Spotlight on Japan's Competitiveness

Part 3: Rebuilding Japan's Innovation System to Meet the Challenges of the IT Revolution

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Innovation Capacity and International Competitiveness

In the two previous issues, we examined the current status of Japan's competitiveness based on the IMD (International Institute for Management Development) *World Competitiveness Yearbook* and trade specialization indexes created from trade statistics. To conclude the series, we will turn to the future of Japan's competitiveness. Where international competitiveness is defined as the realization of medium to long-term economic prosperity by a nation as a whole and the basic conditions for realizing that prosperity, the most critical basic condition is the capacity to realize sustained innovation.

One effective means of examining long-term economic growth is the growth accounting method (GAM), which focuses on the supply side of the economy. Using this method, the economic growth rate can be broken down into the input of the production factors of capital and labor and growth in total factor productivity (TFP). Where capital and labor inputs are unlikely to grow substantially over the long term, TFP trends become pivotal to the future economic growth rate. TFP indicates the technological progress of the economy as a whole, and is boosted by sustained innovation – namely, the development of new products and services with higher added-value and the introduction of new production methods.

The innovation capacity of the country as a whole leans heavily on the ability of companies in that country to develop new products and production processes. However, the sum total of the innovation capacity of these companies does not equate to the national innovation capacity. For example, research and development (R&D) results can be published as papers, which then inspire innovations such as new research or product creation. In the case of patents, licensing contracts open the way for utilization of other companies' research results. In other words, technology spillover produces an external economic effect, and the ability of companies to absorb outside technologies (absorptive capacity) enhances their innovation capacity, while the national innovation capacity is bolstered by promoting university-industry partnership and instituting appropriate intellectual property rights policies to stimulate technology spillover.

As indicated by Japan's second placing in science and technology on the IMD World Competitiveness Scoreboard 2002, Japan is making progress in terms of R&D investment, patent numbers and other technological aspects. However, because of the limited efficiency of innovation linking new discoveries and technologies to product development, these have not boosted economic performance. To restore Japan's competitiveness, we must look for a system which boosts corporate innovation capacity and also increases the probability of national innovation based on existing technology.

The IT Revolution and Changing Innovation Mechanisms

Swift technological progress in the field of semiconductor integrated circuits (ICs) is spawning ever smaller and faster computers, a trend which, along with the development of the Internet and other communications infrastructure, is driving company investment in informatization and altering the economic structure. The rapid slump in the IT industry since the second half of 2000 in the United States in particular has led some to question whether the U.S. economic boom of the 90s was simply an IT bubble. However, U.S. economic productivity remains robust even in the midst of an economic contraction phase, and it is generally believed in the United States that the IT revolution is transforming the economic structure.[1]

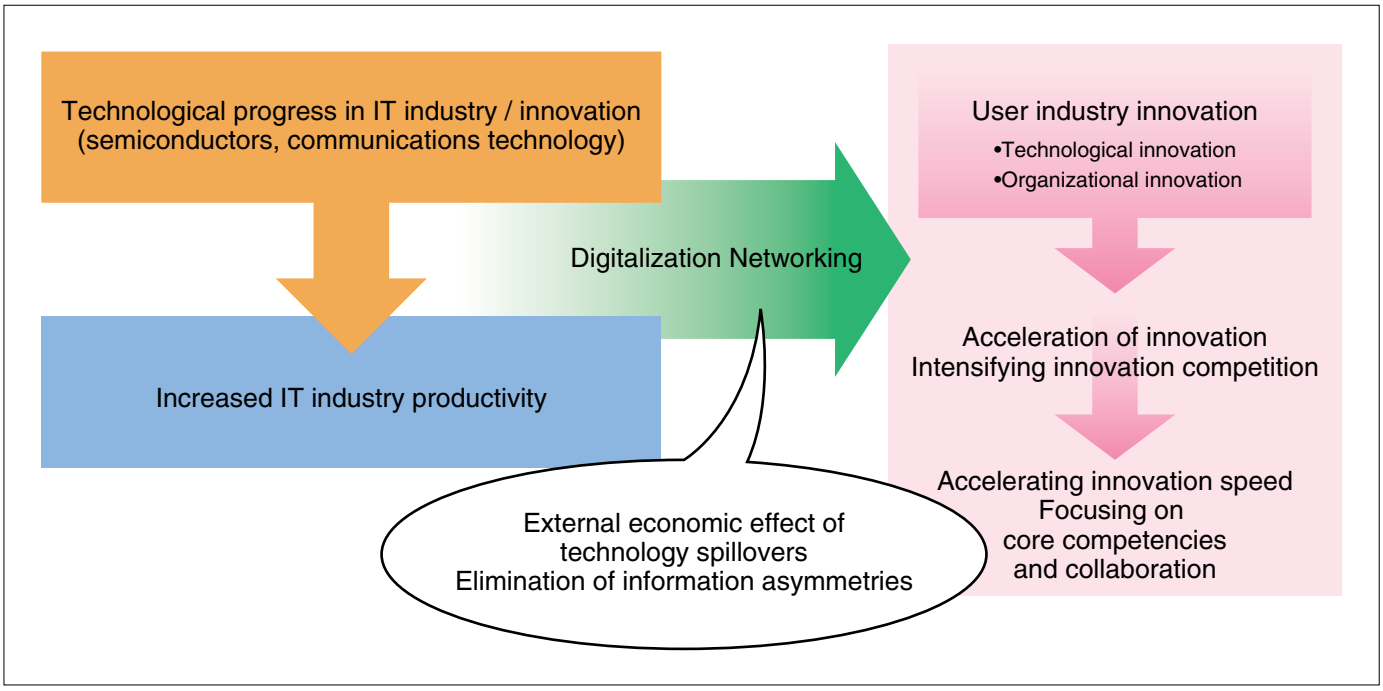
The IT revolution is also impacting heavily on innovation generation mechanisms, as is examined in Figure 1.

Firstly, the IT revolution has been underpinned by rapid innovation in the IT industry. Take semiconductor ICs, for example, as indicated by Moore's Law, semiconductor memory and large scale integration (LSI) concentration are doubling every 18 months to two years, increasing in a geometrical progression. Intel's LSI chip marketing strategy has been developed in line with Moore's Law, with it already announcing mass production by 2005 of LSIs offering 10 times the current speed. Technological innovation in this area therefore seems likely to continue.

In the communications area too, communications networks are rapidly shifting to a broadband basis, enabling massive amounts of data to be transmitted virtually instantaneously. Technological innovation is also proceeding in terms of the information transmission technology used for digital communications, including commercialization of time division multiplex (TDM) and wavelength division multiplex (WDM) technology which allows the transmission of huge volumes of data through a single optical fiber cable. Technology analyst George Gilder has come up with "Gilder's Law," positing that fiberoptic bandwidth will double every six months. The shift of information communications networks to broadband and advances in digital communications technology should see the productivity of communications service businesses soar.

As information communications technology advances and the latest IT sys-

Figure 1 The IT revolution and innovation strategies



tems rapidly permeate throughout the economy, our economic activities are becoming increasingly dependent on IT systems. The key issues in terms of innovation mechanisms are the way in which informatization of the economy as a whole is promoting the digitalization of information, while the development of network infrastructure, epitomized by the Internet, is rapidly boosting the speed of distribution of information. Innovation can be broadly divided into technological innovation based on technological discoveries, such as the development of new products and production processes, and organizational innovation, which includes the discovery of new business models and corporate structure and management innovations; however, the spillover effect of technology and ideas is critical to both. Innovation is in many cases created not just through technology developed in-house, but by also using the results produced by other companies and universities. Further, the information gained from interaction with customers when a product is created is also critical.[2] The growing speed of information distribution will increase the efficiency of communication and generate an even greater spillover effect, thus also increasing the speed of innovation.

Digitalized information is efficiently communicated through information networks, but the effect operates not only to the advantage of the company in question, but also equally well for its rivals. Digitalizing information and transmitting it through networks eliminates information asymmetries and stimulates competition based on the same quality of information. Patents submitted and disclosed to the Japan Patent Office can be searched for and downloaded from the Internet, a service which allows even local small and medium-sized enterprises easy access to patent information. In addition, information on research papers and various technologies is also easily obtained through the Internet. In this kind of world, it will be vital to be able to quickly locate the best technology and develop new products. At the same time, the strong possibility of rival companies with the same information winning the race to bring a new product to market will breed fierce competition.

As the IT revolution boosts information distribution speed and pushes down costs, society as a whole has become able to benefit from the greater external economic effect of technology and idea spillovers in generating innovation. At the same time, companies are having to deal with the loss of information asymmetry and accordingly stiff innovation competition. A company now needs to possess unique core competencies which cannot be imitated by its competitors. It is also becoming increasingly important to devise management strategies for extracting from the mass of information available the particular information necessary to that company and pursuing strategic collaboration with other companies.

New Economy in Japan?

Improvements on economic efficiencies caused by the permeation of information communications systems and advances in productivity, which is represented as the IT revolution and the New Economy, have been American phenomena. Does Japan exhibit the same phenomena? In stark contrast to the strong economic growth in the United States in the 1990s, the same period in Japan was bleak enough to win the label of the "lost decade." The average 4.1% economic growth of the 1980s plunged to 1.4% in the 1990s, and the unemployment rate climbed above 5% to the worst-ever postwar level.

Despite this economic situation, Japanese companies too have engaged in vigorous IT investment, with Japan achieving TFP growth rates on a par

Table 1 The results of applying the growth accounting method

	Japanese Data			US Data (Jorgenson)		
	1975-90	1990-95	1995-00	1973-90	1990-95	1995-00
Gross Domestic Output	4.33%	1.69%	1.45%	2.88%	2.42%	4.12%
Contribution of IT Capital Services	0.28%	0.15%	0.51%	0.40%	0.48%	0.99%
Computers	0.16%	0.09%	0.24%	0.20%	0.22%	0.54%
Software	0.07%	0.02%	0.12%	0.08%	0.16%	0.28%
Communications Equipment	0.06%	0.04%	0.15%	0.12%	0.10%	0.17%
Contribution of non-IT Capital Services	1.91%	1.01%	0.34%	1.08%	0.64%	1.10%
Contribution of Labor Services	1.42%	-0.04%	-0.14%	1.15%	1.06%	1.35%
Total Factor Productivity	0.71%	0.57%	0.74%	0.25%	0.24%	0.68%

Source: Motohashi Kazuyuki, "IT investment and productivity growth of the Japanese economy and comparison to the United States," RIETI Discussion Paper 2002

with the United States. Table 1 shows the results of applying GAM to Japan and the United States. Capital input has been further divided into IT capital services and non-IT capital services to identify the degree of contribution of IT investment.

Japan's output growth slipped from the four percent mark sustained up until 1990 down to the one percent mark in the 1990s, but TFP reached an historical high of 0.74% in the late 1990s. Around the same period, the contribution of IT-related investment also rose to 0.51%, confirming that Japan too has seen abundant IT investment and growing productivity since 1995 in particular. However, in the United States, the output growth rate has continued to rise since the late 1990s in particular, while the TFP growth rate has also increased. The contribution of IT-related investment has reached around 1%, approximately double that of Japan. Japan is evidently still behind the United States in terms of informatization across the economy as a whole.

Common patterns are therefore presented by both countries in terms of the New Economy hallmarks of economic informatization and rising productivity, albeit to a different extent. A critical difference, however, is the decline in Japan's economic growth rate where the U.S. rate has risen. In Japan, while the degree of contribution of IT-related stock is growing, Japan's TFP is in fact rising because the other inputs, and particularly labor, are in the negative. The increase in Japan's productivity therefore arises from Japanese companies seeking to boost efficiency by reducing their labor inputs, a development which has yet to improve company competitiveness and elevate production and market share.

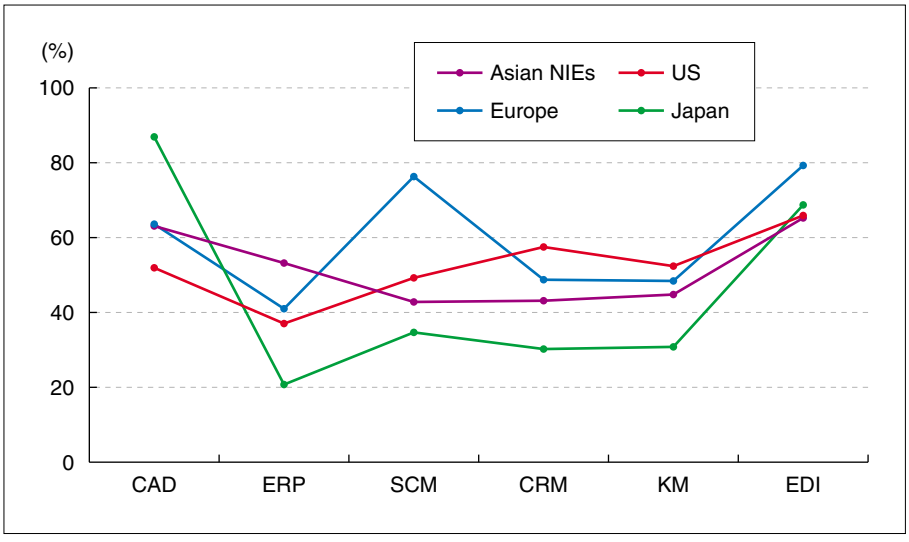
As noted earlier, the advance of the IT revolution is intensifying innovation competition. Information digitalization and network-based collaboration are increasing the speed of company product development and process innovation, but at the same time, inter-corporate competition is intensifying on a world scale. Japanese companies in many areas are losing their market share due to this heightening innovation competition. The relation between informatization and production in Japan illustrated in Table 1 suggests that fiercer innovation competition is causing a relative loss in competitiveness for the products and services of Japanese companies, forcing these companies to restructure and boost the efficiency of existing business operations. This stands in sharp contrast to the co-evolution of informatization and innovation in the United States.

Figure 2 provides an international comparison of IT system introduction rates among large companies. While computer-aided design (CAD) introduction rates are high in Japan, rates for other systems are low compared to U.S. and European companies.

The enterprise resource planning (ERP) system unifies and manages data on procurement, production, distribution, sales and other operational functions, as well as financial affairs, accounting, management planning and other headquarters functions. It uses real-time information on operational functions to allow headquarters to make swift management decisions. However, Japanese companies have been markedly slow to introduce ERP, which requires standardizing data specifications across all sections and integrating management techniques formerly determined on a sectional basis so as to optimize the entire in-house process from production to sales. Japanese companies are said to have been slow to introduce ERP because of their inability to carry out this kind of top-down reform of business processes. As the IT revolution intensifies innovation competition, the speed of management decisions is becoming a critical factor, and the low rate of ERP introduction epitomizes the slow adaptation of Japanese companies to the new competition environment.

The supply chain management (SCM) system is designed to optimize process management from parts manufacturing through to the delivery of final products among the various companies comprising the supply chain, reducing inventories and boosting efficiency. In terms of inter-corporate networks, Japanese companies have been introducing electronic data interchange (EDI), which enables order data to be exchanged electronically among a specific set of companies, but compared to U.S. and European companies, few have adopted the SCM system of production management based on demand forecasts. Japan is also lagging behind in the introduction of the knowledge management (KM) system, which improves business efficiency by digitalizing in-house knowledge as a compa-

Figure 2 International comparison of rate of introduction of IT-related applications



Note: CAD figures are for the manufacturing industry, SCM for the manufacturing, wholesale and retail industries, others for all industries.
Source: *International Survey on Corporate Management and Information Strategies*, Ministry of Economy, Trade and Industry (METI) in *White Paper on International Trade 2001*, METI.

ny-wide resource. Japanese companies are therefore lagging behind in embracing the new information systems emerging from the IT revolution, and have not made sufficient progress in establishing the infrastructure for competing with U.S. and European companies under the new competition rules.

Reform of National Innovation Systems

The keywords in the innovation competition which the IT revolution has wrought are "speed" and "collaboration." To achieve speed, a company needs to make optimal choices among the many possible management decisions based on its core competencies, while strategy and leadership are crucial in prioritizing the investment of management resources. U.S. and European companies are moving swiftly on cross-border mergers and acquisitions (M&As) and business tie-ups, all looking to collaborate with companies with complementary core competencies to heighten the speed of innovation and rates of return. By clinging to their autonomy, Japanese companies, on the other hand, are losing their ability to stand up to international competition.

To succeed in the IT revolution-based innovation competition, company strategies must be reconstructed with an emphasis on speed and collaboration, while mechanisms for that purpose need to be reformed as part of an overall systemic overhaul. That "overall system" comprises a "national innovation system" (NIS), within which linkages among universities and public research institutions designed to stimulate company innovation complement the economic environment underpinning them, the basic elements of which comprise product markets, intellectual property rights systems, finance markets, labor markets, information infrastructure and other elements.

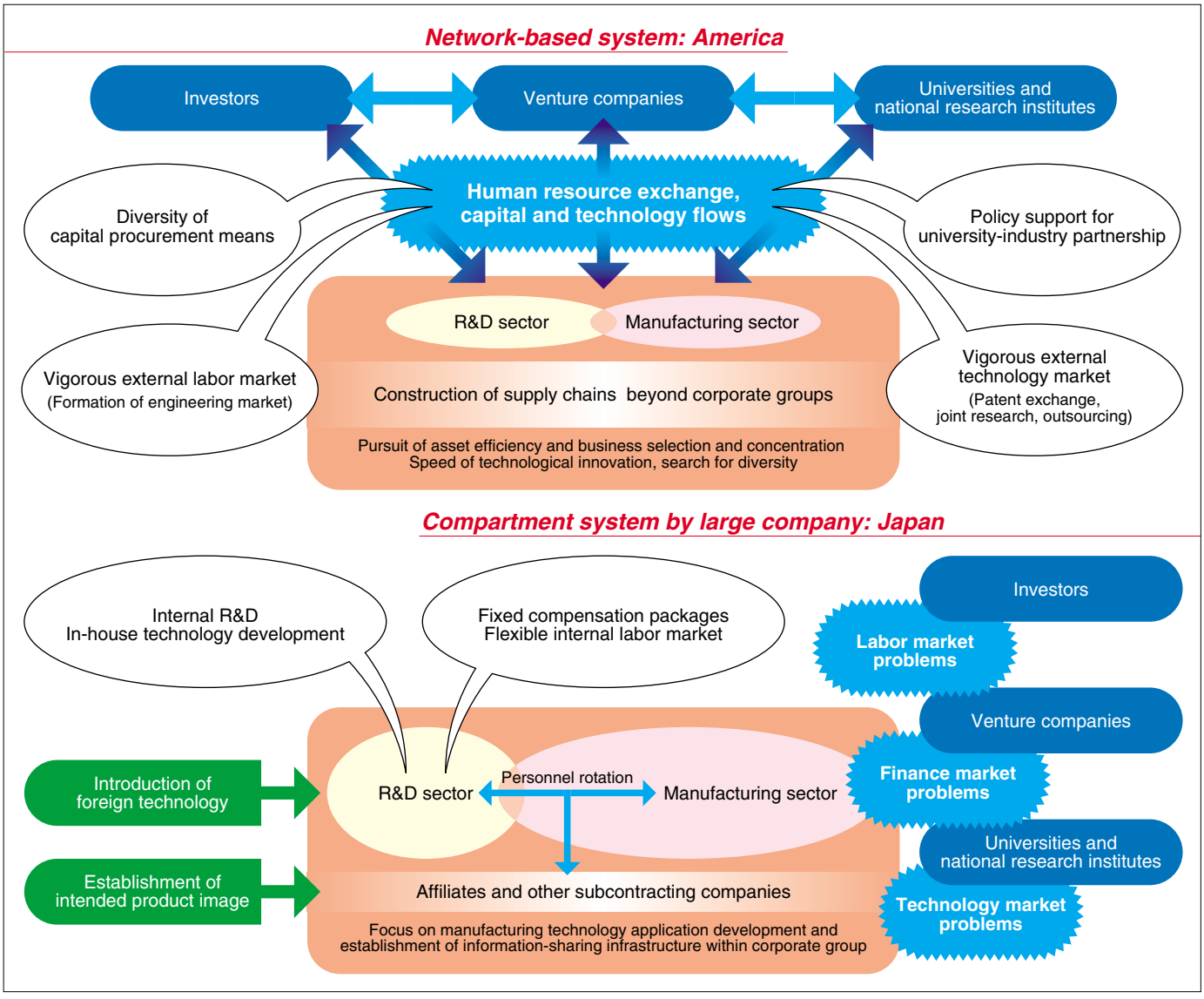
Figure 3 maps differences in the U.S. and Japanese NISs. Japan's NIS has been focused on large companies, with few linkages between universities/public research institutes and industry. A complementary relationship has existed between the NIS and the financing system, which leans heavily toward indirect finance, as well as the labor system, which is characterized by in-house personnel training and low labor mobility. Large companies have established their own central research institutes, and in the course of post-war economic development have concentrated on the creation of products based on Western advanced technology. In the 1980s, when Japanese industrial technology caught up to Western levels, corporate central research institutes began to emphasize basic research. The central research institutes of big companies have been almost entirely isolated, with few links with universities and public research institutes. The role of venture companies has also been limited, in contrast to the key role played by these firms in the United States.

In the United States, on the other hand, large companies collaborate beyond their corporate groups, and since the 1980s, partly due to the impact of policy in promoting the commercialization of research results produced by universities and public research institutes, the United States has developed a unique system of network-based innovation generation. The role of venture companies in high-tech areas such as IT and biotechnology, is also critical. This network-based innovation system stands in a synergistic relationship with a direct finance market suited to supplying risk money and a fluid labor market.

NISs have developed out of the historical and systemic circumstances of individual nations, and it is impossible to identify any one as superior. Japan's strong postwar economic performance was in fact backed by innovation in the form of vigorous new product development by domestic companies and a unique Japanese-style production system. The Japanese innovation system could therefore be said to have functioned well at least up until the collapse of the economic bubble in the early 1990s. However, with the IT revolution ushering in a wave of global competition, the network-based U.S. system has begun to function more effectively.

The Japanese innovation system centering around large companies' central research institutes reached a critical point with the collapse of the bubble economy. As their business performance declines, companies are losing their capacity to conduct basic research with the requisite large-scale research funding, and the mission of central research institutes has swung heavily away from basic research to commercialization research. Moreover, intensifying global competition among companies has accelerated the speed of new

Figure 3 Differences in Japanese and U.S. innovation systems



product development, and Japanese companies too are beginning to turn their backs on in-house R&D in favor of acquisition and development (A&D), procuring basic research results from outside and focusing on product development. At the government level, a technology licensing organizations (TLO) law has been formulated to promote university-industry partnership, while corporate laws are being improved to facilitate corporate business reorganization and encourage greater selection and concentration. Various policies are also being instituted to encourage venture companies, but changing Japan's innovation system will inevitably require reform of the large companies which served as the heart of that system. These companies will need to delineate clear management strategies and they must focus the bulk of their management resources on core competencies and pursue collaboration strategies.

Notes

1. See Baily (2002), "The New Economy: Post Mortem or Second Wind," *Journal of Economic Perspectives*, Vol.16, No.2, pp.3-22.

2. See von Hippel (1994), *The Source of Innovation*, Oxford Press, on the importance of interaction with customers as a source of innovation.

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