Technology Transfer Cooperation among Research Institutes, Universities, and Science Park Enterprises– Taiwan's Experiences and Models

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Abstract

Taiwan has long been well known for its science parks development. Since the first one established back in 1980, thousands of hi-tech companies have formed with a total annual sales over 71 billion US dollars in 2005. Beside government policies, venture capitals, and human resources, proper technology transfer mechanisms are essential factors to achieve such remarkable industrial impacts.

Taiwan's small and medium-sized firms account for the lion's share of the industrial structure. Thus makes research institutes and universities play a major roll for enhancing hi-tech enterprises' R&D abilities, especially during the initial and growing stages of technology type enterprises (most of them are SMEs'). And for those bigger technology enterprises, Taiwan's research institutes and universities also act as major supplementary sources for their global IPR needs.

1. Industrial transformation of Taiwan

Taiwan is a small island lacks of natural resources. In 1952, its per capita GDP was only US$196, outputs from the first grade industries accounted for 32% of the nation's GDP, while the second grade for 15% only. After more than fifty years development, the per capita GDP has reached US$15,271 and 24.64% from the manufacturing sector as of 2005. Manufacturing, especially the technology oriented manufacturing, has been the major driving force for economic development and also the anchor for service industry's development in the nation. (see Figure 1)

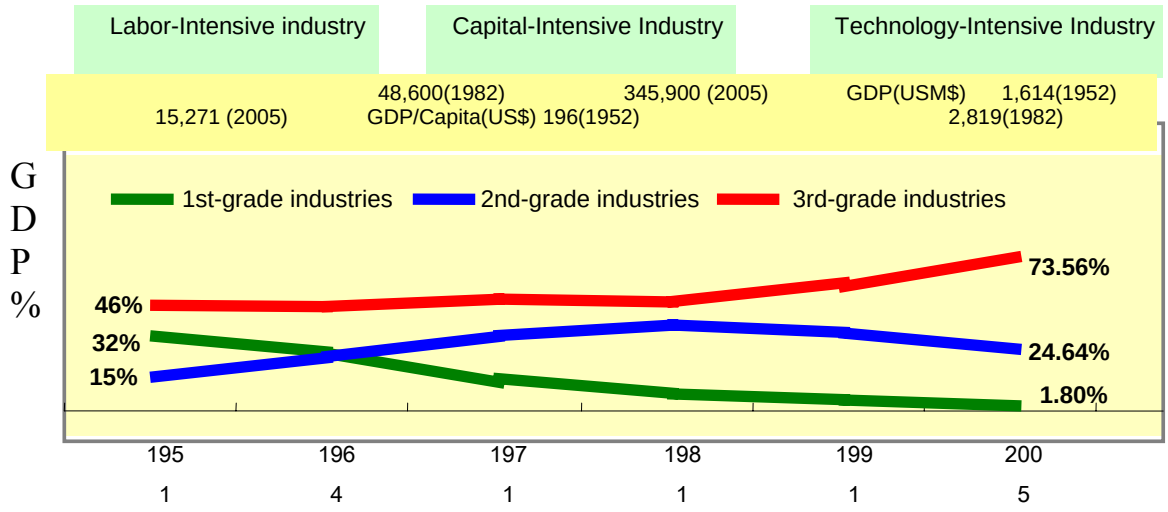

Figure 1 Taiwan's Industrial Transformation

2. Small and Medium-sized Enterprises in Taiwan

For decades, small and medium-sized enterprises (SMEs) have been the backbone of Taiwan's economic transformation. Unlike many advanced nations, where conglomerates dominate the economy, Taiwan's manufacturing and foreign trade are built up and fortified by those countless SMEs. Over 97.8 percent of Taiwan's registered enterprises are SMEs. 18.11 percent of SMEs are in the manufacturing sector(about 222,000 firms). SMEs employ about 7.65 million workers and account for nearly 76 percent of the total workforce. The total sales value of Taiwan's SMEs for 2005 was US$312.5 billion, while export value was US$46.9 billion, accounting for 29.5 percent and 17.6 percent, respectively, of all enterprises' revenue. Those SMEs are nimble, diligent, thrift, and with highly entrepreneurial spirit.

But they have some weakness by the nature such as lack of competitive technologies, information gathering, marketing ability, and not-so-healthy funding and financial structure. Whenever they have technical needs, many of they will turn to some research institutes and universities for help. And it works most of the time.

3. An over view on Taiwan’s hi-tech industries and IPR status

Over the past two decades, the high-tech industry has been the driving force behind Taiwan’s continued economic development. The government of Taiwan has continuously invested large amounts of funds and resources in technology-based industries in the hope that Taiwan’s high-tech industries will continue to develop and improve the nation’s international competitiveness. Table 1 shows the focus ICT industries in Taiwan. They are namely information technology, integrated circuits, flat panel display, and communications. All of them enjoy global top rankings in manufacturing. (Table 2)

Science parks are established to introduce high-tech industries and attract talents to Taiwan, promote the upgrading of industries, balance regional development and drive national economic development. There are five major science parks locate in northern, central and southern Taiwan. Each of them has different focus. (Table 3) The Nankang Park for software; the Neihu Science Park for general high-tech products; the Hsinchu Science Park is primarily focused on semiconductors; the Central Taiwan Science Park on aviation, precision machinery, and optoelectronics, while the Southern Taiwan Science Park on optoelectronics. Consequently, each of these science parks possesses respective core technological advantages.

To ensure the continuous development and long-term competitive advantage of high-tech industries, Taiwan’s science parks improve their articulation with educational and research institutions and innovation incubators, thus helping develop the industrial research infrastructure. They also integrate with other industrial districts and establish an integral upstream and downstream industry supply chain, to improve the value-added of various industrial districts.

Tens of billions investment has been poured into the development of Taiwan’s hi-tech industries. This has already reaped rewards by closed cooperation among enterprises, research organizations, and universities on the island. Companies in Taiwan’s science parks spent five percent of total annual sales on R&D in average and now obtain almost twenty thousand patents globally. Taiwan will focus more on developing intellectual property rights and international technological collaboration through which definitely will cause greater impacts on the long-term development of science parks.

Category	2005 sales (in US$bn)	Major items
IT	77.2	Hardware: Notebook PC, Desktop PC, Motherboard, LCD monitor, CDT monitor
IC	34.7	IC: Design, manufacturing, packaging, test Related applications: Memory, logic components, System chips
FPD (Flat panel display)	30.4	Panel: PDP, TFT LCD, TN/STN/OLED Key components: Glass, color filter, backlight, drive IC
Communications	15.3	Broadband networking: Optical communication, LAN products, broadband access Equipment & IP applications Wireless communications: End user equipment, WLAN, WMAN

Source: IEK, ITRI

Table 1 Focus of ICT Industries in Taiwan

In severe global competition, intellectual right issues are critical. Since 1999, Taiwan has become the global number four in US patents granted. If in terms of IP-population intensity, the ranking turns out to be number 2. For Taiwanese hi-tech enterprises, research institutes, and universities, they put many efforts in granting US patents since such efforts lead to better protection to their business and better deal flows in serving industries and international research cooperation.

Taiwan has long been famous for its high quality hi-tech products with competitive prices. Its opportunities in advanced manufacturing lie in the area with a proper combination of yield and profit margin. The U.S.A. and Japan are on its left while China and India on the right. (Figure 2 and 3)

Global ranking	#1	#2	#3
IC	IC foundry IC packaging Mask ROM	IC design IC resistor DRAM	
IT	Mother board LCD monitor Notebook PC		
Opto-electronics	CD-R disc CD-RW drive/disc DVD-R disc DVD-RW disc	Large scale TFT-LCD OLED TN/STN LCD Digital still camera CD-ROM driver DVD-ROM drive Combo driver	S&M TFT-LCD PDP LED
Communications	Wireless LAN ADSL modem Cable modem NIC Hub SOHO router Ethernet LAN Switch Modem/ Analog modem		

(by 2005 revenue) Source: IEK/ITRI (2006/05)

Table 2 Worldwide Ranking of Hi-tech Products Made by Taiwan Enterprises

	Park	Outputs(US$bn)	# of firms	# of employees
1.	Nankang Software Park	6.2	280	16,000
2.	Neihu Science Park	20.8	2,400	90,000
3.	Hsinchu Science Park	30.8	382	114,800
4.	Central Taiwan Science Park	1.9	73	7,500
5.	Southern Taiwan Science Park	10.9	91	41,300

Source: IEK, ITRI

Table 3 2005 Outputs of Taiwan's Science Parks

Ranking	Country	2002	2003	2004	1977~2004
1	USA	97,126	98,598	94,129	1,725,549
2	Japan	36,339	37,249	37,034	574,865
3	Germany	11,957	12,140	11,367	221,120
4	Taiwan	6,730	6,676	7,207	57,606
5	S. Korea	4,009	4,132	4,671	35,673
6	France	4,421	4,126	3,686	89,402
7	UK	4,202	4,036	3,905	83,991
8	Canada	3,857	3,893	3,781	63,944
9	Italy	1,962	2,022	1,946	36,883
10	Sweden	1,824	1,629	1,388	29,696
11	Netherlands	1,681	1,570	1,537	28,256
12	Switzerland	1,532	1,433	1,405	36,802
13	Israel	1,108	1,260	1,092	12,348
14	Australia	992	1,047	1,093	15,876

Source: USPTO

Table 4 US Patent Granted by Country of Origin
(all patents, all types)

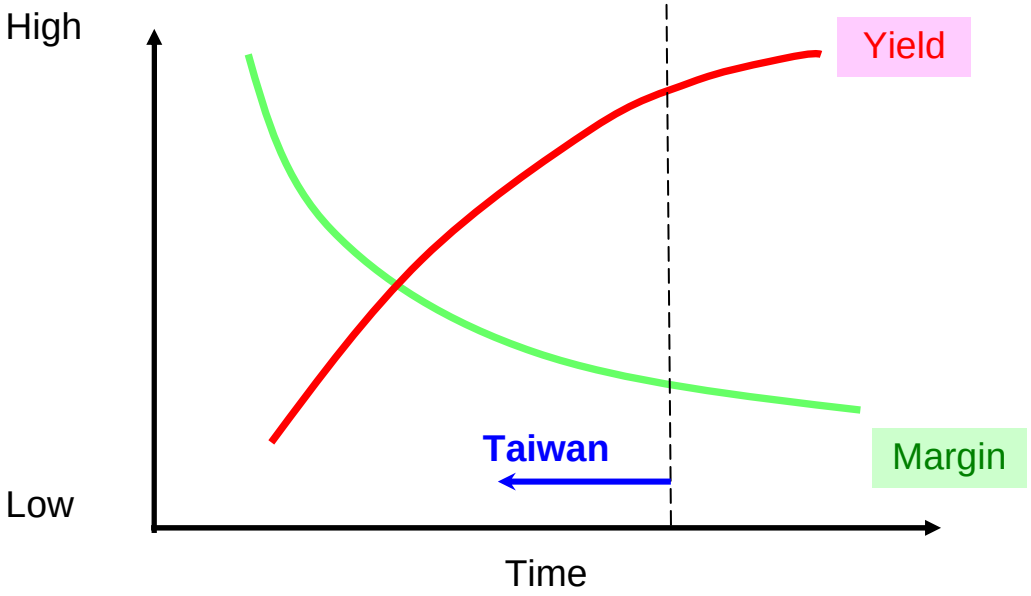

Figure 2 Opportunities in Advanced Manufacturing

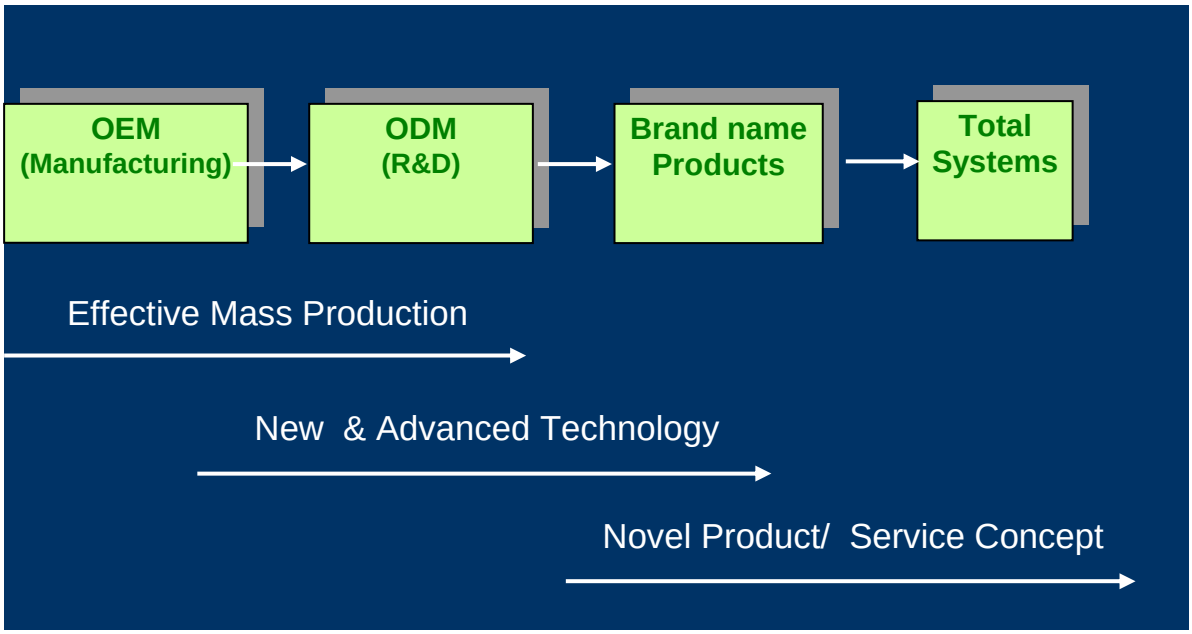

Figure 3 Moving Down the Value Chain

Recently in Taiwan, the "Smiling Curve" has been discussed often. It indicates that the industry's high value added activities were shifting away from system design and assembly, which were the traditional strengths of hi-tech manufacturing companies. Now, the greatest value added comes from R&D on the one hand, and from marketing, services and software on the other. The smiling curve illustrated the ongoing dominance of firms like Intel and Microsoft at either end of the curve, but it also foretold the success of firms who concentrate on design, marketing and customer service while outsourcing most of their production.

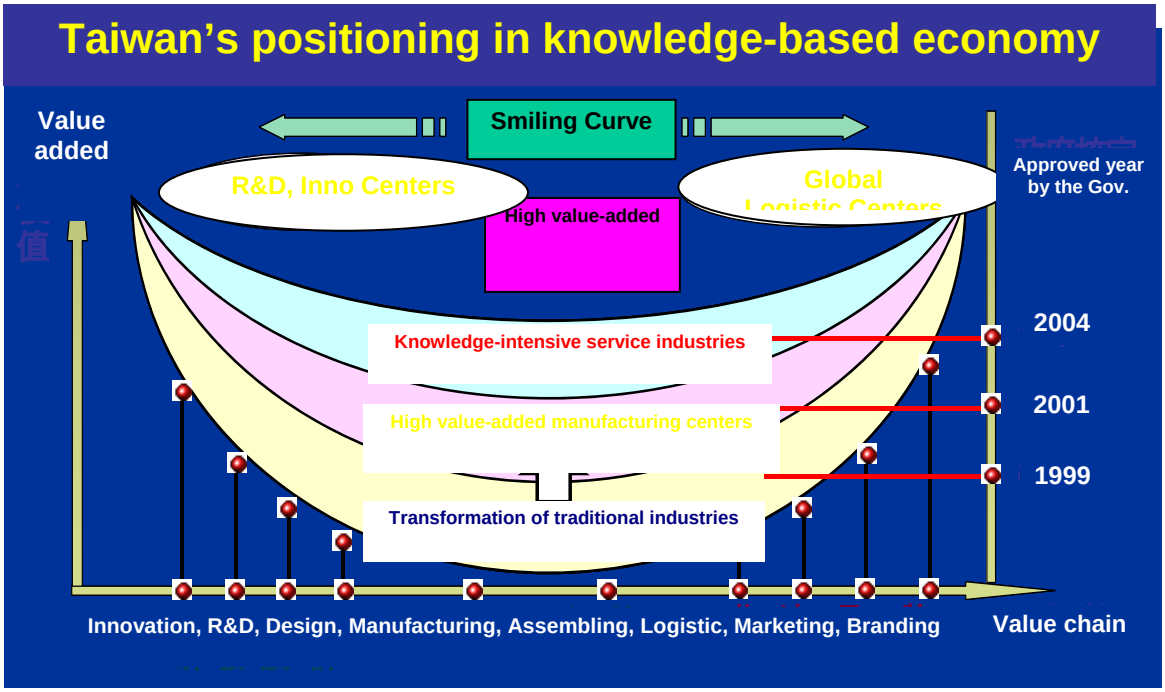

Figure 4 Shift Toward both Ends of Smiling Curve

It always takes a long trip from research to commercialization. Universities are assigned to focus on research, especially on basic research. As for applied research institutes in Taiwan, their outputs are measured by the impact on commercialization, sometimes even as far as on industrialization! (Figure 5.) It takes right strategies to ensure each step is right on the way to move forward: from research topic selection, resources allocation, IP strategy, technology transfer, pilot-run, to mass production.

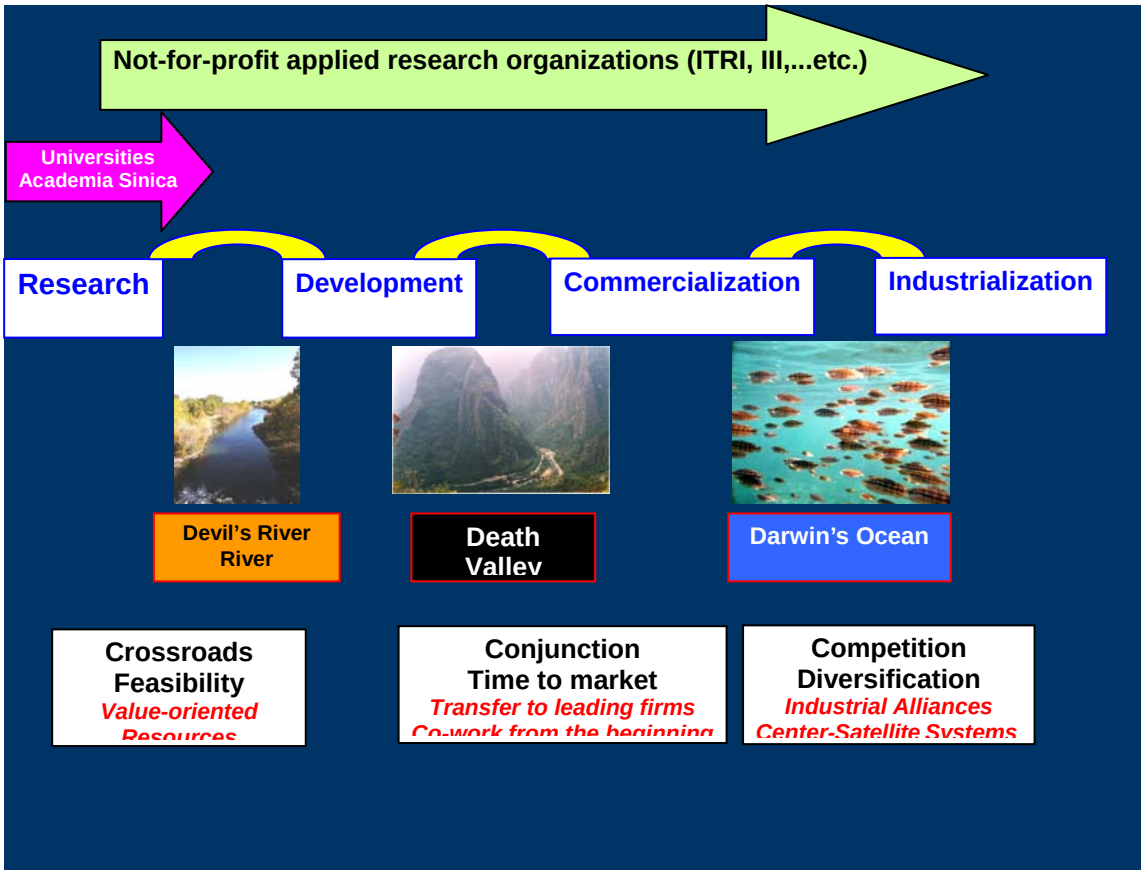

Figure 5 Three Jumps to Create Industrial Impact

4. The role of research institutes in IP activities: ITRI as an example

Founded in 1973 by the Ministry of Economic Affairs and headquartered in the Hsinchu Science Park area(Hsinchu hi-tech hub, Figure 6), the ITRI(ITRI) is Taiwan's largest not-for-profit research organization, with a total workforce of 6,400 and a budget of US$600 million. It receives about half of its funding from the government and half from industrial sources. The ITRI's research projects include communications and optoelectronics (microelectronics, display, and SoC), precision machinery and micro electro-mechanical systems (metrology and system engineering), sustainable development (including energy, environment and industrial safety), and nanotechnology (materials, electronics, and biotech). It is also involved in telecommunications, biotechnology, genomic medicine, and e-learning national research programs.

ITRI has had considerable success in the implementation of government-sponsored technology projects, self-produced R&D, and technology introduction. ITRI has transformed these results into industrial impact through technology transfers and licensing agreements with private firms, the establishment of spin-off companies, and the provision of industrial contract services, technical services, courses and training. ITRI has directly and indirectly brought about the rapid development of Taiwan's high-tech industries, while simultaneously upgrading and transforming the technologies of traditional industry.

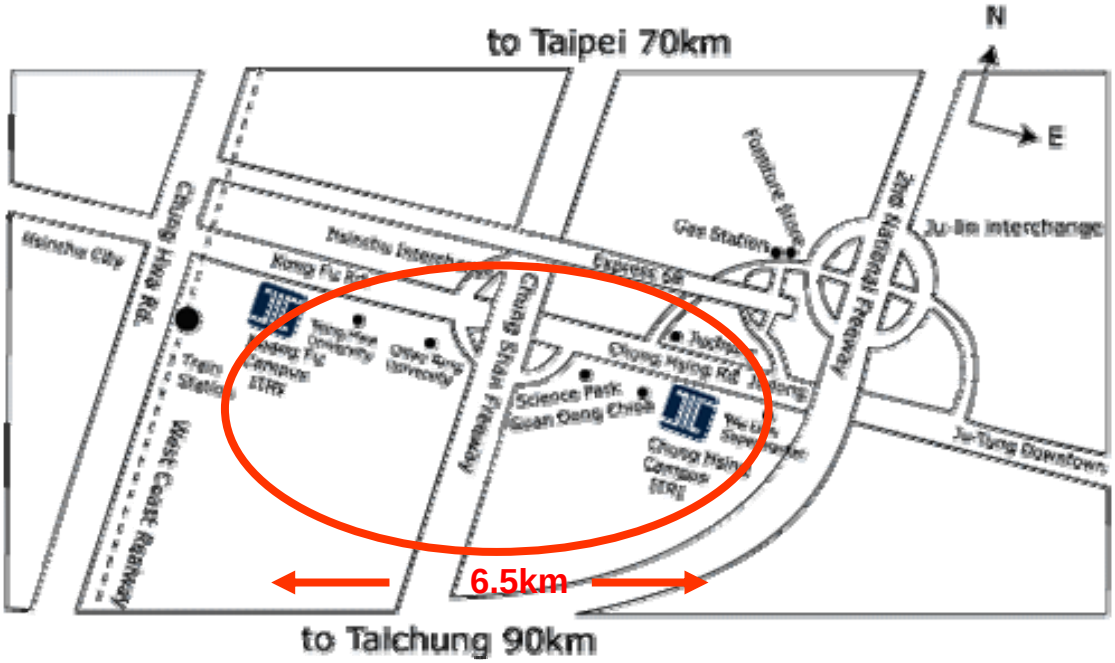

Figure 6 Hsinchu Hi-tech Hub

During the past thirty-three years, ITRI makes significant contributions to applied technological research for the manufacturing sector, such as the IC industry.

ITRI's also established an important mechanism to promote industrial research and new ventures. Open Laboratory/Incubator project, instituted in 1996 for joint research and hi-tech incubation, had accumulated over US$2.5 billion in R&D investment and supported the formation of 142 startup companies as of 2005.

ITRI is a major IP holder in Taiwan. From its establishment, it has already accumulated more than eight thousand patents. The utilization rate of ITRI's patents now has reached 22%. (Table 5) There are some overriding guidelines in handling IPs at ITRI. The first is that, being an organization receiving considerable funding from the public sector, ITRI has to be fair and open to all inquirers. Exclusive licenses can be granted only in specific cases that satisfy certain criteria. The second is that ITRI has to consider the public at large, not just its highest return. The third is that, in the case of acquiring any technology to carry out further research, ITRI will usually ask for related rights, in order to ensure that its own related R&D effort can come to commercial fruition through others, since ITRI does not engage in volume production.

Whether ITRI is a principal or a facilitator in a transaction involving IP, there is a rigorous procedure of evaluation and negotiation. As the technology concerns increasingly involve interdisciplinary issues, multi-lateral negotiation becomes common. ITRI's recognized broad technical competence and public trust enable it to gain a good perspective and to work for effective solutions. ITRI has eight thousand patents in effect worldwide, most falling into five major fields mentioned above, has a strong interdisciplinary character. About one third of all patents are granted by other countries. Figure 7 and 8 show ITRI's strategies and service offering in its patent utilization.

Items	Year	2000	2001	2002	2003	2004
Technology Transfer	Number of technology	471	337	414	520	725
	Number of firms	686	471	542	641	826
Income from TT	(US$k)	12,842	17,029	20,215	25,637	36,926
New venture	(number)	4	2	4	4	3
Patent application	(cases)	521	523	488	441	731
Patent Granted	Taiwan	461	549	459	453	761
	ROW	499	313	362	313	385
Patent	subtotal	960	862	821	766	1,146
Application	Rate	8.6%	9.2%	12.3%	16.9%	22.2%

Source: TTSC, ITRI

Table 5 ITRI's IP Business

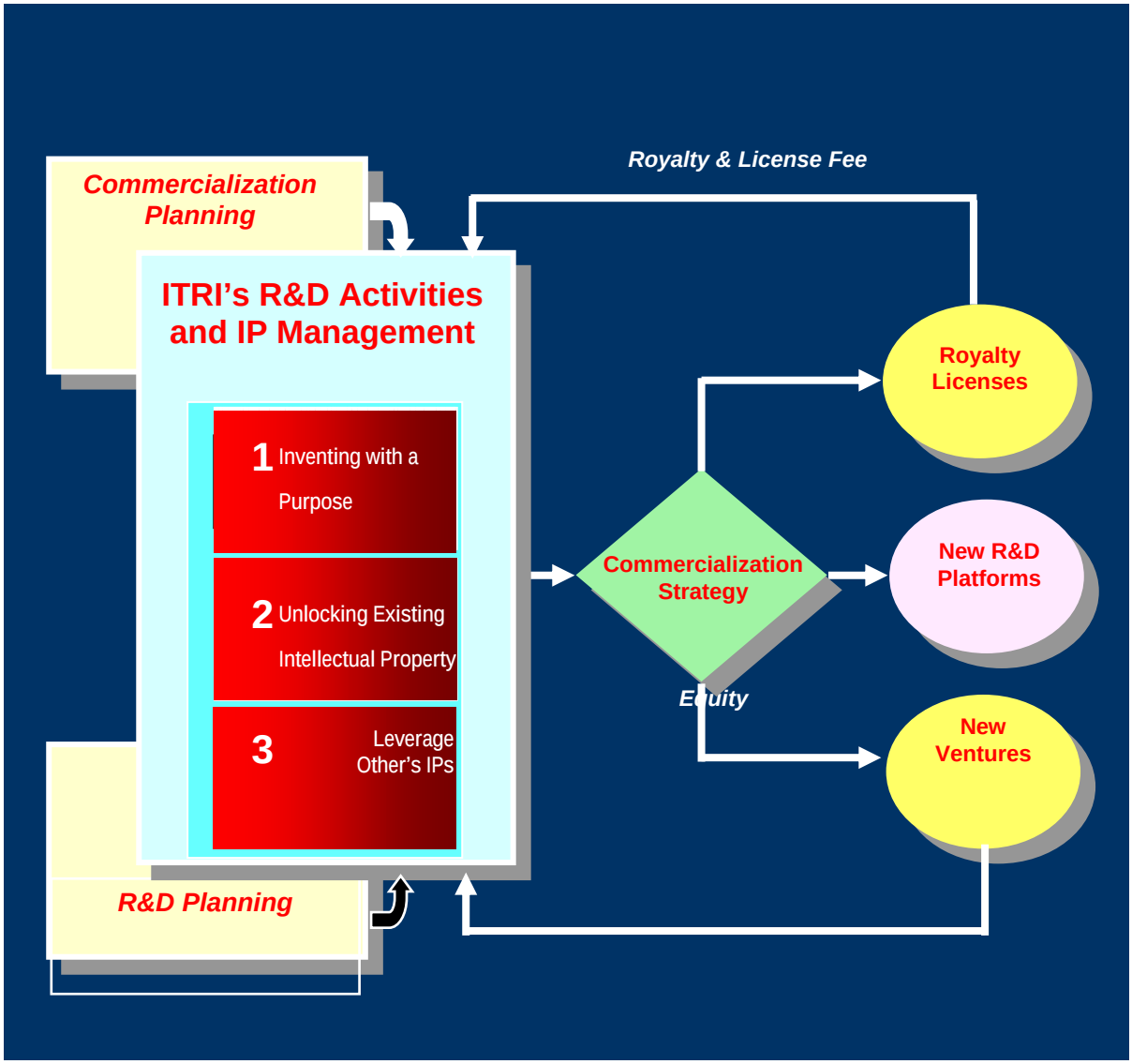

Figure 7 ITRI's Value-added Strategy

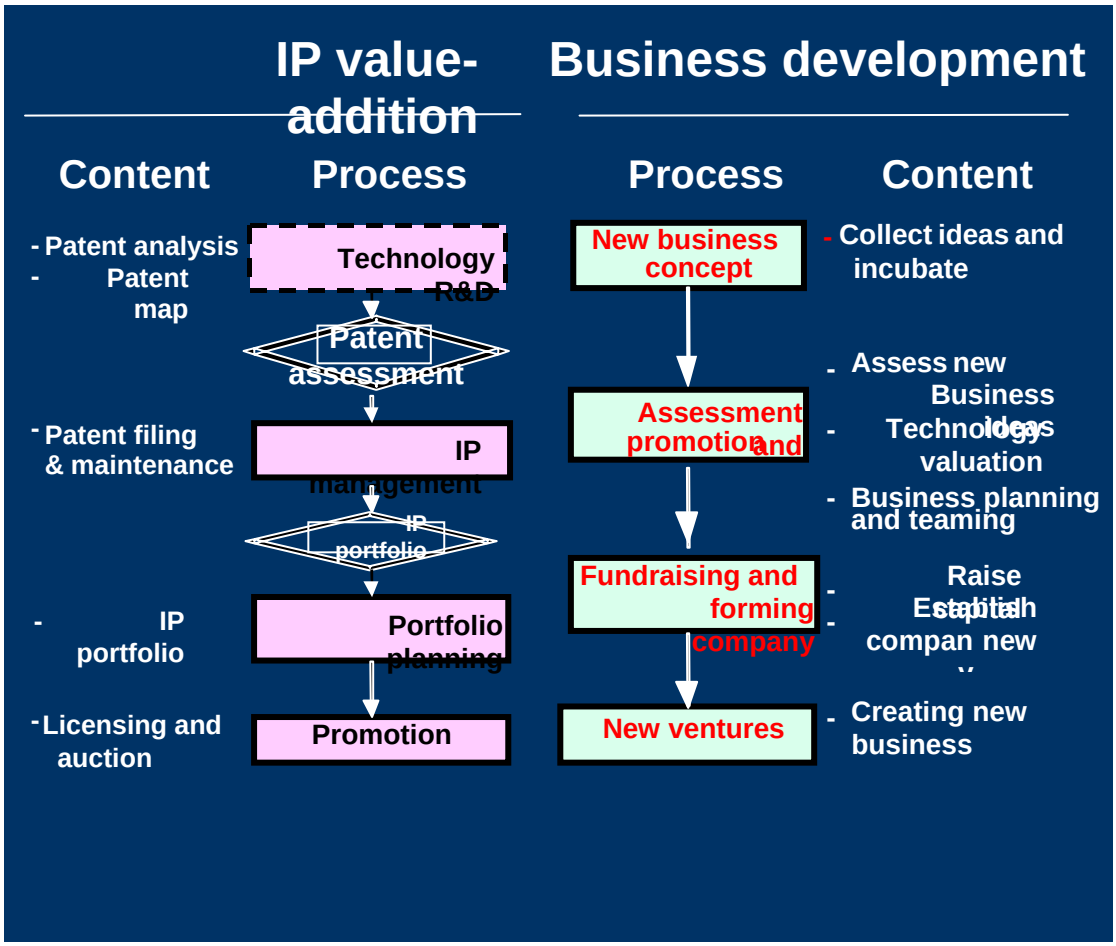

Figure 8 IP Service Offerings

5. The role of universities in IP activities

Academia-industry collaboration has consolidated Taiwan's transformation into a base for innovation. As of the end of 2005, there were ninety-one universities and seventy-three colleges in Taiwan. The number of faculty with PhD degrees is 35,646. Among those faculty, 47.4%(16,900) are in science, engineering, medical, agriculture fields. In terms of SCI 2005, 16,621 papers as global #18 written by those faculty. Among those one hundred and seventy four universities and colleges, sixty-five run incubator business, forty-six formed R&D alliances with the industry, and conduct 24 research projects for industrial applications.

Traditionally, professors' research was more basic or academic oriented. But Taiwan's government encouraged them to be more industrial-oriented by means of a new profit sharing system and other effective encouragement. Professors found that if they work with experienced R&D institutes like ITRI, a better result in commercialization could be expected.

6. Case demonstration

I. Patent auction

To make the better use of patents, ITRI started to inventory its "sleeping" patents and arranged them into some portfolios for auctions since 2003. As shown on Table 6, the number of patents sold and the

unit price are making progress annually. Now some universities and other research organizations already joined such activities. They entrust some of their patents to ITRI to form better portfolios and share profits from such activities. The purpose of industrial buyers is mainly hope to obtain solid IP bargaining power while dealing with international competitors. Such patent auctions turned out to be a win-win game between both sellers and buyers.

	Year	2003	2004
Number of patents sold		135	180
Countries	Taiwan	87	96
	USA	47	68
	Rest of the world	1	16
Category (%)	ICT related	83	79
	Others	17	21
Unit price (US$k)		3.6~22.2	4.5~89

Table 6 Patent Auction

II. Strategic IP services

Although Taiwan's hi-tech companies are successful as a whole, they usually suffer from international law suits concerning IP issues and paying considerable amount of money for royalty fees overseas. In 2004, ITRI's closed American partner Stanford Research Institutes International tried to handle some sleeping patents. ITRI played as a value-added agent and sold more than 230 ICT related ones out of those SRI patents to local firms. Thus successfully enhanced Taiwanese firms' IP position and accumulated IP assets for their new business.

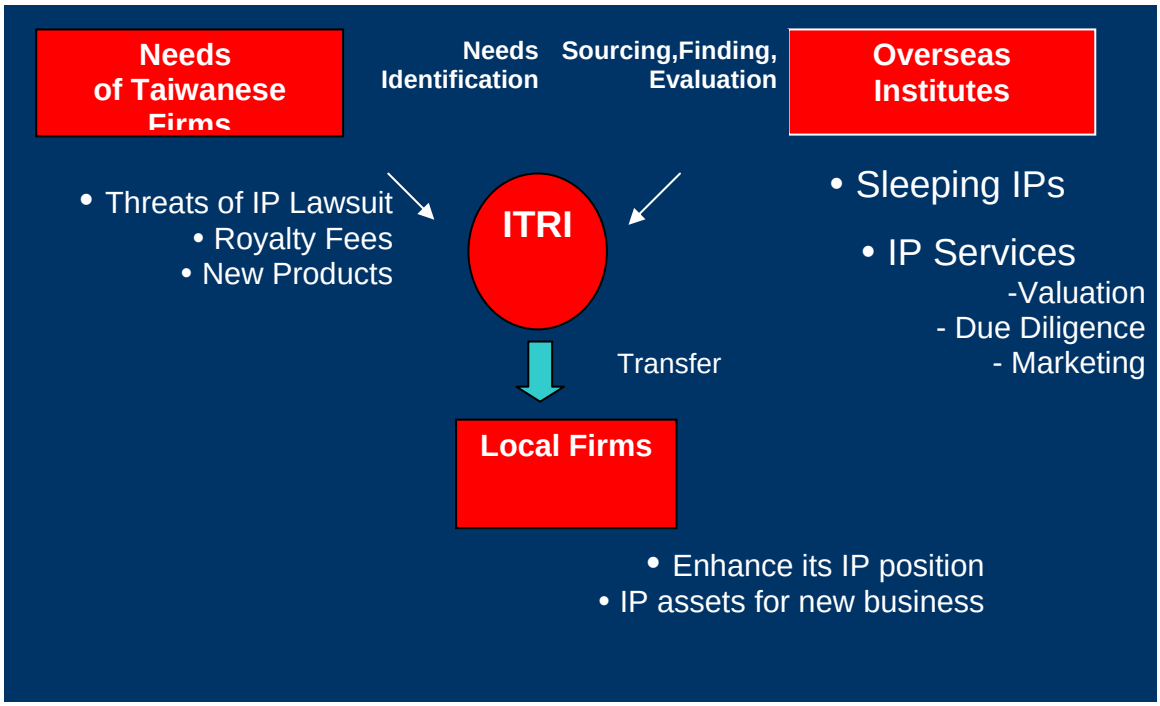

Figure 9 Strategic IP Services (SRI case)

III. Portfolio based exclusive licensing

Individually and non-exclusively used to be ITRI's principle in technology transfer for most of its research budget comes from the government. But such constrain caused some competition problems among firms received ITRI's technologies and diluted their global competitiveness for resources were

diversified. Now ITRI applied a new model in technology transfer. It is portfolio based and exclusively. It likes a change from being a vendor to be a whole seller. The efficiency of IP utilization and industrial impacts were increased by the implementation of the new model.

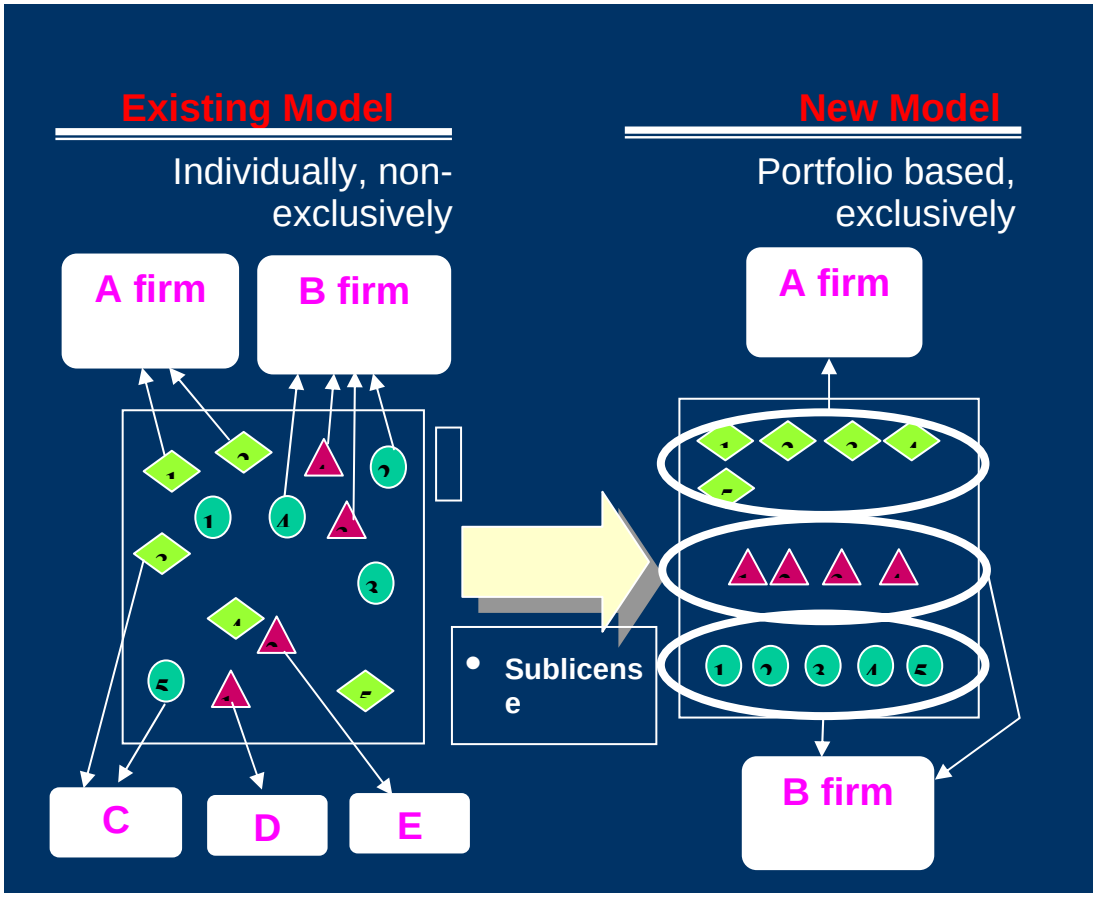

Figure 10 Portfolio Based Exclusive Licensing

IV. To establish emerging industries by spin-offs: IC industry as an example

During the mid-1970s, ITRI obtained access to CMOS technology from the US RCA and, over the following decade, led Taiwan's fledgling IC industry by providing both technology and personnel. Today, the top two IC foundries in the world, TSMC and UMC, command more than 60 percent of the world's dedicated chip foundry market.

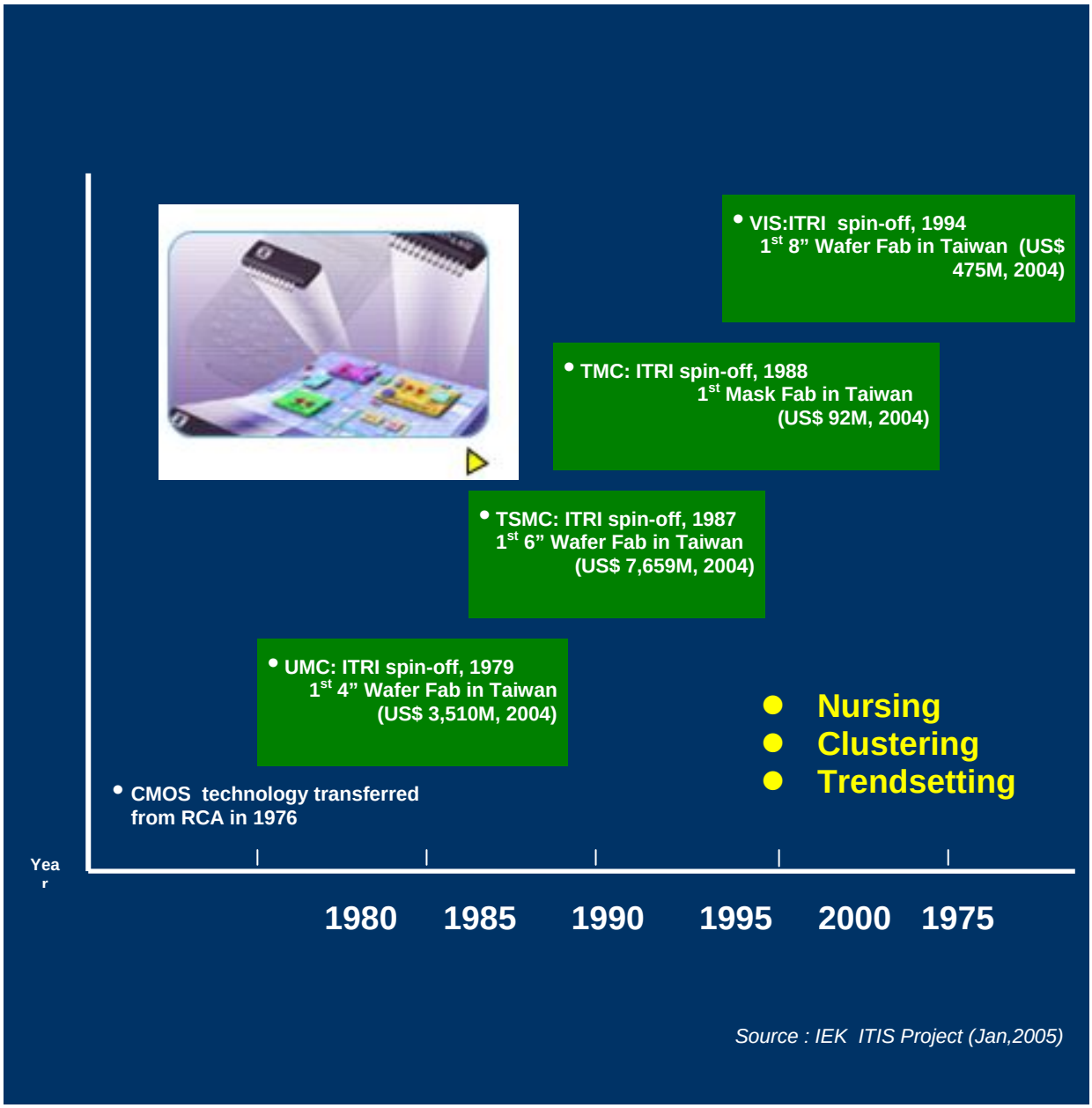

Figure 12 ITRI Spin-offs in IC Industry

7. Conclusion

1. Technological R&D is a powerful tool in promoting economy growth, and this has proven by Taiwan's experiences.
2. In the era of knowledge-based economy, new challenges and opportunities call for more innovation and quicker response.
3. Intellectual Property has become a major issue in global economic competition.
4. Strategic thinking in IP mapping & utilization is essential.
5. Team up R&D institutes, universities, and enterprises to create synergy is the key.
6. Taiwan, especially ITRI, is willing to share its experiences in IP issues with friends around the world.

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