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SPEECH BY DR TAY ENG SOON, MINISTER OF STATE FOR EDUCATION, AT THE STANFORD RESEARCH INSTITUTE (SRI) INTERNATIONAL CONFERENCE AT THE HOTEL MANDARIN ON WEDNESDAY, 5 DECEMBER 1984 AT 9.00 AM

TECHNOLOGY TRANSFER - SINGAPORE'S EXPERIENCE

Introduction

The past three decades have witnessed an almost unprecedented explosion of technological innovation with worldwide impact. There is hardly any country or society which has not been affected by this technological revolution. But relatively few developing countries have been able to absorb the new technologies and achieve economic growth through technology transfer.

I propose to explore this question drawing upon Singapore's experience. I am aware that it may be dangerous to generalise from the experience of one country. Moreover, there are many successful but different models where technology-led growth has taken place. The newly-industrialised countries of South Korea, Taiwan and Hong Kong are such examples. So are the rapidly growing nations of ASEAN. Nevertheless, I believe that our experience will be of some value to those concerned with technology transfer.

I will use the term technology to mean the know-how and the software associated with any economic activity. The hardware is usually the visible and sometimes spectacular part. But in my definition, it is the intimate knowledge

and experience the user may have which constitutes the technology which makes the whole thing work. The higher the technology, the more knowledge-based it is. In the Singapore context, our starting point was entrepot trade, the main reason why Singapore was founded by the British.

For over one-and-a-half centuries, the main business of Singapore was buying, sorting, grading and refining the primary products of the region and reselling them to markets in the West. Singapore also acted as an incoming centre for manufactured goods from the West, providing such services as import and export financing, shipment, quality control, repair and maintenance, etc. An intricate web of business relations based on an intimate knowledge of the local market as well as those in the West grew out of this long experience. Singapore's first and oldest technological base is trading and financial services. These sectors still form a vital part of our economy with considerable extensions now to the newer sectors of manufacturing, communications and tourism.

Post-War Problems

This happy state of affairs as an entrepot centre came to an end after the Second World War. First, after achieving independence, many of the countries in the region decided to establish direct links with their trading partners. Singapore's accumulated experience was becoming less in demand. Secondly, unemployment was rising. Our post-war population was growing rapidly. Entrepot activities could not generate enough jobs for the thousands of young job seekers. This problem coupled with the political upheavals against colonial rule created a very dangerous situation. On the plus side, there were the institutions of government and the wealth accumulated for many years. But the new economic problems had to be solved

quickly if the young state was to have any chance of survival. The key problem was job creation. Industrialisation was seen to be the most promising route although the big questions of which markets and what types of industries were unanswered. Merger with Malaysia was sought as the solution to this problem. But that was shortlived. In 1965, Singapore found herself out of Malaysia and having to chart a new course of economic survival. How could a tiny nation of two million without any natural resources solve its economic and political problems? How could it transform its economy from entrepot trade to industrialisation? These were the basic questions.

Among its strengths, Singapore was well-located in the international communications routes. Its population was hardworking, adaptable and fairly well educated. The problem was to attract investments in manufacturing to Singapore as well as to promote local investments in industry. Fortunately for Singapore, the world in the 1960's and early 70's was going through a period of unprecedented growth. Trade was booming and inflation was low. Many MNCs were looking for suitable locations to expand their production plants. Singapore set out to become such a location. The MNCs would catalyse industrialisation in Singapore. They offered the quickest way to job creation. They had their own capital, technology and markets.

Basic Pre-Conditions

But to attract investments to Singapore, certain pre-conditions had to be created. The chief of these is political and social stability. Without stability, no investor would put in his money with no confidence that his investment would be safe and would bear fruit. Several major policies were initiated by the Government to create such a climate of stability and confidence. They were:

(a) A major public housing scheme linked to a compulsory saving scheme (the Central Provident Fund). This ensured workers of good housing and a chance to become home owners. It gave them a growing stake in the prosperity and stability of Singapore.

(b) A massive education programme to raise the educational level of the young. This included a strong emphasis on technical and vocational training. But the growth was allowed to keep pace with economic development and job creation. As a result we never experienced any brain drain problems.

(c) Persuading trade union leaders to accept that job creation and income growth depend on industrial peace and discipline. This included legislation to require industrial disputes to be settled in an orderly manner through an industrial arbitration court.

(d) Establishing a reward system based on merit and performance and not on nepotism, a practice which was endemic in many traditional Asian societies. This policy released new talents and enabled the best talents in the country to rise to the top, thereby ensuring effective management in both the public and private sectors.

(e) Upholding the legal system inherited from the British to protect property and profit gained by lawful means. Under such a protection, entrepreneurs had the greatest motivation to achieve success, confident that the fruits of their success would be safeguarded.

(f) Taking a fair but firm line on matters related to racial, religious and language issues. In our multi-racial society, these are potentially emotional issues. But by being fair and firm and by ensuring equitable treatment for all, the issues have generally receded.

I have spent some time on the political and social conditions because I believe that if these pre-requisites are not met, it is futile to talk about economic growth and technology transfer. The "take-off" conditions, to borrow an expression from Rostow are not economic, technical or financial ones but the vital ones of consensus, political stability and working together in community. I was interested to find an article quoted in the Straits Times yesterday by Rostow himself expressing exactly these points.

The momentum of economic growth started in the mid-60's has continued to the present day despite the two oil crises of 1973 and 1979 and the recent world recession. This is because, essentially, the political and social policies, the crucial ground rules for our society have been maintained and stability and confidence have prevailed.

The Education Factor

I will turn my attention now to trends in technology transfer in Singapore. As a small economy, our position must essentially be reactive and adaptive to the major external trends, seeking always to capitalise on our strengths. We have, therefore, sought to keep our economy well diversified and open to international competition. Our ability to adapt quickly is a key factor. This places a premium on education and training. We are, therefore, investing heavily in education. Education forms 12 per cent of the Budget or about five per cent of the GDP. Recognising that technology is ultimately absorbed and

transferred by people to people, we have embarked on expanding all our vocational training institutions, polytechnics and university. We are doubling the enrolments of all these institutions. By 1986, when our present phase of expansion is completed, about half of each cohort of all our students entering the job market would have either a vocational skill, a diploma in technology or a degree in engineering, science or management. Continuing education at all levels has also been organised. Noting that a sizeable number of our adult workers never had much educational opportunity in their youth, we have started a novel basic education scheme called BEST (which stands for Basic Education for Skills Training). BEST involves all the major employers. It is funded by the Skills Development Fund and reaches out to over 40,000 workers each year.

Technological Upgrading

In the early 1970's, most of the investments in manufacturing were labour-intensive operations. This fitted in very well with our goal of job creation. But the situation has changed completely. Today, we have a tight labour market and have to allow guest workers into Singapore. This new situation has presented us with the opportunity to upgrade our whole economy. Because of tight labour, wages have gone up. Employers have become very conscious of productivity and are receptive to the need to mechanise and automate as much of their operations as possible. There is, therefore, a strong push to bring in more technology to substitute for costly and scarce labour.

The Government has played several decisive roles in this technology upgrading movement. First, the Government, working with the trade unions and employers organisations carried out a "wage correction" exercise. This had the effect of raising wages and causing firms to shed labour in favour of mechanising their operations. It thus released

scarce labour back into the market for other employers to recruit. Secondly, Government working again with unions and employers initiated a productivity movement. This on-going campaign took many forms. It included training courses for supervisors and managers and the promotion of QC Circles. The productivity message was aimed at all levels - from top management down to the shop-floor workers. The goal is to bring about a new attitude and perception towards productivity. Surveys show that attitudes are indeed being changed by the campaign. Over the past three to four years, productivity has grown steadily at about four to six per cent per annum. These initiatives have an important spin-off. They teach the value and importance of co-operative effort instead of the traditional confrontational approach between workers and management. The lesson is driven home when workers see their wages go up because of their productivity efforts and employers see their profits go up when they invest effort in promoting teamwork and productivity among their workers.

Computerisation

I should highlight two other initiatives which illustrate our commitment to technological upgrading. First is in the field of computerisation and the software industry. Realising that further productivity can only come about by the massive use of computers, the Government took the bold decision to computerise the whole public sector and the civil service. Every government ministry and statutory board today either has installed or is on the way to installing a computer-based management information system. This massive project of course has many positive spin-offs. A National Computer Board (NCB) was created not only to supervise this project but also draw Singapore further into the information technology age. The NCB has responsibilities for computer manpower development and promoting the transfer of software and hardware technology.

The business climate in Singapore today is very receptive to computers, automation and robotics. For example, there is growing interest not only in data processing and management information systems but also in CAD, CAE and CAM applications. One of NCB's objectives is to develop Singapore into a software centre and thus make Singapore a conduit for the software and hardware needs of the region.

R & D Trends

In the 1970's, most MNCs and local industries concentrated on production. But in recent years, many have begun to carry out backward and forward integration of their operations. Starting with making improvements to their processes and their products, they have embarked on new product development and design. These are the essential steps towards R & D. Some of the larger firms have started their own R & D departments. A new market has been created for R & D engineers which has in turn stimulated the university to start post-graduate courses and R & D activities. Up to now, the Government has deliberately played the role of facilitator, encouraging private industry and the university to step up R & D activities. It has not gone in to become a doer of R & D by setting up R & D institutes, preferring to let the demands come from industry. One reason is the observation that the most useful and profitable R & D is usually carried out by enterprises who have a strong motivation to compete in the market place. A second is that public sector R & D institutes can become costly white elephants unless they are forced to compete also in the market place. Nevertheless, the Government has not hesitated to spend on R & D activities where it believes that this is necessary to develop specialised R & D manpower. Thus at the university, research grants are given to projects. The latest of this is the setting up of the Institute of Molecular and Cell Biology. The purpose of this is to gain expertise in the new field of biotechnology which is expected to be one of the major growth areas of the future.

Various tax incentives and inducements have been provided to encourage firms to engage in R & D. One of these is the creation of a Science Park near the National University to accommodate R & D oriented firms and organisations. To date, over 10 firms have started operations in the Science Park. This is our mini-version of the Stanford Science Park. It is a modest beginning but it represents the direction we want to go.

One area of technology transfer in the private sector is worth mentioning. The operations of the major MNCs have created a spin-off among supporting industries. Many specialised supporting industries with considerable technology and know-how have sprung up to meet the demands of the major industries. Thus, there are precision engineering firms, tool and die specialists, firms specialised in industrial plastics, precision PC boards, chemical treatment, etc. This is a good example of technology transfer to local industries. Many of these are now becoming export-oriented operations.

Conclusion

Let me conclude with the following comments. As a Government, we have striven to create the best possible conditions of stability believing that this must ultimately help Singapore to develop and thus benefit all our people. There is indeed a strong nexus between stability, technology transfer and job creation. Our policy towards technology transfer has been one of maximum freedom, leaving it to the MNCs and local entrepreneurs to decide of what technologies they need and how much they want to bring in. I believe that this policy has worked to everyone's advantage, the enterprise, the workers and Singapore itself.

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TABLE 1

GROSS DOMESTIC PRODUCT

Year	GDP (At Current Price S$ Million)	Per Capita GDP (At Current Price S$)
1960	2168	1430
1970	5815	3063
1975	13373	4889
1980	24285	7424
1981	28696	9049
1982	31946	10103
1983	35171	11031

TABLE 2

TOTAL INVESTMENT IN THE SINGAPORE ECONOMY*

Year	Investment (S$ Million)	Percent Share of GDP
1960	245.0	11.3
1970	2244.5	38.6
1975	5592.0	39.1
1980	10991.1	45.4
1981	12736.9	44.9
1982	14438.0	45.1
1983	15865.9	45.1

* This includes infrastructure, housing, as well as investment in manufacturing.

TABLE 3

CONTRIBUTION TO GDP BY INDUSTRY - 1983

		S$ Million	Per Cent
	Total	35171.4	100.0
1	Agriculture/Fishing	344.4	1.0
2	Quarrying	152.7	0.4
3	Manufacturing	8467.7	24.1
4	Utilities	666.5	1.9
5	Construction	3862.8	11.0
6	Trade	7240.6	20.6
7	Transport/Communications	4562.8	13.0
8	Finance/Business Services	7902.7	22.5
9	Other Services	4086.7	11.6
10	Less: Imputed Bank Service Charge	2626.5	7.5
11	Add: Import Duties	511.0	1.5

TABLE 4

CUMULATIVE FOREIGN INVESTMENT IN MANUFACTURING BY COUNTRY OF ORIGIN (GROSS FIXED ASSETS)

	Country	S$ Million Mid 1983	Per Cent
1	USA	3479	33.1
2	Japan	2099	20.0
3	UK	1652	15.7
4	Netherlands	1454	13.8
5	Germany	236	2.2
6	Switzerland	203	1.9
7	Sweden	128	1.2
8	Italy	103	1.0
9	France	90	0.9
10	Others	1070	10.2
	TOTAL	10514	100.0

TABLE 5

CUMMULATIVE FOREIGN INVESTMENT IN MANUFACTURING BY INDUSTRY GROUP (GROSS FIXED ASSETS)

	Industry	S$ Million Mid 1983	Per Cent
1	Food/Beverages	394	3.8
2	Textile	97	0.9
3	Apparel/Footwear	72	0.7
4	Leather/Rubber (*except Rubber processing*)	37	0.3
5	Wood products	122	1.2
6	Paper products	125	1.2
7	Industrial Chemicals	649	6.2
8	Other Chemicals (except plastics)	415	4.0
9	Petroleum products	4053	38.6
10	Plastic products	159	1.5
11	Non-metallic Mineral products	152	1.5
12	Base Metal industries	78	0.7
13	Fabricated Metal products (except machinery & equipment)	385	3.7
14	Machinery (except electrical)	980	9.3
15	Electrical/Electronic Industry	1936	18.4
16	Transport Equipment	531	5.1
17	Precision equipment/Optical	259	2.5
18	Others	70	0.7
		10514	100.0

TABLE 6

QUALITY OF NEW INVESTMENTS IN MANUFACTURING

Year	Expected Fixed Assets Per Worker (S$)	Expected Value-Added Per Worker (S$)
1980	52000	72900
1981	76300	83200
1982	67100	79800
1983	73500	87200

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