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and Its Open Lab

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Industrial Technology Research Institute and Its Open Lab

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1. TAIWAN: Across the Last Half Century

Fifty years ago, Taiwan was merely a small economy in the southwestern of Okinawa subsisting on the hard-working ethics of tough-minded populace. Not long after the WWII, its economy was decidedly third world and agrarian. With the per capita income of US\$196, its main industry was bananas and pineapples. As fifty years past, not only Taiwan became a modernized industrial economy, the small island state is now a major center for many of the high technologies that is driving the information and knowledge-based economy the whole world over. In the past five decades, GDP grew by 180 times to US\$288 billion and GDP per capita has grown more than 70 times to US\$14,000. In spite of a GDP that is only 0.9% of world GDP, Taiwan has become one of the world's leading suppliers of many technology-based products. Table 1 and 2 list those products Taiwan ranks as number 1 and number 2 in terms of world market share today respectively. (*Source: Industrial Technology Information System Project, Industrial Economics & Knowledge Center, ITRI, 2002*)

2. Industrial Technology Research Institute (ITRI)

A critical part of the rise of Taiwan's high-tech industries can be attributed to the work of ITRI. ITRI's history can be traced back to the 1930s. Its precursor was the Natural Gas Research Laboratory sustained by the Office of the Governor of Taiwan. (台湾总督府轄下天然瓦斯研究所) After the Kominton's (国民党) withdraw from China to Taiwan, it turned out to be Union Industrial Research Laboratories (UIRL, 联合工业研究所). Then in 1973, merging two other research laboratories, UIRL was transformed to a new organization — ITRI. ITRI was created with a single purpose that was to be an instrument to continuously elevate the technological content of Taiwan's industries as a whole, and most specifically, to bring Taiwan into high technology. When ITRI was first founded, the government wanted the new organization to become self-sufficient — meaning it would have to earn its keeps through service contracts with the industries — within five years. For the next thirty years, ITRI has played a series of substantial roles in the creation and the growth of one high-tech industry after another, such as IC, LED, LCD, Biochips . . . etc. Itri's recent performances are shown as Table 3.

ITRI is today a more than 6,200-person organization with annual revenue of some 475 million dollars (Figure 2). About fifty percent come through R&D projects founded by the Ministry of Economic Affairs (MOEA). These are strategic-minded projects with signifi-

Table 1. Taiwan's Global No. 1's

Items	Production	Value	Production	Volume	Export	Value
	Unit: US\$M	Global Market Share	Volume (K)	Global Market Share	Unit: US\$M	Global Market Share
1. Wafer Foundry	9,446	76.8%				
2. Mask ROM	630.5	53.5%	192,694	45.9%		
3. IC Packaging	3,115	34.1%				
4. Mother Board	3,225	35.1%	42,998	35.8%		
5. Notebook PC			12,707	52.5%		
6. CD-R			3,362,500	81.2%		
7. CD-RW			83,700	55.1%		
8. DVD-Video			138,000	65.0%		
9. NIC			30,028	58.6%		
10. Router			45,095	70.3%		
11. Analog Modem			35,878	62.5%		
12. Sewing Machine for home-use	267	40.0%	2,582	51.0%		
13. DIY Tools	1,200				1,277	20.1%
14. ABS Resin	508		1,400 (K) Ton	22.5%	93.8	
15. PU Artificial Leather			108,600 (KM)	28.0%	450	

Ps. Products listed above were produced in Taiwan, which does not including the overseas manufacturing of Taiwan local companies.

cant implications to the future well being of Taiwan's industry, formulated through multi-stakeholder planning efforts. The rest comes from commercial service contracts with the industries. ITRI's experience showed that a "one to one" relationship between longer term R&D and customer-focused service work to be an ideal mix. The balance has allowed ITRI to maintain both a forward-looking mindset and a down-to-earth work ethic. ITRI's R&D work is conducted by its eleven R&D units — seven laboratories and four centers. (Figure 3)

On the human resources side, more than fifty percent of ITRI's employees have advanced academic degrees. (Figure 4) However, unlike most R&D institutions around the world, those with PhD degrees account for only thirteen percent of the total while forty nine percent with Master degrees. Since ITRI was set up for industrial impact, people need to work in teams, and a proper mix of training and education backgrounds is required to deliver the right kinds of results. Since ITRI's establishment, there are more than 15,500 employees left and switch their jobs to other fields. About 80% went to the industries. At the Hsinchu Science-based Industrial Park (新竹科学園), ITRI has at least 5,000 alumni and they are all backbones for companies they serve. Some people even regard ITRI as the Shao-lin Temple (少林寺) for Taiwan's industries. (Figure 4)

Table 2. Taiwan's Global No. 2's

Items	Production	Value	Production	Volume	Export	Value
	Unit: USSM	Global Market Share	Volume (K)	Global Market Share	Unit: USSM	Global Market Share
1. IC Design	3,869	20.7%				
2. Small / Medium TFT-LCD Module	210.3	8.8%			159	6.6%
3. Small / Medium TN / STN LCD	777.4	13.8%			513	9.1%
4. PC Camera			8,000	33.3%		
5. Digital Camera (> 350 k pixel)	240		2,372	15.7%		
6. Cable Modem			2,530	32.8%		
7. Switch			31,228	26.9%		
8. Resistor	925	14.0%			323	5.0%
9. LED	896.9	25.4%			421.9	12.0%
10. Scanner	251		3,799	13.0%		
11. Polyester Fiber			1,535 (K) Ton	14.3%		
12. Nylon Fiber			430 (K) Ton	10.3%		
13. Machinery for Shoe Leather					154	19.0%
14. Sewing Machine	477	15.0%	2,947	20.0%		
15. Bike / Poer Transmission System	80	20.0%			77.6	20.0%
16. Nuts & Bulbs (Fastner)					1,730	16.9%

Ps. Products listed above were produced in Taiwan, which does not including the overseas manufacturing of Taiwan local companies.

3. Industrial Technology Investment Corporation

An important part of ITRI's approach toward bringing industrial impact such as creating IC and other new industries from the ground up was the ITIC, a 100% owned subsidiary and investment arm of ITRI. Being the first venture company in Taiwan, ITIC runs its own funds and is very much a player on the local venture scene, it is a very different kind of investor. ITIC is positioned to maximize industrial impact instead of returns, as truly strategic ventures are normally high-risk in return. Typically, ITIC prefers a minority position in the projects it finances, mainly to demonstrate ITRI's commitment and to bolster investors' confidence. Table 4 shows a sample list of "first of its kind in Taiwan" companies

Table 3. ITRI's Recent Performance Statistics

Item		1997	1998	1999	2000	2001
Technology Transferred to Industry	technologies	332	361	353	314	337
	companies	499	582	538	457	471
Services Contracts	numbers	1,019	1,046	1,124	969	1,159
General Services to Industry	companies	27,811	27,099	27,827	28,431	30,427
Patents Awarded	numbers	548	559	537	640	862
Technology Conferences and Training Programs	cases	957	998	1,485	1,229	1,148
	attendees	68,918	76,265	96,036	73,959	78,336

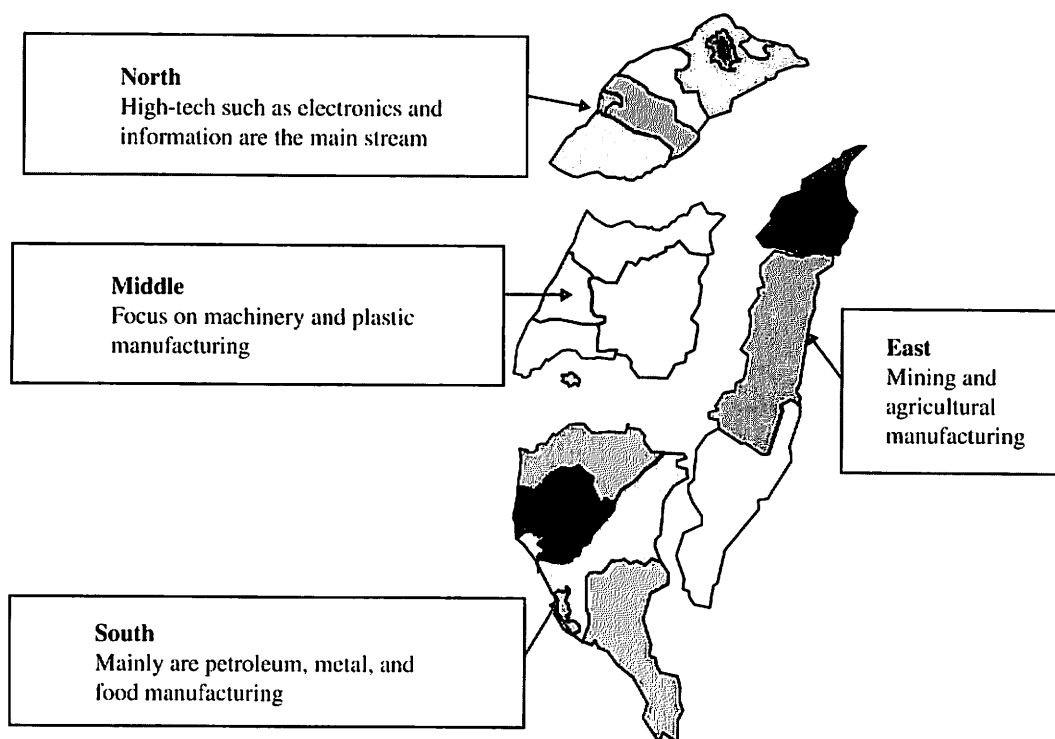


Figure 1. Geographic Allocation of Industries in Taiwan

founded by ITIC.

4. OPENLAB: One of the Major Channels to Promote Business Relationship with the Industries

Over the past three 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 Taiwan's interna-

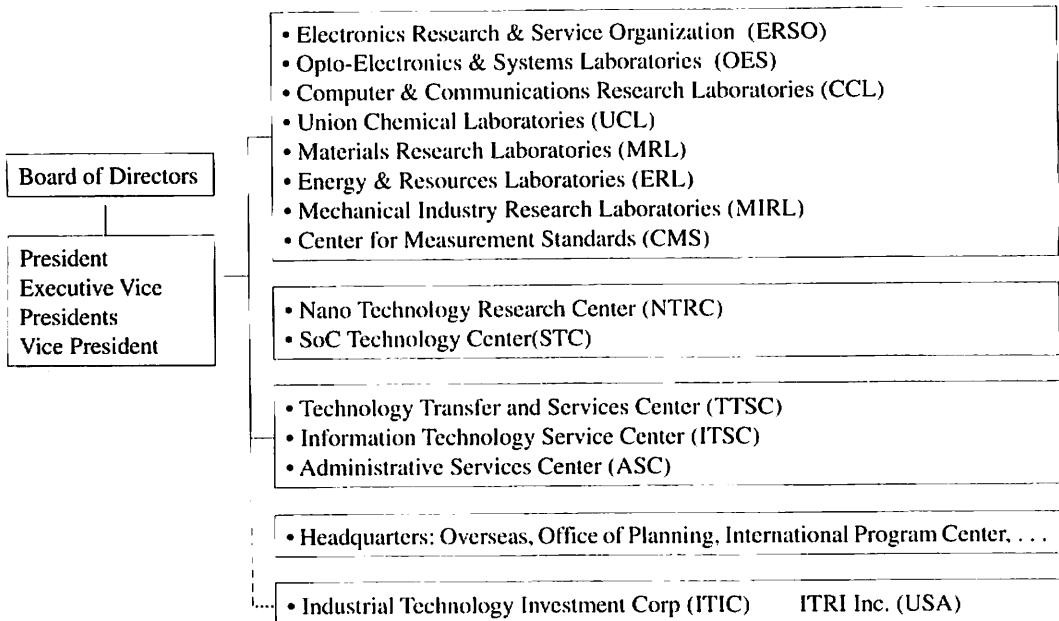


Figure 2. ITRI's Organization

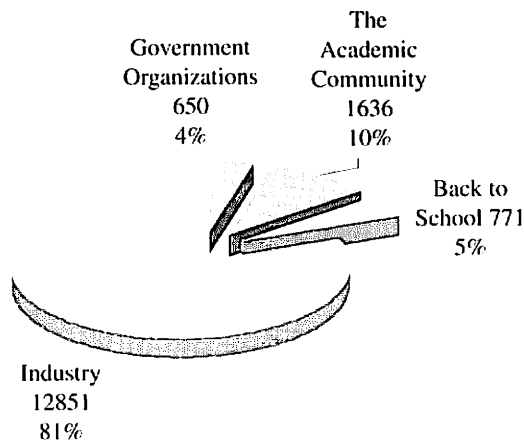


Figure 3. TRI's Manpower as of Feb. 28, 2003

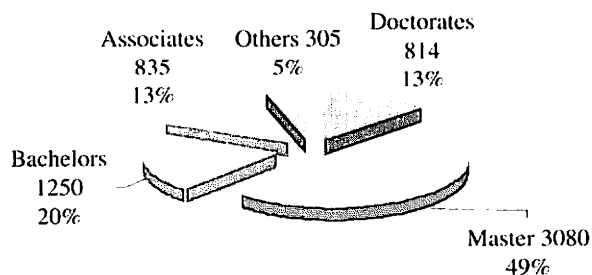


Figure 4. ITRI's Repository of Industrial Human Resources

Table 4. Sample “first of its kind” in Taiwan ITIC holdings

Company Name	Industry	ITIC's initial equity position	ITIC's current equity position
United Microelectronics Company (UMC, 联华电子 1980-)	IC	11.3%	0.1%
Taiwan Mask Company (TMC, 台湾光罩 1988-)	Masks	54.9%	6.1%
(MIRLE, 盟立自动化 1989-)	Automation Service	9.5%	0.4%
Acer Display (达基科技 1996, now is called United-Acer (友达光电))	Displays	10.0%	0.8%
EpiStar (晶元光电, 1996-)	LED	9.3%	5.3%
Phalanx (华联生技, 2002-)	Biochip	8.0%	3.0%

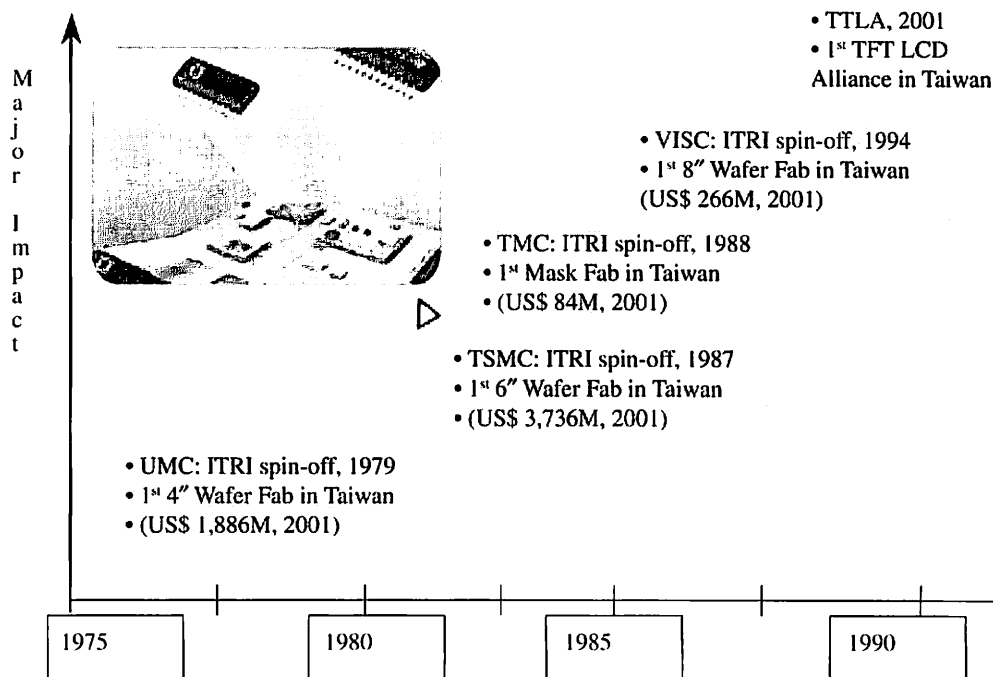


Figure 5. ITRI's R&D Dissemination through Spin-offs

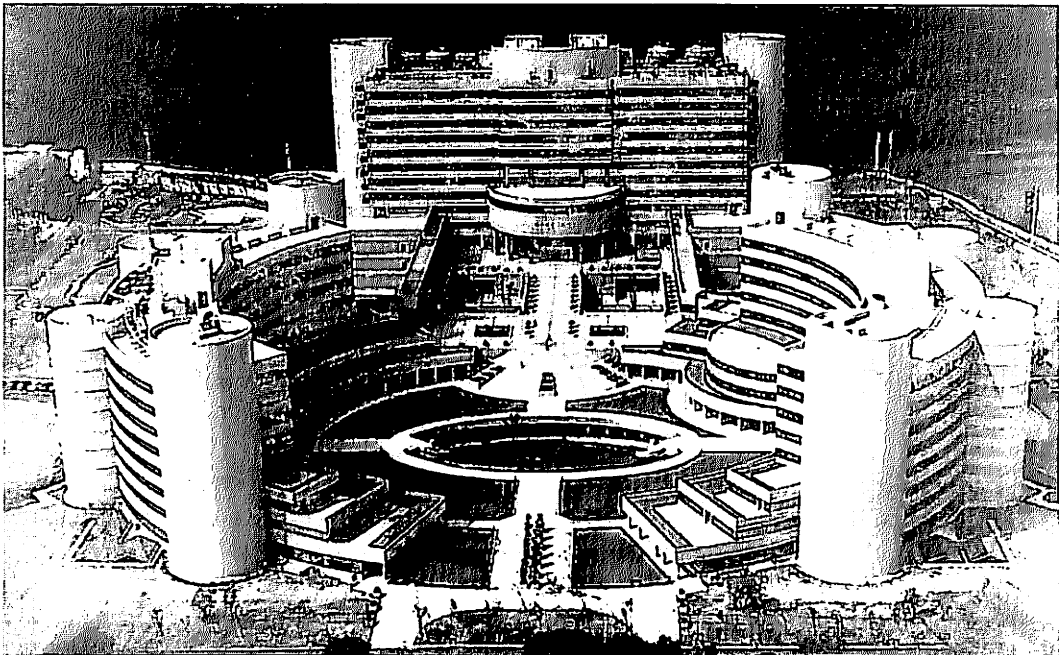
tional competency. ITRI has had considerable success in the implementation of government-funding technology projects, self-produced R&D, and technology introduction (技術引進). ITRI has transformed these results into industrial impact through technology transfers and licensing agreements with private firms, the establishment of spin-off companies (Figure 5), 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.

Regarding the technology level and scale of recipient firms, traditionally, ITRI never purposely focused on small- and medium-sized hi-tech firms; furthermore, interaction between ITRI and technology transfer recipients tended to be limited. Therefore, with the completion of its R&D building complex in July, 1996, the Research Building Complex(綜合研究大樓, Picture 1) commissioned by the MOEA under a government-funding technology project, ITRI started promoting the creation of its OpenLab.

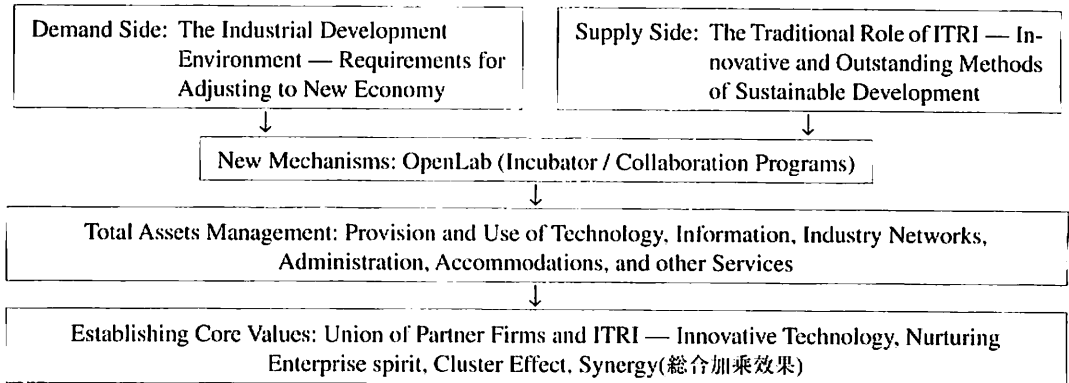
ITRI OpenLab contains a dual mechanism. One is Collaboration Research Projects, which develop innovative and competitive technology and products for firms; while the other is a technological Incubator (創業育成中心), which assists inventors and entrepreneurs in launching new technology-based business. After six and a half years' operation, the OpenLab has proved to be a successful tool, greatly benefiting the development of Taiwan's high-tech industry.

To meet the changing environment, however, ITRI has promoted the OpenLab program through the concept of total assets management (全資源管理), enabling it to conduct comprehensive planning, to open up to outsiders and to provide a wide range of services, allowing it to create even broader industrial impact using its existing resources. At the same time, ITRI took the opportunity to improve its internal management mechanisms and strengthen its own operational framework.

By Economics theory, transactions occur when both the demand and the supply meet with each other. The industrial environment in Taiwan can be treated as the demand side where firms need some actions to compete in the era of knowledge-based economy to survival. And on the other hand, ITRI is specialized in helping the industries to improve their technologies thus plays as the supplier. Open Laboratory is exactly the new mechanism or transaction that happened by the interaction from both sides.



Picture 1. The Research Building Complex at ITRI's Main Campus



Finding ways to create new mechanisms to enable ITRI to sustain and enlarge its impact on industry has long been one of the most important topics facing ITRI's decision makers. Compared to most other research institutes in Taiwan, ITRI has significantly more resources, allowing it to provide a comparatively wide range of services and produce a larger impact on industry. In turn, this has enabled Taiwan businesses to create a larger niche in the globally competitive high-tech environment.

One of ITRI's most outstanding achievements over the years has been the establishment of United Microelectronics Corporation (UMC 联华电子), Taiwan Semiconductor Manufacturing Corporation (TSMC 台湾积体电路) and other spin-off companies (衍生会社) through the transfer of the results of government-funding technology research projects, leading to the development of Taiwan's Science-based Industrial Parks (科学园) and high-tech enterprises.

Most of ITRI's spin-off companies are engaged in the high-tech sphere and most are of a large scale. ITRI's main methods of assisting industry are technology transfers, licensing, joint development, commissioned R&D, technical services, courses and training, and other services. The technology level of most of the firms served by ITRI is, generally speaking, relatively low; however, those enterprises whose technology level is low and whose business scale is small are limited by their own financial situation and their ability to carry on technological development; therefore, they are relatively unable to produce substantial business relations with ITRI.

The advancement of technology is the source of economic development. If appropriate assistance can be given to new technology-based enterprises whose technology level is high, but whose scale is small, then hope can be given to Taiwan's high-tech industry. After a review of the methods used by advanced nations in relation to its own conditions, ITRI decided to establish an Incubator to provide a superior R&D environment and range of services to nurture Taiwan's new technology-based enterprises and lower their start-up risks.

Furthermore, through previous cooperation with private firms on research projects, ITRI discovered that project members on both sides had to travel extensively between ITRI and the firm, making time-use inefficient. In addition, interaction between the two sides was often not close enough and this had a negative impact on the quality of research. To resolve these damaging impacts, while increasing utilization of its abundant resources, ITRI invited firms to deploy R&D staff at ITRI or to establish research departments within ITRI (Figure 6). The reason for this being that if firms could be surrounded by a high-tech research

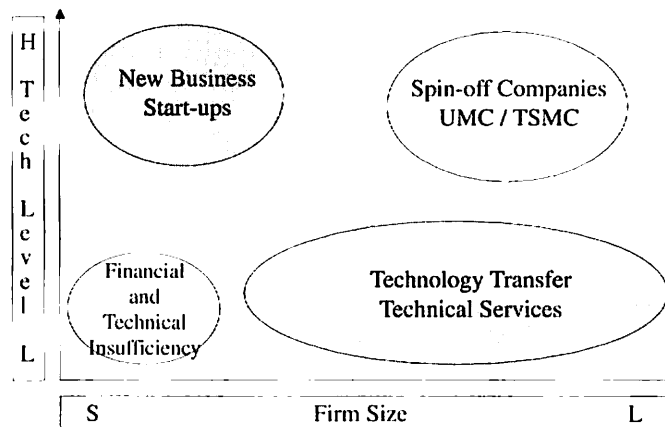


Figure 6. Matrix of How ITRI Serves Industry

environment like that provided by ITRI, this should have a positive effect on the resident firm's long-, medium- and short-term development. As a result, ITRI started promoting Collaboration Programs based on existing R&D projects.

ITRI has also included the establishment of a service center in Taiwan for internationally-recognizing enterprises and a joint service development center for specific industry technologies, the training of professional technical staff, the hosting of international conferences and other projects in the work of OpenLab. These projects already include the IC packaging material service center of Japan's Matsushita Electric Works, the technology promotion center of America's Telcordia, the DVD Certification Lab, the SD Verification Lab, Opto-communication Lab with Agilent, Microsoft-Windows CE, Wireless Communication Training Class, the Annual Conference of Asia Science Parks Association (ASPA), . . . etc.

The Concept of Total Assets Management

For many years, ITRI has accumulated a considerable amount of tangible and intangible resources. Total assets management is the process of consolidating, planning and increasing the total impact of all existing resources. Under this operational concept, ITRI not only provides firms with information and research-related software and hardware equipment, it also offers administrative, general affairs, living and recreational resources, as well as industrial relations with the aim of producing synergy and allowing resident firms to enjoy the same level of services and support as ITRI employees. This allows firms to concentrate fully on research and innovation, and increases the likelihood of success.

Establishing Core Values

To achieve sustainable development and optimal performance, an organization must establish a set of core values. These core values can only be considered true core values after they have been tested by market forces and have created automatic repayment and growth mechanisms. From the processes of growth and development, a society or industry can be considered an organic life-form; its economic activities, cultural and artistic techniques, philosophical behavior, etc. are the organic factors that compose that particular life-form. As far as industry is concerned, ITRI OpenLab is the mechanism that promotes the replacement of old with new, the activation of society's old resources, and the creation of

recycled energy. By participating or promoting OpenLab, resident firms create closely interactive relationships with ITRI; both sides learn from each other, and the entrepreneurial spirit of the firm is united with ITRI's research capabilities, allowing private firms to restructure old ideas, operations and personnel, thus increasing vitality and hope through transformation and innovation. In this way, both sides can grow continually, while increasing value mechanisms — this is where the core values of ITRI OpenLab lie.

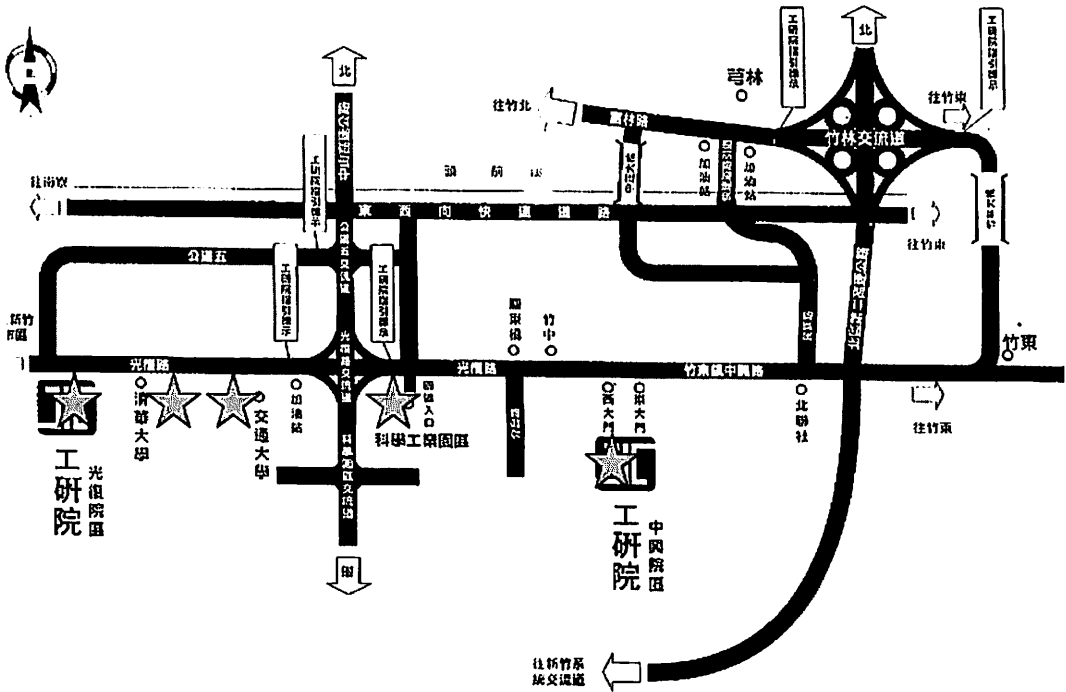
Operational Results

Since its inauguration, now, OpenLab has already yielded some considerable achievements. As a pioneering and unique operation model, it has attracted the attention of international enterprises and organizations, many of which have come to Taiwan to visit OpenLab and exchange ideas. As of the end of March 2003, ITRI OpenLab had undertaken 160 projects with 181 partner firms and 4,830 staff deployed at ITRI premises. At present, the net area in use for tenants is 4,600 坪. The amount of venture capital (VC) investment and R&D investment by related firms already exceeds US\$1.74 billion (VC investment: US\$1.5 billion / joint R&D investment: US\$240 million).

Key Reasons for Success

1. **Initial Government Investment in Building Infrastructure:** Since 1990, the government has provided funds worth US\$670 million in technology projects to commission ITRI to plan and build laboratories, including the new R&D building complex with total floor space of 46,000 坪. In addition to standard physics and chemistry laboratories, offices and conference rooms, the new multi-functional R&D complex also includes space for training, restaurants, displays and exhibitions, car parking, etc. The complex came into use in July 1996. ITRI uses part of it for its own purposes, while reserving the other part for use by OpenLab. Without government funding for construction at that time, the results of ITRI's OpenLab today would be unachievable today.
2. **Determination of ITRI's Leaders:** It is hard to effect reforms or new measures at any institution without the solid determination and support of decision-making levels. During the initial stages of OpenLab, it was inevitable that some units or individuals within ITRI would have some reservations about the changes. Fortunately, the reforms were made possible through the patient negotiations and support of various levels of managers and cadres.
3. **Comprehensive Planning:** During the planning stage, before OpenLab was opened to firms, ITRI applied its "Total Assets Management Concept" and gathered its all units and departments related for intensive discussion to clearly demarcate each department's rights and responsibilities. This enabled ITRI to offer a fully-comprehensive range of services once partner firms were deployed at ITRI premises. In addition, a market differentiation strategy was drawn up based on ITRI's advantages, in which it was decided that ITRI's valuable total assets services, not cheap rental rates, would be used to attract firms, distinguishing ITRI OpenLab from other open laboratories and incubation centers.
4. **Customer-oriented Service:** Even though ITRI is a not-for-profit non-government organization in the public domain, its semi-official role and the fact that unprecedented numbers of partner firms are stationed at OpenLab for the long-term meant that ITRI's customer service level was inferior to that of private, profit-oriented

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Map 1. Hsinchu High-tech Belt

enterprises. In its efforts to promote OpenLab, however, ITRI has carefully selected a professional team of sales staff to offer services based on customer-oriented principles with the aim of continuously improving the level of satisfaction of resident firms.

5. The Trend for High-tech R&D and Start-ups: Thanks to the healthy prospects for high-tech businesses in recent years, a trend for high-tech start-ups has arisen in Taiwan. Researchers, overseas Chinese scholars, and engineers at research institutes and Science-based Industrial Parks have one after the other entered the ranks of high-tech start-ups. ITRI OpenLab creates opportunities for these start-ups a conjunction before they move to the Science-based Industrial Parks.
6. Physical Location: The Hsinchu (新竹) area is a hotbed of high-tech activity in Taiwan (Map. 1). The comprehensive high-tech network formed by National Tsinghua University (國立清華大學), National Chiao Tung University (國立交通大學), ITRI, and the Hsinchu Science-based Industrial Park is an important and solid resource for developing the high-tech industry in that region. Therefore, ITRI is in a better physical position to promote open laboratories/incubator than other organizations. The presence of two prestigious universities and the Hsinchu Science Park are considerable advantages for attracting partner firms.
7. ITRI's Business Reputation: ITRI is not only the largest industrial research organization in Taiwan; it has also built up a solid international reputation through many years of hard work. This has a multiplication effect on resident firms' efforts to upgrade corporate image, improve price negotiation abilities, and attract workers.

Appendices

Appendix I. Number of U.S. Patents Granted by Countries

COUNTRY	2002		2001		2000		1999		1998		1997		1996	
	patent	rank	patent	rank	patent	rank	patent	rank	patent	rank	patent	rank	patent	rank
U.S. TOTALS	87,033	1	87,610	1	85,072	1	83,905	1	80,291	1	61,707	1	61,104	1
Japan	34,882	2	33,224	2	31,296	2	31,104	2	30,840	2	23,179	2	23,053	2
GERMANY	11,282	3	11,261	3	10,234	3	9,337	3	9,095	3	7,008	3	6,818	3
TAIWAN	5,430	4	5,371	4	4,667	4	3,693	5	3,100	7	2,057	7	1,897	7
FRANCE	4,035	5	4,041	5	3,819	5	3,820	4	3,674	4	2,958	4	2,788	4
UNITED KINGDOM	3,838	6	3,965	6	3,667	6	3,572	6	3,464	5	2,678	5	2,453	5
SOUTH KOREA	3,786	7	3,538	8	3,314	8	3,562	7	3,259	6	1,891	8	1,493	8
China			237	22	179	23	155	22	160	22	81	25	88	24

Source: Indicators of science and technology, Taiwan

Appendix II. Ranks: Number of U.S. Patents Granted to Taiwan

	1999		2000		2001	
	Rank	Patent	Rank	Patent	Rank	Patent
UMC	53	266	33	430	24	584
TSMC	47	290	39	385	28	529
Hon-Hai	151	106	35	397	34	441
ITRI	73	210	75	198	75	221
Winbond	131	115	134	115	130	126
Vanguard	135	112	119	131	147	112
NSC	227	73	261	65	225	78
Mosel		36	257	66	262	68

Source: FUSPTO