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Japanese Enterprises and R&D Activities by Multinational Enterprises in China

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ABSTRACT

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1. According to a 2005 UN survey, China ranked as having the third highest number of foreign-owned R&D centers, behind only the US and the UK. Moreover, China was cited as the most attractive region for establishing R&D centers in the next five years. According to statistics from China's Ministry of Commerce, there were 750 foreign-financed R&D centers established in China as of July 2005. In contrast to these trends, however, Japanese enterprises have been wary of fully engaging in R&D activities in China due to fears of technology leakage and personnel loss.

2. This report presents case studies of a total of eight enterprises (two from Europe and three each from Japan and the US) with local establishments in China in order to investigate the state of R&D activities by multinational enterprises in China. While there is no great difference in the motivations of Japanese, US and European enterprises' R&D forays into China, US and European enterprises combine strategies for the Chinese market together with R&D, while Japanese enterprises employ minimal coordination between their R&D and market strategies. There are also differences in the way Japanese enterprises handle localization and human resources strategies within the organization and personnel of their R&D centers.

   It should be noted, however, that the job turnover rate at R&D centers in China is never much higher than 10%. Furthermore, R&D centers in China are also actively working toward the improvement of copyrights for research results as well as enhancing systems for protecting confidentiality. Additionally, there have been no confirmed cases of intellectual copyright infringement or technology leakage due to personnel turnover.

3. Intellectual copyright infringement and technology leakage due to the turnover of personnel have not become serious issues in China, and enterprises should not confuse the problems faced by operation centers (such as production and sales) with those of R&D centers. Enterprises must clarify the role of R&D centers in China and create human resources and organizational strategies that match these roles in order to attract talented personnel. It is also necessary for enterprises to create a

bright research environment by including a mix of employees with varying academic backgrounds and experiences in order to lower the job turnover rate at R&D centers. One measure that is indispensable in lowering this turnover rate is to establish a system of institutionalized intellectual copyright protection in place of monitoring by individuals. Fair and balanced results can be achieved if enterprises throw out the preconceived ideas that "China has weak enforcement of intellectual copyrights" and instead take firm action in the case of infringement. Furthermore, enterprises should avoid making local university-industry collaboration their goal; instead, contracts should clearly reflect a strategy of attributing research results from a cost performance perspective.

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Japanese Enterprises and R&D Activities by Multinational Enterprises in China

1. The Issues at Hand

In recent years, there has been a shift in the foreign investment strategies of Japanese enterprises from a concentration solely on China to a "China plus one strategy". However, the pace of investment in China has continued to increase. While China saw a double-digit decline in investments from the US, South Korea and Taiwan in 2005, investments from Japanese enterprises reached double-digit growth and investment totals were the highest in history.

There have been new developments in the Chinese business strategies of Japanese, US and European enterprises in recent years. From the use of cheap labor to market development and the utilization of intellectual human resources, the course for business strategy has been greatly altered. While European and US enterprises are shifting their business in China from the manufacturing industry to the services industry, such as finance and distribution, Japanese enterprises are focused on automobiles and electronics manufacturing as dictated by domestic demand. Among new business developments, however, Japanese, US and European enterprises all show acceleration in research and development (R&D) activities in China. For example, in the automobile industry the western enterprises General Motors and Volkswagen have already set up R&D centers in Shanghai, while Hyundai of South Korea is developing a large R&D center in Beijing. Meanwhile, the Japanese enterprises Nissan (Guangzhou, Shanghai), Mazda (Shanghai), Mitsubishi (Shanghai), and Toyota (in preparation) are all either beginning or preparing for R&D activities in China. This trend, which has followed globalization and the spread of information technology, is attributed to an increasing emphasis of multinational enterprises on the internationalization of intellectually-intensive activities such as R&D.

When multinational enterprises decide to develop R&D activities, which are more intellectual-intensive compared to production or sales, they must overcome risks inherent in China such as instability in legal systems, weakness in the protection of intellectual property rights (IPR), and high turnover rates in personnel. They must concurrently develop a foundation that will improve the efficiency of intellectual output. In reality, many Japanese enterprises fear a leakage of technology know-how that comes with IPR infringements or the turnover of personnel, and are hesitant to proceed with any real activity. Why is it that the R&D activities in China of European and US enterprises are accelerating despite the "China risk"? It is necessary to

examine whether or not there is substance to the “China risk”, or if it is nothing more than simple apprehension.

Starting with an awareness of these issues, this report will explore the Chinese R&D activities of Japanese, US and European enterprises, and examine the development of this R&D through case studies. There are two models of R&D in China: the contract-based commissioned research or joint research cooperation model, and the direct investment model where enterprises establish their own centers. The case studies will focus on the latter model (R&D activities conducted through centers established by enterprises).

2. Acceleration of the Internationalization of R&D activities and the Emergence of China as a Target Country

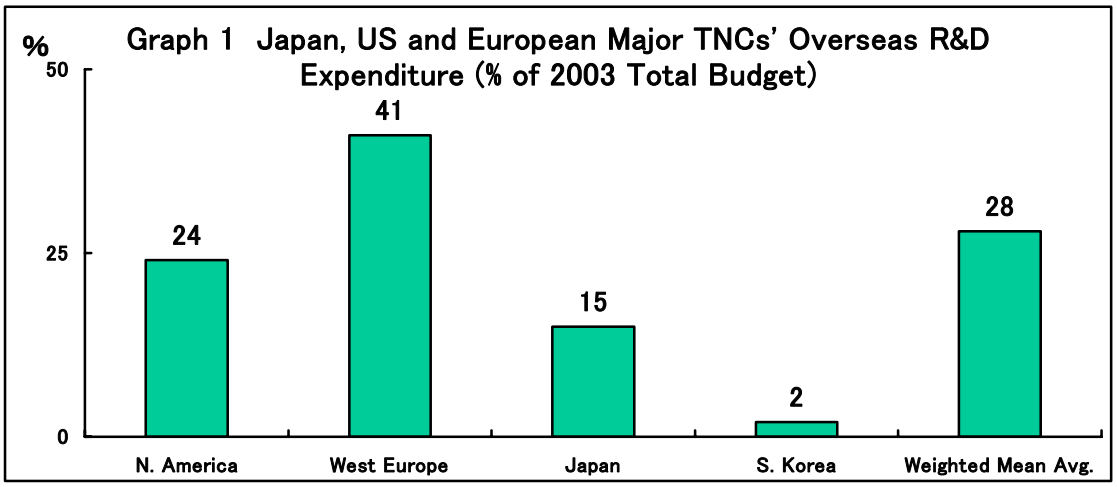
The internationalization of business activities of multinational enterprises is developed in the order of sales, production, and research. Faced with the need for technological support to promote overseas sales and the restriction of researchers and “know-how” and etc., multinational enterprises have been left with no choice but to pursue R&D activities overseas. The march of globalization and the spread of IT since 1990, however, have led to a more proactive acceleration of the internationalization of R&D activities as a strategy of multinational enterprises. There has been a trend towards sharp expansion in R&D activities of enterprises with established centers as a result of foreign direct investment (FDI), and of strategic development of international R&D activities based on contractual cooperation.

2.1 Movement of Multinational Enterprises towards the Internationalization of R&D Activities.

The first systematic research on the internationalization of R&D activities of multinational enterprises was conducted by the United Kingdom Department of Trade and Industry (DTI) and the Economist Intelligent Unit (EIU) of the Economist magazine. Based on the DTI research, the United Nations Conference on Trade and Development (UNCTAD) conducted a survey on the internationalization of R&D activities targeting 300 of the 700 enterprises with the highest amount of R&D expenditure in the world, as well as multinational enterprises from a selection of developing countries. The UNCTAD published the findings of this survey in the

"World Investment Report 2005" on September 29, 2005[1].

According the UNCTAD study, R&D activity of multinational enterprises is increasingly becoming global, and the subject enterprises' overseas R&D expenditure as a percentage of total expenditure was averaged at 28% (2003). The budget for overseas R&D expenditure includes in-house expenditure into foreign subsidiary enterprises, and contract-based expenditure into overseas R&D institutions such as overseas universities, research centers and enterprises. As graph 1 indicates, the internationalization of western enterprises' R&D activities is way ahead of their Japanese counterparts, which are focused mainly on domestic R&D activity.



Source: UNCTAD, 2005. p. 125

According to the survey results, overseas R&D expenditure percentages for IT hardware, automobiles, pharmaceutical/bio, and chemistry were 29.8%, 31.0%, 40.3%, and 47.7%, respectively[2]. Of these, the internationalization of R&D in the chemical and pharmaceutical industries was the most advanced. Phizer, the world's largest pharmaceutical enterprise, and Roche, a Swiss pharmaceutical enterprise, as well as chemical enterprises such as Dupont have set up global R&D centers in China and are aggressively developing R&D activities. On the other hand, the low level of R&D internationalization in the electronics industry can be attributed to Japanese enterprises' sluggish development of overseas R&D activity.

However, in the first group's report of the Japan Management Association's

[1] UNCTAD. 2005. "World Investment Report 2005: Transnational Corporations and the Internationalization of R&D"
[2] UNCTAD. 2005. "UNCTAD survey on the internationalization of R&D" Table 4.

first Japan CTO Forum (2005) entitled "How to promote R&D in China", CTOs expressed that, "It is not easy to protect intellectual property rights in fields such as chemistry, bio and pharmaceutical. Furthermore, there are many cases where intellectual property plays a decisive role in business execution so we must proceed cautiously. On the other hand, because the protection of intellectual property is relatively easy with machines and equipment, and products can be created by combined different intellectual properties, intellectual property is not decisive and therefore operations can be pursued aggressively in these areas"[3]. It seems that Japanese enterprises' cautiousness with regards to the internationalization of R&D is reflected in the risk assessment.

Though Japanese enterprises were late in the international development of R&D activities, it is a fact that they are increasing overseas R&D expenditure in line with the expansion of global business. According to the Ministry of Economy, Trade and Industry, the percentage of R&D expenditure into overseas subsidiaries among Japanese enterprises' entire R&D expenditure grew from 1.5% (1994) to 3.7% (1999), and then to 4.2% (2002)[4]. Meanwhile, US enterprises' R&D expenditure into overseas subsidiaries (majority-controlled subsidiaries) as a percentage of total R&D expenditure showed marginal increases from 11.2% (1994) to 12.6% (1999), and then to 13.8% (2003)[5].

According to the UNCTAD survey, 69% of enterprises responded that they will expand overseas R&D activity over the next five years (2005–2009). In comparison, 29% responded that will maintain the status quo, while 2% said that they will decrease such activity. In particular, over 80% of Japanese and Korean enterprises, which had previously not shown much aggressiveness, responded that they will expand.

2.2 Accelerating R&D Activity in China

The internationalization of R&D has hitherto been concentrated primarily in and among developed countries. Since the mid-1990s, however, some developing countries have also surfaced as bases of activity for multinational enterprises. As the result of the breakdown ("modulization") of R&D activity and the spread of information technology, it has become possible for this activity to be conducted not only in

[3] http://www.jma.or.jp/keikakusin/cto/action/all, Japan CTO Forum documents.
[4] Ministry of Economy, Trade and Industry's "Survey of Japanese Enterprises' Overseas Business Activities" (each survey).
[5] FRI calculations derived from the U.S. Bureau of Economic Analysis' "Survey of U.S. Direct Investment Abroad", http://www.bea.gov/bea/di/di1fdibal.htm.

horizontal divisions but also with vertical labor specialization. This has led to increased investment in developing countries such as China.

For example, the percentage of R&D expenditure via overseas subsidiaries (majority-controlled) of US multinational enterprises into developed countries decreased from 92.4% in 1994 to 84.4% in 2002. In the same period, however, the percentage into developing countries increased from 7.6% (1994) to 13.5% (2002)[6]. A closer look reveals that the percentage into the EU and Japan decreased 11% and 3%, respectively, while it increased across the board into China, Singapore, Hong Kong, Malaysia, South Korea and etc. In particular, China's percentage jumped from 0.1% to 3.1% during this period, representing the greatest increase among developing countries.

As Graph 2 indicates, R&D activity among Japanese enterprises (manufacturing), which have had a relatively low level of international R&D, is growing in developed and developing countries alike. The enterprises targeted in the survey showed a 72.3% increase in the number of overseas R&D centers established from 2000 to 2005. Of this, while there was only a 28.8% increase in 15 developed EU and North American countries, activity in developing countries showed a three-fold increase. During the same period, the establishment of R&D centers in China increased four-fold, and China's overall share expanded from 7% (2000) to 18.4%[7].

Graph 2 Overseas R&D Centers of Japanese Manufacturers (Number, Stock)

	2000	2001	2002	2003	2004	2005
NIEs	16	15	30	21	25	24
ASEAN-4	10	18	21	18	29	27
China	13	19	28	29	67	56
India	—	—	—	—	3	4
Other Asia	2	2	2	3	3	4
N. America	88	84	92	88	108	107
Latin America	2	1	1	0	4	4
EU-15	44	47	70	48	60	63
Eastern Europe	1	1	3	3	3	7
Australia	—	4	6	6	8	7
All	177	193	256	216	310	305

Source: Annual Reports by the Japan Bank for International Cooperation

[6] UNDTAC's "World Investment Report 2005" p. 129.

[7] China and India are both emerging as important target regions for R&D activity for US and European enterprises, but Japanese enterprises do not yet consider India to be a base for R&D.

Graph 3 "Want to Increase Overseas R&D Output Here" in the Next 3 Years (%)

	Country	%	Rank	Country/Region	%	Rank	Country/Region	Rank
1	China	39	11	Canada	7	21	Norway	4
2	USA	29	12	Hong Kong	6	22	Poland	4
3	India	28	13	Russia	6	23	Slovakia	4
4	UK	24	14	Mexico	5	24	Finland	3
5	Germany	19	15	Singapore	5	25	Saudi Arabia	3
6	Brazil	11	16	Australia	4	26	S. Africa	3
7	Japan	10	17	Australia	4	27	Sweden	3
8	France	9	18	Ireland	4	28	Taiwan	3
9	Italy	9	19	Israel	4	29	Venezuela	3
10	Czech Rep	8	20	New Zealand	4	30	Argentina	2

Source: EIU2004.

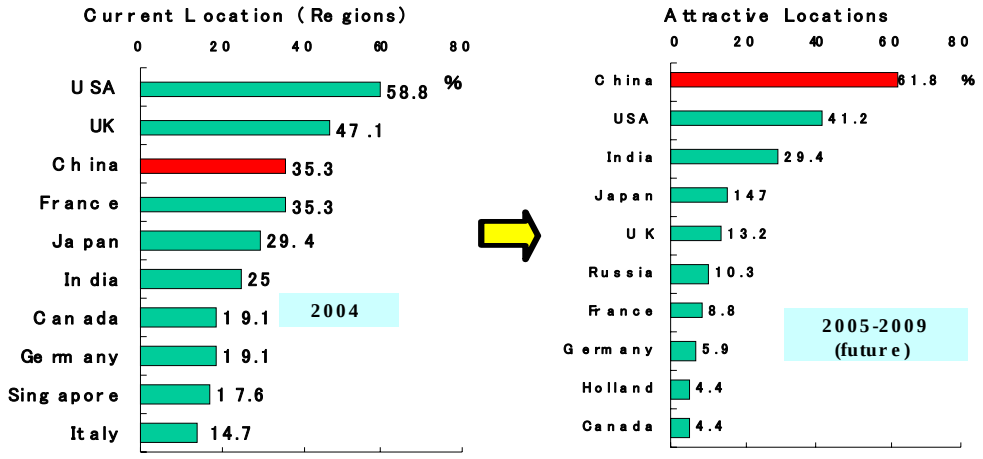
Note: Excluding domestic markets. Top three countries/regions selected.

From two comprehensive surveys conducted targeting major multinational enterprises, it has been confirmed that R&D activity in developing countries is expanding and that China has been placed as the primary target country for this activity. As Graph 3 (a survey of British EIU enterprises) indicates, among enterprises' top ten target countries/regions for increasing R&D expenditure over the next three years (from 2004) were China (1st), India (3rd), Brazil (6th), and the Czech Republic (10th). Since all countries/regions (including developed countries) were included as possible answers, it can be concluded that in addition to the low wages typical to developing countries, the fact that China and India are increasingly equipped with the necessary kinds of environments and resources for R&D activity was also recognized.

A UNCTAD survey was conducted from November 2004 to March 2005 targeting 300 enterprises with substantial R&D expenditure. The results prove that multinational enterprises consider China to be the most attractive region for international R&D development. As Graph 4 shows, until now overseas R&D activity has been focused primarily in developed countries (the UK and the US were the top target countries), but by 2004 China (3rd), India (6th), Singapore (9th), Brazil (11th) and etc. also began to emerge as leading target regions. In terms of position, China is recognized as the most attractive region for the next five years. China received 62%

of all replies, more than double the percentage of third-place India.

Graph 4 Emergence of China as a Region for R&D Activities



Source: UNCTAD(2005)

3 R&D Activity of Multinational Enterprises in China

The establishment of R&D institutions is becoming an important symbol of multinational enterprises' investment in China in recent years. Similar to global trends, R&D activity of multinational enterprises in China is also divided into the kind that is done through local R&D centers, and the contractual type done through Chinese universities, research institutions, and enterprises as commissioned or joint research. As there are restrictions in the availability of data concerning contractual R&D activity, this analysis focuses on type of activity conducted through R&D centers.

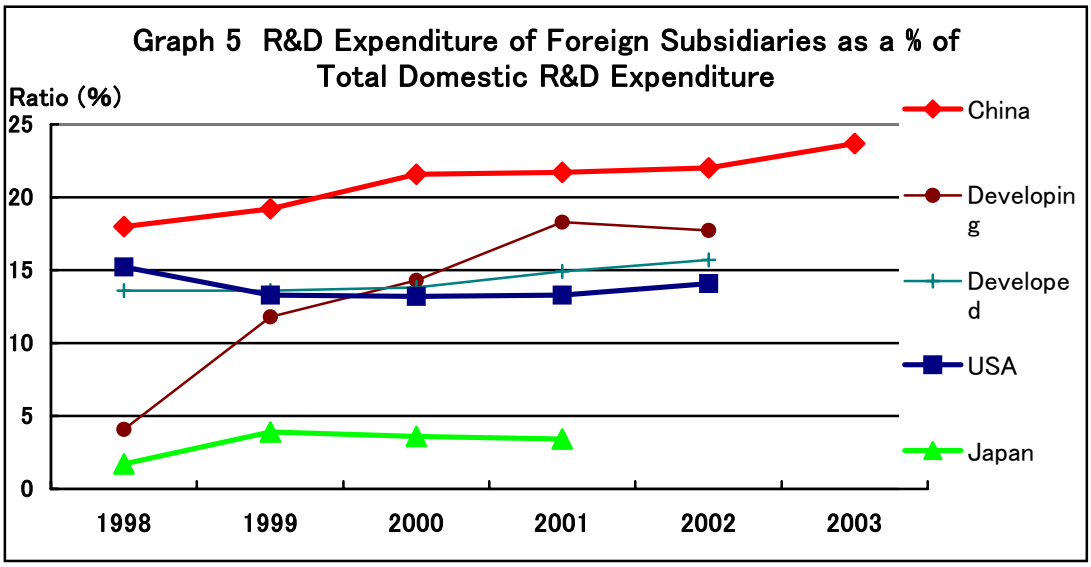
3.1 Multinational Enterprises' R&D Activity of in China: The Big Picture

According to statistics from China's Department of Commerce, the first multinational enterprise R&D center was established in 1994 by Canadian telecommunications equipment maker Nortel in cooperation with the Beijing University of Post and Telecommunications. By the end of July 2005, the number of R&D centers established by multinational enterprises had reached 750, of which 400 were established after January 2004[8].

The countries/regions with the most R&D-related investment in China are the

[8] China's "Economic Daily". February 9, 2006.

US, Japan and Europe, as well as the Hong Kong-Korea-Taiwan-Singapore Asian NEIS region. Some years ago China's Ministry of Science and Technology conducted a survey of 82 leading foreign-financed research institutions, and found them to be 39% US, 24% Europe, 22% Japan, 7% Hong Kong/Taiwan, 4% South Korea, and 4% other[9]. These international R&D centers are concentrated primarily in such areas as information-communication, bio/pharmaceutical, chemical materials/products, transport, and food and cosmetic products.



Source: FRI created from the UCTAD (2005) Annex table A.IV.1

The R&D activity of multinational enterprises in China is becoming a significant presence in the field of Chinese R&D. A look at graph 5 shows that in 2003 the expenditure percentage of international subsidiaries reached 23.7% in China. This percentage does not reach the levels of the UK (45%) or Brazil (47.9%), but it far exceeds the average of both developed countries (15.7%) and developing countries (17.7%). In addition, according to a survey of 2,161 high-tech enterprises in Shanghai, a city rich in international enterprises, only 26% of all high-tech enterprises were international. On the other hand, they represented 57% of total investment in R&D[10], and the top-ten enterprises in R&D investment were all international enterprises.

Leading global enterprises such as Microsoft, IBM, Hewlett-Packard, Motorola, Intel, General Electric, 3M, Sun, GM, Dupont, P&G, Pfizer, Siemens,

[9] China Ministry of Science and Technology. 2003. "2002 Indicators of China's Science and Technology".
[10] "Shanghai Science and Technology Report". January 11, 2006. http://shkjb.shkp.org.cn/?q=node/view/3273

Phillips, Nokia, Ericsson, Volkswagen, Fujitsu, Matsushita, Hitachi, Nissan, Samsung, and LG Electronics have already launched R&D centers in China. Recently, R&D centers in the fields related to 3G mobile communications (ex. Nokia, Ericsson, Alcatel, Lucent, Siemens, NEC and etc.) and automobiles (ex. GM, Nissan, Hyundai and etc.), and R&D activity in the fields of pharmaceutical (ex. Pfizer, Roche, Lonza and etc.) and chemical (Dupont, Dow AgroSciences, Bayer, Rom and etc.) have been receiving attention. It has been reported that in the field of automobiles Toyota is also looking to establish a R&D center in China[11]. Among pharmaceuticals, the British enterprise AstraZeneca announced that beginning in May 2006 it would invest US$100 million into funds for pharmaceutical drug R&D over the following three years[12]. Sanofi-Aventis (France) and GSK (UK) have also revealed plans to establish R&D centers in China[13].

In the past, there has been no shortage of R&D centers aimed at local market development or the utilization of local resources. However, in recent years the establishment of corporate level R&D centers equipped with global R&D capabilities has also been increasing. For example, the R&D centers operated by GE (Shanghai), Dupont (Shanghai), Microsoft Asia (Shanghai), Nokia (Hangzhou), Alcatel (Shanghai), Panasonic (China) and etc. are all corporate level R&D centers, and each conduct applied research (including basic research) that saturates the global market. The Samsung Group, which has invested over US$4 billion in China, has made clear its intention to have China be its global R&D center. Currently four R&D centers (Beijing Communications Research Institute, Suzhou Semiconductor Research Institute, Nanjing Digital Research Institute, and Shanghai Design Research Institute) maintain a R&D workforce of 2000 employees[14].

A majority of international R&D facilities are located in heavily populated areas such as Beijing and Shanghai[15]. However, coastal cities such as Tianjin, Hangzhou, and Guangzhou, as well as inland areas such as Chengdu, Chongqing, and Xian are also seeing development in order to promote unity with production centers and because of the stability and the low cost of personnel. In particular, the inland area of Chengdu has attracted R&D centers of major US and European telecommunications enterprises such as Motorola, Alcatel, Nokia, IBM and Intel.

[11] "Nihon Keizai Shimbun". February 2, 2006.
[12] http://www.astrazeneca.com.cn/
[13] China's "Economic Daily". November 2, 2005.
[14] "International Trade". August 30, 2005. Samsung has announced its strategy to place China as its second R&D base and establish a global R&D center.
[15] Currently in mid-2005, there are about 200 foreign-financed R&D centers established in Beijing and over 150 established in Shanghai.

With regards to methods of R&D in China, options include additional investment into R&D costs of existing R&D centers, additional construction onto R&D centers, and the creation of new R&D centers[16]. For example, over the past five years Ericsson has averaged a yearly increase of 30% in R&D costs, with a 50% budget increase in 2005. In April 2005, Lucent invested an additional US$80 million in its 3G research center in Nanjing, bringing its total investment to US$200 million. In August 2005, Nokia, which had been operating five R&D centers, anticipated the imminent start of 3G services in China and launched a 3G-related research center (its sixth overall) in Chengdu[17]. Similar to Nokia, Alcatel also established a new R&D center in Chengdu. In the beginning of 2005, NEC launched a 3G R&D center in Beijing. There are also enterprises such as NTT Docomo and France Telecom which have not yet developed services but are beginning research activity in China.

In order to strengthen intellectual property management, multinational enterprises are giving priority to 100% own-equity R&D investment. For example, Motorola's China research center (US$155 million investment), Lucent's China research center (US$200 million), Microsoft's China research center (US$80 million investment), IBM's China research center and etc. are all 100% equity R&D centers. However, there are cases where contract-based joint-research with local universities or national research institutes is deliberately promoted in order to utilize China's R&D resources (universities and research centers). For example, the US enterprise UTC's R&D center in China, established in May 1997, does not have its own researchers. It is a "virtual research center", where the principle aim is a research plan where the research costs are covered and research is conducted on themes set by the enterprise in collaboration with 16 local universities and research institutes[18]. There are also cases like Samsung, which has established four joint R&D centers with the Chinese Academy of Sciences[19]. Additionally, there are cases where market development in China is given priority as an attempt to appeal to the Chinese government and society, and after intellectual property management systems have been installed R&D centers are established jointly with the Chinese side. The French enterprise Sagem established a mobile phone development center under a fifty-fifty joint investment

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[16] "China Electronics Report". September 13, 2005. R&D competition has already begun among the various foreign-financed enterprises ahead of the start of 3G services in China.

[17] "China Electronics Report". September 27, 2005. Introduction of Nokia's six R&D centers in China.

[18] Zhi Le Wang. 2003. "New Movements of Multinational Enterprises in China", p. 59-60. Omron's R&D center (Shanghai), established in December 2005, operates on something close to the concept of a "virtual research center".

[19] Confirmed by a Japan CTO Forum delegation's visit to the Chinese Academy of Science's September 23, 2005

with a local mobile phone maker. Five US personal computer enterprises including IBM, Intel and Microsoft have established joint R&D centers with the local and major personal computer enterprise Lenovo. In this way, R&D centers established jointly with local enterprises are also becoming a viable option[20].

3.2 Background of the Acceleration of R&D Activity by Multinational Enterprises in China

This analysis will explore why China has become the most attractive target region for international R&D of multinational enterprises. These enterprises consider many elements in making the decision for the location of overseas R&D activity, such as macro-economic and social stability, industry structure, market scales and growth potential, culture and language, natural resources, living conditions, and physical infrastructure. The decisive factors in the acceleration of Chinese R&D investment from multinational enterprises are: 1. the expanding markets and bases of production, 2. the number of science and technology graduates and R&D personnel (currently approximately 1 million students graduate from science and technology universities per year in China, and the R&D workforce of 1.1 million exceeds that of Japan), 3. the government's recruitment policies, and 4. the direction of intellectual property protection, which will be improved by WTO membership.

3.2.1 The Expanding Global Production Base and Exposed Market

I. China as a Production Base

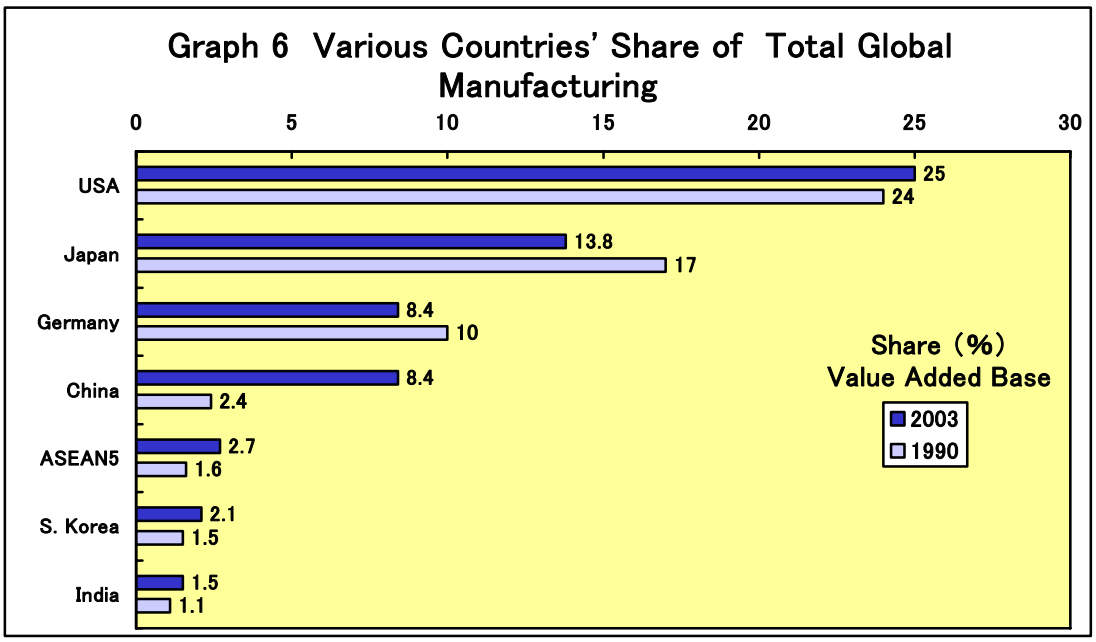
It is common knowledge that China is becoming a global production base. As graph 6 illustrates, if viewed from the manufacturing industry's value-added base in the 1990s, China's share of total global production increased from 2.4% in 1990 to 8.4% in 2003. By 2003 China had caught up to Germany to become the third greatest producing country after the US and Japan. Compared to ASEAN member countries or developing countries such as India, China is growing by leaps and bounds.

However, a phenomenon of production enterprises becoming foreign-owned has emerged, and in some industries international enterprises have replaced state-owned enterprises as the primary players. For example, international enterprises' share (value-added base) in food manufacturing, apparel, plastic

[20] "China Electronics Report". December 6, 2005. "Fuji Sankei". September 24, 2005.

manufacturing, manufacturing for transportation, and electronics and telecommunications equipment manufacturing exceeds 40% in all fields. In particular, the presence of international enterprises as a percentage of China's electronic information industry in 2005 was 77% (sales), 77% (added value), 77% (profits), and 87% (exports), an across the board increase from 2004[21]. The percentage of production in China to overall production exceeded 20% for global enterprises such as Motorola, Phillips, Samsung, and LG.

R&D that will support this expanding production in China is necessary.



Source: FRI calculations from the World Bank's annual "World Development Indicators"

II. China as a Market

Looking at China as a market, graph 7 shows that China has surpassed Japan in the market for intermediate goods such as steel products, mineralized products, machine tools, and semiconductors. The demand for power generating facilities is nearly 10 times as high as in Japan, where the development of infrastructure has already been completed. Moreover, most areas in the market for finished goods have surpassed the market size in Japan. With the sheer size of the population, markets in areas such as beer consumption and mobile phones are nearly five times that of Japan. Even the markets for automobiles and computers have become massive with the

[21] "China Electronics Report". End of 2006.

spread of IT and motorization. A look at the penetration rate of these products shows that, unlike the saturated Japanese markets, the Chinese markets still have much room for growth[22].

Graph 7 Comparison of Japan and China's Domestic Market Size

	China	Japan		China	Japan
Steel Consumption (100 million ton)	2.7 (2003)	0.76 (2003)	**Automobile sales** (10,000 units)	572 (2005)	580 (2005)
Petrochemical product (Ethylene conv, 10,000t)	1,700 (2004)	550 (2004)	**Computer sales** (10,000 units)	1,510 (2004)	1,180 (2004)
Machine tools (US$ 100 million)	65.8 (2002)	41.5 (2003)	**Mobile ph. membership** (10,000 people)	39.0 (2005)	8.5 (2005)
Power plant construction (10,000 kw)	5,055 (2003)	529 (2000)	**Television sales** (10,000 units)	4,250 (2004	~850 (2004)
Semiconductors ($US 100 million)	408 (2005)	330 (2005)	**E-commerce market** (US$ 1 billion)	53 (2004)	1,010 (2004)
Beer consumption (10,000 kl)	2,864 (2004)	655 (2004)	**Mobile contents market** (100 million ¥)	156 (2004)	2,314 (2004)
Housing sales (100 million m2)	3.2 (2003)	1.1 (2003)	**Financial insurance** (GDP・US$ 1 bill.)	718 (2003)	3,029 (2000)

Source: Statistics from both countries, FRI interviews and etc.

For enterprises, success in the Chinese market is taking highest priority among business issues for the future. For this kind of market development, technical support is indispensable.

3.2.2 Cheap and Abundant R&D Human Resources

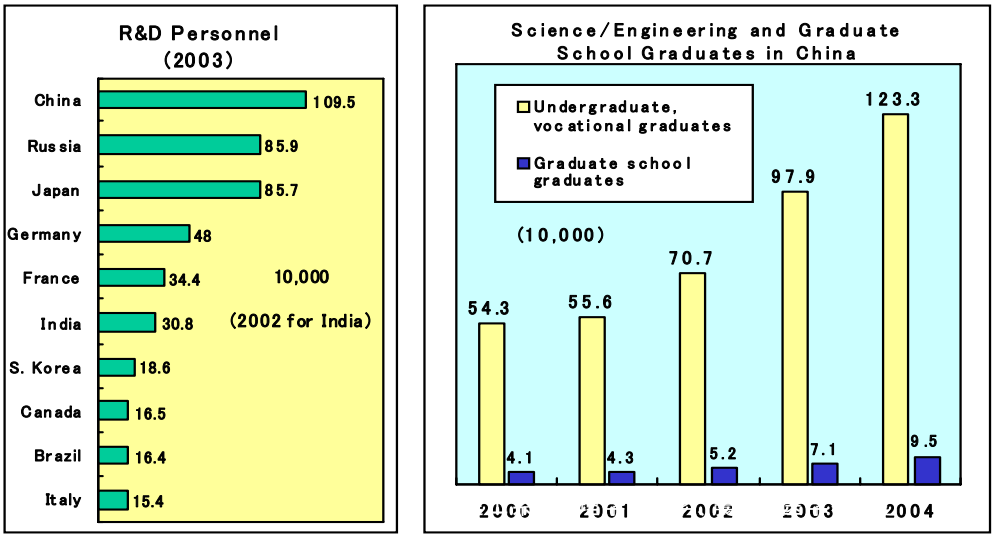
Excluding the Cultural Revolution period, China has consistently endeavored towards the cultivation of human resources (especially engineers) under the slogan of "regeneration by one's own efforts". When it comes to choosing education paths, Chinese citizens have a tendency to choose science and engineering (primarily natural sciences) over social sciences, which involves more of a political risk in the long-term. China is already cultivating more than 31.13 million engineers (end of 2003) and 1.16 million R&D workers (end of 2004).

As graph 8 illustrates, China has the largest R&D workforce outside of the US.

[22] For example, 486 computers are owned for every 1000 Japanese people, while the same rate is only 44 computers in China ("Nihon Keizai Shimbun". April 16, 2006, morning edition). In terms of the penetration rate of mobile phones, China is only at 30% compared to 85% in Japan.

In recent years, in science and engineering alone China is annually churning out nearly 100,000 graduate students and over a million undergraduates from around 1,500 universities[23]. A primary goal of multinational enterprises in accelerating R&D activities is to utilize this massive stockpile of human resources.

Graph 8 International Comparison of R&D Personnel, and China's Science/Engineering and Graduate School Graduates



Source: IMD (2004), (2005), China's Ministry of Science and Technology (2005)

In addition, every year roughly 20,000 students studying overseas (the majority of which are science and engineering students) return to China[24]. In particular, the number of Chinese PhD candidates enrolled at various US universities in science and engineering has grown to an average of 2,500 per year, and 27% of all international students studying in the US in science and engineering or PhD programs are Chinese[25]. Many of the R&D centers in China operated by US and European enterprises are managed by personnel with experience studying overseas. For example, top executives of the Dupont, GE Medical, and Novo (a Danish enterprise) R&D centers are all Chinese researchers with experience studying overseas. These leaders exhibit superior qualities in early recognition of market trends, cooperation with local universities and research institutions, management of human resources, and communication with the government.

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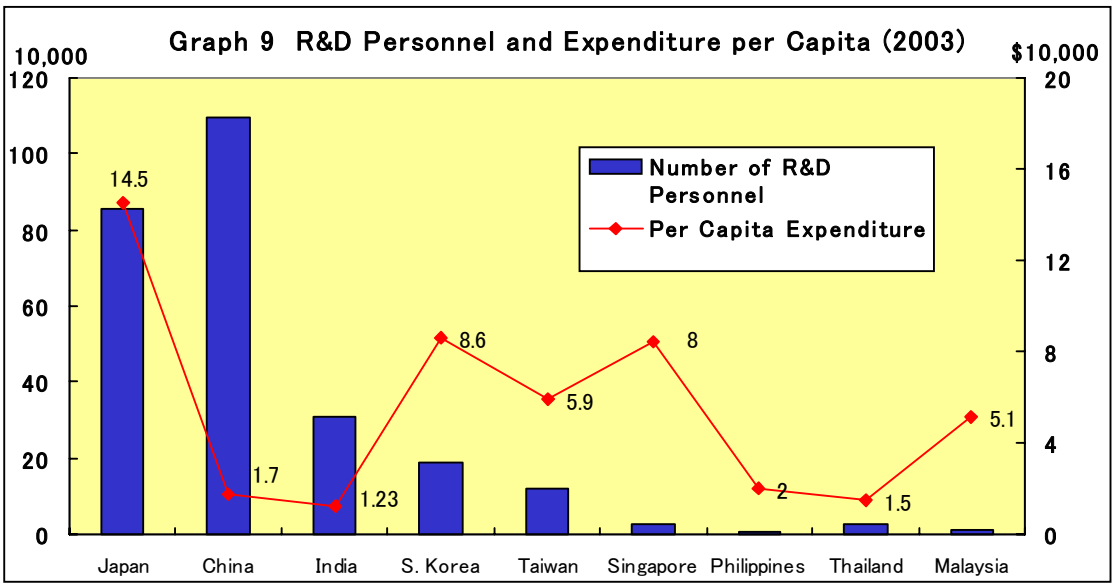
[23] "Science and engineering" refers to physics, engineering, agriculture, and medicine.
[24] http://scitech.people.com.cn/GB/1057/4234718.html
[25] NSF's "Science and Engineering Indicators 2006".

In recent years, cutting costs and the utilization of research manpower has become even more important with regards to the internationalization of multinational enterprises' R&D activity. In order to overcome global competition, these enterprises, with increasing development costs and shorter development periods, are being forced to outsource lower value-added (not core) R&D processes to countries or regions with low costs and abundant manpower. China, rich in R&D human resources and also with low costs necessary for research, is becoming an attractive location for multinational enterprises.

As graph 9 shows, China and India not only have abundant R&D workforces but the average expenditure per employee is also low. Research conducted by UNCTAD and EIU found that China and India's high ranking as regional candidates for R&D activity is a product of these merits. Even generous estimates for the average annual salary for professors at Chinese universities or senior researchers at research institutes (equivalent to university professors) would be in the range of 50,000 to 100,000 yuan. This is an attractive figure for multinational enterprises.



Source: FRI calculations from IMD (2005)

3.2.3 Aggressive Government Recruitment Policies

Until the late 1990s, the Chinese government did not have a clear understanding of the merits of R&D investment from multinational enterprises. As such, it did not impose regulations, but neither did it engage in aggressive recruiting[26].

[26] Chang Cheng Enterprise Strategy Research Institute. 2002. "R&D-friendly China: R&D Research

The reason for this is while R&D centers of multinational enterprises produced little effect on tax revenue or employment compared with production centers, the possibility of an outflow of human resources from China to these R&D centers was high. For example, in the "Law Regarding the Establishment of Joint Chinese Research and Development Institutions, and Collaborative Chinese Research and Development Institutions" that was enacted in September 1997 in the former State Scientific and Technological Commission, there were no incentive provisions.

Since the Asian currency crisis of 1997-1998, there has been more awareness towards technological innovation and the role of multinational enterprises' R&D activity in Chinese technological innovation systems. This awareness has led to a widespread view that China should actively recruit R&D investment from multinational enterprises. In June 1999, Beijing City enacted a provision to facilitate the establishment of foreign-financed R&D centers ("Provision to Encourage the Establishment of Research and Development Institutions in Beijing") with a unique basis for approval, as well as measures for preferential treatment[27].

As a result, the state office for overseas business promotion (formerly the Ministry of Foreign Economy and Trade) produced the "Notice Pertaining to the Issue of Foreign Investment into Research and Development Centers", and national recruitment policies were set. The preferential treatment policies (listed below) established by this notice are continued today.

Preferential Treatment Policy for the Establishment of Foreign-financed R&D Centers[28]:

I. Exemption from import tariffs and import tax increases, and exemption from import tariffs and import tax increases related to private use facilities and the import of related technology, accessories and equipment.

II. Exemption from business tax, and exemption from business tax related to the transfer of technology developed at concerned R&D centers.

III. Deductions from taxable income. In the event that tax authorities recognize a greater than 10% percent increase (from the previous year) in the costs of technological development, 50% of these costs can be deducted from tax payments on taxable income for the same year.

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of Multinational Enterprises in China".

[27] Shanghai city established a similar incentive provision in September 2004. www.fid.org.cn/cn/tzsh/p0921-5.htm

[28] http://www.gddoftec.gov.cn/wjmzc/Detail.asp?ID=1501

IV. Imports and sales in order to assess products. In order to assess the products developed at the enterprise, the imports or sales of a certain range of high-tech products produced by new enterprises will be allowed.

V. Aid for R&D costs, consideration for personnel arrangements, preferential treatment for land-use. Depending on the region, a variety of preferential treatment policies can be used.

China, which has become a global production center, is raising the level of encouragement for R&D investment from overseas enterprises. In the "11th Next Five-Year Plan" adopted by the National People's Congress in March 2006, regional headquarters for international recruitment policy, R&D centers, fundraising centers, and human resource development centers were designated as important subjects for recruitment. Regions or development areas particularly advanced with regards to foreign investment are being asked to shift international recruitment towards R&D and modern distribution[29].

Whether or not a multinational enterprise has set up a R&D center in China has become a basis for the evaluation of that enterprise's contribution to society[30]. Multinational enterprises that do not establish R&D centers in China are evaluated negatively, while enterprises that actively pursue R&D activities receive high marks. In particular, enterprises that are targeting the Chinese domestic market have no choice but to consider the interest of both the Chinese government and society.

UNCTAD concludes that "the policies of host countries have a great deal of effect on location choice for international R&D activity of multinational enterprises"[31].

3.2.4 Development of Intellectual Property Right (IPR) Protection Systems

It goes without saying that IPR systems of host countries greatly influence the choice of overseas R&D locations for multinational enterprises. For example, for the British pharmaceutical enterprise GSK, which is attempting to invest in R&D in East Asian developing countries, the most important factor in the decision is the issue of IPR protection[32]. IPR also represents a major concern for Japanese enterprises considering whether or not to pursue R&D operations in China. "The risk of right

[29] China's Economy and Social Development: 11th 5-year Plan Outline, Chapter 36 Section1 "Guidance of Foreign Investment".
[30] Le Wang, Zhi. 2003. "New Movements of Multinational Enterprises in China", p. 60.
[31] UNCTAD. 2005. "World Investment Report 2005", p.161.
[32] "Financial Times". June 10, 2005.

infringement is high, and even if a lawsuit is pursued rights are still not protected. There is also a great risk of being copied by a rival enterprise of a third country via China. Legal systems have been established, but the strength of these systems is questionable. Furthermore, while there is no choice but to rely on problem resolution from administrative measures, requests for damage compensation are unfeasible. There was a spate of such grim assessments." The discussion at the Japan CTO Forum Committee was summarized by these kinds of concerns[33].

There is an inherent split in the view on whether or not IPR systems are a decisive factor in the attraction of R&D related investment[34]. There has been an experimental study conducted concerning the development of R&D activities in countries weak in IPR protection entitled, "Enterprise Management Transcending the Legal System". It will be discussed later in further detail, but despite the fact that China's IPR protection regime is relatively weak, many multinational enterprises maintain tight cooperation with the IPR department of the headquarter office, set up IPR management sectors at the overseas base, and/or implement systematic measures such as frequent IPR education for staff. As such, according to field surveys of these overseas bases, problems of IPR infringement related to R&D activities in China have not been confirmed. In fact, motivated by membership in the WTO, China has noticeably strengthened its IPR systems.

Regulations related to IPR protection have been revised to be consistent with the patent and commerce privacy protection law, trademark law, and copyright laws of the WTO's "Trade-related aspects of intellectual property rights agreement" (TRIPs)[35]. Protection of computer software, semiconductor design, new varieties of plants and etc. are being planned in the shape of regulations. Despite this, a portion of Japanese enterprises argue that "with regards to plants, because China does not have a system of registering different types we are hedging risks through ideas, such as management through the use of labels". These enterprises overlook the existence of "Regulation for Protecting China's New Plant Varieties" which was implemented on October 1, 1997. Furthermore, in response to concerns over the leaking of company secrets or know-how from the turnover of employees, the regulation prohibiting competition among enterprises, which had hitherto not been clearly written, was added to the draft version of the published "Labor contract law".

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[33] First group of the first Japan CTO Forum. 2005. "How to Promote R&D in China".

[34] UNCTAD. 2005. "World Investment Report 2005" Box V.3, "IPR regimes and R&D location".

[35] Regarding the protection of pharmaceutical drugs, protection provisions were established in China in the January 1st, 1993 amendment of the patent law, but in India these provisions were not established until January 1st, 2005. UNCTAD. 2005. "World Investment Report 2005", p.165.

These kinds of efforts have even been recognized by people such as overseas experts[36]. However, the current situation in China is that while legal structures have been put in place, the problem of strong enforcement regarding patent infringement remains. It is a fact that the wave of regional protectionism has made complete regional implementation of state-level laws problematic. Viewpoints such as "even with lawsuits rights are not protected" or "there is no choice but to rely on government measures to resolve problems, but damage compensation requests cannot be made" are flawed[37]. For example, concerning the infringement of Honda's intellectual property, a subject raised by the Japanese media, an appeal was made to legal structures in China and of the 20 cases that were closed 19 ended in victory. While it also depends on court enforcement procedures, in all cases damage compensation has been received[38].

In response to the recent high level of overseas interest related to IPR protection, China has hammered out measures in rapid-succession such as the reduction of the requirements for developing a criminal case, the establishment of special intellectual property court by China's supreme court and the encouragement of filing suits from overseas enterprises, making mandatory the loading of normal and basic software (OS) onto computers at the stage of shipping, and establishing service centers for intellectual property complaints in 50 cities.

However, China's headache with the problem of IPR is not limited to the strict attitude coming from overseas; it also comes from the rapid increase of the fee payment to international enterprises for the use of intellectual property. China's deficit for technology-use fees surged from US$1.2 billion in 2000 to US$4.3 billion in 2004. To escape from this situation, China is introducing long-term strategies for the creation of an innovative state by strengthening innovation systems (including technological strategies, brand strategies, standardization strategies and etc.) and establishing national IPR strategies. These kinds of efforts should lead to an enhancement of the R&D environment in China, and accelerate the Chinese R&D development of multinational enterprises[39].

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[36] Armbrecht, Dr. F.M. Ross. 2003. "Conducting Research in the People's Republic of China" http://www.iriinc.org/webiri/publications/R&DINCHINA.PDF.

[37] Research conducted by Japan's Ministry of Economy, Trade and Industry shows that there were 4,236 requests from Japan enterprises for administrative procedures related to intellectual property (2003-2004). There were, however, only 53 civil and 139 criminal for a total of 192 lawsuits.

[38] NNA. "The Changing Legal System to Strong Outlook". March 16, 2006. "Points of Caution for Japanese Enterprises Concerning Intellectual Property Lawsuits in China – Honda". Jetro's "Chinese Economy", Volume 3. 2006.

[39] UNCTAD analyzes that strong National Innovation Systems (NIS) serve as a significant pull for the location selection of multinational enterprises.

3.3 Japanese Enterprises' Dilemma Regarding the Development of R&D Activity in China

According to a recent JETRO survey of Japanese enterprises that have expanded business into China, 32.6% of the enterprises that answered have already begun R&D activity in China and 22.1% are planning activity in the future. In other words, over half (54.7%) of the Japanese enterprises that have expanded into China have begun or are planning R&D development in some form[40]. While there are many R&D centers of Japanese enterprises in China, however, these centers are small in scale and have a weak presence. For example, according a survey conducted by the commercial department multinational enterprise research center, a Chinese government think tank, on R&D centers of foreign enterprises in China, of a total of 30 independent R&D centers and research centers rich in physical and human resources (middle of 2001), 17 were US, 7 were European, and 5 were Japanese (1 "other)"[41].

The weak presence of Japanese R&D centers in China can be attributed to the fact that, as mentioned in 2.1, the internationalization of R&D activities of Japanese enterprises has been slow compared to their European and US counterparts. However, it can be surmised that concerns over technological leaks and the outflow of quality personnel have also made Japanese enterprises reluctant to begin full-fledged R&D activity in China. Graph 10 shows the attitude of Japanese enterprises (CTOs or those in charge of technology development) concerning R&D development in China. IPR management and personnel retention represent the two greatest concerns for Japanese enterprises. As Graph 11 indicates, Japanese enterprises facing this dilemma hold great interest in the strategies of European and US enterprises that are actively developing R&D activity in China, and wish to use these enterprises as a reference (the JETRO survey mentioned above).

[40] JETRO. 2006. "Chinese Economy", Volume 5, p. 87.
[41] Le Wang, Zhi. 2003. "New Movements of Multinational Enterprises in China", p. 60-64.

Graph 10　Japanese Enterprises' Views on Developing R&D Activities in China

Enterprise	Viewpoints, Concerns
"A" (Food)	・Fill the core positions with Japanese employees, do not share important technology information such as intellectual property with local personnel
"B" (Chemical)	・Must assess whether or not technology and know-how leaks can be prevented ・Personnel are important, but the main issue is retention
"C" (Health)	・Concerns about patent applications to China ・Place Japanese in charge of management, accounting and product design & etc.
"D" (General electronics)	・Transfer middle-ranking employees who have been with the enterprise 3 years ・Difficulty in finding management that will prevent technology leaks
"E" (Machine parts)	・Difficulty in securing high-caliber personnel ・Technology leaks have been reported at production centers
"F" (General electronics)	・Loyalty to the enterprise and morals are weak. ・Issues with technology leaks due to high turnover

Source: "Japan CTO Forum" First Sectional Meeting Report (2005) and FRI interviews

The development of R&D activity in China should be done only after weighing the risks and benefits from the perspective of market development, use of human resources, movements of global competitors, risks in technology leaks, and the cost of personnel management. Additionally, instead of just location selection, decisions regarding business models such as whether to proceed as an in-house, outsourcing, or collaborative operation should also be made. In the case of China, the following should be investigated: 1. whether or not the retention rate of personnel is low, 2. whether or not uncertainty regarding IPR is real, 3. if it is real, then what exactly is the risk.

4. Case Study of Chinese R&D Activity by Japan, US, and European Enterprises

As we can see from the above analysis, while China holds an advantage with regards to the location selection of international R&D activity by multinational enterprises, many enterprises (in particular Japanese) are hesitant to pursue R&D

activity in China because of concerns over the uncertainty of IPR protection and the instability of personnel. For example, Pfizer, the world's top pharmaceutical enterprise, had concerns in areas such as IPR protection and only established an official R&D center after a 1.5 year test run[42]. Other examples include Toyota, which decided against pursuing collaborative research for its hybrid cars because "systems for IPR protection have not been established", and Honda, which is cautious about transferring its development facilities[43]. On the other hand, European and US enterprises in particular are only accelerating R&D development in China, and the scramble for personnel is intensifying. For example, Google (China) has adopted an employment policy of hiring R&D personnel without limit, while Microsoft (China) is implementing a plan to expand their "Asia Research Center" in China from the current level of 1,500 employees to 5,000 employees in the next three years[44]. GM, GE, Motorola, Intel and etc. have all established R&D centers with over 1,000 employees. The US enterprise Applied Material has invested US$255 million in Xian, and is establishing its largest global technology center (excluding its US headquarters)[45].

In this way, while they face the same investment and business environment, the R&D activity in China among multinational enterprises greatly varies. This comes from a difference in risk assessment and measures with regards to this R&D activity. Interviews were conducted at relevant Japanese, US, and European enterprises (2-3 enterprises each) to reveal the state of multinational enterprises' R&D activity in China, and to provide the results of this research as a reference for Japanese enterprises.

4.1 Goals and Strategies of R&D Development in China

As graph 12 indicates, a majority of the R&D centers of the enterprises targeted in the case study were established after 2000. These R&D centers belong to a wide array of industries such as ICT, electronics/machinery, chemical, bio, and food

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[42] China's "Economic Daily". November 2, 2005. Global pharmaceuticals such as Sanofi-Aventis (2nd largest) and GSK (3rd largest) are cautious about establishing R&D in China for the same reasons. However, as the advantages have become clear from the experiences of other enterprises and from their own practice, these enterprises have stated their intentions to establish R&D in China.

[43] "Nihon Keizai Shimbun". February 2, 2006 (morning edition). In fact, even at the government level, in the Ministry of Economy, Trade and Industry's information management manual entitled "Guidelines for Preventing Technology Leaks", which pays attention to Japanese enterprises' development of business in China, measures such as, "new technologies will not be transferred in joint ventures", and "development should be done domestically or in countries with strong intellectual property protection" are revealed. "NNA. "The Daily". March 17, 2006).

[44] China's "Economic Daily". January 16, 2006.

[45] China's "Economic Daily". April 18, 2006.

products.

In 1997, the Danish enterprise Novo became the first multinational bio enterprise to establish a R&D center in China. In the beginning, its goals were public relations towards the Chinese government and society at large, and to utilize local human resources[46]. In fact, among the goals of IBM and the Japanese enterprise "F" when they established R&D centers in China in the 90s was to carry out a promise to the Chinese government. Novo and IBM achieved their initial public relations goals, but the situation is unclear regarding the R&D center of Japanese enterprise "F"[47]. R&D centers established after 2000 were basically products of global R&D strategies rather than the kind of political and social objectives of the 1990s.

Graph 12 Examples of Japanese, US and European R&D Centers in China (Part 1)

Country	R&D Center	Established	Staff #	Format	Goals	Activities
US	Dupont	02/2005	100	Independent Inc. 100% equity	Client tech support R&D Center in Asia Pacific	Local technology development center
	GEHealthcare	03/2000	400	Within prod. ctr. 90% equity	Localize technology Low value-added model dev.	Low value-added product development
	Wyse(IT)	08/2005	75	A-P headquarter 100% equity	Global development center Localized development	Offshore developemt ctr. OEM production support
Euro	Novozymes (bio)	09/1997	45	Holding co. 100% equity	Global research center Local support center	Basic research center Local support center
	FrancTelecom	07/2004	116	Independent Inc. 100% equity	Global research center Tech. dev. for local markets	Basic research center Local mkt. development
Japan	A (food)	07/2002	113	Independent Inc. 100% equity	Cost reduction Collection of data & info. Materials supplier management	Offshore devlopment ctr.
	D (electronics)	10/2001	30	Holding co. 100% equity	Global research center Application in China Secure local R&D releases	Offshore research ctr. Basic research center Offshore development ctr.
	F (electronics)	02/1998	40	Independent Inc. 100% equity	Global research center Application in China Tech. support for local mkts.	Offshore research ctr. Basic research ctr.

Source: Based on the results of interviews at local R&D centers September – December 2005

From the scale of the bases it is apparent that R&D centers in China are still overall in the explorative stages, with GE Healthcare's Beijing R&D center representing the only large-scale center with hundreds of employees. The centers of the Japanese enterprises "D" and "F" remain relatively small considering that they are both general electronics makers. The principle of establishment is basically 100% equity. GE Healthcare's Beijing R&D center was established in a joint format within

[46] Ma, Lu. 2003. "Novozymes in China", p. 152. From the autobiography of Mr. Kaare Anderson, former president of Novozymes (China).
[47] Ma, Lu. 2003. "Novozymes in China". Zhi Yun, Dao and Bay, Li. 1998. "The Blue Giant IBM in China".

a production center in a historical relationship. However, recent onsite interviews indicate that it will move towards 100% equity in the future. From the perspective off maintaining control of IPR management this seems like an obvious choice. In terms of organizational structure, middle and small centers with under 100 employees tend to operate within a section of a regional headquarters or a general center, while most of the large centers with over 100 employees operate as independent and incorporated institutions. Middle and small-scale bases are able to share the back office facilities of regional headquarters or the holding company, and management costs are therefore minimized. Furthermore, becoming independent and incorporated is not among the application requirements for the preferential treatment given to foreign-financed R&D centers.

The following can be listed as goals of R&D center establishment: 1. localization of technology and local client support for market development, 2. development of products and technology for both local and global markets, 3. basic research that is global in nature, and 4. information gathering and technology monitoring. However, the focal points of these goals differ among enterprises. Three US enterprises lay emphasis on the localization of technology and local client support, as well as the development of global technology and products. Meanwhile, the centers of the two European enterprises and the Japanese enterprises "D" and "F" have been established as global research bases including basic research. The Japanese enterprise "A" has made it clear that its goals focus on slashing costs. The US enterprises Dupont and Wyse, the two European enterprises, and the Japanese enterprise "C" all emphasize that one of the goals for the R&D centers is to monitor trends in technology development and criteria establishment.

However, looking at the situation of local activity, European and US R&D centers are consistently providing support for the development of products for the local market and local operations centers. The centers of Japanese enterprises, on the other hand, maintain weak collaboration with local operations bases and seem to function as offshore bases of the home office's R&D department. For example, one of Dupont's goals for R&D establishment is to bundle its various operation centers in China into "One Dupont" from the technological support side. Apparently they are pulling one person from each operations base to research and develop a comprehensive solution. GE Healthcare is integrating production and R&D, and is makings its R&D center in Beijing function as its global production development center for low-end models. A top executive of Novo's local sales enterprise has also been put in charge of development at Novo's R&D center in China, and is pursuing development that is done

closely with the market. France Telecom has not yet begun business operations in China, but the research content of its R&D center in Beijing is almost entirely related to the Chinese market, and it is busy preparing for the development of Chinese operations at each of its various business units. In comparison, despite the fact that the operations departments of the three Japanese enterprises have all begun operations in China, collaboration between the R&D centers and the local operations centers is weak, and one gets the sense that their R&D and operations strategies in China are worlds apart.

4.2 Organizational and Human Resource Strategies of R&D Bases

As graph 13 shows, each of the centers are headed by an executive with a rich academic history. The top executives at US R&D centers are all ethnic Chinese with experience working at the head office, while that is only the case at a portion of European and Japanese enterprises. For example, the president of Dupont's Chinese R&D center is from Tianjin (39 years old), and spent nine years in Dupont's R&D and human resources divisions after getting his PhD from an American university. GE Healthcare's (China) president is also ethnically Chinese from Hunan province, and spent seven years in GE's corporate R&D department after finishing his doctoral degree in the US. He was also the first president of GE's R&D center in China (Shanghai) that was established in 2003. Novo's (China) president is from Shanghai and obtained his PhD in Denmark, after which he served as an executive at Novo's head office in Denmark as well as Novo Asia Pacific before his ascent to the top. The president of the R&D center of Japanese enterprise "D" is from Beijing and ethnically Chinese, and received his PhD in engineering from Tokyo University. The president of Novo's R&D center, who is ethnically Chinese and holds a PhD, was selected from over 1000 international applicants responding to an advertisement published in the British magazine "Science"[48]. Local visits confirmed a sense of responsibility and company loyalty among these leaders .

The composition of the staff at the various R&D centers depends on the actual activities of the center. Research leadership positions are given to veterans with PhDs, but the chief of Novo's first Chinese R&D center claims that "research personnel are not necessarily required to possess superior academic histories, and even mid-career professionals with masters or bachelors degrees are welcome"[49]. In fact, it

[48] Ma, Lu. 2003. "Novozymes in China", p. 153.
[49] Ma, Lu. 2003. "Novozymes in China", p. 157.

is critical to have an optimal grouping of personnel which can conduct smooth research. For example, the staff composition at France Telecom's R&D center in China is 24% PhD, 53% master's, and 22% bachelor's degrees. On the other hand, Japanese enterprise "A"'s R&D center's main R&D activity is routine offshore work sent from the head office, so the composition of staff is 25% master's, 25% bachelor's, and 50% vocational school degrees[50]. The staff of the Japanese enterprise "F", in comparison with enterprise "A", is 50% PhD and 40% master's degrees. In all of the interviews conducted, this represents the highest percentage of strong academic backgrounds. Whether or not this kind of high-academic composition is necessary is debatable. As a rule Japanese enterprises "A" and "F" employ new graduates, while both Wyse (US) and France Telecom are only mid-term career employers. The rest are split between employing new graduates and employing mid-careers.

Graph 13 Examples of Japanese, US, and European R&D Centers in China (Part 2)

Country	R&D Ctr.	Top Exec.	Staff	From Hdqtrs.	Salary System	Hiring	Turnover	Personnel policies
US	Dupont	Chinese-Am. (PhD, age 39)	Some PhDs, the rest Masters	Some/100	N.A.	New grads, mid-career half-half	Under 10%	High-level research ctrs Career development Performance based
	GE Healthcare	Chinese-Am. (PhD, age 40)	Some PhDs, the rest Masters, Undergrads	None/400 Some short-term	N.A.	New grads, mid-career half-half	5%～7%	Challenging environment Chances for key persons Promotion Opps
	Wyse(IT)	Chin.-Taiwan (50s)	Masters, Undergrads	None/75 Some short-term	90% Fixed 10% Floating	Mid-career	～5%	Fruitful work Competitive wages Tri-monthly assessment
Euro	Novozymes	Chin.-Danish (PhD, age 50)	6 PhDs, the rest Masters, Bachrlors	1/40	N.A.	Half-half	～5%	High wage standards Bright environment
	Franc Telecom	French (PhD?)	24% PhDs Masters 53%, Business 22%	9/116 (3 French)	90% Fixed 10% Floating	Mid-career	Under 10%	Career development Competitive wages Bright environment
Japan	A	Japanese (PhD, age 50)	Some PhDs, 25% BA, 25% Jr., 50% Voc.	4/113 (4 Japanese)	N.A.	New grads	Unknown	Nothing in particular
	D	Chinese-Japanese (PhD, age 40)	Primarily Masters	one/30	85% Fixed 15% Floating	Half-half	Unknown	High wage standards Fruitful work Wages and benefits
	F	Japanese (50s)	50% PhDs 40% Masters, etc.	5/40 (5 Japanese)	80% Fixed 20% Floating	New grads	～10%	

Source: Same as Graph 12.

Very few workers are dispatched from the head office at R&D centers of US enterprises. Management is primarily left in the hands of local hires. In comparison, the important posts at the R&D centers of Japanese enterprises "A" and "F" are filled almost entirely with Japanese employees dispatched from the head office. We can

[50] China's Department of Commerce regulates that "Over 80% of staff who work with direct research and development activities must be at least university graduates" as a condition for the establishment of foreign-financed research and development centers. The staff composition of Japanese enterprise "A", however, is clearly not meeting this regulation. It unclear how these kinds of discrepancies are being dealt with.

interpret this as these two enterprises deeming it necessary to have Japanese leaders in charge of what is mainly offshore work from the head office, because this kind of work requires that the R&D center coordinates well with the head office.

With regards to the salary system, Wyse (US) and France Telecom both consist of 90% fixed salaries and only 10% unfixed salaries. The percentage of unfixed salaries is higher in Japanese enterprises ("D" and "F"). This may imply that financial incentives might not fit in easily with the basic nature of R&D activities. The various centers responded that their turnover rates, which Japanese enterprises are greatly concerned with, range from about 3% to about 10%, a figure that is not impossible to manage. The Japanese enterprises "A" and "D" both boast a higher retention rate than the European and US enterprises. It was thus confirmed that the concerns expressed by Japanese enterprises at the Japanese CTO Forum and the findings of this interview survey show a discrepancy.

However, European and US enterprises do not only raise salaries to produce a low turnover rate – they also create brand name strength through high levels of research, develop productive research work and a cheery company culture, provide opportunities such as overseas training for self-improvement, and so on. Japanese enterprises, on the other hand, do not tend to institute measures other than raising salaries.

4.3 R&D Centers' IPR Management

As graph 14 shows, while the necessary budget for the R&D centers of the subject enterprises basically comes from the R&D section of the head office, there is a gap between European/US enterprises and Japanese enterprises in terms of whether primary leadership is local or from the head office. R&D centers of European/US enterprises are closely involved with local market strategies, and basic research themes are set by the R&D centers themselves. Research and development of Japanese R&D centers is done mainly offshore, and is controlled primarily by the R&D section of the home office. As discussed in 4.2, because these centers are regarded as offshore centers directed by the head office, Japanese personnel that are adept in coordinating with the head office are dispatched to fill leadership positions.

With regards to university-industry collaboration done through local R&D centers, while it depends on the nature of the center, the centers that are pursuing basic research or monitoring activities have active university-industry collaboration. However, it appears that cases of collaboration with Chinese universities or research

centers are more frequent among Japanese enterprises than European/US enterprises. IPR management is more difficult in university-industry collaboration than in enterprise-owned R&D centers, so there is a need to examine its necessity.

The various R&D centers are proactively working towards improving copyrights for research results. Novo has so far registered 15 patents. The Japanese enterprise "F" apparently makes requests for over 10 registrations in China every year. However, these achievements are attributed more to the head office than the local R&D centers in China. Even in cases where IP registration is necessary in China it is done via the head office. It seems that this is based on a strategy to avoid the Chinese regulation that "in the event that a Chinese corporation applies for an overseas patent for an invention completed within the country, it must apply with the appropriate Chinese government section", which is stipulated in article 20 of China's patent law.

While few patent applications come directly from the various centers, systems for IP protection and confidentiality are being put in place and appropriate leadership is being assigned. GE Healthcare (China) employs a specialized lawyer as an IPR measure, and Novo (China) instituted a new IPR protection department in 2004. The measures are not limited to the establishment of IPR protection systems: Wyse (AP) is introducing a room monitoring system, while Japanese enterprise "A"'s Shanghai R&D center is implementing an IP monitoring system within its information network. Cases of IPR infringement and technology leaks have not been confirmed in any of the above cases. IPR infringement and technology leaks did not occur for the following reasons: 1. IPR protection and confidentiality management systems were established, 2. R&D personnel possess a high degree of loyalty, 3. the inherent improbability for there to be leaks in the kind of technology that can only be used in conjunction with other technologies or equipment, 4. the uselessness of information content when confined to individual researchers. Concerns expressed at Japan's CTO Forum about IPR infringement and technology leaks have thus been confirmed as not being consistent with the findings of this field research.

Graph 14 Examples of Japan, US and European R&D Centers in China (Part 3)

R&D Ctr.	Research	Research funding	U－I coll.	Research results	IPR Mngment	Secrecy Sym.	IP infringe	Leaks
Dupont	R (basic)	Hdqtr. R&D budget	Yes	Minimal results	Hdqtr. Support	Yes	No	No
	D (some)	Tech support income	Important					
GE Healthcare	R (little)	Hdqtr. R&D budget	No	Localized technology	Lawyer	Yes	No	No
	D (main)	Subsidiary budget	Some	Dev. global models				
Wyse(IT)	BD (little)		No	Some cases in hard-	IP Manager	Yes	No	No
	D (offshore	Hdqtr. R&D budget		ware design	IP monitor			
Novozymes	R (basic)	Hdqtr. R&D budget	Yes	15 patents recorded	Creation of	Yes	No	No
	D (little)	Tech support income	Some		IPR Dept.			
FrancTelecom	R (basic)	Hdqtr. R&D budget	Yes	Intra-company result	IP Manager	Yes	No	No
	D (little)		Important					
A	R (little)		Yes		Nothing	Yes	No	No
	D (offshore	Dev. Commission fee	Some	Nothing in particular	IP monitor			
D	R (offshore	Hdqtr. R&D budget	Yes	3 patent apps.	IP Manager	Yes	No	No
	D (offshore	Commission by hdqtr	Important					
F	R (offshore	Hdqtr. R&D budget	Yes	10+ apps. per yr	IP Manager	Yes	No	No
			Important					

Source: Same as Graph 12.

In reality, it seems that issues of technology leaks and intellectual property are being confused with the problem of Chinese counterfeit products that is well covered by the Japanese mass media. As mentioned above, unlike manufactured products, problems of R&D-related IPR infringement have not been confirmed. The issue of technology leaks, on the other hand, is related to the outflow of people. However, according to the survey the turnover rate of R&D personnel at European/US centers is 5%～10%, a rate that is not particularly high. In fact, it is roughly on par with the turnover rate in the US or European countries.

This is not to say, however, that concerns over IPR infringements are groundless simply because they have yet to be confirmed. Rather, enterprises should come up with effective preventative measures while referencing the risk measures employed by the various centers.

5 Implication for Japanese Enterprises

The following became clear from the local research:

1. R&D activity is built into global strategies
2. R&D activity is integrated with market development and production systems
3. Systematic intellectual property measures have been established
4. The presence of localized management is key to the success of R&D management

Specifically, I would like to present the following implications.

5.1 Issues Faced by Operations Bases, such as Production and Sales, and Issues Faced by R&D Centers Should not be Confused

According to the third survey on the damage of Chinese imitation products conducted in March 2005, 51.7% of the 167 enterprises who responded have a firm grasp on the facts concerning imitations, marking a 16.1% increase from the second survey conducted in December 2002[51]. The main rights infringed upon were trademark (75%) and design (62.5%), while patent infringements were at 25%. The percentage of patent right infringements increased 10.2% from the December 2002 survey. These results suggest that the problem of intellectual property right infringement in China is becoming grave. However, the damage is localized to the expansion of factories in China or the use of licensed technology in Chinese enterprises; it is not damage from the expansion of R&D centers in China or in collaboration between industry and local universities and research centers.

In fact, there have been no reports of technology leaks or IP infringement in R&D activities of foreign enterprises, and as described above this local field research also did not confirm such infringements. In other words, the issues facing production and sales operations centers and the issues facing R&D centers are different and should not be confused. The fact that major European and US global enterprises are developing large-scale R&D centers in China, where IPR protection systems are weak, is not so much a result of the mentality that "the expectations of future growth are the basis for investment decisions"[52], but rather because IPR problems in R&D activity in China have not really surfaced.

The posture of Japanese enterprises and the government in avoiding R&D investment in China, a country rich in research resources, is related to concerns that "the overwhelming disparity with European and US enterprises in terms of R&D investment in China will become a significant problem concerning future leading edge intellectual property"[53].

Japanese enterprises should learn from the R&D management of successful European and US enterprises and strategically develop their own R&D activities in China.

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[51] JETRO Beijing Center. 2005. "Results of the 3rd Survey on Damage Caused by China's Imitation Products".
[52] Kazuhiro Asakawa. 2005. "Acceleration of R&D Development in India and China". http://www.rieti.go.jp.
[53] Kenji Hidaka. 2005. "Current and Future State of Intellectual Property Rights in China", Intellectual Property Management Research Vol. 3.

5.2 Clearly Defining the Roles of R&D Centers, then Establishing Corresponding Personnel and Organizational Strategies

The problem of technology leaks is deeply connected to personnel outflow. However, the local field research described above found that the turnover rate of R%D personnel in the European and US enterprises is between 5% and 10%, a surprisingly low rate. Representatives at the R&D centers of European and US enterprises agreed that "this turnover rate is at the same level as in the US or European countries". It would seem that personnel and organizational strategies consistent with the research goals are bringing about lower turnover and higher retention rates. It is necessary to have an optimal combination of mid-career and new graduates, doctoral and master's, and head office transfers and local staff. In fact, the content of R&D activities varies among the Japanese enterprises that were interviewed, and employment and placing of personnel is conducted accordingly. Enterprise "A" is an everyday, routine offshore business and as such it primarily assigns junior college graduates; enterprise "D", on the other hand, is concentrated on offshore development of embedded software and typically assigns master's degree graduates. Enterprise "F" is focused on offshore development of research, and is PhD-heavy. At the present stage the retention rate at all three Japanese enterprises is respectable. It is unlikely that research-oriented personnel with rich academic backgrounds will settle for routine offshore work.

Of course, having the right people for the right jobs cannot maintain stability in personnel by itself. To accomplish long-term personnel retention, it is necessary to implement personnel strategies such as the consideration of competitive wage standards, career development opportunities including the localization of important posts, fair evaluations, and free and bright research environments[54]. If Japanese enterprises such as "A" and "F" continue to fill leading posts with Japanese dispatched from the head office, there is a good possibility that they will lose talented local personnel. It is also important to localize as a way to establish a competitive edge in early detection of market trends, collaboration with local universities and research institutions, personnel management, and communication with the government. Japanese enterprises do not pursue localization because of concerns over leaving external personnel in charge. In reality, the Chinese leaders (president or vice-president) of Dupont, GE, Wyse, Novo, France Telecom and the Japanese

[54] A portion of US enterprises (Bell Lab, Microsoft Asia Research Center and etc.) are introducing pseudo stock-option systems for researchers (Le Wang, Zhi. 2003. "New Movements of Multinational Enterprises in China", p. 67).

enterprise “D” all left the impression of being highly loyal to the head office.

In this way, more than monitoring from dispatched workers from the head office, it is the establishment of systems related to the management of intellectual property protection, technology, and know-how that is critical for Japanese enterprises.

5.3 Systematic Intellectual Property Systems as Preventative Measures

As seen above, currently neither the media nor this research survey has been able to confirm problems of technology leaks or intellectual property right infringement in R&D investment in China. Furthermore, the R&D staff turnover rate is at a respectable 5% - 10%. As seen from this research survey, the reasons for this can be summarized as follows:

1. R&D activities in China are conducted in one specific area, or even if they are conducted in all areas the work is divided among many people, so it is unlikely for there to be a meaningful technology leaks.
2. IP protection and management is being conducted strictly at the various R%D centers.
3. R&D staff have a higher sense of loyalty than their counterparts at production sites.
4. R&D staff have a relatively high income.[55]

In particular, that problems of technology leaks have not been confirmed by this field research is a result of strict IPR protection and management measures. These measures include close collaboration with the IPR management section of the head office, the installation of IP management sectors at the local centers, frequent IP education for staff and etc. It seems that there is a high probability that the weakness of the IPR systems could be offset by a strengthening of IP measures at the various enterprises.

However, though IPR problems have been negligible until now, it cannot be denied that developing R&D activities in China, where IPR protection systems are

[55] UNCTAD explains the following as reasons for the fact that weak IPR systems do not have a significant impact on the location selection for R&D activity: 1. R&D content and commercialization are conducted in different markets, 2. different elemental technologies are concentrated in different research institutions, 3. technologies developed by multinational enterprises are advanced and difficult to imitate, 4. characteristics such as tacit knowledge and no documentation are difficult to imitate (UNCTAD. 2005. “World Investment Report 2005”, Box V.3. “IPR regimes and R&D location”).

weak and there is great fluidity in human resources, does present a risk. In fact, there are already examples of competition among US enterprises at the stage of technology leak prevention. For example, Taiwan-native Kai-Fu Lee, a top developer of language recognition and search technology and the former president of Microsoft Research (China), was scouted by Google and assigned to establish a new research center in China. Microsoft took Lee to US court for breaching non-competition and confidentiality provisions, as well as Google for intentional collusion in this breach, and the case was settled out of court several months later[56]. This case suggests that the competition over human resources in China is becoming fierce, and underlines the seriousness of the problem of technology leaks that comes with personnel turnover. Japanese enterprises can garner various lessons from this case in establishing their own systematic IP systems as preventative measures.

First, enterprises can legally have know-how protected even in China, but only under the premise that these enterprises have established systems for managing business confidentiality. The establishment of these management systems becomes legal proof in the unlikely event that there is a lawsuit. Next, enterprises should publicize these confidentiality management systems, and also be thorough about confidentiality and non-competition contracts. There had previously been no provisions in China's labor law related to non-competition, but in practice they have been adopted by many enterprises. Provisions related to non-cooperation were then clearly-stated in the "labor contract law" announced in March 2006. Moreover, in the event of a violation, a strict stance will be taken where even lawsuits will not be ruled out. Japanese enterprises often express concern about whether there will be fair trials with regional protectionism, but Honda's record of 19 wins and 1 loss in court suggests that the enforcement of law in China is stronger than it seems. In fact, many of the Japanese enterprise executives (Honda, Sony) involved in IPR lawsuits in China highlight the independence and fairness of China's legal system[57].

In general, for Japanese enterprises attempting to develop R&D activities in China, the first basic steps are to begin with small-scale R&D, and expand activities once the know-how of market trends and management has been gathered. Within this process, enterprises should establish IP rights and know-how secrecy, and implement systematic and organizational responses to IPR as well as firm follow-up measures.

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[56] http://news.com.com/Microsoft,+Google+duke+it+out+for+China/2100-1038_3-5797231.html

[57] JETRO. 2006. "Chinese Economy" March edition", p. 70. Report from the First Group, Second Meeting of the Japan CTO Forum. "Of Concern to the CTO: IP Strategies and Issues for and Responses by IP Management", p. 72.

5.4 Reconsideration of the University-Industry Collaboration Model

This research confirmed that one role of the local R&D centers of Japanese enterprises is to promote collaboration with local universities and research institutions. The reasons for promoting university-industry collaboration are:

1. Lower costs from establishing flexible research development systems
2. Utilization of research environments at universities and research institutions not available within the enterprises
3. Formation of human networks and acquiring new academic knowledge from collaboration with universities and research institutions.

For example, if university professors who serve as committee members that help to establish China's basic domestic policy are pushed to do commissioned or joint research, enterprises could read the mentality of China's national standards before they are formed.

The significance of university-industry collaboration is easy to understand, but the problem of IP management remains. As it is commissioned or joint research, IPR management will be weaker than that of the enterprise's own R&D center. It is the same difficulty with technology and know-how management that joint enterprises have experienced in the past. Therefore, following an analysis of the risks and returns, university-industry collaboration should be limited to necessity. In terms of attributing the research achievements, there is a good possibility that the "joint possession" system that a majority of Japanese enterprises employ will lead to trouble, and it is preferable to have one of the sides clearly in 100% possession[58]. Attributing research accomplishments is also connected to the costs of commissioned or joint research, so decisions should be made from the perspective of cost performance.

[58] This kind of method was confirmed during interviews at France Telecom's R&D center (China).

REFERENCES

China Ministry of Science and Technology. 2003. "2002 Indicators of Science and Technology in China", China Statistics Publishing Company.

China Ministry of Science and Technology. 2005. "Annual Statistics of Science and Technology in China, 2005", China Statistics Publishing Company.

China Department of Commerce. 2005. "Report on China's 2005 Foreign Investment".

Chang Cheng Enterprise Strategy Research Institute. 2002. "China Embraces R&D: R&D Research of Multinational Enterprises in China", Guangxi People's Publishing.

EIU. 2004. "Scattering the Seeds of Innovation: the Globalization of Research and Development",
http://www.eiu.com/site_info.asp?info_name=eiu_scattering_seeds_of_invention

Yun, Dao Zhi & Bay, Li. 1998. "The Blue Giant IBM in China", Beijing University Publishing.

F.M. Armbrecht, Ross. 2003 "Conducting Research in the People Republic of China", http://www.iriinc.org/webiri/publications/R&DINCHINA.PDF

IMD. 2005, "The World Competitiveness Yearbook".

Japan Ministry of Economy, Trade and Industry's "Survey of Japanese Enterprises' Overseas Operations", Annual Surveys, Ministry of Economy, Trade and Industry website.

Japan Bank for International Cooperation's "Report on the Questionnaire Survey on Foreign Direct Investment", Annual Survey, Japan Bank for International Cooperation website.

Ma, Lu. 2003. "Novozymes in China", Author's Publishing Company.

NSF. 2006. "Science and Engineering Indicators 2006", http://www.nsf.gov/

First group of the first Japan CTO Forum. 2005. “How to Promote R&D in China”.

Second group of the first Japan CTO Forum. 2005. “CTOs Take Notice: Challenges of and Response to IP Strategy and IP Management”.

Le Wang, Zhi. 2003. “New Movements of Multinational Enterprises in China”, Xin Hua Publishing Company.

UNCTAD. 2005a. “World Investment Report”, http://www.unctad.org

UNCTAD. 2005b. “UNCTAD survey on the internationalization of R&D”, http://www.unctad.org