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Abstract:

The failure of Japanese electronics firms to participate fully in the Internet-fueled growth of the global electronics industry during the late 1990s triggered a period of questioning among top executives. This paper examines Japanese managerial responses to the organizational model deployed by the American electronics firms driving the creation and deployment of the Internet, 'value chain modularity.' While there were partial but significant steps taken in the direction of this new American model — increased specialization, outsourcing of low-end products, and shared factory investments in Japan — wholesale restructuring was resisted. This evidence is consistent with larger patterns of gradual institutional change in Japan. I argue that the result of this process will likely be increased, not diminished institutional diversity over time. While globalization has accelerated the pace of change by opening new avenues for organizational experimentation and institutional layering, the drag on organizational change exerted by existing institutions slows the process enough to allow institutional and organizational innovations to develop into coherent systems with distinct characteristics. The result, inevitably, will be a uniquely Japanese approach to the challenges posed by globalization.

Keywords: Value chain modularity, institutional diversity, global value chains, lean production, electronics industry, Internet bubble, outsourcing, offshoring, organizational models, production systems

JEL codes: L2. L63, P5, O32

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How Globalization Drives Institutional Diversity:
the Japanese Electronics Industry's Response to Value Chain Modularity

Timothy J. Sturgeon

Intoduction

Japan has long been a laboratory for examining the processes of institutional and industrial change. During the Meiji period (1868-1912) Japan shifted from a feudal to a capitalist mode of accumulation by imitating and adopting a range of "modern" institutions, manufacturing methods, and communications technologies that had been developed in the West. As Westney (1987) has shown, the result was not a carbon copy of the West, but a distinctive system that remained deeply rooted to traditional Japanese culture. After World War Two, the political system was re-ordered into a Western-style democracy, but economic institutions — labor markets, industry organization, corporate governance, finance — all retained distinctly Japanese characteristics. Economic institutions in Japan were seen as much more supportive of long-term planning and group action than institutions in the West. The debate in the 1980s centered on the role that these institutional characteristics played in Japan's economic success, and how portable they might be to Western societies.

After more than a decade of economic stagnation in Japan after 1989, and an uneven recovery since, the focus of research has shifted. The very institutions that support long-term planning and group action are now seen, by some, as hindrances to the flexibility needed in the more dynamic and competitive age of economic globalization. Is Japan adapting, or adapting quickly enough, to the increased pressure for institutional change wrought by globalization? Moreover, can the changes we currently see in Japan be characterized by incremental adaptation or crisis and wholesale replacement of existing institutions? Is globalization driving convergence toward a common, global production system or will institutional diversity persist, or even increase with time?

In Japan, the picture that is emerging from this research is one of substantial, but controlled transformation. Institutional diversity is increasing as monolithic approaches to employment, industry organization, and finance break down (Sako, forthcoming). Nevertheless, the shift to this new, more diverse structure is by and large being achieved

through the functioning and gradual adaptation of existing institutions. An example is the institution of long-term, or "lifetime," employment and age-based pay for permanent workers in large Japanese corporations. During the long recession of the 1990s, traditional cost-cutting methods functioned well enough to protect permanent workers. Firms reduced their labor bill by cutting overtime and slowing wage increases for permanent workers, while shedding temporary and part-time workers, moving work to lower-cost offshore locations, and seeking price concessions from suppliers. Because robust rates of attrition were possible with an aging workforce and low rates of population growth, slow hiring of permanent workers and increases in offshore production in export industries did not dramatically increased the share of temporary and part-time workers in the labor force (Brown et al, 1997; pp. 55-59).

Nevertheless, the share of temporary and part-time workers did increase in Japan, from 20.2 per cent of the workforce in 1990 to 31.4 per cent in 2004 (JILPT 2005, p.33, cited in Sako, forthcoming, p. 15). However, since 85 per cent of these workers were part-time (Sato 2005, cited in Sako, forthcoming, p. 15), we need to question any assumption that temporary workers are broadly displacing the permanent workforce in Japan. The increase in 'non-standard' work could easily be due to other trends, such as increasing labor market participation by women. The apparent functioning of Japanese institutions in the face of extreme and protracted pressure has led most observers to highlight the processes of gradual institutional evolution over breakdown and radical change (Berger and Dore, 1996; Vogel, 2005).

The empirical evidence provided in this paper supports this incrementalist view. Our research, primarily a series semi-structured in-person interviews conducted from 2000-2004,[1] was designed to examine the responses of highly placed managers at eight of Japan's largest electronics firms to the events of the late 1990s and early 2000s, often referred to, with hindsight, as the "Internet bubble." This period was marked by the sudden emergence of new market opportunities for building the Internet and utilizing it to create products and deliver services. It was also a time when electronics manufacturing, long one of the "core competencies" of Japanese firms, was becoming more commodified. Outside of Japan, the electronics industry were being rapidly reformed into two broad groups of firms, firms that conceived of and marketed products and electronic components, on one hand, and firms that produced them on a contract basis, on the other (Sturgeon, 2002; Berger, 2005). These two trends strongly reinforced each other. First, the new market opportunities for IT-based services decreased the relative importance of hardware (and by extension, manufacturing) in comparison with

software and IT services. Second, the links between legally independent design and manufacturing firms were enabled by digital technologies, including the Internet.

The choice of managers of the largest electronics firms as research subjects might seem obvious, since these companies are large employers and are more deeply engaged in the global economy than smaller firms through exports, foreign investment, and head-to-head competition with foreign rivals. They are also more likely to be engaged in what Gereffi, Humphrey, and Sturgeon (2005), and others,[2] call "global value chains," the increasingly elaborate business linkages between firms located at great distance from one another.[3] The largest Japanese electronics firms both buy and sell components on global markets, and the demand for interoperability requires mutual adaptation to both *de facto* and open standards. All of these attributes suggest that the largest electronics firms in Japan would be a fruitful place to observe the impact of globalization on organizational and institutional change.[4]

This paper examines the decision-making processes of managers who were reacting to financial pressures and rapid market changes that, in many ways, revealed deep weaknesses in the market and organizational strategies of their companies. Because of the sample of firms and qualitative methods employed, we cannot make claims about the overall trajectory of Japanese economic institutions or the organization of Japanese industries with absolute certainty. But our results fit with the findings of a broader literature on recent patterns of institutional adaptation in 'coordinated market economies' in Europe and Japan (Streeck and Thelen 2005). Our findings suggest that there are limits to wholesale adoption of institutional and organizational innovations developed abroad. In Japan, these barriers are created by institutions such as "lifetime employment" and shared expectations that large firms engage in vertical integration and long-term, paternalistic relationships with suppliers. Substantial changes are nevertheless being made. The pattern is more one of institutional 'layering' and increasing diversity than of institutional 'displacement' (Streek and Thelen, 2005; Sako, forthcoming). The 'drag' on organizational change created by existing institutions slows the process enough to allow institutional and organizational innovations to develop into coherent systems. The result, inevitably, will yield a distinctively Japanese approach to the challenges posed by globalization. It is too early to tell what the precise contours of this new model will be, or how competitive it will prove in the long run.

The first goal of this paper is to provide a portrait of gradual institutional change in the face of extreme pressure, with all the nuance gained from considering the prevailing

technological and market trends in a specific industry, electronics. The second goal is to highlight how the functional integration of the global economy (Arndt and Kierzkowski (2001), is working to accelerate institutional diversity, both within and between nations. Before I describe the uncertainty, organizational experimentation, and adaptation that we uncovered in our in field research, I first characterize the model of industrial organization that generated this uncertainty: 'value chain modularity.' This model contains many of the elements that the Japanese managers we interviewed felt compelled to consider, and in large part reject, for their own companies.

Value Chain Modularity as a Response to the Japanese Production System

A distinctly Japanese production system emerged in the 1950 and 1960s as Japanese firms adapted the principles of American-style 'Fordist' mass production to the constraints of the post World War Two Japanese economy, namely small markets, scarce capital, and limited consumer spending power (Sayer, 1986). The American system of mass production required mass markets to absorb the output from large-scale, dedicated (inflexible) production equipment. Market variability was managed by building up huge buffer stocks of in-process and finished inventory, often produced by wholly-owned supplier affiliates, and by laying off and re-hiring core workers as needed. Purchasing was done in bulk, on an arms-length basis, from suppliers that were cut off during downturns or summarily replaced when lower-cost substitutes could be found (Hounshell, 1984).

Firms in post-War Japan, by contrast, had neither the capital to install large-scale machinery nor the markets to absorb its output, and were therefore forced to adapt the techniques of mass production to both conserve capital and increase product variety. In-process inventory was kept low, or "lean," by scheduling parts deliveries from a tiered system of contractors and sub-contractors on an as needed, or "just-in-time" basis. Lower-tier suppliers and non-permanent workers were used to manage market variability. Nevertheless, Japanese lead firms took an interest in the survival of their main suppliers, and have historically assisted them in adapting during both sides of the business cycle. Low levels of in-process inventory and tight linkages to highly responsive suppliers proved an advantage when methods to tightly regulate and continuously improve product quality were grafted onto the system in the 1970s (Ohno, 1988; Suzuki, 2004). In the American system, defective parts were masked by huge inventories and in some cases, used whether defective or not (Hamper, 1992). Because

of the success of Japanese firms in the 1980s, some of the key principals of their altered version of mass production had a profound impact on the industrial organization in the United States in the 1990s.

There is now a rich literature on how the production system that emerged in post-war Japan has been adopted and adapted differentially outside of Japan in various industries, companies, workplaces, and stages of the value chain (e.g., Abo, 1989; Kenney and Florida, 1993: Liker, Fruin, and Adler, 1999; Holweg and Pil, 2004). American firms did respond to the Japanese production system, and the MIT book that codified its elements as 'lean production,' *The Machine That Changed the World,* was extremely influential among managers in the automotive industry and beyond. Investments by Japanese firms in the 1980s and 1990s in North America and Europe also did much to expose non-Japanese managers and workers to key elements of the system. These lessons resulted in an increased focus on quality at American firms, achieved through systematic and continuous defect reduction programs and reduced in-process inventories, at least in final assembly (Cole, 1999). In the realm of industry organization, however, the elements of lean production that admonished lead firms to ask more from their suppliers dovetailed with other forces in the United States that were both driving and enabling increased outsourcing. I characterize the organizational model that emerged from this process as 'value chain modularity.'

In the 1990s, outsourcing became extremely popular among managers in the United States. This trend was driven by some of the same motivations that exist in Japan: the search for greater flexibility in the face of increased international competition and market volatility through the transfer of fixed assets and inventory to suppliers. A close lead firm-suppler relationship was a key aspect of the Japanese system. Japanese lead firms are in many cases highly vertically integrated, and when suppliers are heavily used, as they are in the emblematic case of lean production, the automotive industry, they are more likely to be highly dependent on one or a small number of key customer firms. Buyer-supplier relationships have traditionally been canted towards affiliates of the same industrial group, or *keiretsu*. Because of the expectation that buyer-supplier relationships will be extremely long-term, qualification processes for new suppliers (Japanese and non-Japanese) can be extremely lengthy. Lead firms may make equity investments in their suppliers and can in some cases come to dominate them financially.[5] Lead firms often provide the required technical assistance and financial support to help their main suppliers adopt asset-specific production technologies and systems for improved inventory management, capacity planning, and quality control.

These tight linkages between lead and suppliers have been identified as a source of competitive advantage for Japanese firms (Dore, 1986; Dyer, 1996; Nishiguchi, 2001).

While outsourcing in the United States grew, in some industries, beyond anything that had been imagined in Japan, one striking difference was that relationships with suppliers did not change their adversarial tone, but retained much of their arms-length, short-term, and contractual character (Helper, 1991). Nevertheless, the challenges of transferring and coordinating complex and sensitive information along the supply-chain, reducing in-process inventories, and ensuring quality remained. Here American industry drew on a long engineering tradition of *systems integration*, 'the art of conceiving, designing, and managing the development of large systems involving multiple disciplines and many participating organizations' (Sapolsky, 2003: 31).

Value chain modularity is based on functional specialization, formalization of value chain linkages, and an increase in the scale and geographic reach of each horizontal segment — or 'module' — of the value chain.[6] In modular value chains distinct breaks in the sequence of activities tend to form at points where information regarding product and process specifications can be highly formalized. Activities tend to remain tightly integrated and based on tacit linkages within functionally specialized nodes of "relational" activity. Within these relational nodes tacit knowledge is created, exchanged, and processed by workers who tend to be co-located. Between these nodes, however, linkages are eased by the application of widely agreed-upon protocols and standards. Codified linkages allow value chain modules to more easily be located at great distance.

Systems integration developed as a formal practice in the United States during the Cold War in response to a need to coordinate the invention, development, production, deployment, and maintenance of increasingly complex and exotic weapons and aerospace systems. Projects to create complex weapons systems such a ballistic missiles, early warning radar systems, and nuclear submarines were so large and interdisciplinary that detailed knowledge required to deign and produce all of the sub-systems were far beyond the scope of knowledge and expertise contained within any single military branch, firm, university laboratory, or other single organization. Someone had to make sure the systems worked as intended. At first, the task of systems integration fell to a few aerospace contractors, government agencies, and specially created non-profit agencies, but over time, the approach and methods of systems integration migrated to the private sector as private military contractors gained experience with the approach

and systems engineering and management became an established engineering discipline by the 1970s (Johnson, 2003). According to Pavitt (2003), systems integration has remained robust in the face of growing complexity and increased product variety because advances in information technology, especially computer simulation technologies, have reduced the cost of experimentation and technological search. In other words, codification and standardization have helped to create simplified and reliable methods for transmitting detailed product and production specifications along the value chain, and for keeping track of large, complex projects with participants in diverse locations and organizations.[7]

Specifically, the key business processes that have been formalized, codified, standardized, and computerized are product design (e.g., computer aided design), production planning and inventory and logistic control (e.g., enterprise resource planning), as well as various aspects of the production process itself (e.g., assembly, test and inspection, material handling). Furthermore, because it is "platform independent," the Internet has provided an ideal vehicle for sharing and monitoring the data generated and used by these systems. Such technologies and practices are at the core of value chain modularity. It is the formalization of information and knowledge at the inter-firm link, and the relative independence of the participating firms that gives value chain modularity its essential character: flexibility, resiliency, speed, and economies of scale that accrue at the level of the industry rather than the firm (Sturgeon and Lee, 2005).[8]

Value chain modularity introduces risks as well as benefits for participating firms. Responsiveness may suffer as contracts are hammered out. There is potential for intellectual property and other sensitive information about product features, pricing, production forecasts, and customers to leak to competitors through shared suppliers. The ability of lead firms to innovate and design successive product generations may suffer from the atrophying of manufacturing and component knowledge, a problem that has been referred to by Chesbrough and Kusunoki (2001) as the 'modularity trap.' Reliance on standard interfaces may lead to the use of standard components, leading in turn to a loss of product distinctiveness. Shared and overlapping inventory resident in supplier organizations can lead to distortions and tracking problems that introduce waste. One unavoidable issue is that independent firms in buyer-supplier relationships often have competing interests.

Takeishi and Fujimoto (2003) argue that firms and industries that make products with integral product architectures[9] tend to have integral value chains, while firms and

industries that make products with modular product architectures tend to have modular value chains. They conclude that the institutional bias in Japan for tight, long-term, asset-specific relationships contribute to the competitive success of Japanese companies and industries in products that have integral architectures, such as motor vehicles and very small consumer electronic devices. The looser organizational structure of American industries, by contrast, leads to success in products that have modular architectures, such as desktop personal computers and communications equipment. While there is doubtless some truth to this, value chain architecture is not always a function of design architecture. As Baldwin and Clark (2000) have shown, there are many cases in which break points in modular value chains have been willfully engineered. While products with highly modular design architectures such as the personal computer certainly make value chain modularity more likely, even a single modular link in the flow of activities, such as the link between an integral product design and its manufacturing, can unleash the scale dynamics of value chain modularity. In the electronics industry, firms such as Autodesk, Cadence, and Mentor Graphics have aggressively created new opportunities for value chain modularity by developing and marketing design automation tools that produce (or translate) files in standard format. The degree of modularity in a given chain of activities thus involves a large measure of strategic choice, and thus cannot be read directly from design architecture.

What is clear is that national-scale institutions heavily influence managerial choices related to industry organization (Hall and Soskice, 2001). For example, corporate responses to intensified competition and market volatility depend on the strength of worker protection and how well the institutions of new firm formation function at the level of the nation-state. In the United States, volatility is high, not only because globalization and technological change displace workers in vulnerable industries, but also because worker protection laws are relatively weak and labor unions have been in serious decline for decades (only 8.5% of the United States private sector workforce is unionized). On the other hand, the financial and regulatory mechanisms that support entrepreneurship and corporate restructuring are quite strong, and so volatility has spurred the formation of new kinds of businesses that focus on the pooling and rapid redeployment of workers and equipment. Today, lead firms in the United States can lease almost anything, from workers to trucks to entire factories, by making a phone call to Adecco or Ryder or Solectron. These large, specialized suppliers have arisen in direct response to increased volatility. In countries where worker mobility is lower, such as Japan, the infrastructure and motivation for new firm formation tends to

remain underdeveloped, and so volatility is weakly translated into industry re-organization and fewer huge, independent, functionally specialized suppliers emerge.

In the American electronics industry, value chain modularity took shape during the late 1980s and early 1990s. Because many established firms had in-house manufacturing and components divisions, this change required the break-up of vertically integrated corporate structures and the aggregation of cast off activities in suppliers. Hewlett Packard and IBM led the way, selling most of their worldwide manufacturing infrastructure to contract manufacturers such as Solectron and Flextronics, or spinning off internal divisions as merchant contract manufacturers, as IBM did with its Toronto manufacturing complex in 1997, creating the contract manufacturer Celestica. Another source of growth in contract manufacturing was increased business from newer firms that never built up internal manufacturing divisions, such as the Internet switch company Cisco and the computer workstation and server firms Sun Microsystems and Silicon Graphics (Sturgeon, 2002).

Outsourced circuit board and final assembly of commercial electronics (products for the medical, automotive, communications, military, corporate computing markets) was mostly transferred to contract manufacturers based in North America, specifically the big five 'electronics manufacturing services' (EMS) firms Flextronics, Solectron, Sanmina-SCI, Jabil, and Celestica, while the assembly and even some of the design of notebook and desktop personal computers were outsourced to 'original equipment' and 'original design' (OEM and ODM) contract manufacturers based in Taiwan, such as Quanta, Compal, Inventec, Hon Hai (Foxconn), and Wistron, the contract design and manufacturing arm of Acer. By the end of the1990s, much of the manufacturing capacity of the Taiwan-based contract manufacturers had shifted to Mainland China, and the big five United States-based contract manufacturers had established a global-scale network of factories (Sturgeon and Lester, 2004). At the level of components, the 1990s was a time of rapid growth among 'fabless' semiconductor design firms and the semiconductor foundries (chip manufacturing plants) that serve them, such as the Taiwan-based TSMC and UMC, as well as IBM (Linden and Somaya, 2003). By the end of the 1990s modular value chains in the electronics industry were highly developed and global in scope. An important aspect of globalization, then, is the globalization of the supply-base. Globalization provides lead firms with greater access to suppliers that have arisen in foreign institutional settings. As a result, experimentation with novel forms of industrial organizational is eased and institutional layering is enabled. This is one of the ways that globalization is working to drive institutional diversity.

Value chain modularity was in part developed as a response to the lessons learned from the employment, organizational and manufacturing practices developed in Japan. Ironically, this system began to put competitive pressure on Japanese firms in the 1990s. This was especially true in the electronics industry, where thoroughgoing digitization of design and production methods, as well as the data communication systems that connected them, worked to reduce transaction costs and substitute for the dense inter-organizational patterns in Japan. Hence the pressure for industrial transformation and institutional change circled back to Japan.

Competitive Challenges to Japan's Electronics Industry at the End of the 1990s

Value chain modularity came to the attention of Japanese electronics firms in the late 1990s, triggered by the fantastic growth of the Internet and the huge demand for data communications and Internet-enabled enterprise computing equipment that came with it. American firms are leaders in nearly all Internet-related electronics hardware and software product categories; Cisco Systems and Juniper Networks in Internet routers and switches; IBM and Sun Microsystems in powerful computer servers; Dell in personal computers; EMC in storage arrays; Microsoft and Netscape in Internet browsers; Yahoo! and Google in Internet portals and search engines; Amazon and E-Bay in Internet retailing and auctions; Accenture, Price Waterhouse, McKinsey, and IBM in Internet-enabled corporate computing networks; and Electronic Data Systems and IBM information technology services. Japanese electronics firms are focused on components, stand-alone consumer electronics devices, and proprietary enterprise computing systems that connect client sites through private leased data lines.[10]

The sudden rise of the Internet, and almost complete lack of any driving role for Japanese electronics firms in this rise, combined with severe financial losses, initiated a period of questioning in the Japanese electronics industry. Cisco Systems, based in California, jumped to an early lead in the market for Internet (TCP/IP) protocol switching equipment. Through a combination of technological excellence and a shrewd and efficient acquisition strategy Cisco managed to accrue and maintain an 80% market share in Internet routers while continuing to drive innovation in the field (Mayer and Kenney, 2004). As they rushed to learn about the Internet, managers of Japanese electronics firms looked to Cisco and saw some very striking features. First, Cisco relied almost entirely on third-party systems integrators such as Accenture and McKinsey for the creation of fully functional Internet-enabled data networks and

enterprise computing systems. Even more striking from the Japanese point of view was that Cisco did not directly produce its own equipment, but relied on U.S.-based global contract manufacturers such as Solectron and Flextronics. Cisco's success was based on its 'platform leadership' (Gawer and Cusumano, 2002), that is, its ability to drive the standard-setting process through technological and market leadership while leveraging the capabilities of its suppliers and customers. The major Japanese electronics firms, on the whole, are much more vertically integrated, with in-house design and manufacturing of many sub-systems and components.

But competition from American firms with global-scale modular values chains formed only part of the challenge facing Japanese electronics firms in the late 1990s. Korean firms such as Samsung, LG Electronics, and Hyundai are highly vertically integrated. Similar to Japanese firms, large Korean electronics firms tend to follow the 'components plus products' strategy; they design, manufacture, and sell components on world markets, and use their most advanced components first in their own branded products to the degree possible. Until the late 1990s, Japanese companies followed the 'flying geese' strategy of licensing older component technologies to less capable firms in Korea and Taiwan and moving to newer technologies without much worry, but by 1999 Korean firms, especially Samsung and LG, began to close the gap in specific consumer electronic and component markets, such as mobile phones, digital cameras, digital televisions, computer monitors, high capacity memory chips, and flat panel displays.

In Japan, intensified competitive pressure from both the United States and Korea fostered the widespread impression that Japanese electronics firms were losing ground. This perception, along with losses at several firms in 1998, focused managerial attention on the practices of rival firms and fostered the consideration of radical shifts in strategy. The build-up of the Internet bubble, and its bursting in 2001, whipsawed Japanese electronics firms, not because they were driving innovation in the field, but because Japanese firms were significant suppliers of components, personal computers, and computer peripheral equipment, the sales of which were being driven by the expanding Internet. The near moratorium on IT spending that followed the excesses of the Internet bubble deeply affected Japanese firms along with the rest of the industry. Table 1 summarizes the financial performance of the largest 10 Japanese electronics firms during the period 1997-2004. The 2001-2002 period constitutes an obvious trough.

Table 1

Net Income (Loss), Largest Ten Japanese Electronics Firms, 1996-2004, $M

Firm name	1996	1997	1998	1999	2000	2001	2002	2003	2004
Matsushita	1,228	764	107	898	376	(3,427)	(160)	374	545
Sony	1,243	1,812	1,409	1,098	152	123	948	785	1,527
Fujitsu	411	46	(107)	385	77	(3,064)	(1,002)	441	297
NEC	827	387	(1,190)	94	513	(2,499)	(202)	364	632
Toshiba	598	60	(109)	(252)	871	(2,035)	152	256	429
Hitachi	800	41	(2,652)	152	946	(3,876)	229	141	480
Canon	839	970	862	633	1,215	1,342	1,566	2,446	3,200
Mitsubishi	76	(864)	(351)	224	1,131	(625)	(97)	398	663
Sharp	433	202	36	253	349	91	268	539	716
Sanyo	157	101	(204)	195	366	11	(506)	119	(1,599)
Top 10	6,612	3,517	(2,199)	3,681	5,995	(13,959)	1,196	5,862	6,892

Source: Company reports

Notes: Except for Canon, dates are approximate calendar years ending on March 31 of the year following the year listed. US dollar figures were derived from average currency "ask" prices for the period April 1 of the year listed through March 31of the following year. Currency pricing was obtained from http://www.oanda.com.

The Japanese Response to Value Chain Modularity

This section examines the reactions of Japanese managers to the competitive and financial challenges discussed in the previous section. Our interviews reveal that Japanese electronics firms have, unsurprisingly, resisted certain aspects of the value chain modularity while adopting and adapting others. What emerged most powerfully in our interviews was the depth and scope of the questioning taking place within the highest levels of Japanese electronics firms. One respondent summed up the situation in the late spring of 2001 in this way:

> Mega-competition means we are facing strong companies with narrow core competence, such as Micron and Dell. Such single-function players are very strong. We are an all around diversified player so we cannot fight such players with agility. We have convened a series of one-day meetings to determine how to survive. (Japanese electronics executive, June, 2001)

The dilemmas and contradictions facing the largest Japanese electronics companies were great during the interview period, as they continue to be today. Japanese electronics firms are highly diversified and have large numbers of employees both in Japan and abroad. For firms selling corporate computing systems, key customers in Japan, which prominently include national and local governments, are demanding systems comprised of the best hardware and software in the world, and since such systems now must be connected to, or even through, the Internet, this often means using elements created by non-Japanese companies. For firms selling consumer electronics products and electronic components, competition is intense from low-cost producers with modular value chains, such as Dell in personal computers, and with high levels of vertical integration, such as Samsung in mobile phones and flash memory chips. These pressures prompted decision-makers at Japanese electronics firms to consider new strategies to rapidly acquire or develop new competencies, increase specialization, and relocate in-house operations to low-cost locations such as China. At the same time, the managers we spoke to agreed that it would be politically and strategically impossible to enact the layoffs that would be required if radical restructuring was taken too far.

The bursting of the Internet bubble in early 2001 led Japanese managers to step back from the brink of radical transformation, not least because it dramatically exposed some of the weaknesses and risks of value chain modularity. As a result of over-anticipating demand, Cisco was forced to liquidate $2.2 billion of finished and in-process inventory, largely held by its contract manufacturers. The company cut 8,500 jobs and posted its first loss in its 11 years as a public company ($2.69 billion) in the third quarter of 2001 (Niece, 2005). Over the next few years Solectron, Cisco's most important contract manufacturer, suffered a total of $6.5 billion in losses and laid off nearly a third of its global workforce of 60,000.

However effective these developments were in driving Japanese firms back to their traditional industrial model, managers at Japanese electronics firms have nevertheless made significant breaks with past practices. Only key components, such as system-on-a-chip (SoC) — known in Japan as LSI — semiconductors, leading-edge flat panel displays, high-capacity batteries, and advanced memory chips are to be produced in Japan, either in-house or in joint-ventures with other Japanese firms. In-house final assembly in Japan is typically being limited to high-cost models with advanced features. Low-end models are to be produced offshore, especially in China, either by affiliates or by Taiwanese contractors. Divestiture of old, unprofitable, and unrelated businesses and

products lines has accelerated, though these steps toward downsizing and specialization are being made incrementally. Increased specialization, increased complexity, and the continued importance of foreign component sales has led to increased outside purchasing and higher dependence on global markets for a wider variety of inputs, including technology inputs.[11] The remainder of this section presents evidence of these changes, and their limits, in three areas: alliances, outsourcing, and the provision of system integration services for corporate computing and communications.

Alliances

The renewal of traditional strategies of vertical integration at Japanese electronics firms has a high price. The fast pace of technological change in the technologies that underlie key components has required a spate of new investments in leading-edge factory production in Japan for advanced semiconductors and flat panel displays (see table 2 for some examples). The high cost of many of these new investments has convinced managers to forge an unprecedented set of production-sharing alliances. Seven of the twenty-five factory investments listed in Table 2 involve more than one firm. The shift in thinking about alliances is captured by the following statements made by the same top manager in 2001 and 2002:

> We have a terrace-house style management where we exchange ideas with people in the same house, so we don't want to sell our factories to other people.' (Japanese electronics executive, June, 2001) 'We're thinking of a smaller terrace house now. And we're also thinking about having good neighbors.' (Same Japanese electronics executive, July, 2002)

Table 2

Examples of recent and planned electronics factory investments in Japan

Firm Name	Kind of factory	Location	Investment ¥ B	Planned opening
Renesas Technology (Hitachi – Mitsubishi joint venture spin-off)	semiconductors (system LSI)	Hitachinaka, Ibaraki	200	latter half of2005
Elpida Memory (Hitachi – NEC joint venture spin-off)	semiconductors (DRAM)	Higashihiroshima, Hiroshima	500	latter half of2005
NEC Electronics	semiconductors (system LSI)	Tsuruoka, Yamagata	100	latter half of2005
Toshiba	semiconductors (flash memory)	Yokaichi, Mie	270	latter half of2005
Fujitsu	semiconductors (system LSI, ASIC)	Kuwana, Mie	160	first half of2005
Renesas Technology (Hitachi – Mitsubishi – NEC joint venture spin-off)	semiconductors (system LSI, flash memory)	Kagami, Kochi	200	undecided
Matsushita	semiconductors (system LSI)	Uozu, Toyama	130	latter half of2005
Sony	semiconductors (microprocessor)	Isahaya, Nagasaki	200	first half of2005
Sony	semiconductors (CCD)	Kyushu (undecided)	100	undecided
Sharp	semiconductors (flash memory)	Fukuyama, Hiroshima	50	first half of 2006
Oki	semiconductors (undecided)	Kiyotake, Miyazaki	100	undecided
Toshiba Matsushita Display Technology	liquid crystals for cellular phones	Kawakita, Ishikawa	50	April, 2006
Sharp	liquid crystal displays for TVs	Kameyama, Mie	150	June, 2006
IPS	liquid crystal displays for TVs	Mobara, Chiba	110	2nd Q, 2006
Toshiba-Canon	SED displays	Taiji, Hyogo	180	January, 2007
Matsushita (Panasonic)	plasma displays	Ibaragi, Osaka	60	April, 2004
Matsushita (Panasonic) - Toray	plasma displays	Amagasaki, Hyogo	95	September, 2005
Fujitsu Hitachi plasma display	plasma displays	Kunitomi, Miyazaki	85	latter half of 2006
Pioneer	plasma displays	Tatomi, Yamanashi	26-27	September, 2004
Konica Minolta	polarizing film for liquid crystal displays	Kobe, Hyogo	30	autumn, 2006
Fuji film	film for flat panel displays	Kikuyo, Kumamoto	100	December, 2006
Dainihon insatsu	film for liquid crystal panels	Kitakyushu, Fukuoka	30	end of 2006
Toppan insatsu	film for liquid crystal panels	Hisai, Mie	50	October, 2006
Sumitomo Chemical	polarized plates	Niihama, Ehime	10	autumn, 2006
Asahi glass	glass plates for liquid crystal panels	Takasago, Hyogo	25	autumn, 2006

Source: Nikkei Shinbun, various dates

In contrast to the technology and standards development deals forged with American and European firms in the 1980s, most of these recent agreements have been between Japanese firms. In some cases the deals are simple technology development and patent sharing deals between firms with complementary assets and capabilities. In other cases firms have combined component divisions and spun them off as separate companies. In still other cases firms have purchased the divisions of other firms to gain control over needed components or to build larger, more viable divisions, especially in the face of volatile global markets and fierce competition (e.g., DRAMs). The greatest interest and significance lies in the eight deals listed in Table 3 that involve joint factory investments, where partner firms share output. Such deals require significant investment that heightens risk and makes withdrawal difficult. Alliances of this kind create shared factory space, and shared risk. They move the Japanese electronics industry in the direction of value chain modularity in that large fixed investments are pooled and shared by a number of lead firms in an industry. But in this case the number of firms sharing capacity is limited to the members of the alliance, which is typically two, and in a few cases, three firms. Investment risk is diluted in comparison to single ownership, and factory capacity can be assigned more flexibly, but external economies of scale do not accrue at industry level. As result investment risk remains quite high for participating firms.

Overall, this restructuring activity is leading the Japanese electronics industry on a path toward greater specialization, concentration, and fixed capital sharing. These are the same goals that American firms have sought as they have moved toward value chain modularity, pursued in different and more partial way. Table 3 provides some examples of recent restructuring in the Japanese electronics industry, including mergers, spin-offs, acquisitions, and alliances.

Table 3

Examples of recent restructuring in the Japanese electronics industry

Partners (% share)	Year announced	Products	Type of deal
Sony – Konica - Minolta	2005	digital still cameras (SLR)	joint product development
Matsushita - Olympus	2005	digital still cameras (SLR)	joint product development
Hitachi - Matsushita	2005	flat panel displays (plasma)	joint R&D, production, marketing and intellectual property sharing
Hitachi (50%) – Matsushita (23.4%) – Toshiba (23.4%)	2004	flat panel displays (liquid crystal)	joint production
NEC - Pioneer	2004	flat panel displays (plasma)	sale to Pioneer
Seiko Epson (55%) – Sanyo (45%)	2004	flat panel displays (liquid crystal)	merger and spin off
Toshiba - Mitsubishi	2004	semiconductors	sale to Mitsubishi
Sharp - Sony Ericsson	2004	software for cellular phones	joint development
Casio (51%) – Hitachi (49%)	2003	cellular phones	joint product development, design and purchasing
Konica - Minolta	2003	cameras, printers, and copiers etc	merger
Fujitsu	2002	flat panel displays (liquid crystal)	spin off of division
Hitachi (55%) - Mitsubishi (45%) (Renesas Techology)	2002	semiconductors (system LSI)	merger and spin off of R&D, product development, production and marketing
Mitsubishi – NEC – Hitachi (Elpida Memory)	2002	semiconductors (DRAM)	merger and spin off of R&D, product development, production and marketing
Toshiba (60%) – Matsushita (40%)	2001	flat panel displays (liquid crystal)	joint production
NEC	2001	semiconductors (network applications)	spin-off
Sony – Toshiba - IBM	2001	semiconductors (system LSI)	joint product development
Matsushita - NEC	2001	software for cellular phones	joint product development
Matsushita - Toray	2000	flat panel displays (plasma)	joint venture
Fujitsu - Hitachi	1999	flat panel displays (plasma)	joint production
Toshiba (50%) – Canon (50%)	1999	flat panel displays (SED)	joint R&D and production
NEC (50%) – Hitachi (50%)	1999	semiconductors (DRAM)	merger and spin off of R&D, product development, production and marketing
Mitsubishi - Matsushita Electronic	1998	semiconductors (system LSI)	joint product development
Toyota Jido Shokki (50%) – Sony (50%)	1997	flat panel displays (liquid crystal)	joint venture

Source: Trade press publications and *Nikkei Shinbun,* various issues

Outsourcing

In the realm of outsourcing as well, Japanese electronics firms have taken a partial step in the direction of value chain modularity. Dense interactions between design and manufacturing is one of the hallmarks of the Japanese production system, and much criticism was leveled at the tendency at American firms' to "throw designs over the wall" to manufacturing (Kenney and Florida, 1993). But this was one lesson of lean production that went largely unheeded in the United States. On the contrary, one of the most significant challenges to the traditional Japanese system posed by value chain modularity is the notion that manufacturing can be entirely separated from product development with little or no loss of innovative capacity or responsiveness. Are American firms simply misguided or has technology enabled new, more powerful ways of organizing the value chain?

One respondent put the question this way:

> Traditionally we thought that if we don't keep manufacturing, we can't keep our core technological competence. US firms threw that out. This is the central question. For 'analog' manufacturing, where you have the in-house accumulation of technology, [outsourcing] is dangerous. For 'digital' manufacturing, [outsourcing] is OK. But does digital equipment eliminate the accumulation of manufacturing expertise? This is one of my questions. We need at least to keep experimental pilot plants in Japan. For manufacturing technologies, like miniaturization, there is real Japanese strength. What will US core competence be if all their manufacturing goes? New technology must combine various technologies and expertise within the company. The question is: can we throw manufacturing out of this mix totally? (Japanese electronics executive, July, 2001).

The general strategy in the large Japanese electronics companies where we conducted interviews has been to keep the production of leading edge products in-house and to embrace outsourcing for high-volume, price-sensitive products such as low-end personal computers, mobile phones, and previous generation video game consoles. But instead of American contract manufacturers, Taiwan-based contract manufacturers have received the lion's share of these new orders from Japanese firms. Taiwanese contract manufacturers were thought to have access to lower cost capital and be willing to tolerate lower returns on investment than either Japanese or U.S.-based firms. Taiwanese manufacturers of commodity flat panel displays, personal computers, and

mobile phones are especially popular. Some use of Taiwan's semiconductor foundries, TSMC and UMC, was reported as well. Japanese managers have confined the use of contract manufacturers and semiconductor foundries to older and simpler products and components because of the engineering time required to transfer specifications and because they fear the leakage of intellectual property. One respondent put it as follows:

> Some of our products require special components and finishes. If we used a Taiwanese [contractor], we would also use them as parts vendors, and we'd have to teach them about this [advanced process], and we don't want to — it would take too much of our engineering time. Eventually they will be able to do everything, but we don't want to teach them so quickly. It's a constant decision to figure out how much of our resources to invest in teaching them as opposed to the cost of doing it ourselves. Moreover it leads to the leakage of our intellectual property. Eventually they catch up — but maybe we can delay that (Japanese electronics executive, October 2004)

This statement reveals a deep ambivalence about outsourcing that has not been as evident in American electronics firms, which tend to deal with such problems by codifying complex product specifications and punishing suppliers that try to compete with them by withdrawing business. While American companies have had some problems with technology leakage to rivals via shared suppliers, these have neither slowed outsourcing nor led to the loss of innovative capacity, at least not yet. Managers of Japanese electronics firms, in contrast, have largely opted to continue traditional strategies that seek to develop and leverage complementarities within their organizations. As one respondent put it:

> In can be an advantage to have both components and [final products] in-house; we can use advanced components in our own products first and introduce new features faster. If manufacturing is outsourced, 100% of the strength of Japanese companies will die. Launching new models quickly is the key. If we don't have a manufacturing function, we will not be able to launch new products based on new [in-house] technologies, such as batteries, LCDs, and semiconductors, nor could we make modifications to existing products. The ability to make incremental modifications on the factory floor is important. Dell doesn't create. They will have a hard time creating new products because they depend on outside [contract manufacturers] that have no unique technology. Making parts and products is important. When products are commodities, then using [contract manufacturers] is OK, but advanced products are better made in-house. (Japanese electronics executive, June 2001)

Still, it was recognized that the benefits of this strategy were declining with the increased ability to codify product and process information that has come with digititzation. One respondent put the problem this way:

> With digital technology it becomes easier to gain the capability to manufacture. It's easier to make personal computers than televisions. Everyone can buy the technology. The machines embody the instructions. It's no longer a 'black box'; the Japanese advantage when it used to be that way is eroding. For example, the Koreans can simply buy the machines and have the technology. (Japanese electronics executive, July, 2001.)

On the other hand, in some areas the increasing consolidation of functionality enabled by digitization has created new technical challenges and a greater need to integrate product and component design efforts. The Japanese managers we spoke with believed this to be especially true in the case of system-on-a-chip semiconductors.[12] As one respondent put it:

> United States companies specialize in a core competence, a piece of the value chain. We do it all: system LSI, [product] design, manufacturing, production equipment, and marketing. The main business [of our division] is to manufacture digital audio-visual products. To do this we must co-develop with our semiconductor group. We can put all of our knowledge about system design into the LSI design. The system LSI made by a specialist may not work as well or fit as well within the final product. In the past we could buy key components from the outside, but now system LSI determines everything so we buy these from inside. But this is the exception. Other components can be bought from the outside. (Japanese electronics executive, October 2004)

Another respondent listed the benefits of in-house system-on-a-chip semiconductor production as:

> 'Speed, cost, and intellectual property protection.' 'When outside vendors are used, roadmaps are leaked to competitors. Inside we don't have that problem.' (Japanese electronics executive, October 2004)

Our interviews suggest that by 2003 the response to value chain modularity had led only to modest changes in Japan. One of the main difficulties was the work force reduction that would be required for more radical restructuring, for instance by selling in-house manufacturing plants to contract manufacturers, as many large, high-profile North American and European electronics firms did in the 1990s. As one respondent put it:

> If we got rid of manufacturing, we'd have to get rid of 50% of our workforce. We couldn't survive if we did that because other stakeholders, like the governments who procure our services, couldn't accept our doing such a thing. (Japanese electronics executive, July, 2002)

Severe workforce reductions were also seen as problematic because of their effect on morale. As one respondent put it:

> We can't just fire people, because if we did, we couldn't keep the others. This is the Japanese way of business; we can't just adopt the American way. We have to make full use of Japanese people. If we fire the laggards, the talented promising people will think about their own future and also leave. They would think that [our company] is not a good place to work. We are building up some outside companies like real estate and maintenance to absorb excess people, but all this has to happen slowly. We are thinking of cutting some businesses, but this must be done gradually, according to the Japanese way. (Japanese electronics executive, June, 2001)

To sum up, the Japanese electronics firms we interviewed appear to have settled on a mixed model in the realm of outsourcing. Advanced components and products are to be produced in-house or in joint ventures, and older, simpler, and non-strategic components and products lines are to be outsourced. While this strategy might seem clear and decisive on its face, it provides no real guidance on how far to take outsourcing. What comprises a core technology, a key component, or advanced product? How soon should advanced process technologies be transferred to outside suppliers? It was recognized that the definition of core competencies and key components would shift over time. One respondent summarized this point as follows:

> In regard to outsourcing, we have a mixed model. We make key components in-house. We must choose these key components carefully and engage in constant search and revision. What is considered key will change over time. Then, we must choose our real high tech collaborators; firms that can provide specialties and have special R&D capabilities. (Japanese electronics executive, October, 2004)

What this suggests is that Japanese electronics firms face the same strategic challenges that American electronics firms do and have similarly moved in the direction of value chain modularity, in most cases for older product lines but in some other cases with the aim of developing high-level technological collaborations. But even in the case of older, non-strategic products, the migration of in-house production to low-cost

locations, especially China, was mentioned at least as often as outsourcing. What is clear is that the degree and speed of these changes are limited in the Japanese institutional context. The following statement sums up this point well:

> Suppose we do away with all of our plants and fire all of our workers? If we were driven to this we might do it, but in Japan you can't do this. It is our policy to protect jobs. It is part of our mission as a company. So we must continue to develop products that cannot easily be outsourced. Putting parts together is the job of a trading company. We are not a trading company. This is why we cannot do what Apple computer has done [externally sourcing the components and assembly of its iPod digital music player]. (Japanese electronics executive, March, 2004)

Information technology and communications services

As they lost money in the late 1990s, Japanese electronics firms with the breadth to supply large-scale corporate computing systems saw a solution to their financial woes through growth in the service side of their business, following IBM's long success in this area. An expanding information technology and communications (ITC) services business is attractive in many ways, not least in its potential to absorb a large number of employees in high-value-added, knowledge-intensive work. But customized ITC systems and IT-enabled business services tend to require a deep and thorough understanding of the end user's line of business and close collaboration to identify and fulfill the buyer's needs. Such 'domain knowledge' is typically industry-specific, requiring knowledge that is applicable only to relatively narrow 'vertical' markets, so there is an obvious knowledge gap.[13] Again, national differences in banking, education, communications, and corporate use in IT, matter. Japanese electronics firms have very little experience providing ITC services outside of Japan. There is, moreover, a great deal of competition in the realm of ITC services, both from other integrated electronics hardware and software firms such as IBM and from services-only consulting firms, such as Accenture, Price Waterhouse, and McKinsey, and well as from smaller, specialized local firms that might have a high market share in a given national economy or metropolitan region.

Competing with foreign ITC service firms even in Japan has proved difficult, and Japanese electronics firms have found that their product lines and service offerings are not always considered serious contenders. One reason for this is Japanese electronics

firms' continued bias toward using their own products for the ITC systems they sell. Vertical integration means that salespeople have incentives to sell systems that use a full range of in-house hardware products, from components to PCs to servers to large computers to networking equipment, as well as software. With the deployment of global-scale data communications systems, and especially since the rise of interoperability based on Internet, or TCP/IP, protocols, it has become much easier and in some cases necessary to integrate hardware and software from a variety of vendors. In fact, many customers, even in Japan, believe that their systems should be comprised of a mix of the best products available. It has been very difficult for Japanese electronics firms to adopt this model, not least because of strongly held notions about the beneficial complementarities between various components of large complex systems. One executive explained this dilemma as follows:

> Five to seven years ago, there were no cases of United Sates [firms'] success in selling [IT systems] in Japan, but today, even local governments are choosing whoever has the best integration package. If we try to sell only our own products we'll lose business. We do have one case where we sold a big system integration solution with no in-house products. It included only American-made hardware and software. Our engineers on that project asked, 'What company am I working for?' But pure systems integration like this is profitable. (Japanese electronics executive, July, 2001)

Debates about shifting from manufacturing to services at Japanese electronics firms have apparently been quite intense. For now, it seems as if the integrated approach has won the day. This is captured well by the following three statements made by the same high-level Japanese electronics executive over the research period:

> July 2001: Now we want to change from a hardware to a software and services solutions business, so we need more differentiation to fit customers in every country. Will turning away from manufacturing create weakness? We are struggling to find an answer. Even on government programs, we can't do it ourselves and so we are using some American firms as sub-contractors. Accenture, Mckinsey, and Price Waterhouse and others have a very good business in Japan and can win bids over us. Our engineers make full use of our products first. So customers prefer to go with American companies because they'll provide integrated packages using the best components from a variety of vendors. Our engineers are trying to integrate products from Cisco and others but sales and engineering issues force them to use our own products, so we lose some bids.

July 2002: There are two different views at our company. Some say we should simply be good at choosing the best components, but others say anyone could package them in the same way. They would be standardized parts, so anyone could do the same thing. Where's the competitive advantage for us then? With no differentiating hardware, there is no way of succeeding in a pure software/services business. How would we make profits in such a business? In this view, we need to maintain advanced hardware capabilities.

October 2004: Service companies cannot expect to make profits. We found we cannot make money from just software services. Even IBM is facing losses from its system integration business. Competition is too tough in being a pure provider of services. Therefore my opinion now is that we need to keep making all the necessary hardware in our company. Some people in our company said we should lead in services and software and use the best hardware we can find whether it's ours or another company's. Gradually we realized that the company that produces the key hardware in-house can provide customers with the confidence and security they need.

Conclusions

The failure of Japanese electronics firms to participate fully in the Internet-fueled growth of the global electronics industry during the late 1990s triggered a period of questioning among the top executives in Japan's leading electronics firms. At the time, value chain modularity seemed to be providing American firms with significant competitive advantages. Moreover, the key features of the modular value chains constituted a direct challenge to a host of the most cherished strategies of Japanese electronics firms. In modular value chains, manufacturing capacity is pooled in specialized suppliers, freeing lead firms to engage in 'open innovation' (Chesbrough, 2003) by specializing in specific aspects of technology development and system architecture while depending on outside firms for complementary system elements. The goal of 'platform leaders' (Gawer and Cusumano, 2002) is to attain early market dominance to set standards in emerging technologies, thereby forcing 'partner' firms to create products, subsystems, and components that comply with, and often pay for licenses for, the standards they set. These strategies clash with the strongly held belief among Japanese managers that competitive advantage comes from design collaboration within a diversified organization, tight feedback between internal design and manufacturing, and the first-use of internally developed components.

The bursting of the Internet bubble in 2001, and the ensuing inventory and financial problems at firms closely associated with open innovation and value chain modularity such as Cisco and Solectron, affirmed the skepticism of Japanese managers regarding the model. Our interviews after 2003 suggested that the pressure for radical moves to outsource manufacturing had lost momentum and that traditional strategies of vertical integration were being reasserted, especially for advanced products and technologies. In addition, financial performance at many large Japanese electronics companies improved in 2004, driven in significant degree by rising demand from Japanese customers with booming sales to China for products such as steel, ships, and heavy machinery. Only the threat from Korea failed to diminish.

So the period of intense questioning came to an end, at least temporarily, as decisions were taken to deepen traditional strategies, especially for advanced products and technologies. Japanese electronics firms continue to have shallow, tactical alliances with foreign firms, and have reasserted their vertically integrated approach by investing in a new round of factory construction — in Japan — for key components such as system-on-chip semiconductors, advanced flat panel displays, high capacity batteries, and high-performance memory chips. Managers have opting instead for a series of more gradual and partial approaches to organizational change. There have been significant steps taken in the direction of value chain modualrity in the form of increased specialization, outsourcing of low-end products, and shared factory investments in Japan, but wholesale restructuring has been resisted, at least for now.

However slowly it may be moving, restructuring at Japanese electronics firms is indeed underway, and most large firms reported reductions in their global workforces by 10-15% since the late 1990s, mostly through attrition. Still, this restructuring is proceeding under the substantial weight of existing organizational routines, investments, and workforces, and is being strongly shaped by existing institutions. What this reveals is that many of the most important institutions that protect core workers and support tight supplier relationships are part of the legal code of Japan, but come from the shared belief that Japanese companies exist, not only to produce profits for shareholders, but to provide a stable livelihood and work life for permanent employees. Managers clearly felt pressure to take dramatic steps to change their companies, but their actions were constrained by the perceived damage to their reputation among current and future employees and suppliers. As a result, the firms were simultaneously shedding and protecting jobs, getting out of old business lines and adding new ones, opening their sourcing networks and investing in new in-house component plants, and expanding

some facilities and shrinking or closing others, both off- and on-shore, in an effort to rebalance their organizations.

The question is what is emerging from these decisions. The largest Japanese electronics firms are clearly emulating the practices of American firms for lower-end product categories, in some cases using the same Taiwan-based contract manufacturers and semiconductor foundries that American firms helped to create in their rush to outsource production during the 1990s. For extremely expensive and risky factory investments for flat panels and semiconductors, Japanese firms are forging alliances that achieve part of the capacity sharing advantages of value chain modularity, but allow for advanced processes to be more closely held and therefore less likely to benefit competitors.

The continuation of this trend will result will be a smaller "relational" core, both in terms of employment and closely held, domestically located technology creation, product development, process innovation, and production investment. But this core will be surrounded by a mass of "modular" externalized and internationally located design and manufacturing to flesh out product lines with lower-end products. American electronics firms have their core competencies as well, and hold some aspects of design, and even manufacturing, very closely within their own organizations and in close collaboration with key suppliers and customers. But this relational core is, in general, much smaller and narrower than what Japanese companies have decided, for now, to keep.

Perhaps American firms have given ceded too much to their suppliers, become too specialized, and created inter-firm networks that will, eventually, become unmanageable and leak too much key intellectual property to keep them at the forefront of innovation and new market creation. Perhaps the promise of IT-based services will be empty and unprofitable. If this is the case, we may have to invent a new term for the industrial model currently being created by Japanese firms. In retrospect, we see the late 1990s and early 2000s and a time when Japanese electronics firms took what they could from value chain modularity in the process of creating a new, characteristically Japanese model of industry organization supported by distinctly Japanese institutions that are undergoing a process of gradual, incremental change. Or, we may see it as a period when the institutions of Japanese capitalism blocked successful emulation of value chain modularity, a model better suited to the new, more dynamic reality of economic globalization. At the time of this writing, is it too soon to tell.

This paper depicts a process of industrial, and by extension institutional transformation, triggered by competitive pressure from abroad. This process is not unique to this case. Rather, it is characteristic of the geographic expansion of capitalism (Polanyi, 1944). "Late" developers, from 1860-1890 Germany to 1960-1980 Taiwan, have sought to emulate institutions of more "advanced" capitalist nations, but in the end had to adapt many of these to different material, cultural, and historical circumstances, not least the fact of "lateness" itself. Most often depicted as a process of less developed countries emulating the institutions of more advanced economies (e.g., Amsden, 1989, 2003; Wade, 1990; Evans, 1995), competitive pressure can also circle back from a highly successful late developers to influence institutions and industrial practices in the countries that had been the target of emulation in the first place.

What our research makes clear is that globalization is accelerating and deepening the geographic circulation of industrial models, not only because heightened international competition and better information trigger change from within, but also because global value chains have become more elaborate through the processes of foreign direct investment, value chain fragmentation, and increasing trade in intermediate inputs (Yeats, 2001). In the case of the electronics industry, Japanese firms have extensive investments in the United States, sell extremely complex components and production machinery on world markets, share some of the same Taiwan-based contract manufacturers used by American firms, and have made huge recent investments in China, both for the local market and for export, just as their American competitors have (Borrus, 2000; Sturgeon and Lee, 2005). The rise of extremely elaborate yet functionally integrated global value chains has led national economies to become deeply embedded in one another (Gereffi, 1994; Dicken, 2003; Feenstra and Hamilton, 2006), and the globalization of the supply-base has opened new possibilities for organizational experimentation and institutional layering. While this may not be leading to convergence toward a single institutional and organizational model, it does accelerate the pace of change and organizational innovation. Given the persistence of many economic institutions in the face of protracted pressure for change, and the apparent commonality of institutional layering over wholesale displacement, the result of this process will likely be increased, not diminished institutional diversity over time.

Notes:

[1] The interviews were semi-structured in that the same themes were covered. They were conducted at the respondent's office, and typically lasted 1-2 hours. The names of the firms and managers are withheld for reasons of confidentiality. The respondents typically, but not always, occupied high-level decision-making positions at their firm.

[2] See http://www.globalvaluechains.org for an overview of this literature and database of related publications and active researchers.

[3] These linkages may be horizontal research, development, or marketing collaborations with peers, or "vertical" buying and selling relationships that take a variety or forms.

[4] An opposite argument might me made: smaller firms could be willing and able to engage more aggressively in testing and refining organizational innovations that, if successful, might provide examples that diffuse to larger, less nimble of firms. The author is currently engaged in research to test the questions raised in this paper in the context of medium-sized Japanese electronics firms.

[5] Although this pattern of cross-holding has been quite strong historically, the *keiretsu* structure has loosened considerably in the past decade or so, in part driven by the efforts of foreign investors, such as Renault and Wal-mart, to drive down the cost of components (Vogel, 2005).

[6] Baldwin and Clark 2000; Sturgeon, 2000, 2002; Takeishi and Fujimoto, 2001; Langlois, 2003; Principe et al, 2003; Gereffi, Humphrey, and Sturgeon, 2005; Sturgeon and Lee, 2005.

[7] The high volume of non-price data flowing across the inter-firm link differentiates modular value chains from simple markets. Because of this complexity it is not unusual that additional engineering and coordination be required. The hand-off of product and process specifications between firms need not be perfectly clean, but only relatively so for modular value chains to function.

[8] Relational nodes of tacit activity can reside within divisions of the same firm, but only when activities are outsourced can scale economies build up beyond the level of the firm (Langlois and Robertson, 1995).

[9] Products with integral architectures have tight design interdependencies with components and subsystems.

[10] See Cole, forthcoming, for a detailed account of the Japanese response to the Internet and the weakness of Japanese firms in the network equipment sector.

[11] For example, most large Japanese electronics firms have licensed processor cores, a modular block of design code (or 'IP block') for inclusion in SoC semiconductors, from the British firm Advanced RISC Machines Ltd. (ARM) as a way to stimulate business in Europe, where ARM technology amounts to a *de facto* standard for embedded communications equipment.

[12] This is in contrast to American lead firms, which commonly source their SoC semiconductors externally or do the logic design in-house and outsource the remaining design and fabrication tasks (Greg Linden, personal communication, September 2005).

[13] See Rtischev and Cole (2003) for an analysis of the not always wise penchant of large Japanese firms to try to use expanding businesses to absorb redundant labour.

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