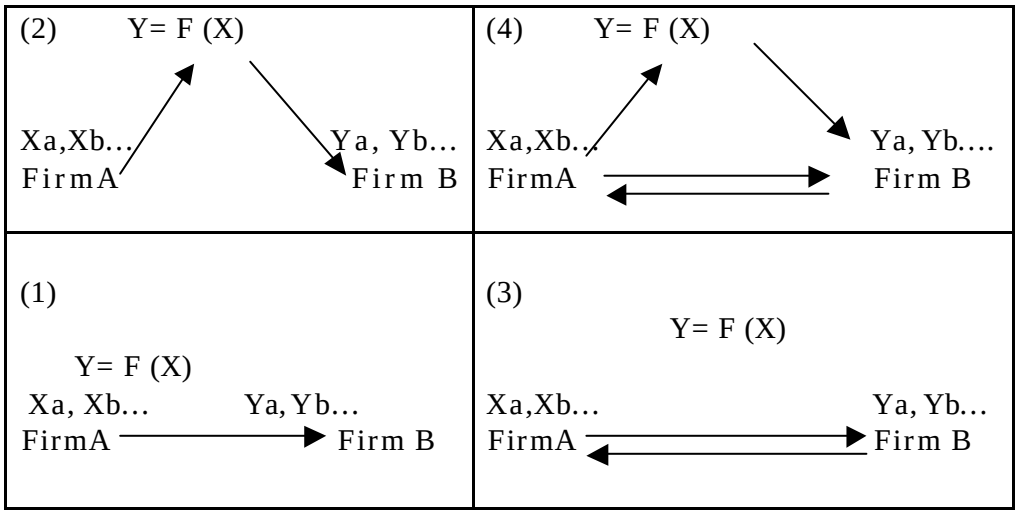
After all, the same contents of functions realised through close collaboration and cooperation, which are promoted within the Keiretsu group in Japan, are realised through the internet. While Japanese firms implemented, just in time, a system for delivery of intermediate goods by the "Kanban System", organised by teamwork between the parent firm and subcontractors where the composition and relationship of these actors remains the same for a long period, U.S. firms realised the system by an electronic manufacturing system (EMS), operated by independent suppliers of components, through the internet. Benefiting from the information technology, U.S. firms achieved efficient division of labour among them by organising teams of firms with flexibility to change the members. In other words, they realised an individual based economic society where diversified entities integrate as a team with frequent changing of its participants, not only in the field where each unit/component is for general purpose but also in the field where each unit/component requires deep coordination between members. Needless to say, this is also supported by technological developments in the areas of network technology and computers, etc. Regarding the contribution of the information technology for increasing productivity in the U.S., several quantitative analyses support the positive role of the technology. Firstly, Oliner and Sichel (2000) show that annual growth of total factor productivity (TFP) increased from 0.31% in the first half of 1990s to 0.63% in the second half of 1990s. The authors conclude that the contribution to productivity growth is from the use of information technology (computer hardware, software, and communication equipment) surged in the second half of the 1990s. Moreover, secondly, Saito (2000) presents that 80% of the increase in labour productivity in the

U.S. after 1996 can be explained by utilisation of the information technology for operating capital. Moreover, Brynjolfsson and Hitt (1988) categorises U.S. firms into 4 groups by the degree of utilisation of the information technology and decentralisation of decision-making process. They argue that productivity of the firms, which highly utilise the information technology and decentralise their decision making process, show the highest productivity.

(2) Perspective on Coordination of the Division of labour between Firm Organisations

Regarding the different types of coordination between firms, Takeda (2001) explains the mode of communication between them. She divides 4 modes of communication differentiated by the types of transaction between firms (See Figure 1). The first type, (1) in the figure, the purchaser consider the conditions such as environment, for its own or the supplier's, which corresponds to Xa, Xb... in the figure. Then, the purchaser conveys the result that it wants (Ya, Yb...) to the supplier. This is a simple form of subcontracting system that does not gain either the merit by integration among diversified entities or the merit by deep coordination between entities. The

Figure 1



(Source: Takeda (2001), Figure 2)

second type, (2) in the figure, is the case in which there are many transactional partners, thus it is difficult to consider the conditions of each partner. Therefore, by specifying the function of problem solving that enables all entities to understand and share it easily, if the purchaser inputs Xa, Xb..., the suppliers can understand what they should supply, Ya, Yb.... This form benefits from integrating diversified entities but does not gain the advantages of deep coordination. This is suitable for

trading goods for a general purpose that does not require deep coordination between firms. The third type, (3) in the figure, is the case in which transactional partners are finite and the members can share the hidden function (or create the same wavelength among them), Y= F (X), and communicate with each other. By sharing the function, the members can flexibly improve or evolve it for solving the problems. This form is observed in subcontracting systems of Japanese firms. The system does not benefit from integrating diversified entities but gains the benefits of deep coordination between entities. The last type, (4) in the figure, benefits from both integrating diversified entities and from deep communication that enables the function, Y= F (X), to evolve. The information technology, as explained above, enables diversified entities to interact through the network. Also, the technology enables them to have deep communication by transmitting data or pictures (see the explanation about CAD and SCM above). Moreover, concerning evolving or improving the function, accumulation of knowledge through open networks enabled diversified entities to see the factors that may change the function and to participate in the process of the change. The last type is the communication method realised by the information technology that brought U.S. firms a competitive advantage.

In summary, in type (3), the coordination mode of the division of labour is characterized by deep coordination that can be explained by the long-term relationship between a small number of firms sharing tacit knowledge. In this mode of coordination, the function: Y=F(X) is not always necessarily available for anonymous entities. This coordination also enables entities to realise ex-post improvement of the function through face-to-face communications. On the other hand, the new mode of the coordination explained by type (4), which prevails in the U.S., realises merit by integrating diversified entities as well as merit by deep coordination. Moreover, ex-post improvement of the function is also realised through participation of diversified entities by the network. Here the difference seems to be the types of knowledge shared and, in type (4), the knowledge is an explicit one, such as documentation or formulae that can be intermediated by the network. This knowledge seems to correspond to the "visible rule" introduced in the argument about modularity. In this mode of coordination, open architecture is suitable for promoting the division of labour, and modularity of units develops.

Section : Conclusion - Reorganisation of Firm Management Influenced by the Information Technology and its Relevance to the Movement of Modularity of Entity/Component -

The influence of the information technology on firm management, examined above, seems to have a similarity with the modularity of entity, such as component or design unit. The modularity of components or design unit is promoted with standardisation of the interface and establishment of visible design rule that is used by each module unit as a tool for coordination or communication. The visible rule

seems to correspond to the function (in Takeda (2001)'s term) that is shared with the form of explicit knowledge.

On the other hand, the essence of the influence of information technology on firm organisation is to establish open and standardised interfaces through the network, and stimulate the movement toward modularity of the unit by reducing transaction costs in the market. Also, the technology enables firms to benefit from integration between diversified entities and deep communication or coordination (through explicit knowledge) between them. Therefore, the information technology enables both the benefit of integrating diversified entities, which are highly specialises on their operation, and the benefit of deep coordination/communication between highly specialised entities.

Concerned with the mode of the division of labour between firms, comparing these current movements in firm organisations influenced by the information technology and in physical feature of products whose components are developed as modules, they are better suited for the mode of coordination for the division of labour realised by the information technology. In such products, like personal computers, the interface of the component is weak, thus can be modularised, and the pace of technological development is drastic. In order to cope with the features efficiently, autonomously decentralised coordination of the division of labour that can benefit from a high level of specialisation, thus can cope with drastic innovation, seems to be suitable. Also, this mode of coordination can benefit from integration of diversified entities[xi] as previously explained. Therefore, it can be implied that, in the area of industry where modularity is promoted, the competitive strength is a shift from type (3), which has been prevalent among the division of labour between firm organisations in Japan, to type (4).

On the other hand, regarding the mode of the division of labour within firms, the determinants of competitive strength of mode of coordination seem to be (1) degree of complementality or stochastic correlation between units (See the detailed explanation of Aoki (1995)), (2) industry's core of competitiveness (whether it lies in innovation of design or in process (or incremental) innovation). As examined above (also indicated by Aoki (1990)), Japanese firms displayed their strength in the latter type of innovation through horizontal and deep communication (hence complementality between units is strong, and often the different steps are overlapped) by sharing tacit knowledge.

However, as for the former type of innovation, as in the information industry, U.S. firms, which enable obtaining the benefit of high specialisation, displayed their strength. Moreover, the evolved mode of U.S. firm organisation (explained by Aoki (1995)) enables each unit to share the whole firm information, and that seems to be accelerated and to be getting easier due to information technology (The sharing of the information of the whole firm seems to be promoted through sharing explicit knowledge in U.S. firms). On this point, Aoki & Dinc (2000) also points out:

.....aided by fast moving technological progress in digital communications and information processing, American industry is modifying the traditional hierarchical control of specialised tasks. The technological innovation in communications and information processing has made the scope of individual job tasks much wider without forgoing the benefits of specialised skills, while facilitating less hierarchical coordinating among individual tasks within and across organisation. (Aoki & Dinc, 2000, p. 33-34)

In summary, the stronger the complementality (or stochastic correlation) between units has been, the more strength has existed in stylised Japanese firm organisations, displaying strong competitiveness in process development through deep communication and sharing of tacit knowledge. In other words, each unit is not modularised in this case. However, the weaker the complementality (or stochastic correlation) between units is, the more strength exists in the U.S. mode of firm organisation, displaying strong competitiveness in design innovation. In this case, the modularisation (hence merit by specialisation) of each unit is highly developed and explicit knowledge is shared between different units.

After all, in order to gain strength in the computer and information industries by fully utilising the information technology, Japanese firms face pressure to restructure their organisational form both in the division of labour within and between firms.[xii]

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[i] These can be characterized by limited power of stockholders for corporate management and to entrust the management to the manager and employees, dominance of indirect finance, and long-term employment relationship.

[ii] In the argument, Sasaki also points out that accumulation of technology, such as precise processing, assembling, mass production and cooperative networks with suppliers of intermediate goods (or subcontractors) that enable coping with flexible demand from parent firms (consumer electronics makers), contributed to establishing the dominant market share in the world market.

[iii] The reference for arguments presented in this section are Itami (1998), Ibid, Itami (1996) Ibid, and Oniki, H., (1997) .

[iv] In this trend, there is movement towards integrating several production sites and to utilise the integrated one as a multi-purpose production unit.

[v] Baldwin & Clark also point out that the freedom to experiment on product design of module suppliers makes difference from subcontractors, which is by and large under the control of the parent firm in this regard.

[vi] ME evolution and the mode of Japanese firm organisations is also explained in Kawabata, Y., (2002), Chapter 5 in "Coordination for the Division of Labour and Economic Institutions – With Reference to Japanese Electronics Industry –" PhD Dissertation, School of Oriental and African Studies, University of London

[vii] The movement is also accelerated by improvements in computer quality, such as increase in capacity for accumulation of information, increase in speed for data processing, downsizing of the body etc.

[viii] The White Paper on International Trade (2001) points out, while Japanese JIT focuses increase in productivity of assembler and suppliers of intermediate goods, SCM in the U.S. expands the scope to grasp the diversified demand of the consumer and to respond to the demand swiftly. The Paper also indicates that operations of SCM is characterized by more preciseness and utilisation of the explicit idea.

[ix] In the Japanese subcontracting system, the means has usually been to voice for improvement.

[x] Regarding electronic business commerce, the White Paper on International Trade (2001) shows that the main communication line of Japanese firms is not the internet but a privately leased line. This reflects a mode of coordination for the division of labour between firm organisations in Japan characterized by a long-term and fixed relationship. In other words, Japanese firms have not fully utilised new information technology (or the internet) for their operations through restructuring of the organisation, expansion of trade partners, and globalisation.

[xi] Pine ('93) also explains the benefit as "flexible coupling and decoupling with other units facilitated by the standardisation of interface".

[xii] Strong leadership of the top manager is necessary for the reform. However, as the White Paper on International Trade (2001) says, Japanese firms face constraints in which the top manager is unable to display a strong initiative for the reorganisation.

References

Aoki, M., "Information, Incentives and Bargaining in the Japanese Economy", (Cambridge University Press, 1988)

Aoki, M., (1995), "An Evolving Diversity of Organisational Mode and Its Implications for Transitional Economies", Journal of the Japanese and International Economics, 9, pp 330-353

Aoki, M. & Dinc, S., (2000), "Relational Financing as an Institutional and Its Viability under Competition", in Aoki, M. and Saxonhouse G. R. eds., "Finance, Governance, and Competitiveness in Japan", Oxford University Press, New York

Baldwin C. Y. & Kim B. Clark "Managing in an Age of Modularity", Harvard Business Review, September-October, pp84-93, 1997

Brynjolfsson, E. and Hitt, L., (1998), "Beyond the Productivity Paradox", Communications of the ACM, August

Ishiguro, N., (2000), "Nihonno Kyosoyuitoha Nanika: What is Competitive Advantage of Japan? ", PHP, Tokyo

Itami, K., " Nihonsangyo Mittu no Nami", (NTT shuppan, Tokyo, 1998)

Itoh H. (1993), "Coordination, Specialisation, and Incentives in Product Development Organisation", chapter 10 in Aoki, M., & Dore, R., eds. "The Japanese Firm - Sources of Competitive Strength-", (Oxford University Press, New York, 1993)

Kawamura, T., (1996), "Nihongata Seisan System to ME Johoka", chapter 6 in Itoh, M., and Okamoto, Y., eds., "Johokakumei to Shijokeizai System – Kigyyo to Sangyo no Kozotenkan – ", (Fujitsu Books, Tokyo)

Kusunoki, K., (2001), "IT no Impact to Kigyo Senryaku", Hitotsubashi Business Review, 2001, Vol. 48, No.4, pp. 50-74

Noguchi, Y., " 1940 Nen Taisei ", (Toyokeizaishinposha, Tokyo, 1995)

Okazaki, T. and Okuno-Fujiwara, M., " Gendai Nihon no Keizai System to Sono Rekisiteki Genryu ", in Okazaki, T. and Okuno,.M. eds.," Gendai Nihon Keizai System no Genryu ", (Nihonkeizaishinbunsha, 1993)

Okazaki, T., " Kogyoka no Kiseki – Keizaitaikoku Zenshi -, (Yomiurishinbunsha, Tokyo, 1997)

Oliner, S. D. and D. E. Sichel, "The Resurgence of Growth in the Late 1990: Is Information Technology the Story?", FRP Finance and Economic Discussion Paper, March 2000

Oniki, H., (1999) "Japanese/US Comparative Advantage: Width and Depth of Co-ordination," A Chapter of *Information and Organization: A Tribute to the Work of Don Lamberton*, edited by S. Macdonald and J. Nightingale, 1999, Amsterdam: Elsevier Science B.V., pp.197-214.

Oyama, H., (2000), "Kanagata Maker toshiteno Buhin Module ka nitaisuru kangaekata, torikumi to kongo", Katagijutsu, vol.15, no. 11

Pine, J., Jr. (1993), "Mass Customisation: The New Frontier in Business Competition", Boston, Mass: Harvard Business School Press

Piore, M., "Technological Trajectories and the Classical Revival in Economics", in Michael Storper and Allen J. Scott eds. "Pathways to Industrialisation and Regional Development", (Routledge, London, 1992)

Porter M.E., (1990), "The Competitive Advantage of Nations", (New York: The Free Press)

Porter M.E. & Takeuchi H. in cooperation with Sakakibara M. (2000), "Can Japan Compete?" (Japanese version), (Diamond-sha, Tokyo)

Saito, K., (2000), "Johoka Kanrentoshi wo Haikeitoshita Beikokudeno Seisansei Kojo", Nihonginkochosageppo, 2/2000

Sasaki, Y., (2000), "Kadensangyo ni okeru Yushutushudogata Seisankakudaikozo no Tenkan", chapter 7 in Sangyokozokenkyukai eds., "Gendainihonsangyo no Kozo to Dotai", (Sinnihonshuppansha, Tokyo)

Smyth, R. & Lo, D., (2000), "Theories of the Firm and the Relationship Between Different Perspective on the Division of Labour", Review of Political Economy, Vol. 12, No.3, 2000

Takeda, Y., (2001) "IT de kigyokankeiha dou kawaruka: How relationship between firms will be changed by Information Technology? ", pp. 31-35, (Keizai Seminar, Tokyo)

White Paper on International Trade, (2001), chapter 2: "IT Kakumei to Business no Dynamism", (Ministry of Economy, Trade and Industry, Tokyo)