From Income Generation to Patent Creation – Mapping out APEC Best Practices Guidelines For Industrial Clustering

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Abstract

The aim of this paper is twofold. First, we introduce several case studies on industrial clustering, including the biotech clusters in Canada, the automotive parts industry in Thailand, Chinese Taipei's Hsinchu Science-based Industrial Park (HSIP), the Silicon Valley in the US, Malaysia's Penang and Kelang Valley clusters, the machine tool cluster in Taichung, Chinese Taipei, and the Hamamatsu cluster in Japan, in an effort to gain an understanding of, and to draw some lessons from their developmental experiences. Second, we conduct questionnaire surveys and field interviews for several clusters in member economies. After the analysis, we present policy recommendations to help member countries to establish new clusters or to promote the further growth of existing clusters.

Although it is possible for a government to assist in the formation of a cluster through regulatory or policy measures, or through the establishment of industrial parks in the early stage, as indicated by Pietrobelli (2002), it is extremely unlikely that one can determine a 'best practice' for the organization of industrial clusters since globalization and time will provide continuing challenges for them. However, as time goes by and global competitive pressure increases, it becomes much more difficult for such groups to grow into major and more internationally recognized clusters.

As noted by Saxenian (2001), entrepreneurship, linkages to major and growing markets and the availability of skilled labor are three important ingredients for the successful formation of a cluster. The success of Silicon

Valley is no accident, since it satisfies all three conditions: access to the US and global markets, worldwide talent providing abundant skilled labor and the ongoing encouragement of entrepreneurship through the wide availability of venture capital.

These same factors have also contributed greatly to the stable growth of the HSIP. The same environment is discernible in the HSIP, the biotech clusters in Canada, the Teheran Valley of Korea and the electronics industry in Penang; however, for other clusters, because of the lack of either indigenous effort or availability of international technology and access to skilled labor, they will find it extremely difficult to nurture their much looser formations into internationally recognized industrial clusters. If these industrial formations desire to grow into clusters with an internationally recognised reputation, then they must realise that linkages to international markets, pools of skilled labor and venture capital are prerequisites.

To achieve sustainable growth, therefore, an industrial cluster needs to take advantage of international networking, and technology transfer and the availability of skilled labor are prerequisites. However, to build competitive advantage within a global production network (GPN) a cluster cannot rely solely upon market power because there is still a need for government support and policies. According to our major findings from questionnaire surveys, tax incentives, technology support from research institutions and infrastructural provision are the most needed policies for a cluster to achieve sustainable growth.

Moreover, taking industry-specific characteristics into consideration when designing policy measures to foster a cluster is also crucial. For instance, for a traditional industry cluster seeking technology transfer from buyers or suppliers, introducing IT technology to speed up innovation and fitting into the global division of labor system are key to the success of the industrial cluster. For a high-tech cluster, facilitating labor mobility and the related lemming effect, and strengthening the support from universities and research institutions are crucial factors for the further growth of the cluster. As for emerging industries, here university manpower plays a crucial role in their development. Besides, the flow of capital venture capital and the capital markets are also of great importance in the start-up of new businesses and clusters.

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I、INTRODUCTION

In a knowledge-based economy, the ability to innovate is the key to the competitiveness of a nation, and industrial clusters are favorable to the establishment of such ability. There are a number of distinct advantages for firms involved in the formation of an industrial cluster (Chen, et. al., 2001). First of all, a cluster provides complementary resources such as technology and information exchange, management assistance, and so on, to improve the performance of all firms within the cluster. Secondly, the cluster strengthens competition and thus promotes technical efficiency because, as firms are located nearby, the inherently fierce competition for clients or suppliers becomes unavoidable; nevertheless, competition inevitably pushes up the level of efficiency. Thirdly, firms can quickly respond to the demands of the market, or to changes in technology, since firms within the cluster can reorganise subcontracting work more quickly than those outside of the cluster. This particular ability to leverage resources to adapt to fluctuations in the market and changes in technology has been the major benefit for firms located within clusters.

There are, however, a number of questions surrounding the existence of such clusters, such as: what is the historical background and what have been the major incentives behind the formation of clusters by firms? How do clusters interact with other clusters? Have they been able to adapt to the more open, internationalized

environment that has emerged in recent years? And, as time goes by, how will these clusters continue to evolve? All of these questions are worthy of further exploration. Therefore, the aim of this paper is twofolds. First, we introduce several case studies on industrial clustering, including the biotech clusters in Canada, the automotive parts industry in Thailand, Chinese Taipei's Hsinchu Science-based Industrial Park (HSIP), the Silicon Valley in the US, Malaysia's Penang and Kelang Valley clusters, machine tool in Taichung, Chinese Taipei, and the Hamamatsu cluster in Japan, in an effort to gain an understanding of, and to draw some lessons from their developmental experiences. Second, we conduct questionnaire survey and field interviews for several clusters of member economies. After the analysis, we present policy recommendations for member economies to establish a new cluster or to promote the further growth of the existing cluster.

II、THE DEVELOPMENT OF MAIN CLUSTERS IN APEC MEMBER ECONOMIES

1. BIOTECH CLUSTERS IN CANADA

There are approximately 300 biotech companies in Canada, some of which are amongst the world's leading companies. It is estimated by experts that the US still leads the world in biotechnology; however, Canada's R&D standards have already surpassed those of France and are now almost equivalent to those of the UK. Many of the biotech companies have formed clusters in the cities of Toronto, Montreal and Vancouver; indeed, there are currently 73 private high-tech firms in Toronto, 72 similar firms in Montreal and 59 in Vancouver. The biotech firms in Montreal provide work for 2,300 employees, with the top four biotech firms hiring around 1,094, namely 50

per cent of the total employee population in the trade.

The achievements in biotech research in Canada are the result of a number of issues including the profound basic scientific ability, the continuous input into the biotech industry of highly qualified scientists from universities in Montreal, Quebec, Vancouver and Toronto, the fact that labor costs for Canadian biotech workers are far less than those in the US, and more importantly, the generous investment by the Canadian government and local authorities into the development of biotechnology, with Quebec Province being the most aggressive amongst the provinces in its implementation. In order to attract biotech companies to start business in the local area, the government of Quebec has applied measures which include permission to set up 'biolabs', and tax allowances for individuals and businesses; for example, the executives of foreign biotech companies are entitled to five years' provincial level tax exemptions.

One of the key factors in the achievement of biotech clusters in Canada is support for innovation and the supply of quality workforce/talent from research centers; the Canadian National Research Council (NRC) is responsible for this crucial task. The NRC's R&D and innovation, plus the R&D and innovation from other regions throughout Canada, are resolved in highly competitive technical clusters featuring local features/flavors. There are for example, around 100 agri-biotech companies in the agricultural and biotech cluster in the innovative research park in Saskatoon, which has annual revenue of around CAD$ 2 billion. This agri-biotech cluster was achieved through the joint cooperation and efforts of universities in Saskatoon, the local authorities, local businesses and the NRC.

In Ontario (within which Toronto is situated) the government has been striving to encourage biotechnology by means of a number of strategies and measures including a budget of CAD$ 20 million allocated as funding for the biotech commercial center, a budget of CAD$ 20 million allocated to provide incentives for medical and other scientific discoveries, a budget of CAD$ 30 million allocated for technological innovations in the area of general health in Ontario, a budget of CAD$ 40 million allocated for the establishment of biotech institutes in Ontario, and the provision of tax incentives, along with easier access to venture capital support.

The reasons behind the successful development of the biotech parks are; (i) ease of assess (transportation); (ii) development of uniqueness through solid foundations; (iii) the encouragement of clustering effects; (iv) comprehensive services and support; (v) accessible financing services; (vi) educational, leisure and recreational facilities; (vii) investment tax allowances and incentives; and (viii) the emergence of intellectual property

The process of development of the biotech clusters in Ontario, Quebec and other provinces in Canada shows that these regions feature competitive resources, including universities, teaching hospitals, venture capital, success stories, rich human resources and full support from the local government.

Whether there should be a so-called ‘biotech industrial park’ is not at all important; for example, at the University of West Toronto in Canada, and at the University of Manchester in the UK, biotech research units are simply based in a building within the campus in which academic researchers and businesses cooperate with each other to construct a promising future for the biotech industry. Thus it is not at all unusual to see

students going straight to laboratories owned by the biotech companies immediately after class.

In general there is no real need for a large industrial area in order to develop biotech industrial clusters. Consequently, the government of Ontario has plans to build a biotech industrial R&D complex in Toronto city center where there are skyscrapers everywhere. The complex will comprise of a university, a teaching hospital, a medical research center and an incubator.

Hence the key to success in developing biotech industrial clusters is establishing a platform upon which academic institutions, venture capital investors and biotech companies can cooperate with each other. It may be just as simple as that for Chinese Taipei, if only the county or city government could provide an appropriate piece of land and build a biotech building with a floor area of only 200m2 or so, to accommodate twenty biotech companies. Once such a platform was provided, the biotech clusters in Chinese Taipei would be very likely to emerge and become formulated on a gradual basis. This may be why many biotech companies are very optimistic about the future of the biotech industrial parks in Chinese Taipei and Hsinchu.

2. THE AUTOMOTIVE AND PARTS INDUSTRY IN THAILAND

Thailand's automotive and parts industry is even more competitive than its counterpart in mainland China. The thriving development of this industry in recent years is greatly indebted to the Japanese investors who put in enormous amounts of money, leading to the development of relevant peripherals, and thus contributing to the prosperity of this industry.

The industry was formulated in the 1990s when both of the major US automotive companies, Ford and GM, chose Thailand as their base for automotive production and for supplying their products to the regional market. In particular, GM preferred Thailand to the Philippines for a number of reasons, including Thailand's position as the largest domestic market amongst all of the ASEAN economies, the economy's better overall development of its infrastructure and its relatively well-developed automotive parts industry.

Industrial clustering in Thailand's automotive industry can be traced back to the 1980s and 1990s when the Thai government facilitated such clustering by implementing rules governing the self-production ratio. The Japanese parts factories already existed in Thailand, even before the government regulated the self- production ratio, although the parts were imported from Japan for assembly in Thailand. After the self-production ratio was regulated, the Japanese automotive companies were forced to purchase the parts from local vendors, and as a result, Japanese automotive companies required their allied parts suppliers to establish parts and accessories factories in Thailand in order to reduce the investment cost for these items. These factories would of course have to be located in close proximity to the main consumers, and since most of the Japanese automotive factories were located in Bangkok and Samut Prakan (40 minutes from Bangkok by car), Thailand's automotive clusters began to form in these two areas in the first half of the 1970s.

Most of the automotive parts manufacturers and suppliers entered Thailand in the late 1980s as a result of the rise in the Japanese currency and the prediction of huge demand for automobiles. Most of these manufacturers chose to be closer to their main

customers, namely Bangkok and Samut Prakan; thus the industrial clustering in these locations was very significant.

The Thai government was very successful in its policy-making because it recognised the need to provide a new industrial area close to the freeways which would provide easy access to both the airport and the harbors, thus avoiding congestion within Bangkok city itself. The Thai government also actively encouraged automotive manufacturers to move out of Bangkok through the provision of incentives. A number of incentives were designed by the Board of Investment (BOI) essentially splitting Bangkok into three different industrial zones. Firms in Zone 1 (Bangkok Province) were provided with no incentives; firms in Zone 2 (the inner circle of the greater Bangkok area) were provided with medium level incentives; and firms in Zone 3 (the outer circle of greater Bangkok) were provided with high incentives (including tax allowances and discounts on their utility bills. As a consequence of these incentives, new industrial areas emerged in Zones 2 and 3.

3. HSINCHU SCIENCE-BASED INDUSTRIAL PARK (HSIP)

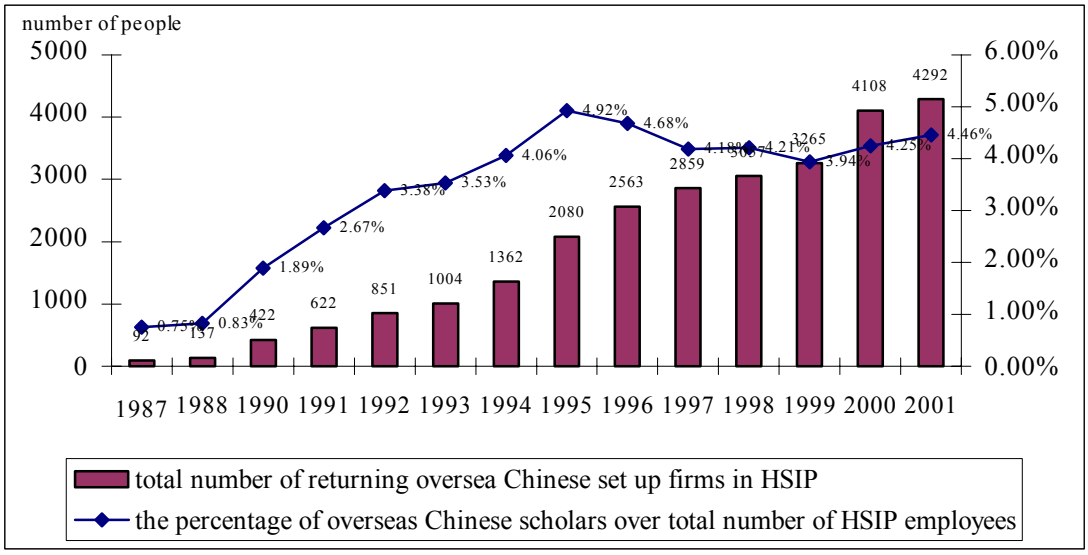
Following the first oil crisis in 1973, the government realized that Chinese Taipei's industrial development was built on a weak, labor-intensive structure, which was liable to disintegrate during any protracted period of recession. It was clear that Chinese Taipei needed to pursue a policy of development of hi-tech, high value-added industries, and in order to attract investment and technology transfers from foreign hi-tech industries, the government had to provide a suitably attractive environment. It therefore decided to create a science-based industrial park similar to the well established example of Silicon Valley in California. When deciding on the location for

the new park, the availability of highly skilled manpower and technical support were vital preconditions, and Hsinchu was seen as a prime target, with its two universities – the National Tsing Hua University and the National Chiao Tung University – being particularly strong in sciences and thus ensuring that there would be no shortage of skilled workers. One additional factor, the fact that the Industrial Technology Research Institute (ITRI), an organization created to provide much needed technological support, had already been established in Hsinchu, made Hsinchu the obvious choice.

With the effective provision of manpower supply having been created, along with other incentive measures for land purchase and building construction, the government formally established the HSIP in 1980. In the previous year, the Statute for the Science-based Industrial Park Establishment and Administration (Year 1979) had been promulgated, providing under Article 15, five-year tax holidays for companies establishing themselves within the park, along with exemptions from import duties, commodity taxes and business taxes for imported equipment, raw materials, parts and semi-finished products imported from abroad (Article 17), and a variety of other tax incentive measures.

The whole concept behind the establishment of the HSIP represented the creation by the government of a space where industry could group together, enabling manufacturers to reduce the costs of personnel training, buildings, land and other basic infrastructure, whilst also allowing them to enjoy the benefits of concentration in technology transmission (Mai, 1996; Mai and Peng, 1999). In addition, the tax incentives also clearly had the effect of encouraging manufacturers to invest within the park (San and Wang, 1996).

The development of the industrial park is closely related to the return of Chinese engineers from overseas. As Figure 1 shows, the increase in the number of overseas Chinese engineers returning to Chinese Taipei led not only to the technological development of the industrial park, but also to the rapid development of the economy as a whole.



Source: Wang, et. al. (2002), pp.2-16.

Figure 1 The trend of overseas Chinese returning to HSIP to work, and the ratio over total number of employees in HSIP

As for international interaction, according to the study by Saxenian (1997), it was shown that an industrial cluster without international connections (foreign buyers, manpower, capital or technology importation, and the like) would hardly be in a position to achieve success; therefore, international connections and the resultant learning-by-doing effect are both critical to the further development of a cluster.

For this reason, we will attempt to explain international interaction from a perspective of technology connection, from an alternative perspective of the introduction of skilled manpower, Access to a major and growing market, as well as the encouragement of entrepreneurship.

(1) Technology Connections

The most successful example of R&D clustering is indeed the technology cluster in Silicon Valley. The subsequent connections that were developed between Silicon Valley and the HSIP were built by overseas engineers and specialists returning from Silicon Valley to Chinese Taipei (hereafter refer it as "CT"), with these connections generally being based on personal networks via international strategic alliances wherein joint R&D is conducted between MNCs and CT's subcontractors. For example, the CT Windows CE Alliance project involved an alliance that was specifically targeted at expanding the share of the software market. Such cooperation not only accelerated the development of products with high value-added but also reduced the obstacles to R&D through close ties with the major international firms. Such a scenario indicates that CT's high-tech firms were fairly aggressive in both their R&D and their competition for technology licenses, and it also indicates that CT's firms have developed technological capacity which the international community has clearly recognized.

(2) The Introduction of Skilled Manpower

Before CT's own capacity for R&D was fully developed, aggressive recruitment of overseas engineers and specialists helped to bring in the advanced technologies and know-how. The introduction of these talented employees contributed to the

development of CT's semiconductor and information industries for a number of reasons. Firstly, overseas Chinese workers have an impressive track record of service. As Tu (1995) noted, CT and the US established a special and close relationship way back in the 1950s, with this relationship incorporating material supply during the early stage, and thereafter, increasing numbers of returning overseas students. This relationship therefore provided CT with easy access to Western culture and language.

Secondly, CT developed itself into a depot for MNCs in the Asia-Pacific region by improving its relationships with Japan and Europe. Yang (1998) affirmed that there was a considerable correlation between the development of CT's electronic and information industry, and talented individuals educated in the US, thus the CT's government has offered strong incentives to encourage overseas specialists to return to work in CT. On 31 December 2001, there were 4,292 overseas engineers and specialists working in the companies in HSIP, with 123 companies having been founded by Chinese entrepreneurs returning from abroad.

(3) Access to a Major and Growing Market

US firms such as IBM, Compaq and HP have been subcontracting their production to CT's computer manufacturing companies ever since the 1980s, largely as a result of their solid manufacturing ability, timely delivery, efficient management and reasonable costs. CT's own information technology began to take off as a result of such partnerships, thus providing a major boost for the further development of the HSIP, with the production value of the IC industry in the HSIP accounting for 57 per cent of CT's overall IC industry. Within the IC industry, CT's foundry firms now serve as the manufacturing base for many US fables IC design houses, with the subsequent growth

in OEM demand for the US IC design houses helping to build up CT's world class foundry companies, CT Semiconductor Manufacturing Company (TSMC) and United Microelectronics Company (UMC).

(4) The Encouragement of Entrepreneurship

Following successful international technology transfer to firms within the HSIP, and the nurturing of their manufacturing ability, the resultant favorable environment that emerged in the mid-1990s created a hotbed for entrepreneurship. During this period, technology personnel from the IC, computer and peripherals industry began setting up their own businesses; indeed, by the end of 2001, overseas returning Chinese businessmen had succeeded in starting up 723 new companies. The key factors behind this level of entrepreneurship are threefold. First of all, the ITRI has continued to transfer its research results into industry, which has resulted in the rise of spin-off companies; by 2000, the ITRI had succeeded in giving rise to 31 such spin-off companies (Wang et. al., 2002). Secondly, demonstration effects will of course bring about entrepreneurship, and since the mid-1990s, CT's IC manufacturing companies (TSMC and UMC) and IC design houses (including VIA and SIS) have performed well beyond expectations; in consequence, more entrepreneurs have been encouraged to start up their own ventures, thus further advancing entrepreneurial spirit. Thirdly, the boom in venture capital has also contributed greatly to the raising of funds in the early stages of business start-ups.

With these efforts, The overall performance and contribution of HSIP deserves further study. Therefore, we then use some statistical evidence to demonstrate their performance and economic contribution.

(1) Overall Performance

As can be seen from the level of employee productivity, measured by sales divided by the number of employees, per capita sales generated by employees within the park in 1992 were lower than in some other industrial areas, such as Taipei and Taoyuan Counties; however, the average per capita sales within the park grew from NT$2.5 million in 1992, to NT$ 5 million in 1995. The calculations shown in Table 1 provide a comparison between productivity in the HSIP and other major industrial areas based upon a national productivity perspective. From this comparison, per capita sales in the park's information and electronics industries in 1999 were 30 per cent above the national average. The result suggests that the information and electronics industries achieved more agglomeration benefits than the industries in Taipei and Taoyuan Counties.

Table 1 Sales generated by employees (employee productivity)

Unit: NT$ millions

	Employee Productivity		
	1992	1995	1999
National average	2.43	3.82	5.07
HSIP	2.55	5.06	6.60

Source: Wang, et. al. (2002).

(2) The Contribution of HSIP to Economic Development

There can be no doubt as to the important contribution made by HSIP to CT's economic development; indeed, the park has had a major impact, both in terms of stimulating development of the hi-tech industry and in earning foreign exchange from the growing level of exports. During the twenty-year period after the establishment of the HSIP, the government invested NT$18 billion in 'software' and 'hardware' construction at the park, turning it into the main centre for CT's industrial development.

Companies located within the HSIP spent, on average, 5.94 per cent of their sales revenue on R&D in 2000, whilst the number of people employed at the park had increased from 8,275 in 1986, to 102,775 in 2000. Furthermore, total sales of companies located within the park increased from US$450 million in 1986, to US$29.80 billion in 2000 (see Table 2).

Table 2 The development of the Hsinchu science-based industrial park

Indicators	1986	2000
No. of companies established within the park	59	289
No. of persons employed within the park	8,275	102,775
Total paid-in capital of all companies located within the park	US$151 million	US$226 billion
Expenditure on R&D as percentage of business volume	5.4 per cent [a]	5.94 per cent [b]
Total business volume of all companies located within the park	US$450 million	US$29.80 billion
Total export value of all companies located within the park	US$4.51 billion [c]	US$15.98 billion [d]

Notes:
[a.] The data provided here are from 1990, when the park began reporting this data.
[b.] The data provided here are 1999 data.
[c.] The data provided here are from 1993, when the park began reporting this data.
[d.] Accounting for approximately 9.14 per cent of CT's total export value.

Source: Science-based Industrial Park Quarterly Statistical Report (consecutive issues).

4. THE ESTABLISHMENT OF SILICON VALLEY

Geographically, Silicon Valley is contained within a thirty-mile by ten-mile strip of land between the cities of San Francisco and San Jose in Santa Clara County in Northern California. This economic region begins in the Northwest of the Valley in Palo Alto, where the bulk of theoretical and practical technological research in this field is carried out at Stanford University and the Stanford University Research Park. A combination of regional advantages and historical accidents conspired to produce the greatest 'science park' in the world, with observers having identified a number of regional advantages for the valley, including world-class academic institutions (Stanford University and the University of California at Berkeley), brilliant scientists,

military procurement of semiconductors, and the pleasant climate of Northern California (Rogers and Larson, 1994).

Several factors have been attributed to the success of the valley, the first of which is, as already noted, the influence of nearby higher education institutions, particularly Stanford University. In the 1920s, Stanford recruited highly respected faculty members from the East Coast of the US, including such important recruits as Fred Terman, David Hewlett and William Packard, who became the pioneers for innovation and commercialization of innovative products. In 1950, Hewlett-Packard (HP) sold seventy different products, achieving sales in excess of US$2 million and rapidly expanding to a 200-employee company. The formation of HP's distinctive Silicon Valley management style soon encouraged numerous enterprises to follow suit. In 1954, HP rented part of Stanford Research Park for its operations, which then led on to the formation of the cluster of industries in Palo Alto.

Secondly, the government also played a major role in the prosperity of Silicon Valley. The relocation to California of the military contractor, Lockheed, in the mid-1950s brought federal defense dollars to the area, whilst public procurement from defense agencies also hastened the growth of the semiconductor industry.

Thirdly, the flexible environment, informal means of information exchange and the high level of labor mobility also promoted collective learning and flexible adjustment between companies which subsequently encouraged further entrepreneurship and experimentation (Saxenian 1994).

The driving force behind the economy in the valley is technology, and more specifically, specialized clusters of technology firms and talented individuals. Almost

40 per cent of Silicon Valley's workforce is employed in technology-related industries, and many more jobs are tied to the support of these industries. These clusters are dynamic; constantly innovating and changing. They draw strength from the valley's business environment, its tangible assets, such as world-class universities, extensive supplier networks and specialized professional services, as well as from intangible qualities such as competitive spirit and the willingness to take risks.

In the 1990s, Silicon Valley's economy has been shifting from a high-tech manufacturing economy to a knowledge-based economy, which is now moving towards higher value and greater service-oriented activities. The valley's competitive advantage comes from the productive and creative use of human inputs, from value rather than from volume.

After more than fifty years of continuing progress, Silicon Valley has made a significant contribution to the long-term economic development of the US, with a number of indices demonstrating its importance. First of all, the value added per employee in the valley (a measure of productivity), increased by 4.6 per cent in 2001 to US$170,000, as compared to the national figure of US$56,000. Secondly, although the valley is home to less than 1 per cent of the US population, its latest annual patent awards came to more than 6,800, representing 8 per cent of all the patents awarded to US residents.

5. PENANG AND THE KELANG VALLEY
Multinational-dominated Clusters in Malaysia

The industrial clusters in Penang and the Kelang Valley in Malaysia have enjoyed strong MNC operations in electronics manufacturing since the early 1970s, indeed,

foreign-owned corporations accounted for 83 per cent of all fixed assets in the electronics industry in Malaysia in 1998. Comparing these two Malaysian electronics clusters, and drawing on Rasiah (2002), this paper underlines the human capital and network cohesion that exists between the domestic and foreign firms within these clusters, and the coordination between government and businesses as the critical conditions for such industrial clustering.

Both regions enjoy advanced levels of basic infrastructure and educational institutions. Over the period from 1970 to 1990, the high unemployment rates of around 6.0 per cent to 8.1 per cent ensured that MNCs engaged in labor-intensive assembly began relocating to this economy. Political stability, financial incentives and controls on unionization ensured that Malaysia was one of the more attractive sites. However the exhaustion of labor reserves in the 1990s resulted in a significant shift in the demand structure for human capital in Malaysia's manufacturing sector. The resultant labor shortages, rising wages and the emergence of other low production cost sites, such as mainland China, Thailand and the Philippines, along with their improvements in basic infrastructure and political stability, began to challenge the ability of Penang and the Kelang Valley to sustain their operations.

The labor shortage problems of the 1990s led to a shift in the government's industrial strategies from a focus on employment generation to industrial deepening, clustering and the upgrading of industry to higher value-added activities. These new policies included the 'Action Plan for Industrial Technology Development' in 1990, and the 'Second Industrial Master Plan', which set out the guidelines for the proposed transformation in 1995.

Alongside the Federal Ministry of Education, which governs formal education institutions (including general, vocational and technical education), the Human Resource Development Council Fund, which was established in 1993, required manufacturing firms with 20 or more employees to contribute 1 per cent of their payroll to the council, which the firm could then reclaim by submitting bills from approved training establishments. In order to complement domestic human resource capabilities, the government initiated exemptions for IT firms in the Multimedia Super Corridor (MSC) starting from 1997, to support the importation of technical and professional human capital from abroad.

Despite the intense emphasis on the development of infrastructure, the supply of high-tech human capital has consistently lagged behind the growing demand, and as a result, there has been a severe widening of the gap between the supply and demand of human capital, and a constant structural mismatch caused by coordination problems within the two clusters. Both Penang and the Kelang Valley have therefore failed to establish a sufficient supply of high-tech human capital, largely as a result of the problems of poor coordination of supply and demand. Although allowing immigration by professionals possessing high-tech human capital may be the only answer to overcoming this growing deficit, the main barriers to accessing such high-tech talent are the existing conservative immigration policies (Rasiah, 2002).

Penang

Penang's manufacturing sector accounted for 13 per cent of the economy's GDP in 1971, a figure which subsequently rose to 46 per cent by 2000. The electronics industry in Penang employed over 90,000 workers in 1995, with the outstanding

economic performance of this particular cluster being attributed to the important contribution of the MNCs. The essential intermediary role of the Penang Development Corporation (PDC) was established in 1969 with the aim of placing considerable effort into attracting export-oriented MNCs into the manufacturing sector. Integrated business networks, with the PDC fuelling their cohesion, have helped in the dissemination of knowledge embodied in human capital for the creation of new firms, differentiation and the division of labour. The development of the MNCs has driven strong supplier networks, whilst institutional coordination aimed at supporting their growth has increased the localisation of inputs by MNCs.

From the perspective of a global production network, Penang has successfully drawn industry 'species' from other locations. Specific capabilities, in terms of specialisation, have helped the region to sustain its level of growth, and have provided the mechanisms for accelerating inter-firm links. Industry 'sub-species' have also evolved domestically in Penang to stimulate further differentiation and diversity. The development of several tiers of firms has enabled workforces to further expand their development of knowledge and its dissemination within the Penang cluster. Within such clusters, there are often a number of MNCs which tend to play the vital role of a training ground for the hiring and nurturing of entrepreneurs; this has thus stepped up the creation of new firms, and has led to a more flexible industrial system within the region. In contrast to the Kelang Valley, Penang was able to develop sufficient network cohesion and institutional coordination to support the need for flexibility and interface between its domestic firms and the MNCs. Strong inter-firm relations and systemic coordination effects have thereby generated and expanded this industrial clustering whilst also appropriating considerable economic synergies.

Kelang Valley

Just barely trailing the accomplishments in Penang, the electronics industry in the Kelang Valley was employing almost 85,000 people in 1995, and in fact, the Kelang Valley was better endowed than Penang when the first major influx of electronics MNCs relocated to Malaysia in the early 1970s. As a result, it was quickly able to set up its high-volume production capacities in consumer electronics, semiconductors and picture tubes. However, despite the fact that it already enjoyed a concentration of manufacturing firms, the lack of an intermediate agency, such as the PDC in Penang, weakened the network and inter-firm cohesion in this cluster. This resulted in the development of comparatively less knowledge spillover, and the lack of real stimulation of inter-firm links and new firm creation.

Generally speaking, many of the parts and components produced by industries within this cluster, particularly those for the electronics industry, have been produced as elements within global production networks coordinated by the parent MNCs. A number of high value-added components, such as TFT LCD display screens, are imported from their subsidiaries or suppliers located in their home bases. Parts of the foreign MNCs act as anchors, offering markets and technological support for both foreign and local firms; however, most local suppliers are still limited to low value-added non-core activities, hence the key technologies and high value-added components are mainly imported from MNCs' other expatriate subsidiaries, or from their home economies, such as the US, Japan and CT.

As a result of their poor network cohesion with domestic firms, MNCs in the Kelang Valley not only source from abroad, but also internalize the production of

upstream activities, demonstrating that their preferred form of division of labor is intra-firm rather than inter-firm. The competitiveness of the local firms is largely undermined by their costly and poor quality supplies, which results in MNCs building up very few industrial linkages within the domestic economy; indeed, foreign firms will generally tend to source most of their supplies from their home bases. We can thus expect that the weakness of the vertical division of labor between MNCs and local suppliers in the Kelang Valley has also led to limited knowledge spillover.

In addition to infrastructure and national policies, human capital (in particular, abundant skilled labor and entrepreneurship which provide the international linkages that are embodied in MNCs) becomes even more important in driving the formation of industrial clusters, especially in this era of the globalization of production. Some successful industrial clusters have managed to overcome the problem of local supply capabilities falling behind the existing demand by absorbing those foreigners who have working permits. Under the constraints of restrictive policies on the immigration of foreign professional workers, Penang relies on the network cohesion derived by the intermediate agency, the PDC, to improve systematic coordination, so that the relative ease of firm entry and exit will encourage entrepreneurship. The presence of such systematic coordination also helps to develop the inter-firm dissemination of tacit and experiential knowledge in Penang, much more so than in the Kelang Valley. As noted by Rasiah (2002), the quality of government vis-à-vis business coordination in Penang means that even small machine tool firms in Penang perform much better than those in the Kelang Valley.

6. THE INDUSTRIAL MACHINE TOOL CLUSTER IN TAICHUNG

CT's machinery industry has matured significantly since the 1980s, particularly with regard to the techniques involved in the machine tool industry; these techniques include refinishing, casting, grinding and cutting. In other words, satellite industries are developing to provide the necessary support to the machine tool industry. In Central CT, for example, buyers may obtain all their parts and components including molding, mechanical processing, refinishing, and so on, from suppliers within a radius of 30 km. Such an interlocking quasi-ecological business relationship based on mutual dependence contributes to the solid foundation of the development of the machine tool industry.

Such a disintegrated system also helps businesses to achieve higher efficiency in purchasing and processing through flexible operating systems that survive both market changes and the fierce competition. In this way, all resources in the system can be used in every stage of processing, including R&D, design, trial, production, assembly and sales. Within this process, the value added that is related to the products is naturally upgraded. This is the so-called 'industrial disintegration network' formed by 'professional disintegration' and 'flexible complementation'.

The center-satellite system in Central CT has achieved a close and interdependent production and sales system which brings together the core businesses and all of the ancillary and supporting units. Such an advantage could be expanded by including the ecology of industrial clusters; for example, support may be needed to boost access to all of the machine parts and processes available within one hour's driving time of the Taichung and Tainan areas; such a niche advantage is particularly significant in Central

CT's, thus, this advantage could form the perfect niche for CT's machinery industry. As Chang (1996) noted, the metalwork system surrounding Taichung incorporates thousands of small professional metal processing factories which facilitates powerful support for CT's CNC machine tool industry. By outsourcing various functions, CT's CNC machine tool factories not only reduce their production costs significantly, but also save on costs associated with hardware development and other indirect charges.

The current status of the alliance system in CT's machinery industry can be examined from two aspects. Firstly, the center-satellite system is constructed within the framework of the supporting, disintegrated system focusing on the dominant master vendors. Within this system, the center and satellite businesses form a close cooperative relationship. The second aspect is similar to the 'flexible alliance business combination structure' which is formed by interconnected alliance networks between many small or medium-sized factories, with no large enterprises in close proximity (Liu, 1994). These two aspects may be resolved in the two types of small and medium machinery industrial alliance networks that exist in CT, namely 'networks led by the center companies' and 'networks between the companies', depending on the core products, the size of core members within the networks, or the dominating force of the networks.

7. HAMAMATSU, JAPAN

Hamamatsu-shi, situated in Shizuoka-ken, Japan, is characterized by industrial clusters involving the machinery and musical instrument industries. This was also the birthplace of some of the leading automotive and instrument companies, such as Honda, Suzuki, Yamaha and Kawai. Nowadays, Hamamatsu is still the foremost

productive cluster of automotive parts and mouldings in Japan, and its musical instrument industry has secured a very prestigious position. The headquarters of the Suzuki Motor Corporation are located in Hamamatsu just 15 km away from its suppliers of major parts. The frequent face-to-face communication between Suzuki and its parts suppliers is extremely beneficial in terms of technical exchanges and maintaining the balance between demand and supply. Other companies in the business of mouldings, precision machinery design, computer software design and CAD, also work with these parts suppliers. These enterprises are provided with powerful support from the machinery industry making it very easy to obtain the necessary parts.

The Hamamatsu area features the largest number and most prosperous development of ‘angel’ and ‘venture capital’ businesses in Japan, where those intending to start a business (or those who have already started one) can easily gain access to potential investors. Many successful entrepreneurs have also gone on to become investors supporting other business start-ups. These entrepreneurs’ personal networks with local banks are very helpful in creating easy access to sources of funding; indeed, with their experience in financing matters, they can also serve as consultants to new young business start-ups since the local banks tend to provide venture capital along with refinancing services.

The Hamamatsu area has been famous for the diligence of its people since the Edo period and was also the cradle for many influential entrepreneurs, including Shuichiro Honda, the founder of the Honda Motor Company. One of the main characteristics of this area’s development is the large scale appearance of businesses within the same industry, followed by fierce competition, and eventually, the survival

of only the few most competitive businesses. In the heyday of the motorcycle industry, for example, which only emerged after the Second World War, there were at least 30 brands competing with one another. In the end, only Suzuki, Honda and Yamaha survived, and even today, these are still the three major motorcycle producers in Japan, which also dominates the motorcycle market on a global scale. Other similar cases include the keen competition between Yamaha and Kawai in the musical instrument industry, and Heian in the woodwork machinery industry. These are all examples of businesses competing for the No.1 in the world in their particular field, and yet collocated in the same area. These businesses continue to innovate during the intense competition whilst cooperating with other businesses in the upstream and downstream industries.

The industrial clusters in this area also feature technology transfer whilst engaging in the other main feature of Hamamatsu, continuous industrial innovation and regeneration. For example, the motorcycle industry was transformed into the automotive industry, whilst in the traditional music industry, companies such as Yamaha moved into the creation of innovative instruments using electronic technology.

As a result of the general decline in the traditional machinery industry in recent years, Hamamatsu also went on to develop its optoelectronics industry. Of all the features of this region, the most valuable is that the industrial clusters have the internal power to regenerate, thus, there is a need for further concentrated studies on the secrets of success in the Hamamatsu clusters.

III、COMPARISON OF THE INDUSTRIAL CLUSTERS

Having examined some of the major industrial clusters in the APEC member economies, we now go on to draw a comparison between these industrial clusters (see Table 3). From the analyses of the previous section, industrial cluster can be formed naturedly (such as Silicon Valley of the US, or Hamamatsu in Japan) or through "government's policy design" (such as HSIP of CT, automobile cluster of Thailand). However, as time goes on, for a cluster to achieve sustainable growth, the following four requirements should be fulfilled: first, technology connection (such as HSIP's close technology connection with Silicon Valley); second, the introduction of skilled manpower (such as returning engineers and specialists from Silicon Valley to HSIP, or abundant supply of quality researchers from universities or research centers in Canadian biotech cluster); third, access to a major and growing market. The strength of CT's IC design house has been built on subsequent growth in OEM demand of US. Hamamatsu cluster's firms also create demands for US and Asian market; fourth, the encouragement of entrepreneurship. Venture capital channeled fund to firms has been the driving engine for the booming of HSIP, Hamamatsu, and Silicon Valley.

Moreover, in the era of globalized production, if local cluster are to keep pace with new development in the global organization of economic activity, they must employ the advantage of proximity to create new knowledge through business-network exchange.

Table 3 Comparison of industrial clustering features in APEC member economies

Features	Hsinchu Science-based Industrial Park (Chinese Taipei)	Silicon Valley (USA)	Penang and Kelang Valley (Malaysia)	Hamamatsu (Japan)
The Role of the Government	Park planned by the government which also provided tax incentives and industrial land in the early stage. In the later stage, HSIP interacted with Silicon Valley and other clusters, to fit into the internationalized environment and achieve self-sustained growth.	Private sector plays a major role pushing the growth and development of the cluster. However, the relocation of military contractor, Lockheed, and defense agencies to California in the mid-1980s, also hastened the boom of the IC industry.	The government provides infrastructure and financial incentives.	Most effort is from the private sector, with the government playing only a very limited role.
Sources of Innovation	Silicon Valley Industrial Technology Research Institute (ITRI) Suppliers interact with firms inside the cluster	Private sector and nearby institutions, particularly, Stanford university	Multinational firms play a major role in providing grounds for the hiring and nurturing of entrepreneurs.	Continuous innovation is the key for the sustainability of the cluster, which continuously produces new industries to replace old ones. Innovation comes from the in-house efforts of major enterprises such as Suzuki, Yamaha, Honda and Kawai.
Selection of Geographical Location	Planned by the government (based on the location of universities and research institutes)	The economic regions began in the northwest of the valley in Palo Alto, where Stanford university provides abundant research staff and technical personnel.	The government's policy aimed at attracting export-oriented MNCs gradually formed the cluster	Hamamatsu has been an important manufacturing sector in Japan since the 19th century.
Relationship between firms in the clusters and downstream suppliers	Very intensive interaction and the provision of a huge amount of knowledge and know-how from suppliers	Very intensive	Penang: Developed network cohesion and institutional coordination to support flexibility and interface between domestic firms and MNCs. Kelang Valley: The lack of an intermediate agency weakens cohesion and interface in the cluster	Complete division of labor system between firms and suppliers
Relationship between firms in the clusters, universities, research institutes, and local businesses	Intensive interaction with universities and research institutes.	Intensive interaction between firms, university and research institutes.	Penang: Vertical division of labor between MNCs and local suppliers. Kelang Valley: Inter-firm division of labor is less popular; linkage between MNCs and local company is limited	Very intensive interaction
Sources of Talent	Global	Global	Nationwide	Nationwide

Table 3 Comparison of industrial clustering features in APEC member economies (contd.)

Features	Teheran Valley (Korea)	Automobile & Parts Industry (Thailand)	Machine Tool Industry (Chinese Taipei)	Biotech Industry (Canada)
The Role of the Government	As a result of the Asian financial crisis, conglomerates laid off many employees, inducing them to start up their own businesses. The government provided encouragement with tax incentives, grants and the privatization of the telecommunication industry.	The government's policy of local content requirement induced investment by Japanese firms. Firms were induced to a move into the industrial area through various incentive schemes.	The role of the government is very limited; most efforts come from firms themselves.	Designs incentive schemes and related platforms to induce investment by firms. Assistance from universities and research centers.
Sources of Innovation	Firms' autonomous innovation. Foreign economies' experiences and government research institutes.	Mostly from Japanese firms	Foreign buyers, and technology assistance from core firms	Assistance from universities and research centers
Selection of Geographical Location	Many PC firms already resided there, therefore the cluster formed naturally.	Close to the main consumer market in Bangkok. Firms were encouraged to move out of Bangkok to Samut Prakan through various incentive schemes.	The cluster is formed around core firms.	Ease of access to research centers or universities to obtain skilled labor and technology transfer.
Relationship between firms in the clusters and downstream suppliers	Very intensive	Very intensive	Very intensive	Close relationship with venture capital companies and major enterprises.
Relationship between firms in the clusters, universities, research institutes, and local businesses	Very close relationship with local businesses	Very close relationship with local businesses	Not very close with universities or local research institutes, but very close relationship with local businesses	Close relationship with universities and local research institutions
Sources of Talent	Nationwide	Nationwide	Local	Global

In general, in terms of supply, all industrial clusters have advantages such as access to professional manpower, special intermediate materials and information dispersion (Krugman, 1991). As regards demand, these clusters also have an advantage in getting close to substantial users (according to the Hotelling model, companies moving to other existing vendors can obtain a larger market share). These clusters may also reduce search costs for users who can obtain the external benefit of information, whilst costs are certainly incurred within the clusters themselves. These costs include congestion costs, the costs of competition for materials in supply and, in terms of demand, a decrease in the company's profitability in a more competitive product market.

One of the reasons for forming industrial clusters is economies of scale; the larger the scale, the higher the level of performance that the cluster can achieve. In terms of demand, the cluster is aimed at providing services for 'international buyers', especially with regard to access to major growing markets. In such cases, it is very unlikely that the cluster would be able to sustain itself, or indeed survive, if it is not internationalized.

IV、QUESTIONNAIRE SURVEY AND FIELD INTERVIEWS

In this section, we explore the development of several clusters of member economies from both questionnaire survey and field interviews. Due to time constraint, we cannot cover as may clusters as expected. However, we still wish it can present some insights for firms as well as governments to formulate policies or strategic planning.

1.Questionnaire Survey

In the questionnaire survey (see Appendix 1 for details of sample) it was only possible to use a limited sample of Taiwanese IT firms because of time constraints. In the survey, we distributed 80 questionnaires to IC design houses in HSIP and 150 machinery firms in Taichung respectively. The effective sample consisted of 30 IC design houses and 20 machinery firms which returned the questionnaires. The results are as follows.

In Table 4, we can see that the main considerations for firms choosing a cluster location are "local available resources", "availability of skilled labor" and "material supply." Distance, transportation and rent are not major factors when firms choose their location.

Table 4 The main considerations for firms when choosing location（%）

Considerations	IC firms	Machinery firms
1.Material supply	30	75
2.Sources of technology	50	50
3.Local resources available	70	87.5
4.Transporation cost	0	25
5.The potential for technology development	20	0
6.Close to other firms within the industry	20	12.5
7.Rent	0	50
8.Logistics services	0	12.5
9. Availability of skilled labor	70	62.5
10.Close to research center or university	20	0
11.The distance from major clients	30	37.5
12.Others	0	0

As shown in Tables 5 and 6, firms' major buyers and suppliers are mostly domestic firms inside the cluster, which implies that the division of labor inside those two clusters is very pronounced.

Table 5　Firms' major buyers（%）

Buyers	IC firms	Machinery firms
1.Foreign firms	10	50
2.Domestic firms inside industrial cluster	90	25
3.Domestic firms outside industrial cluster	0	25
4.Others	0	0

Table 6　Firms' major raw materials or component suppliers（%）

Supplies	IC firms	Machinery firms
1.Foreign firms	10	25
2.Domestic firms inside industrial cluster	90	62.5
3.Domestic firms outside industrial cluster	0	12.5
4.Others	0	0

As for sources of technological innovation, IC firms rely on “Others” (mostly in–house R&D) and “firms inside the cluster”, while machinery firms rely mostly on “firms inside the cluster (Table 7)“ However, both IC and machinery firms have very weak connections with the academic sector and with research institutions, which is a warning sign for firms’ further learning and innovation.

Table 7 Firms’ major sources of technology or innovation（%）

Sources	IC firms	Machinery firms
1.Foreign firms (supplier or buyer)	10	25
2.Domestic research institutions	0	0
3.Domestic academic institutions	0	0
4.Domestic firms inside the cluster	40	62.5
5.Other domestic firms	0	0
6.Others	50	12.5

In Table 8, it can be seen that both IC design companies and machinery firms depend mostly on "own capital" as a major source of financial capital. Domestic banks serve as a "second source" (see Table 8), while venture capital plays only a limited role in IC design firms' financing. Therefore, venture capital should play a more aggressive role to facilitate the development of both individual firms and the cluster as a whole.

Table 8 Major sources of company's financial capital（%）

Sources	IC firms	Machinery firms
1.Foreign (venture capital or bank)	0	0
2.Domestic venture capital	30	12.5
3.Domestic bank	30	50
4.Own capital	80	75
5.Others	10	0

In Table 9, the statistics show that firms derive their manpower mostly from "domestic and inside cluster", which may limit the further growth of the cluster since firms need foreign manpower and embodied technology know-how to strengthen their learning ability.

Table 9 Firms' sources of manpower（%）

Sources	IC firms	Machinery firms
1.Foreign firms	0	0
2.Domestic and inside cluster	90	100
3.Domestic and outside cluster	10	0
4.Others	0	0

The interaction between firms and foreign buyers or suppliers is “close”, which reflects the fact that Taiwanese firms have been very successful at establishing themselves within the global division of labor system (see Table 10). In addition, firms within the cluster outsource about 10% of their key components or raw materials, which indicates that Taiwan’s division of labor system is close and comprehensive (Table 11). The major reasons for outsourcing are “to bring down investment cost”, and “allow firms to engage in specialized production” (Table 12).

Table 10 The degree of interaction between firms and universities or research institutions（%）

Degree of interaction	IC firms	Machinery firms
Very close	10	0
Close	10	14.3
Moderate	60	57.1
Not close	10	28.6
Irrelevant	10	0

Table 11 The degree of outsourcing of key components or raw materials（%）

Outsourcing or not	IC firms	Machinery firms
Yes	90	87.5
Not	10	12.5

Table 12 The major reasons for firm's outsourcing key components or raw materials（%）

Reasons	IC firms	Machinery firms
1.To bring down costs and save on expenditure	60	87.5
2.To shorten plant set-up time	0	0
3.To focus more on specialized production	60	50
4.To facilitate shipment	20	25
5.To reduce risk deriving from unstable order flow	0	37.5
6.To respond quickly to market demand	20	25
7.To bring down personnel costs	30	50
8.Unable to produce raw materials or components oneself	20	37.5
9.Not cost effective if produce oneself	40	62.5
10.Existence of some standardized components	60	75
11.Others	0	0

Finally, as the firms in the sample see it, the government policy measures for which there is the most need most are tax incentives, infrastructure provision, technology support from research institutions and low interest loans.

Table 13　Policy measures that cluster firms feel the greatest need for　（%）

Reasons	IC firms	Machinery firms
1.Tax incentives	80	50
2.Assistance from universities	10	0
3.Low interest loans	30	50
4.Infrastrasturceal provision	40	50
5.Technology support from research institutions	50	50
6.Access to foreign technology	40	12.5
7.Venture capital	10	0
8.Others	30	37.5

To summarize, our major findings are as follows. First, the major reason for our sampled firms to form an industrial cluster is to obtain local resources and technology, raw materials and skilled labor. Second, reducing production cost and specialized production are the major considerations leading cluster firms to outsource their production or raw materials. Third, from indications such as major suppliers, major orders, sources of skilled labors and so on, it would appear that firms inside a cluster have very close interaction with one another. Fourth, regarding sources of innovation, talent and interaction with local or international research institutions or universities, cluster firms still have considerable room for further cooperation. As we know, international networking, following technology transfer and the learning effect are the keys to sustainable growth for both individual firms and the cluster as a whole. Therefore, the area on which government should focus in its efforts to promote the development of clusters is how to strengthen the interaction among cluster firms and foreign research institutions and universities. Fifth, the most useful tools for the government to foster cluster development are tax incentives, technology support from

research institutions and infrastructure provision.

In addition to the questionnaire, we also conducted three field interviews, targeting clusters in Thailand, South Korea and Singapore. We present a summary of the interview results in the paper; **details of the interviews are given in Appendix II**.

2.Field Interviews

■ Summary – of the Interview Relating to Thailand's Automotive Industry Cluster

Thailand's automotive industry has grown spectacularly since the crisis of 1997, especially in the last couple of years. The Thai government has forecast that production of vehicles will top one million units by 2006, comprising 700,000 1-ton pick-up trucks and 300,000 passenger vehicles (cars) with a total value of US $ 11.6 billion. According to this forecast, Thailand will account for 48% of the total production of vehicles in Southeast Asia.

However, despite the impressive record of Thailand's automotive industry, the formation and development of Thailand's automotive cluster is still, surprisingly, in the very early stages. As far as the Thai government is concerned, building automotive clusters is a goal which will require another 5-10 years to implement; the objective is to improve competitiveness and strengthen the value chain through the synergy created by associated activities. Although the Thai government took an active role in the development of the Thai automotive industry, Thai companies are still very far away from true success, because Japanese firms enjoy almost complete dominance of the Thai automotive market. Japanese companies including Toyota, Mitsubishi, Isuzu, Honda

and Nissan hold at a more than 90% share of the local market. More and more assembly plants have been set up by Japanese firms and companies based in other economies; this plant establishment has, to some extent, been concentrated in particular geographical areas.

Thailand doesn't have any own-brand carmakers of its own, but most of the giant carmakers from Japan, the US and Europe are now in Thailand. Their legions of suppliers have followed them to Thailand, creating concentrations of plants in those areas of the economy where the car assembly firms have set up operations. Nevertheless, although getting foreign automotive companies to invest in Thailand and recognize Thailand as their hub in Asia is a very important goal for the Thai government, it is even more important for Thailand to develop and upgrade local automotive companies so that it has the means to build up a well-planned industrial cluster with the potential for further development. Judging from the current situation, Rayong and Samutprakarn are the most likely candidates for the development of clusters. If Thailand's automotive industry can form a cluster at this stage, this will provide more opportunity to move to a new level of partnership with more leading foreign enterprises. Meanwhile, Thailand's goal of developing into Asia's automotive production hub will become easier to achieve.

■ Summary of the Interview Relating to South Korea's Digital Content Industry Cluster

It is widely recognized that South Korea is rapidly becoming a major player in the global digital content market. The Korean government is planning to invest 689 billion won in the development of the digital content industry by 2007, and in

September 2003 it designated digital content and software solutions as one of the 10 major growth engines for the Korean economy. In terms of market scale, Korea's digital content market was estimated to be worth $2.3 billion won in 2002 and is forecast to reach $20.6 billion won in 2010.

The Asian Financial Crisis in 1997 was a watershed for Korea with respect to its reforms. The IMF (International Monetary Fund) provided $57 billion USD in loans to South Korea and asked for the reform of Korea's financial structure. The Kim Dae-jung administration therefore initiated a series of reforms that shook up the economy's formerly all-powerful conglomerates and paved the way for small and medium-sized firms to lead its economic growth. In March 1999, the Ministry of Information and Communications unveiled the "Cyber Korea 21" project, a four-year policy blueprint designed to make Korea one of the most advanced information societies in the world by advancing the construction of broadband infrastructure. Then the "PC Bang", Korea's version of the cyber café, emerged, leading to the rise of the online game industry in Korea.

The crisis in 1997 caused a tremendous increase in the number of bankruptcies and in the unemployment rate. However, the changes that took place in the labor market led to the emergence of many IT start-ups and ventures. Teheran Road, a strip in an affluent southern part of Seoul, was officially renamed "Seoul Venture Valley" in 2000 and has since enjoyed rapid growth. Some well-developed digital content companies have established themselves in this area as well.

In fact, the Korean government did not start to focus on developing the digital content industry until 2000. The DMC project, which was launched officially in May 2002, is slated to be completed by 2010. The Digital Media City (DMC) is a new town development in Seoul's Sangam area. It is an incubator for the creation of digital media and its application to all aspects of business, personal and community life. It is a place for cultural fusion and a twenty-first century laboratory for innovation. When it is fully up and running, the DMC will develop into a world-class cluster that greatly enhances Korea’s global competitiveness in the digital content world.

V、SUITABLE MEASURES FOR INDUSTRIAL CLUSTERS

Pietrobelli (2002) makes the following three interlocking points in his analysis. Firstly, it is very unlikely that one will be able to determine the most appropriate model for the organization of an industrial cluster. The reason is that institutions vary with their different situations. Secondly, an industrial cluster is by no means fixed; it may progress and change with time. Thirdly, globalization provides SMEs with an option to upgrade themselves because globalization enhances the opportunities to connect to the global stock of knowledge. In brief, globalization changes the proximity and scope of competition within a region; thus, in order to survive, it is necessary for businesses to develop a capability to construct a model of interaction that connects the local area to the international community thereby developing new methods of knowledge production.

However, for specific industry to form an industrial cluster, several points need to be concerned. Swann and Prevezer (1996) compared industrial clusters in the IT industry with those involved in the biotech industry and found that in the IT industry,

cross- departmental clusters helped new businesses to enter the industry whilst the impact of such clusters was not very significant in biotechnology. In addition, the scope of the science base (such as R&D centers and the research strength of universities) played a much more influential role in the biotech industry. In terms of the growth of existing vendors, both the IT and biotech industry can be influenced by current developments in trade; however, both the interdisciplinary effect and the scope of the science base have very limited impact on existing vendors.

In the IT industry, information exchange between engineers in different departments plays a crucial role whilst communication between the company and the science base is also very important. Since sustained innovation is a prerequisite for the biotech industry, biotech companies tend to be close to the science base (such as research centers and universities). Such location advantage provides not only sources of innovation but also professional technical talent. Furthermore, fundraising activities in the stock market are far more important to new businesses in the biotech industry than in the IT industry. It is very important for companies within the IT industry to situate research centers in close proximity to their headquarters as there is a continuous need for the gathering of the necessary parts, fixed devices, hardware, software and systems for the production of new products. In the biotech industry on the other hand, whilst large companies may intervene and guide the development of new companies, they do not necessarily have to be located in close proximity to the new companies. Rather than clustering around these large companies, the new companies can cluster around R&D centers. There is also less interaction between biotech companies than in the case of IT companies.

The automotive parts industry is dominated by multinational firms, with indigenous firms serving only as local suppliers, as opposed to growing into major players; therefore, this cannot emerge as an internationally recognized cluster. Within the machine tool industry international connections are very weak, in terms of technology, sources of talent, and so on, consequently, this cluster can apparently only hope to maintain its current status, since it will be extremely difficult for it to grow into a cluster with a much wider reputation.

Furthermore, Rapid cross-national dispersion coexists with industrial clusters, and therefore, cluster-based economies and the path of cluster development are still very important. Such dispersion will also be applicable in traditional industries such as textiles, but only if dispersion is not restricted to lower-end products.

Systems integration also emerges combining geographical differences and locality. A significant example of this kind of evolution is the 'global production network' (GPN), an important source of inspiration for the future development of industrial clusters. International connections are thus essential for the sustained growth of industrial clusters. In addition, these connections not only vitalize local connections but they may also provide the local clusters with opportunities to obtain international knowledge. Silicon Valley is a classic example of success in obtaining infinite upgrading capacity/power.

The GPN also represents a virtuous circle of the dispersion of international knowledge for several reasons. Firstly, it extends the companies' value chain and fosters more business opportunities for professional suppliers of small and medium size. Secondly, as these suppliers continue to upgrade their capacity, this will place pressure

upon the clusters through the continuous introduction of supporting activities of knowledge intensity and high value added. Thirdly, the participation of SMEs in the GPN helps them to obtain knowledge and to overcome obstacles during the process. A well-known example is CT's computer manufacturing industry.

The advantages of the GPN may not rely solely upon market power because there is still a need for governmental support and policies. The Netherlands, the Scandinavian economies, CT, Singapore and South Korea are all outstanding examples of governments providing support to industries in order to achieve rapid development.

From an examination of the experiences of cluster development in Malaysia, there was clearly an imbalance in the demand and supply of research students, scientific researchers and engineers; however, it was also unlikely that industry would be able to increase the inflow of scientific talent from overseas, largely because of the economy's very restrictive immigration policies. The inadequate scientific manpower makes it impossible for Malaysia to attract large numbers of high-tech companies to move into Penang and the Kelang Valley; however, the tacit and experiential knowledge attached to human resources in Penang still differs from that in the Kelang Valley (Rasiah, 2002).

The Penang Development Corporation (PDC) created the Penang Skills Development Centre (PSDC) as a means of helping vendors to solve their personnel and training problems. The open networks between the companies also reinforced the available interface for adjusting demand and supply in the production lines. These networks then turned some companies' technological limits into other companies' business opportunities, which in turn, strengthened the differentiation and professional labor disintegration in the production system, bringing in human resources with

experience and knowledge. This also succeeded in improving the dynamics and diversification of industries in Penang.

In contrast to the industrial development in Penang, there was a lack of connections and networks between the cross-national electronic companies in the Kelang Valley, although these companies were characterized by world-class production and operation methods (Rasiah, 2002). The other disadvantage was that the supporting authorities in the local government did not fulfill the role of communicator between the companies. Clearly the industrial operation in the Kelang Valley lacks differentiation and well-defined labor distribution.

VI、CONCLUSIONS

As noted in the Introduction, the ability to innovate is the key to the competitiveness of a nation, and industrial clusters are favorable to the establishment of such ability. There are several advantages for firms in the formation of an industrial cluster. First of all, it can provide complementary resources such as technology and information exchange, management assistance, and so on, to enhance the performance of firms within the cluster. Secondly, it strengthens competition and thus promotes the technical efficiency of firms; since these firms are located in very close proximity, fierce competition for both clients and suppliers is unavoidable. However, competition also pushes up efficiency. Thirdly, firms can quickly respond to the demands of the market or to changes in technology; firms within the cluster can reorganize their OEM contractors much more quickly than those outside of the cluster, thus, the ability to leverage resources to adapt to the market and to fluctuations in technology has been a

major benefit for firms locating within the cluster.

Although it is possible for a government to assist in the formation of a cluster through regulatory or policy measures, or through the establishment of industrial parks in the early stage, as indicated by Pietrobelli (2002), it is extremely unlikely that one can determine a 'best practice' for the organization of industrial clusters since globalization and time will provide continuing challenges for them. However, as time goes by and global competitive pressure increases, it becomes much more difficult for such groups to grow into major and more internationally recognized clusters.

As noted by Saxenian (2001), entrepreneurship, linkages to major and growing markets and the availability of skilled labor are three important ingredients for the successful formation of a cluster. The success of Silicon Valley is no accident, since it satisfies all three conditions; access to the US and global markets, worldwide talent providing abundant skilled labor and the perennial encouragement of entrepreneurship through the wide availability of venture capital.

These same factors have also contributed greatly to the stable growth of the HSIP. The same environment is discernible in the HSIP, the biotech clusters in Canada, the Teheran Valley of Korea and the electronics industry in Penang; however, for other clusters, because of the lack of either indigenous effort or availability of international technology and access to skilled labor, they will find it extremely difficult to nurture their much looser formations into internationally recognized industrial clusters. If these industrial formations desire to grow into clusters with an internationally recognized reputation, then they must realize that linkages to international markets, pools of skilled labor and venture capital are prerequisites.

Since the sustainable growth for an industrial cluster is to take advantage of international networking and following technology transfer and skilled labor introduction, however, the advantage of global production network (GPN) cannot rely solely upon market power because there is still a need for government support and policies. According to our major findings from questionnaire survey, tax incentives, technology support from research institutions and infrastructural provision are most needed policies for cluster to achieve sustainable growth.

Taking the specific characteristics of particular industries into consideration when designing policy measures to foster a cluster is also crucial. For instance, for a traditional industry cluster seeking technology transfer from buyers or suppliers, introducing IT technology to speed up innovation and dovetailing into the global division of labor system is a key factor in the success of the industrial cluster. For high-tech clusters, facilitating labor mobility and strengthening the support from universities and research institutions are crucial factors for the further growth of the cluster. As for emerging industries, university manpower plays a crucial role in their development. Besides, the flow of capital venture capital and the capital markets are also key factors in the start-up of new businesses and the evolution of clusters.

This paper aims to explore the current status of industry clusters and present some policy recommendation for member economies. Due to the limited time span available, we cannot analyze or survey as many clusters of member economies as we would have wished. Nevertheless, the exchange of views and sharing of the lessons learned in the development process are extremely important for members looking to establish clusters or promote the further growth of existing clusters.

Therefore, organizing a conference regarding member economies' current industrial clusters to exchange experience among universities, industry, government and research institutions will be beneficial to all member economies. The results of the conference should serve as valuable lessons for the formation of new clusters, or contribute to the growth of existing clusters pointing the future.

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Appendix I

APEC Industrial Cluster Questionnaire

Dear Sir/ Madam：

Greetings! This is a questionnaire regarding industrial cluster. The main purpose of this questionnaire is to explore the current status and activity of cluster of APEC member countries. The result can serve as a valuable reference for government's policy making. Since your company has very good reputation in the cluster, your answer will have critical impacts on our research, therefore please spare 5 minutes to answer the questionnaire.

The result of this questionnaire is only for academic research and individual firm's data will not be released, so please feel comfortable to answer the question and return the questionnaire in two weeks. Thank you very much for your cooperation.

With best wishes and the success of your company

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Part I Firms' basic data

1、Time of establishment:_____year(s), capital registration _____(US, dollars), number of employees_____

2、Firms' major products:_____、_____、_____

3、Firms' major products belong to which part of the supply chain in your industry? □Upstream□Mid-stream□Downstream

4、The sales amount of your firm （in year 2002）and the percentage of R&D expenditure over sales is _____%

5、The export percentage of your company's products? _____%

Part II Firms' cluster and the degree of internationalization

1、What are the main considerations for your company to choose the location？（multiple answers）

□Material supply □Sources of technology
□Local resource available □Transportation cost
□The development of potential technologies
□Close to firms within the industry
□Rent of the firm □Logistics service
□Skilled labor acquirement
□Close to research center or university
□The distance from your major clients □Others_____

2、Who are your company's major buyers：

□Foreign firms □Domestic firms inside industrial cluster
□Domestic firms outside the industrial cluster □Others_____

3、Who are your company's major raw materials or component suppliers?

□Foreign firms □Domestic firms inside the industrial cluster
□Domestic firms outside the industrial cluster □Others_____

4、Where are your company's major sources of technology or innovation？

□Foreign firms(supplier or buyer)
□Domestic research institutions
□Domestic academic institutions
□Domestic firms inside the industry cluster
□Other domestic firms □Others_____

5、Where are the major source of your company's financial capital？

□Foreign (venture capital or bank) □Domestic bank
□Domestic (venture capital) □Own capital
□Others_____

6、Which sources does your firm's manpower come from？

□Foreign company □Domestic and inside cluster
□Domestic but outside cluster □Others_____

7、How close is the interaction between your firm and university or research institution？

□Very close □Close □Common (so so)
□Not close □Not close at all (irrelevant)

8、How close is the relationship of your firm with foreign buyers, technology sources or suppliers？

□Very close □Close □Common (so so)
□Not close □Irrelevant

Part III Vertical division of labor and expectation for government

1、Does your company outsource key components, raw materials, service or products from outside , or contract out part of semi-finished products to other firms？

□Yes
□No（ if answer "no", please skip question 2 and 3 ）

2、How many percentage (in terms of cost) of your firm's products outsource your raw materials, components, semi-finished goods or service of your total cost? _____%. In the above outsource cost, how many percentage of them purchase from domestic firms?_____%

3、What are the major reasons from your company's products to outsource or contract out instead of producing by yourself？（multiple answers）

□To bring down cost and save expenditure
□To shorten plant set up time
□To focus more on specialized production
□To facilitate commodity's delivery
□To reduce unstable order's risk
□To quick respond to market demand
□To bring down personnel cost
□Unable to produce raw materials or components by itself
□Not cost effective if produce by itself
□Some standardized components has been existing
□Others_____

4、What kind of government policy measures does your company (or your cluster needs most)?（multiple answers）

□Tax incentives
□Low interest loan
□Technology support from research institutions
□Venture capital
□University's assistance
□Infrastructure provision
□The imports of foreign technology
□Others_____

5、Excepts for USA, Japan, which country and which industry is more likely to emerge new industrial clusters in the next 5~10years?

_____country _____industry

6、Including USA, Japan, which country and which industry is more likely to emerge new industrial clusters in the next 5~10years?

_____country _____industry

——End of the questionnaire, thank you again - -

Appendix II
Contents of the Interview Relating to the Development of Industrial Clusters in Thailand, Korea and Singapore

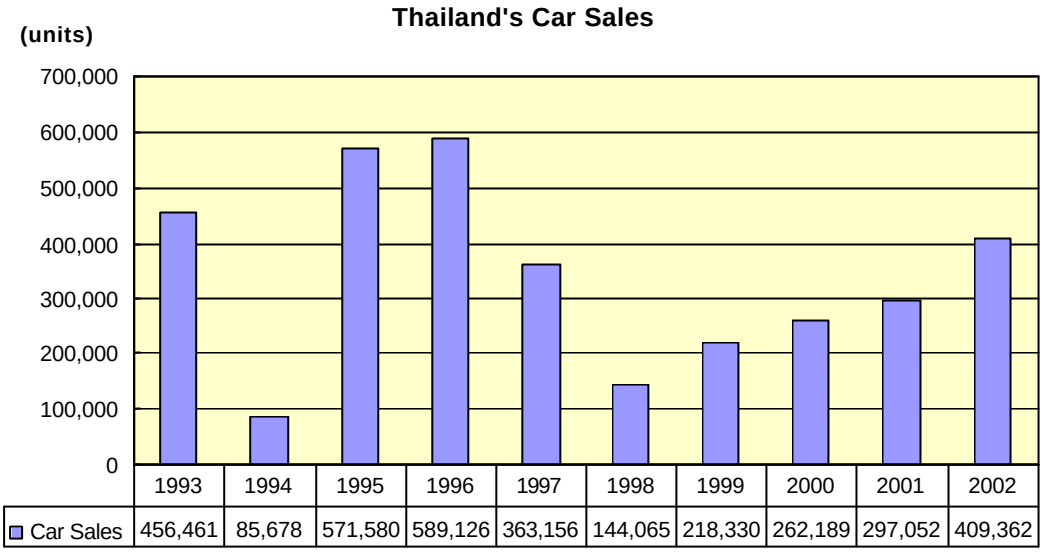
■ Contents of the Interview Relating to the Development of Automotive Industry Clusters in Thailand

Thailand's automotive industry has grown spectacularly since the crisis of 1997, especially in the last couple of years. In 2002, 580,000 vehicles were produced, with 409,000 being sold, 180,000 units of which were exported; export value reached US $2.5 billion. Production of vehicles in 2003 is expected to reach at least 700,000 units, with sales of 490,000 units, 200,000 units of which will be exported. The Thai Government has forecast that production of vehicles will top one million units by 2006, comprising 700,000 1-ton pick-up trucks and 300,000 passenger vehicles (cars) with a total value of US $ 11.6 billion. Over 40% will be exported. According to this forecast, Thailand will account for 48% of the total production of vehicles in Southeast Asia. In addition, several international motor giants plan to expand their production capacity in Thailand. In the first half of 2003, the total investment by Japanese car manufacturers was about US $400 million. Toyota, the largest automotive manufacturer in Thailand, has said that it plans to spend US $720 million to double its Thai output of pickup trucks and multi-purpose vehicles to around 200,000 units a year by mid-2004, with half destined for export. Ford, one of the big three US carmakers, said in March that it planned to produce 27,000 Everests, a new seven-seater sport utility vehicle, in 2003 and 2004 in Rayong Province, with about half of these going for

export to 50 countries in Asia, the Middle East and Africa. Mr. Praphad Phodhivorakhun, Chairman of the Federation of Thai Industries, made the following remarks about Thailand's automotive industry in his speech, "Industrial Sector Perspectives on the East Asian Economic Region".

'At the turn of the new millennium, with the latest addition of General Motors (Thailand) and BMW (Thailand), there are now sixteen automotive assembly plants in Thailand with maximum potential capacity of around one million units per year. Today Thailand has come to be considered "the Detroit of ASEAN" in the automotive industry, since it has the largest vehicle assembling capacity and the highest quality parts manufacturing capability in ASEAN. There is a strong demand within the domestic market with 3 million potential buyers. Moreover, as a member of AFTA (ASEAN Free Trade Area), Thailand's export industries, including automobiles, will enjoy the benefits of market enlargement, producing for a market with a population of more than 500 million.'

Thailand does indeed have a large automotive market (vehicle density in Thailand has been estimated at one vehicle per 13 people). Thailand is the largest of the ASEAN exporters. Thailand is also the world's second largest producer of pick-up trucks behind the US. Thailand is poised to become a leading automotive center in Asia. However, although Thailand's automotive industry has achieved impressive results, the formation and development of Thailand's automotive cluster is still, surprisingly, in the very early stages.



Note: includes 1-ton pick-up trucks *Source: Toyota Motor Thailand Co Ltd*

ASEAN Big Four Vehicle Sales, 1996-2002

Country	1996	1997	1998	1999	2000	2001	2002
Indonesia	332,548	391,807	58,303	94,474	300,573	299,607	317,035
Thailand	589,126	363,156	144,065	218,330	262,189	297,052	409,362
Malaysia	364,789	404,849	163,852	288,547	343,173	396,458	434,859
Philippines	162,096	144,657	80,230	74,414	83,949	78,566	85,587
Total	**1,448,559**	**1,304,469**	**446,450**	**675,765**	**989,884**	**1,071,683**	**1,246,843**

Source: Automotive Resources Asia Ltd.

If we define the automotive cluster as an area with large numbers of automotive-related businesses of all sizes and some supportive institutions (e.g. incubators), Thailand has not developed this kind of cluster so far. Thailand Automotive Institute, a government-supported organization established to promote and develop the Thai automotive industry to be competitive in the global market, refused to

fill out the questionnaire we sent them for the industrial cluster project, explaining that it was "too early for them to answer." We got a similar answer from Mr. Kenji Yamamoto, President & CEO of Thai Suzuki Motor. Mr. Yamamoto said he couldn't point out a specific area that could be called an "automotive cluster." These answers were actually very different from the information which we obtained before the visit to Thailand in early September. A report from Sakura Institute of Research, Inc. in Jan 2001 (the author is Minako Mori) stated that the main automobile manufacturing clusters were the traditional industrial areas around Bangkok, where the Japanese assemblers established their plants during the 1980s, and the emerging industrialized areas in the eastern seaboard region and Ayutthaya Province, where assemblers began to build new plants for market expansion in the 1990s. Although some areas might be mapped out as potential automotive industrial clusters, it was evident that these areas still didn't have the complete functions of a cluster. These geographical clusters combined non-related businesses in other industries, and lacked the research institutes to help support and upgrade the industrial technology and the academic or training schools to cultivate specialists in this field (assemblers and parts suppliers complained about the lack of qualified engineers in the country and the impact of the overall educational level on future development.). Apparently auto or auto parts companies in particular areas did not benefit from their location (e.g. more productivity, efficiency, information, innovation, opportunities for cooperation etc.). As far as the Thai government was concerned, building automotive clusters was a goal which would need a further 5-10 years to achieve, with the aim being to improve competitiveness and strengthen the value chain through the synergy created by associated activities. TAI (Thailand Automotive Institute) was established to offer advice and take charge of the

action schedule for the automotive industry, including the development of the automotive clusters. TAI is actually an autonomous organization, a joint-effort between the government and the private sector. The Institute was established on September 14th, 1998 by the Ministry of Industry. Despite being founded under the Ministry's umbrella, TAI does not operate under the rules and regulations that apply to government entities including state enterprises. For our project, TAI offered two maps (see page 5)that indicated the locations of Thailand's auto and auto parts companies for our reference. However, TAI insisted that the development of this area was not mature enough to be called a "cluster". Although a mature cluster has not been formed, we couldn't deny that the Thai government took an active role in the development of the Thai automotive industry, and would continue its support in the future. In fact, the automotive industry was designated by the government as a strategic industry for the development of Thailand's economy. On the vehicle production side, the Thai government intended to promote Thailand as a global center for both light pick-up truck production and motorcycle production, and to encourage development of more advanced modified vehicles based on pick-up platforms. On the auto parts production side, the government encouraged the industry to pursue three areas for development and growth:

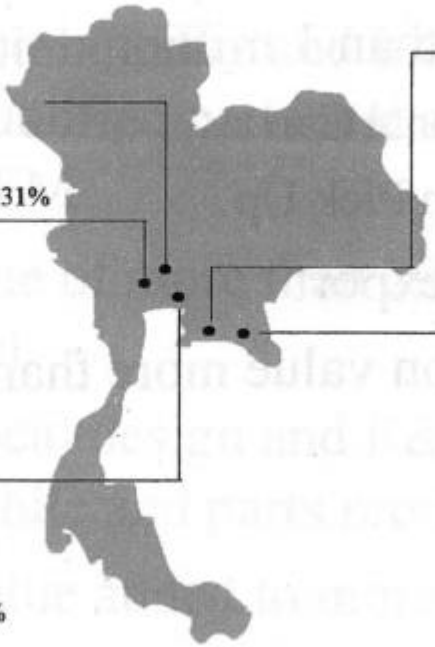
(1) Invest in and develop true R&D capabilities to be able to add value to their products, and to be able to compete on an international level.

(2) Develop into producers of component systems or subsets, rather than just simple parts, again in order to add value and be more competitive.

(3) Leverage the expanded market opportunities that the ASEAN free trade area offers to them.

With the strong support of the government, Thailand's domestic capabilities have improved sharply in the past thirty years, and assemblers have begun to source auto-related parts locally. Furthermore, the local content requirement policy was abolished on January 1, 2000, so the Thai companies were forced to improve the quality of their products in order to compete internationally instead of just locally. Usually, Thai companies must obtain ISO 9000 or QS 9000 certification. However, a protectionist policy continued over a period of many years, including high import tariffs, distorted production decisions. Most the Thai companies were used to receiving work orders for which the customers provided the product drawings, samples and technical specifications. Therefore, most of them lacked design abilities for advanced products. This situation was bound to hamper the future growth of the clusters to some extent. Currently, there are 1,637 registered auto-parts manufacturers in Thailand, 15 of which are large-sized firms, 738 of which are medium-sized and 903 of which are small. Clearly, most of them are Thai-owned small-to-medium enterprises, falling under the category of second or third-tier suppliers. For companies such as these, besides the support of the government, collaborating with other Thai companies is of vital importance. The Thai Automotive Parts Manufacturing Association (TAPMA) was founded for this reason. Formed in 1978 and consisting of more than 200 members, the independent association's goals are to work closely with the government to form industry policy, to advance the working relationship between government and industry, and to collect industry data for use by government and industry in further developing the Thai auto industry.

Mapping of Auto-Parts Industry



Pathumthani
Total suppliers: 39
Body Parts: 18%, Engine Parts; Electrical Parts: 13% each, Suspension & Brake Parts: 10%, Drive, Transmission &Steering Parts; Accessories:8% each, Other:31%

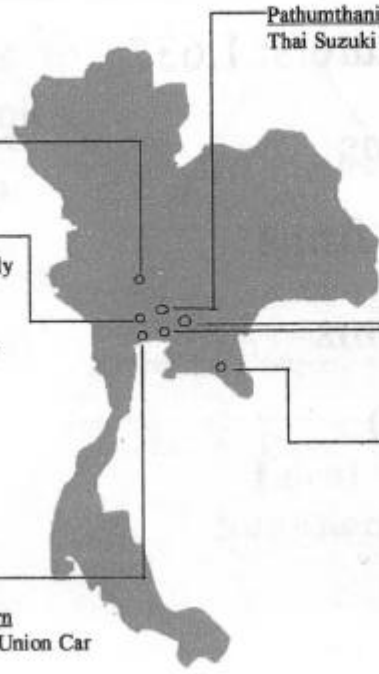
Bangkok
Total suppliers: 232
Body Parts: 9%, Engine Parts; Electrical Parts; Drive, Transmission &Steering Parts; Accessories: 6% each, Suspension & Brake Parts: 4%, Mold&Die: 3%, Other: 60%

Samutprakarn
Total suppliers: 158
Body Parts: 22%, Electrical Parts: 15%, Engine Parts; Drive, Transmission &Steering Parts: 8% each, Suspension & Brake Parts: 5%, Mold&Die: 4%, Accessories: 3%, Other: 36%

Chonburi
Total suppliers: 55
Body Parts: 25%, Engine Parts: 22%, Drive, Transmission &Steering Parts: 15%, Electrical Parts: 9%, Accessories: 5%, Suspension & Brake Parts: 4%, Mold&Die: 4%, Other: 16%

Rayong
Total suppliers: 41
Body Parts: 24%, Engine Parts; Drive, Transmission &Steering Parts: 15% each, Suspension & Brake Parts: 12%, Electrical Parts: 10%, Accessories: 7%, Mold&Die: 2%, Other: 15%

Mapping of Automotive Industry



Pathumthani
Thai Suzuki Motor

Ayudhaya
Honda Automobile (Thailand)

Chachoengsao
Toyota Motor Thailand

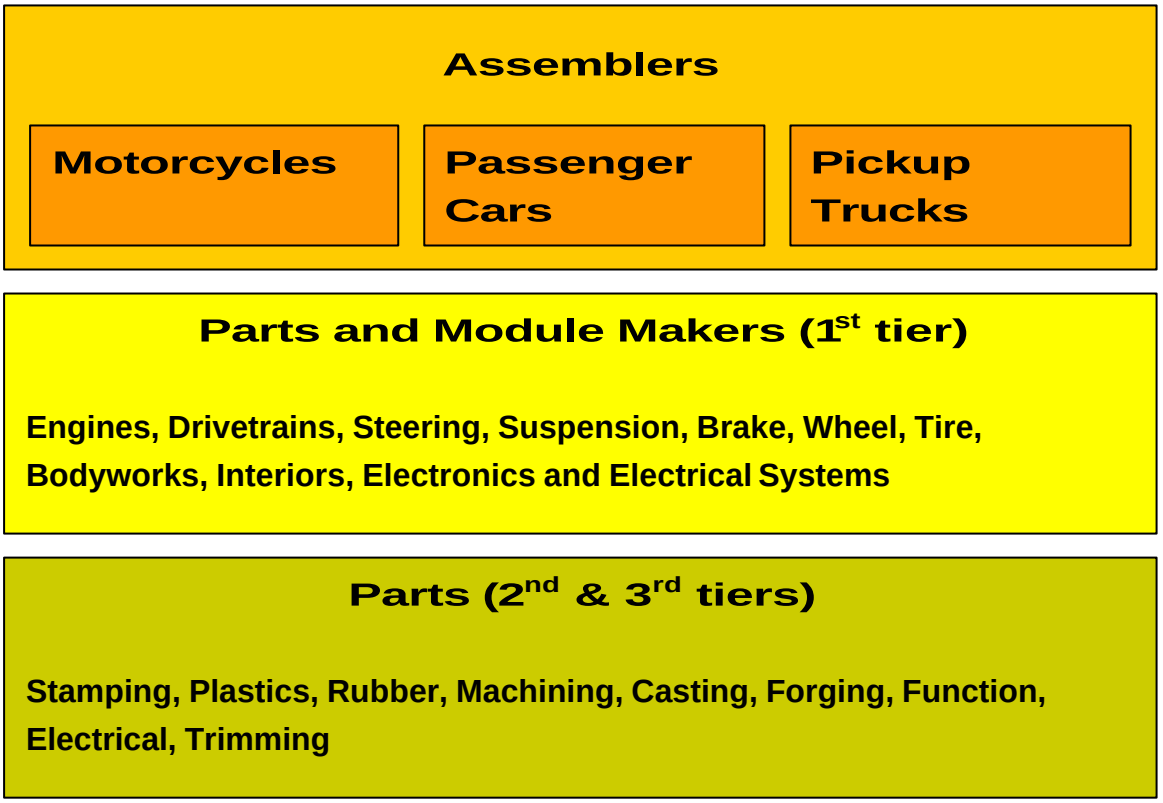
Bangkok
Bangchan General Assembly
Hino Motors (Thailand)
Y.M.C. Assembly
Thai Honda Manufacturing

Samutprakarn
Toyota Motor Thailand
Isuzu Motors
Siam Nissan Automobile
Siam V.M.C. Automobile
Thai Auto Work
International Vehicles
Thai Yamaha Motor
Thai Swedish Assembly
Thonburi Automotive Assembly

Rayong
Auto Alliance
General Motors
BMW Manufacturing (Thailand)
Kawasaki Motors
Enterprise (Thailand)

Samutsakorn
Thai Rung Union Car

The Thai Automotive Industry Structure



Source: Sasin-team analysis

The Thai companies are still very far away from true success because Japan enjoys almost total dominance of the Thai automotive market. Japanese companies including Toyota, Mitsubishi, Isuzu, Honda and Nissan hold a more than 90% share of the local market (Toyota claimed a market share of approximately 31.77% in 2002, making it the number one player in Thailand.) Japan is also the most important investor nation in Thailand. Because of many favorable factors in Thailand such as the stable political situation, the competitive low wages and the efforts made by the BOI (the Board of Investment) to encourage investment, etc., there has been a steady flow of Japanese auto and auto parts manufacturers moving into Thailand. Impressed by Thailand's potential, Japanese companies have invested heavily there, and Japan imports a considerable

volume of goods from Thailand. On October 17, 2000 the Japan Automobile Manufacturers Association (JAMA) and the Japan Auto Parts Industries Association (JAPIA) announced a four-year plan to send automotive field management, production technology and improvement guidance experts to Thailand, to discover and clarify problems at local auto and motorcycle parts suppliers designated by the Thai side, and to furnish advice and guidance to improve operations. The plan was designed by the Japan External Trade Organization (JETRO), which established an office in Bangkok in 2000 (the first such support center anywhere in the world) to encourage Japanese auto makers with production bases in Thailand to localize more parts production.

Year of establishment and location of Japanese car assemblers

Number on the map	Assembler	year establish (product. start up)	location
1	Nissan (Siam Motors)	1962	Samut Prakan
2	Toyota	1964	Samut Prakan
3	Hino	1966	Samut Prakan
4	Mitsubishi	1966	Bangkok (Lad Krabang)
5	Isuzu	1966	Samut Prakan
6	Mazda	1975	Bangkok (Bangchang)
1	Nissan (Siam Nissan Auto)	1977	Samut Prakan
7	Nissan Diesel	1987	Pathum Thani
8	Honda	1993	Bangkok (Minburi)
9	Mitsubishi	1992	Chonburi (LaemChaBang)
10	Toyota	1996	Chachoengsao (Gateway)
11	Honda	1996	Ayutthaya (Rojana)
12	Isuzu		Chachoengsao
13	Auto Alliance Thailand (Mazda/Ford)	1998	Rayong
14	General Motors	2000 (1998)	Rayong
15	BMW	2000	Rayong

Source: http://cockeas.montesquieu.u-bordeaux.fr/lecler_bx.PDF

Japan is of course not the only country that is interested in Thailand's market. In 2002, Singapore was Thailand's second largest source of foreign investment behind Japan, with 40 projects worth US $314.5 million approved for promotion by Thailand's BOI – an increase of 45.9% over 2001. Meanwhile, bilateral trade in automotive parts between Singapore and Thailand increased by 33.1% from 2001 to US$153 million in 2002. Singapore is one of the few countries in ASEAN which possesses superior precision engineering and electronics manufacturing capabilities. Singapore's automotive sector aimed to help Thailand to overcome the capability gap that has existed for so long in auto parts manufacturing, in exchange for a piece of the big market "pie" in Thailand. In February 2002, as a further testimony to the close

bilateral relationship existing between Thailand and Singapore, the Prime Ministers of both countries agreed to the establishment of the Singapore-Thailand Enhanced Economic Relationship or STEER. Singapore's Trade and Industry Minister George Yeo and Thailand's Deputy Prime Minister Somkid Jatusripitak officiated at the first STEER meeting on August 25-27, 2003 and at the same time JSG-AEPCIC (Singapore-Thailand Joint Study Group on Automotive Electronics Parts and Components Industry Cluster) was formed to identify potential opportunities for collaboration between the two countries in the automotive electronics parts field. JSG-AEPCIC members included private-sector business people from the two countries. The Singapore grouping was led by Chairman Ng Boon Hoo, who is also chief executive officer and executive chairman of Sunningdale Precision Industries, with Gilbert Ong Peng Koon, chairman and managing director of Armstrong Industrial Corporation, as Vice-chairman. The Chairman on the Thai side was Vallop Tiasiri, executive director of the Thailand Automotive Institute (TAI), and its Vice-chairman was Thavorn Chalassathien, secretary general of the Thai Automotive Parts Manufacturer Association (TAPMA).

In order to maintain a sustained business relationship, the JSG-AEPCIC recommended the following:

(1) ASEAN auto parts web portal

(2) Enhanced partnership between Singapore Precision Engineering & Tooling Association (SPETA) and Thai Auto Parts Manufacturers Association (TAPMA)

(3) Ongoing efforts to deepen market integration and provide infrastructure and facilities to localize the production of automotive

parts in the two countries.

One concrete deliverable was the signing of the MOU between TAPMA and SPETA on 27th August 2003, to promote increased business opportunities between companies in the automotive sectors of both countries. A private-sector-led Thai-Singapore Automotive Club will be established subsequently to assume the organizing of these activities that will facilitate knowledge sharing and industry networking. The TAI and SPETA websites now also provide hyperlink access to each other's databases with profiles and updated business interests of Singapore and Thai companies supplying to the automotive sectors. Singapore has a pool of more than 60 local enterprises with the interest and capability to serve as Tier II and III automotive suppliers. Of these, more than 30 held QS 9000 certification or have been working towards it. Many have already supplied to top Tier I companies, such as Delphi, Robert Bosch, Sanden, Siemens VDO, TRW Automotive and Visteon, and some even directly supplied to OEMs such as Audi and Ford.

Conclusion

Thailand has no own-brand carmakers of its own, but most of the giant carmakers from Japan, the US and Europe are now in Thailand. Their legions of suppliers have followed them to Thailand, creating concentrations of plants in those areas of the country where the car assembly firms have set up operations. Nevertheless, although getting foreign automotive companies to invest in Thailand and recognize Thailand as their hub in Asia is a very important goal for the Thai government, it is even more important for Thailand to develop and upgrade local automotive companies so that it has the means to build up a well-planned industrial cluster with the potential for further

development. Judging from the current situation, Rayong and Samutprakarn are the most likely candidates for the development of clusters. If Thailand's automotive industry can form a cluster at this stage, this will provide more opportunity to move to a new level of partnership with more leading foreign enterprises. Meanwhile, Thailand's goal of developing into Asia's automotive production hub will become easier to achieve.

■ Contents of the Interview Relating to the Development of Digital Content Industry Clusters in Korea

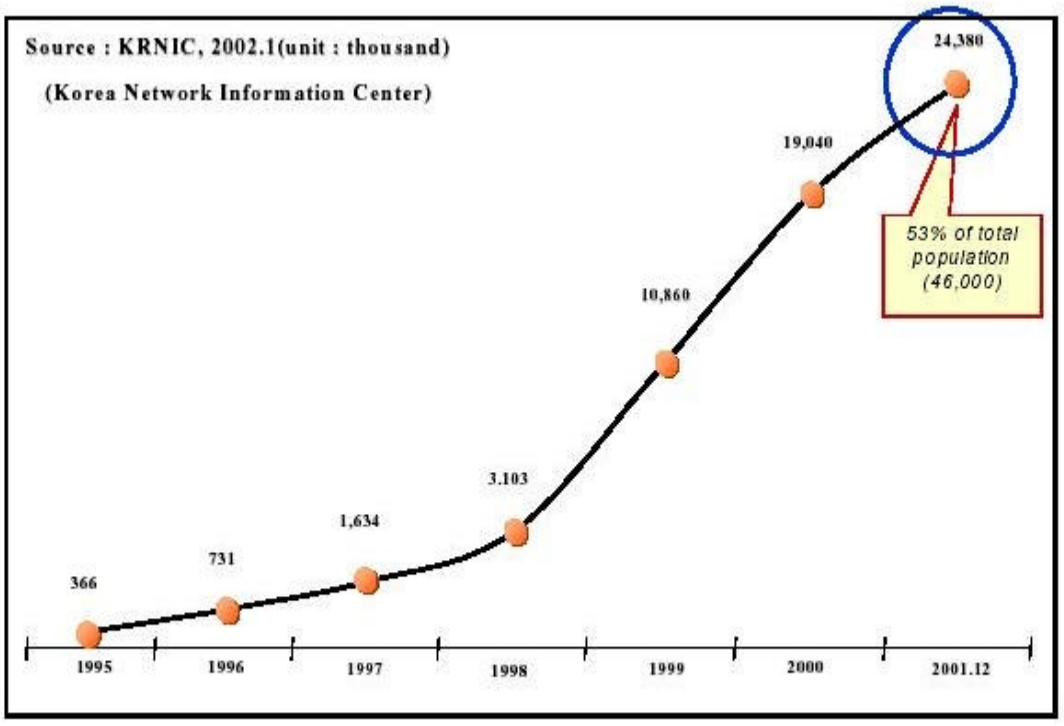
It is widely recognized that South Korea is becoming a major player in the global digital content market. Scrambling to strengthen the digital content industry to spur the growth of the economy and IT exports in particular, the Korean government decided to invest 689 billion won in the development of the digital content industry by 2007, and in September 2003 it designated digital content and software solutions as one of the 10 major growth engines for the Korean economy. In 1999, KGDPI (The Korean Game Development and Promotion Institute) was founded by the Ministry of Culture and Tourism to develop the domestic game industry, and later in the same year KOFIC (The Korean Film Commission) was restructured from the Korean Motion Picture Promotion Corporation founded in 1973 to promote and support the production of Korean films. In 2001, KOCCA (The Korea Culture and Contents Agency) was established to provide systematic support for the cultural industries. In terms of market scale, Korea's digital content market was estimated to be worth $2.3 billion won in 2002 and is forecast to reach $20.6 billion won in 2010. According to the Korea IT Industry Promotion Agency, there are approximately 2,200 registered digital-content-related companies in Korea, about 72% of which have actual business in

the digital content field.

The Asian Financial Crisis in 1997 was a watershed for Korea with respect to its reforms. Many countries of the Far East were gripped by the crisis, which announced its arrival on 2 July 1997 with the steep fall of the Thai currency. Later the crisis spread from Thailand to Indonesia, Malaysia, the Philippines, Singapore, South Korea and Japan. Since the effects of this crisis were very destructive, the IMF (International Monetary Fund) provided $57 billion USD in loans to South Korea and asked for the reform of Korea's financial structure. Hence, while Korea's past growth strategies were focused on increasing output by putting in more production factors like labor and capital, the latest plan turned to putting more into making high-value-added products and services. The Kim Dae-jung administration initiated a series of reforms that shook up the country's formerly all-powerful conglomerates and paved the way for small and medium-sized firms to lead its economic growth. Most significant were its efforts to set low tariffs for Internet access, introduce competition into the local telecommunications market, and privatize state-run Korea Telecom, which was first listed on the Korea Stock Exchange in December 1998. Home broadband connections can now easily be had for as little as $40 per month. In March 1999, the Ministry of Information and Communications unveiled the "Cyber Korea 21" project, a four-year policy blueprint designed to make Korea one of the most advanced information societies in the world by advancing the construction of the broadband infrastructure. A high-speed broadband network connecting 144 call areas was built and came into operation in 2000. In addition, 2-Mbps Internet access is available to 10,482 elementary, middle and high schools and 36,689 lines have been supplied to the public

sector including government offices, research institutions and libraries. It is the Korean government's target to provide 20-Mbps broadband communication service to 84% of Korean households by 2005. In terms of education, the policy program's first target was Korean children, who were taking computer classes from the 1st grade in LAN-connected labs at 10,000 schools nationwide by 2001. The government also had their mothers in mind, having established institutes to train some 2 million housewives in the use of the Internet. By 2003 the programs had brought some 20,000 military personnel, 150,000 farmers, and 20,000 young farmers and fishermen online. Also, the "Silvernet Campaign" project was a bid to decipher the mysteries of computing for citizens 55 and older. The elderly and the conservative may need a bit of prodding to enter the cyber-age, but Korea's younger generation are embracing it with a frenzy all their own. The boom of the PC Bangs in Korea in the last few years has been regarded as a distinctive feature of internet culture in Korea. Playing online games is the most common activity that customers engage in at PC Bangs. It has led to the rise of the online game industry in Korea.

Aside from the effect upon the government and policies, the crisis in 1997 impelled a tremendous increase in the number of bankruptcies and in the unemployment rate. The PC Bang became a refuge for the overstressed and the frustrated. However, the shake-up of the labor market also led to the emergence of many IT start-ups and ventures. Moreover, encouraged by the Korean government and the IT craze, legions of young people fled secure jobs to launch startups, evidence of an inherent tendency among Koreans to take risks. By the end of 1999, the Korean government had poured 350 million won into venture capital and venture investment capital associations.



Explosive Growth of Internet Users in Korea

Like so many other things in Korea, the dot-com industry is concentrated around Seoul. Some 42 percent of all the venture firms in the country are based in the capital area. Teheran Road, a strip in an affluent southern part of the city, was officially

renamed "Seoul Venture Valley" in 2000 in tribute to the businesses that have revitalized it. The names on the office buildings in the area are a virtual who's who of domestic and foreign technology; Microsoft, NEC, Cisco Systems, Korea Telecom Freetel, and Dacom are just a few of the firms who have settled in. Sandwiched between two major subway stations, a stone's throw from major luxury hotels and the massive COEX center and with plenty of financing sources nearby, most venture firms still view this as the paramount place for startups to do business. Some well-developed digital content companies are incorporated in this area as well. Nevertheless, this is likely to change in 2010, when the massive "Digital Media City" project is wrapped up. Aiming to create a world-class digital content cluster, the government has reclaimed the land necessary for the venture and is currently working on establishing the infrastructure for a completely self-sufficient dream city that will house high-tech industries, research institutes, housing complexes and green space. Nearly all of Korea's major companies have invested heavily in the project, as have foreign corporations like Cisco Systems and Intel. Tehran Road and Seoul itself may lose some of their luster if the reality of Media City measures up to the vision.

In fact, the Korean government has focused on developing the digital content industry since 2000. The government has completed the establishment of, and begun providing services from, a digital data bank with 900,000 image materials. The development of a Meta DB system has established a joint utilization system for industrial information, and established Technological Support Centers for Multimedia in regional bases (including Chuncheon, Jeonju, and Busan) to prepare a nationwide foundation for growth in the digital content industry. In addition, the government has provided support to the transformation of IP (Information Provider) business based on PC communication into CP (Content Provider) business based on the Internet.

2001 New Content Business Development Policy

Category	Main Content
Strengthening competitiveness in web casting	● Expanding web casting support center - Training supervisors of digital content development through public equipment. ● Establishing a Digital Content Production Support Center
Promoting e-Books	● Establishing e-Book bank that provides total information about publication, copyrights and resources - Supporting the creation of multimedia books and providing information about the e-Book industry and its technology - Cultivating professional personnel for designing, developing, and circulating e-Books. - Organizing e-Book standarization forum such as ETRI and e-Book industry conference.
Boosting Competitiveness in Wireless Content	● Supporting the selection of bright prospects for core wireless content, then foster the development of wireless content ● Establishing networks that allow wireless content to advance abroad - Installing content on wireless terminals for export
Fostering e-Entertainment	● Supporting creation of e-Music content and advancing it into the market abroad through cooperative relationships with Asia and Pacific regions ● Supporting international cooperative development of 3D animation ● Establishing a test-bed center for e-Entertainment content and holding preview events.

Digital Media City

For 15 years from 1978 to 1993, Nanji-do was a landfill for dumping Seoul City's garbage. Used charcoal briquettes and other waste produced during the course of city development have piled up to form a mountain of trash. By the early 90's, the mountain was 95 meters high and 2 kilometers long even after being compressed to take a rectangular shape that weighed over 120 million tons. When one considers that the height of Mt. Nam-san in Seoul is only 262 meters, the sheer mass of trash is readily appreciated.

From 1996, Seoul began to launch stabilization projects to withhold further industrial developments and build facilities to prevent the environmental contamination caused by the landfill zone. The stabilization projects included the works of reinforcing landfill inclines that were on the verge of collapsing, minimizing the sludge from trash and collecting harmful gases through gas pipes. The gas accumulated in the process will be utilized as the heat energy necessary for heating nearby facilities of the Seoul World Cup Stadium and the Sangam Housing Development Area.

The region was first designated as a housing development zone in March 1997. The 'New Seoul Town Development' project was announced when Mr. Goh Kun became the new mayor in July 1998. In August of the same year, the general planning for New Seoul Town project began to take form. Based on this, a master plan was established for the Millennium City (Sangam New Millennium Town). Along with drawing up a city plan to turn the Sangam region into a secondary center of Seoul, a subsequent plan was drafted to build a gateway town that embodies both information and ecology. The plan is now being carried out in concrete and separate projects such as World Cup Park, an environment-friendly housing complex, and Digital Media City.

The Digital Media City (DMC) is a new town development in Seoul's Sangam area. It is an incubator for the creation of digital media and its application to all aspects of business, personal and community life. It is a place for cultural fusion and a twenty-first century laboratory for innovation.

DMC is 7km away from the center of Seoul. It is located on the way from Inchon and Kimpo Airport to Seoul; if the Kyung-ui Railroad service going through North Korea to Siberia is able to begin operation, DMC will be a strategic place for the unification of North and South. Seoul City has already finished establishing and extending the roads around DMC. Moreover, Sooseek Station on Subway number 6 and the nonpolluting Monorail that will be the new means of transportation inside DMC will make public transportation much more convenient. Ka-yang Bridge, Sung-san Bridge and the second Sung-san bridge will provide rapid access to the IT enterprises which are located on the south side of the Han river.

Digital Media City (DMC) is a place where media technology, industry and cultural arts are harmonized with the city environment. The master plan for Seoul's DMC proposes that the DMS serve as its main street; this means that Digital Media Street (DMS) will be the key element of DMC. DMS will not only be a place for testing new products, events and technology but also a place that will create an atmosphere of excitement, creativity and innovation for all those people who pass by on the street - those going to work and to their homes, as well as visitors from throughout the world.

The DMC is built around three fundamental concepts. First, it should be an eco-city where environmental protection is of prime importance. Technology will meet ecology in the DMC. Second, it should be an info-city leading the Korean as well as Asian digital media industries. It is where innovation will meet investment. Third, it will be a gateway city and a new center of innovation for the whole Asia. It will link Seoul with the real world via cutting-edge transport facilities and its central

position in Northeast Asia. Meanwhile, in order to help integrate digital content industry development, the Seoul Metropolitan Government has designated different lots for different purposes: namely, public facilities, R&D, education, commercial, infrastructure, etc. The DMC project, which was launched officially in May 2002, is slated to be competed by 2010. When it is fully up and running, the DMC will be ready to host leading organizations and businesses operating in the digital content industry dealing with broadcasting, games, film/animation, music and cyber education as well as the IT & S/W industry.

Besides the world-class DMC, there are several other regions dedicating themselves to digital content. The Korean central government has already empowered the regional governments to develop their own potential, understanding the importance of regional innovation to the nation's economic growth. Busan, Puchon and Sondo are being developed as model cities which host digital content complexes and related activities.

An industrial cluster refers to a geographic concentration of companies, colleges and research labs aiming to achieve synergy effects in terms of sharing in the results of technology development, human resources and information. Korea is working on it. In the past, Korea only established policies for the development of industrial complexes, which are simply aggregates of companies or facilities and only provide infrastructure for the companies concerned. However, after the completion of the DMC, Korea may once again take the lead over other countries and enhance its global competitiveness in digital content world.

■ Contents of the Interview Relating to the Development of Industrial Clusters in Singapore

General

The purpose of the study is to examine the subject of industrial clusters with an emphasis on the hi-tech sector.

Background

Industrial clusters are an important factor in the development of industrial infrastructure. Creating a critical mass in one geographical place is fundamental to effectiveness, and to competitiveness in the domain of suppliers and logistics, in a period of barriers to transferring light industry cluster know-how. Creating a skilled reservoir of skilled people is a key factor here.

Have the dawning of the information era and the process of globalization, including the lowering of trade barriers, made the cluster superfluous?

Interviews with different profiles were undertaken in order to study policies in Singapore and the success of these policies, and to attempt to make forecasts regarding future developments:

- The first interview focused on the planning function at the administration level in Singapore. The EDB (Economic Development Board) is responsible for planning, initiation and support of industrial development. A meeting was held with the person in charge of EDB and members of his team to discuss the clusters in the field of logistics and transport.

- The second –interview focused on the research function. For this interview, a meeting was held with NUS (National University of Singapore) university personnel.

- The third –interview focused on industry itself. Meetings were held with local managers, with the staff of large, multi-national companies - HP and Motorola - as well as with an entrepreneur who founded a start-up in the field of biotechnology (a field which the government of Singapore has defined as a central cluster).

EDB

The basic concept in creating clusters originally involved the creation of a critical mass in the field of production by multi-national players. A change in this approach is now being consolidated; the approach to cluster development is now supposed to encompass the whole life-cycle of the activity and all the related technological aspects.

In this new concept –, the aim is to consolidate a mass that includes players at all stages of development, so that small start-ups are given a much greater chance to grow and succeed.

The government is not the only player in the characterization of the domains and the character of the activity; it is more of an accelerating factor. Every package is important to the companies - manpower, suppliers, benefits, etc.

The government is involved up to the stage that a critical mass is formed; then it ceases its involvement and the process sustains itself from the feed-back deriving from industry. Private companies view the construction of the joint infrastructure and

government involvement as a very substantial component for success.

NUS

Despite the progress made in information technology, the question of physical proximity is still very important due to cultural factors.

The advantages of common residence have cultural origins, but there are other factors too, including the very high costs of searching, and the fact that people have a high inertia factor and tend to resist change and relocation. The key factor here is the development of a physical partnership that has a critical mass.

There is a large risk in defining the cluster, since the coming into existence of a cluster is not necessarily determined on an economic basis;more often it is determined on the basis of political or personal considerations, and there can thus be an error of serious magnitude.

Factors for success

Manpower - there is a greater chance of success in an environment with a serious system of manpower training (in academia).

Smart investors - it will be difficult to succeed in the consolidation of a cluster without a population of sophisticated investors that makes intelligent investments directed towards start-ups.

Original ideas - it is clear that in order to succeed in an environment of global competition one has to stay ahead of everybody else.

International connections - it is very difficult to succeed without strategic partnerships. The government must create the background and foundation for this.

Life track -- R ----------→ P ----------→ A ----------→ M

Concept research	Concept proof Prototype	Commercial information	Research

A small part of the information (R, P) is translated into products that succeed in the market; this takes place mainly in places where there is smart money.

Owing to all the risks in characterizing the cluster and supporting its critical segments, cooperation between the government –and the private sector during this period is essential to the success of the cluster.

One-dimensional clusters have been a success story. Here, the intention was to create clusters consisting of only one stratum out of all the action strata; in general, the development of this type of cluster has proceeded smoothly.

In conclusion–, clusters have proved highly effective in the past, and will probably remain important in the more complex, multi-dimensional future, with continuing cooperation between the private sector and government.

Bio-technology Start-Up - Dr. Gurdiner Shahi

Singapore is trying to create a cluster and critical mass in the field of bio-technology. The justifications for this were in existence of an old and successful cluster in the field of chemistry (a field that is closely related to, and complements, biotechnology), and the fact that the biotechnology field itself is enjoying rapid growth.

Carrying the analysis up to the present, there has been great success in the area of production, and this has become a self-sustaining process. There has been considerable effort in the field of research; however, the view expressed in the interview was that, until they succeed in bridging the gap between the production infrastructure and research (i.e. phases P and A), it will be difficult to predict the success of the concept, and it will be exposed [vulnerable] to external risks.

The entrepreneur saw himself as being situated at an important juncture, and attaches much importance to maintaining a production infrastructure, which will enable him to be competitive in the future.

HP

HP came to Singapore because of the special advantages that Singapore offers, and because of its role as the doorway to East Asia. There is little reciprocity with other industries; the main reason why HP has stayed in Singapore is the presence of an educational - engineering cluster, with high-quality manpower, engineering, etc.

Another factor mentioned as an important reason for being in Singapore (and one which was common to all the large multi-national corporations) is the presence of an extensive, highly-developed infrastructure in the fields of communications, transportation, justice, education and law, and stringent observance of intellectual property rights.

Motorola

In the area of production, Motorola was attracted to Singapore by its relatively low labor costs, the availability of government subsidies and the potential of the local

market. The existence of a production cluster was not a significant factor in their decision to locate in Singapore.

Motorola has never used the existence of industrial clusters as a basis for locating activity; it is manpower costs, engineering capabilities and the presence or absence of peripheral industries that are the basis for these decisions. This is why Motorola has been moving production from Singapore to places where production costs are lower. The considerations for engineering, research and development are somewhat more complex and include the manpower resources available, cost, and protection of know-how. Currently, Motorola still has engineering operations in Singapore; an appraisement of whether it will move away from Singapore cannot be made at present.

The regional headquarters is located in Singapore first and foremost because of personal considerations relating to senior management. Currently, the head of the regional headquarters is an Australian; Singapore meets his requirements for convenient access to the whole region, a sound legal system and superior education for his children.

In conclusion, it seems that the crucial issue for regional headquarters is an advanced supporting system with respect to skilled manpower, the legal system and education.