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University of Amsterdam Consortium

Strengthening Private Sector Participation in Philippine Technical and Vocational Education and Training

Background Paper No. 3
The Singapore TVET System

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May 1996

University of Amsterdam: VTP2 project, Philippines

Supplementary mission to Singapore: report by Charles Manton

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1. General

Mission dates: 4 - 7 March 1996

Exchange rate: US$1 = S$1.40 (approx.) S$1 = US$0.71 (approx.)

Objective: To obtain information on advanced and branch-specific training centres in accordance with a case-study framework also used in the Philippines

Implementation:

Preparation of the mission was undertaken directly, without the assistance of any agency in Singapore. Requests for information and assistance were made to the **Economic Development Board**'s London office on 23rd January and to the **Institute of Technical Education** on 7th February but despite reminders no response was received from the EDB until 3rd March or from the ITE until 27th February.

The ITE had arranged a visit to their Precision Engineering Institute, and this was the only appointment made in advance.

The 3½ working days of the mission were thus spent as follows:

Monday 4 March

Making contacts and appointments

Tuesday 5 March

1430 Precision Engineering Institute

Wednesday 6 March

1000 Institute of Technical Education

1630 German-Singapore Institute, Nanyang Polytechnic

Thursday 7 March

0930 Economic Development Board

Results: Meetings, although few, were highly useful in providing an overview of advanced TEVT in Singapore, the most striking features of which (from the point of view of the UvA project) are the high degree of governmental intervention and finance and the detailed medium-term manpower planning.

The PEI provided sufficient information for a fairly complete case study in accordance with the framework and the German-Singapore Institute rather less but still useful information. In neither case was detailed financial information made available. (See case studies)

A list provided by the ITE of 57 "Approved Training Centres" is attached. The function of these centres is decribed under "Institute of Technical Education", para 18 - Industry Based Training, below. The list includes two or perhaps three branch-specific centres, namely the Air Engineering Training Institute, the Electronics Industries Training Centre, and the Jewellery Industry Training Centre. There was no time to contact them. Almost all the other 54 listed are single-company or single-institution centres and a good many are in non-manufacturing sectors. The list does not include one centre found in the telephone directory, namely the Textile and Garment Industry Training Centre Pte Ltd, and this was not contacted either. According to the EDB this industry is in any case defunct.

2. Economic Development Board

The EDB is an organ of the Ministry of Trade and Industry. (Other organs of the MTI include the Trade Development Board, the National Productivity Boar, the Science and Technology Board and the Tourism Board.) The EDB was founded in 1961 after a Dutch consultant had recommended an industrial future for the island, and is responsible for attracting foreign investment in manufacturing and related services. One of the factors which attract investment is a supply of well educated and trained manpower and it is one of EDB's functions to assure such a supply.

In the early years Singapore was a cheap production base for electronics, mostly American. Public investment was concentrated on housing and education. Full employment appeared in the 1970s and there was a shift to attracting capital intensive industry. This shift brought with it a need for more highly qualified workers and as a contribution to provision of such workers, the EDB set up three training centres in 1982, namely the French-Singapore Institute, the German-Singapore Institute and the Japan-Singapore Institute with the assistance of the respective governments. The three institutes offered technician-level training with a high practical content and an industrial environment, e.g. with a 44-hour week and with real-life production, contracted by local industries in the later stages of courses. At least in the case of the German institute practically all technical assistance was discontinued in 1987.

The education and training at these Institutes tended to converge with those at the newly developing Polytechnics (under the Ministry of Education) and they were accordingly transferred to Nanyang Polytechnic in February 1993. They still survive under their own names and have residual connections with their sponsoring countries, but effectively they operate as normal teaching departments.

The EDB is now operating five programmes:

Manufacturing 2000
International Business Hub 2000
Regionalisation 2000
Promising Local Enterprises 2000
Co-investment

and an internal development initiative called "Organisation Development-Learning Organisation".

The M2000 programme "will seek to upgrade capabilities across the entire value chain of each cluster, including product and process development, production, manufacturing engineering and strategic marketing." (EDB Yearbook 1995.) Amongst other activities "an innovation development programme was formulated" ... "a S$1 billion Cluster Development Fund [was set up] for risk sharing projects" ... "tax incentives, financial assistance schemes, industrial land planning and foreign worker policies were fine tuned" ... "national research institutes and centres ... will train R&D manpower for industry, develop pre-competitive technologies, provide R&D infrastructural support and transfer technology to industry".

The EDB promotes and finances advanced training, often in partnership with firms, although it no longer delivers any training itself. Training grants are available for training foreign employees, even for training outside Singapore. Formal CBA is not undertaken. "Singapore is aggressively building up its capabilities to meet the anticipated need for specialised manpower in the electronics sector. To achieve this end, manpower development initiatives such as the Radio Frequency Development Engineers' programme and specialised courses on process technologies for semiconductor wafer fabrication and disk media are currently being implemented. The electronics industry has also been sending its engineers and technicians for overseas training in research and development and new manufacturing process technologies. EDB's INTECH (Initiatives in New Technology) scheme supported the training of more than 750 engineers and technicians from the electronics industry [in 1995], and increase of more than 70% from 1994." (Straits Times, 4 March 1996).

On 6 March 1996 the Straits Times published the second of two supplements entitled "Scholars' Choice", giving prominence to EDB programmes. "Investment commitments of S$1.1 billion in the services sector in 1995 will create some 6,000 jobs. In addition about 4000 professionals and technical staff will be needed in the manufacturing sector over the next three years. These job opportunities are the result of targeted growth of the manufacturing sector of 7% per annum between now and 2000, as well as the expansion of the services sector and the telecommunications, broadcasting and logistics industries. Hence the importance of manpower planning ... Said Mr Goh Eng Ghee, deputy director of the EDB's Manpower and Capability Development Division, 'We are trying to create more awareness of the growth in the manufacturing and services sectors, what good paying jobs there are ...' To spread this message the Manpower Division organises factory visits for career guidance counsellors of schools and higher institutions and holds seminars for junior college students ...

"There are notable manpower shortfalls in the strategic sectors ... The EDB's Manpower Division is employing two strategies, namely capability development and manpower augmentation ... The Board will work closely with industry and institutions to identify and enhance the core skills ... 'We don't just look at total manpower needs but the mix of demand and the mix of supply to see how the two match,' said Mr Goh. In the second strategy the EDB leads companies on overseas missions to recruit professionals and skilled manpower ...

"Other EDB-implemented schemes include the specialist manpower development programmes to meet the short- to medium-term manpower needs ... The programme for wafer fabrication, disk media and integrated circuit packaging will train - with the cooperation of participating companies - 330 graduates each year at the degree level and 4520 graduates per year at the diploma level over the next three years."

"The EDB has various scholarship programmes ... The newest is the S$15 million EDB-PLE (Promising Local Enterprise) programme, under which 100 scholarships will be jointly awarded by EDB and participating enterprises over five years." 60% of the funds will be provided by the EDB and the balance by the PLEs themselves. "Another S$50 million Glaxo Wellcome-EDB HRD Scholarship programme trains scholars in engineering, economics and science disciplines."

This is entirely financed by Glaxo Wellcome."

The "Promising Local Enterprises" programme, PLE2000, has a target to nurture 100 local enterprises each to have sales of S$100 million within ten years. At presen they are mostly sub-contractors. There are altogether some 50 schemes of assistance to local companies, including grants or loans for various purposes. However small companies, as in many other countries, have to be encouraged to adopt training and learning policies; this is more the function of the National Productivity Board.

It should be noted that the EDB does not concern itself with "lower-level" industrial skill training such as is still needed in the construction industry and the shipyards. Nor does it concern itself with management training. This is held to be the responsibility of firms, in accordance with their own corporate culture and practice. Most industrial employment in Singapore is in fact in foreign companies: there are very few big local companies.

It does not worry Singapore if companies move operations offshore in search of lower labour costs, at least to the extent that it is lower-level skills which are moved. Investment in labour-intensive industries is not encouraged. In fact the EDB's Regionalisation 2000 programme aims to encourage Singapore-based companies to establish operations in "resource-rich" countries, sometimes within industrial parks which offer familiar conditions established by intergovernmental agreement. Singapore sees itself as a "business architect", ... "will capitalise on its core competencies and act as a global business and knowledge arbitrageur." Singapore investments in the Philippines are listed as US$52 million in five projects in 1994, up from US$39 million in 10 projects in 1993; but these are by far exceeded by investments in other countries:

(1994)	China	US$1,974	712 projects	(to June 1994)
	Indonesia	1,470	81	(Sept 94, cumulative)
	Thailand	368	41	
	Malaysia	275	119	
	Vietnam	597	29	(Nov 94)
	Myanmar	272	20	

The EDB's staff numbers just over 300. They aim to attract and retain professional staff of the highest calibre. The Industry Development Division[1] has nine groups each of which maintains the closest contact with firms, Chambers of Commerce and training institutions in Singapore. Networking is given high importance and is facilitated. (Chemicals, Electronics Systems, Electronic Components, Light Industries, Aerospace/Defence, Manufacturing Systems, Engineering Systems, Biotechnology, Lands and Infrastructure.)

The EDB keeps informed on technological developments and investment plans elsewhere through 16 offices in other countries and country desk officers in Singapore.

The cumulative picture is of significant, high-quality state involvement in manpower development and of close cooperation with a willing private industrial sector. This cooperation is undoubtedly assisted by the fact that EDB's budget is S$4.3 billion for 1996/97.

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[1]There is also an Economic Resource Development Division, a recently adopted name for the former Manpower and Capability Division. However the organisation is set out in a circular form and it is stated that "the EDB adopts a borderless mindset and recognises that the success of all our programmes depend on the people in the whole organisation - members who work as a cohesive, totally aligned team without divisional borders and practising systems thinking." (EDB Yearbook 1995, page 13)

3. Education and training

The system is shown in the chart on the following page, produced by the Institute of Technical Education. Further details of the technical education system are in the following section of this report on the ITE. Additional points to note concerning the general system :

.Education is not compulsory by law in Singapore, but is virtually compulsory through social pressure. Secondary education is available for all primary leavers and the government encourages a minimum leaving age of 16. Those who leave earlier are designated "Early School Leavers".

.Streaming begins in primary school: the type of secondary school attended depends on performance in primary schools. At the end of secondary school pupils take O-level or N-level exams. (N = normal.)

.Education is in English. All school pupils must study another language, Mandarin (in the case of the majority of Chinese origin, even if they speak a dialect at home), Malay or Tamil. At "Secondary Special" schools two languages are studied to mother-tongue standard.

.Boys must and girls may have some technical training in secondary school.

.Some 1994 figures:

Population	2.8 million
Total student enrolment	541,000
Enrolment in technical and vocational institutes	24,954
Enrolment in tertiary institutions	73,506

(Source: Economic Survey of Singapore 1994, quoted by EDB in "Singapore Update 1995")

.Education is not completely free of charge to users. Parents, or students themselves in higher courses, have to make small contributions to fees. There are various support funds to help needy families or students so that in effect nobody need forego education or training for direct financial reasons.

.The small size of Singapore makes residential facilities unnecessary, except of course for orphans and otherwise deprived children.

4. Institute of Technical Education

1. The ITE was established on 1st April 1992 by the Institute of Technical Education Act (C.141A). The ITE replaced the Vocational and Industrial Training Board in the context of wider educational reform. In particular the ITE no longer offers post-primary vocational training. Although there is no compulsory school-leaving age in Singapore it is now normal practice to stay at school at least until the age of 16, and the ITE only offers post-16 TEVT.

2. The ITE's mission statement is:

> To maximise the human potential of Singaporeans through excellence in technical education and training so as to develop the quality of our workforce and enhance Singapore's global competitiveness.

3. The ITE Act provides for quite detailed control by the Minister of Education. Section 14 (1): "The Minister may, after consultation with

the Board, give such general directions not inconsistent with the provisions of this Act as to the policy to be followed by the Institute in the performance of its functions under this Act as appear to the Minister to be necessary and the Institute shall, as soon as practicable, give effect to any such direction."

4. The Minister holds the main purse-strings: Section 27: "For the purpose of enabling the Institute to carry out its functions under this Act, the Minister may, from time to time, make grants-in-aid to the Institute out of moneys to be provided by Parliament." Section 28: "The Institute may, from time to time, for the purposes of this Act, raise loans from the Government or, with the consent of the Minister, from any source."

5. The ITE does on the other hand have some fund-raising powers under Section 6 (Powers). "The Institute may ... (e) carry on any trade or business... for the purpose of providing training ... (i) levy and collect such fees, rates or charges for training and other services ... (j) solicit and receive donations from any source or raise funds by any lawful means."

6. Moreover there is only one Ministry of Education representative on the Board of Governors. This board comprises a chairman and deputy chairman both from private-sector firms and 15 members of whom seven are from private-sector industrial and commercial firms. Six of the others are from the public sector (one each from the Ministry of Education, the Ministry of Defence, the Economic Development Board, the Housing and Development Board, the National Productivity Board, together with the Director of the ITE itself); and two from trade unions (the National Trades Union Congress and the United Workers of Electronics and Electrical Industries).

7. Total expenditure incurred by the ITE in the year to the end of March 1995 was S$116.5 million, up 6.5% from the previous year. Manpower costs accounted for S$100.3 million.

8. At the end of March 1995 the ITE had 1,270 training staff and 631 non-training staff, a total of 1,901 against an establishment of 2,044. Under the Director there are three Deputy Directors and ten Divisional Directors. The Institute operates eleven training institutions headed by Training Managers all of whom report to the Divisional Director of Institutional Training. Full-time enrolment (new) in the year to end of March 1995 was 6,266, a 7% decline from the previous year. The peak full-time total enrolment in the year was 12,231, down 17% from the previous year, and 9% below the target of 13,400. Output was 6,752, down 1%. (According to the Annual Report 94/95 the ITE's mandate is to enrol 10,000 students a year. Where this "mandate" come from is not stated.)

9. The ITE also runs Continuing Education and Training (under another Divisional Director) and controls the New Apprenticeship Scheme described below. It should be recalled that the total population of Singapore is just under three million and in such a context the size and organisation of the ITE might be thought heavy and bureaucratic. On the other hand it might reflect the very high importance attached to HRD in Singapore and a structure preferred within the basically Chinese cultural context.

10. The ITE offer 25 mostly two-year courses in eight "trade clusters" leading to the Industrial Technician Certificate, the National Technical Certificate Grade 2 (NTC-2), the Certificate in Business Studies and the Certificate in Office Skills. NTC-2 courses have common first-year syllabuses within clusters, and all courses reinforce "key competences". (Not identified in detail.) As part of the transition from the former VITB programme the number of courses has been reduced from 40 and full-time courses leading to the lower level Certificate of Vocational Training and NTC-3 have been discontinued (although NTC-3 is

still available through apprenticeships or continuing education and training schemes).

11. Courses are almost entirely funded by the Ministry of Education through the ITE. The average cost was S$7,530 in the year to March 1995. Students pay fees of S$512 a year for the ITC courses and S$260 a year for NTC-2 courses.

12. The ITE professes a concept of "total training". This is not only a question of balancing theoretical and practical elements but incorporates "physical fitness, positive work values and social responsibility in an integrated approach to developing the future Singapore worker". (Annual Report 94/95, p. 36)

13. Progression to polytechnics or universities is formally controlled by the Ministry and partly depends on whether a Certificate of Merit is obtained. It is advertised in promotional literature, evidently as an enticement to potential students, but of course if students do proceed from ITE courses to the tertiary system they are lost to employers as (much needed) technicians. This mirrors the trend in Germany which (amongst other factors) is playing havoc with the dual system.

14. Apprenticeship. The New Apprenticeship System was launched in 1990 and is well controlled by the ITE. Apprenticeships are on offer in 60 programmes in 18 trade areas (including services and commerce) and lead to NTC-2, NTC-3, various specialised certificates (e.g. in health care or travel services) and in one case to a Certificate of Competence (a one-year course in motorcycle mechanics which only requires three years' primary education for entry, very much the exception. See next paragraph). Durations vary from one to three years. Apprentices sign contracts with training employers, who in addition to the usual obligation to train the apprentices and to release them for off-the-job training, pay them a relatively small salary and training costs. Some 600 companies take on apprentices. 1,335 apprentices were taken on in the year to March 1995, 14% down from the previous year and 21% below target. Total enrolment was 2,172, down 14% from the previous year and 13% below target. Output was 1,350, down 3% from the previous year and 10% below target.

15. Reasons given for the decline in numbers of pre-employment training for school leavers are: reduction in the pool of GCE O-level leavers, increased opportunities at the polytechnics and private schools, and a tight labour market attracting school leavers into direct employment.

16. Early School Leavers (ESLs). Even under the "Improved Education System" some young people leave school before completing ten years. Vocational training centres are being set up to cater for these both through full-time courses and apprenticeships. The first intake of about 860 ESLs started in January 1995 in an NGO centre and 2 temporary VTCs on ITE campuses. These two have now been replaced by permanent centres with 1,350 full-time training places and 500 apprenticeship placements annually. These appear to be quite high figures given the social and governmental pressure for high educational attainment and the stated shortage of labour. VTCs are after all something of a refuge for the otherwise unemployable in labour-surplus countries. On the other hand it may be that even those who cannot cope with school realise the need for some kind of training.

17. Continuing Education and Training (CET). This covers academic education and skills training and is beset by acronyms. BEST and WISE provide the academic reinforcement, while MOST, TIME and ACTS are for skill upgrading. There is also a Continuing Education programme for working adults. (Participant numbers for the year to March 1995.)

BEST: Basic Education for Skill Training
Intake of 16,832, bringing total in 12 years to 192,000 or 85% of the target. Demand expect to decline.

WISE: Worker Improvement through Secondary Education
Intake 16,316, bringing total to 63,000 or 52% of the target pool

Continuing Education: Intake 11,822, 17% down from the previous year and 21% below target. Progressive decline resulting from improving school performance

MOST: Modular Skill Training
TIME: Training Initiative for Mature Employees
ACTS: Adult Cooperative Training Scheme
15,370 training places taken up in these three schemes, 20% down from the previous year and 21% below target.

18. Industry-based Training (IBT). "Under the IBT system, companies, or in some cases industry associations, which have the resources and expertise to mount specially-tailored skills training programmes for their workers, are actively encouraged to do so. Employers gain from such arrangements because it gives them control and flexibility over the design and schedule of training programmes for their staff. Workers, on the other hand, benefit from receiving skills training that are [sic] directly applicable to their job functions and future development and progression in their respective companies. The training centres that companies set up fro IBT can, if they meet ITE's requirements for Approved Training Centres, serve the additional function of providing the Off-JT component of apprenticeship training for their potential workers." (Annual Report 94/95 p.44). The nature of the "active encouragement" is not explained, nor are the criteria for Approved Training Centres. A list of 57 of these centres is attached at Annex 3. In the year to March 1995 899 training places were provided, 45% lower than in the previous year and 25% below target. Primary cause for decline: discontinuation of NTC programmes by the Singapore Hotel Association Training and Educational Centre.

19. Certified On-the-Job Training. This scheme was started in 1994 with 14 participating companies. By March 1995 the number was up to 126 companies, who offered 15,700 training places for some 8,000 workers. The ITE encourages companies to upgrade their on-the-job training and will give them advice on how to do so. The training is structured within a training plan, and once the plan and the trainer(s), together with the training infrastructure, are approved the company can be certified. There was said to be no tangible advantage for employers except that workers can be better trained on their own premises. The National Productivity Board collaborates with this scheme and employers may recoup costs from the Skill Development Fund operated by the NPB. An Industry Trainer Certificate course is jointly run by ITE and NPB. In the year to March 1995 593 trainers completed at least one module and 32 completed all three modules, bringing the total number of certified industry trainers to 117.

20. Trade Tests. The ITE conducts trade testing. It can include validation of prior learning, i.e. it is not obligatory to attend an ITE course before taking the test. In the year to March 1995 49,516 candidates sat for ITE tests and examinations, 12% fewer than in the previous year. Overall pass rate 81%, unchanged from the previous year.

21. ITE 2000 Plan. This starts with a "Vision", namely "To Build ITE Into An Established Post-Secondary Technical Institution By The Year 2000". Below this there are five goals, eight strategies and 21 programmes. The five goals are:

1. An effective training system, responsive and relevant to the needs of the economy
2. An upgraded physical environment compatible with a post-secondary technical institution
3. A campus environment which promotes and support the total

development of students
4. Professionally qualified training staff committed to the needs of post-secondary students
5. An improved public image and recognition of technical training

As of June 1995 11 of the component programmes had been developed, six were under development and four were new programmes. (These categories not further elucidated.)

22. In pursuit of Goal 2 the Physical Development Plan will cost some S$300 million to implement. Four entirely new institutes are being built and three redeveloped on existing sites. The other three are relatively new, having been developed in the 1980s, and will be upgraded to bring them into line with the new institutes. (There is no mention in this plan of the existing Precision Engineering Institute.) In addition the ITE has built itself a new and pharaonic headquarters building at a cost of S$35 million.

23. "What ITE will look like in the year 2000"

".An upgraded post-secondary technical training system (with 90% secondary school leavers)

.Intakes of 40% of GCE 'O' pool and 70% of GCE 'N' pool of school leavers

.A stronger industry-based training infrastructure with 500 companies certified for on-the-job training

.A system of 10 modern institutes of technical education and a new ITE headquarters

.An improved campus environment for the total development of ITE students

.Better-trained and qualified staff to meet the needs of a post-secondary institution

.An improved image and status of ITE as a post-secondary technical institution - well-accepted by industry, parents, school leavers and community"

5. Findings

5.1. Singapore in general.

24. Singapore has practically nothing in common with the Philippines except for its general location on the planet and perhaps for a strong component of Chinese origin in its society and economy. (In Singapore over 75% of the population is of Chinese origin; in the Philippines the proportion is very much less but the total number may of course be greater.)

25. Singapore is a small island state, as much a psychological island as a physical one (being connected to Malaysia by a causeway), and perhaps derives the cohesiveness of its society not only from its relatively small size and predominantly Chinese culture but also from the sense of external menace which islanders tend to feel. For whatever reason, cohesive the society certainly is, reflected in fairly willing acquiescence to authority, willingness to accept and work within decisions once made, and strong social pressure to conform and achieve. This predisposition greatly assists effective collaboration between institutions and individuals and there is no dogmatic divide between the public sector and the private sector.

26. Not everything is perfect. There is for instance a certain amount of juvenile delinquency allied with a trend to join secret societies, and a surprising number (not necessarily delinquent) leave school before the recommended, but not compulsory, age of 16. There is evidence of stress: Asiaweek (15 March 1996) reports that "Domestic violence is on the rise ... In 1994, police dealt with 135 cases of family violence, and gave protection to 284 victims - an 89% increase over four years. In just the first half of last year, 287 people sought police protection." In the organisation of government there is apparent overlap in spheres of responsibility and function between the Economic Development Board, the National Productivity Board and the Ministry of Education, and the whole system appears to be a comparatively large bureaucracy. But this last observation must take account of the equally apparent effectiveness of the system.

27. Singapore has no natural resources and its economy depends to great extent on the operation of some 3,000 foreign companies. Investment is attracted by stability, consistency of public policy, public order, a clear legal and procedural framework, absence of "improper practices", certainty of ownership, no requirement for local partners, good infrastructure, communications and public utilities, low rates of tax, freedom to import labour and repatriate profits - and not least by the availability of a certain number of highly educated and trained professional and technical employees, even if these must be supplemented by non-Singaporeans in large numbers. Some 10% of the population is foreign with permanent residence rights.

28. There is also a shortage of lower-skilled workers and new investment requiring much unskilled or semi-skilled labour is discouraged. Lower-skilled workers are admitted with one-year permits. According to the Manila Bulletin (9 March 1996) there are some 65,000 Filipino workers in Singapore "dominated" by domestic helpers, but with some professional managers including construction managers in their number. This figure represents over 2% of the resident population.

29. The state budget is in surplus an allows generous government funding of education and training, presumed to be for the wider benefit without formal cost-benefit analysis. This is not sloppy: there is a very strong and coherent intellectual input to the formation of policy, or a hierarchy of agreed policies, within an agreed long-term framework, succeeded by disciplined and consistent implementation. Funding of education has been going on for thirty years and appears to be the key, or one of the keys, to evident success.

30. As one of its policies Singapore is encouraging Singapore-based firms to invest in other regional countries, especially "resource-rich" countries, i.e. those with plenty of labour, and thus to expand the country's "economic area". (See R2000 in the section on the Economic Development Board below.) Singapore will concentrate on its core competences in high-value, high-technology manufacturing and in provision of high-class financial and other services (See IBH2000). Such policies seem to lead to the emergence of the "virtual state", on the lines of the "virtual organisation" which contracts out all its activities including production expect the core functions which give it some minimal identity. What happens to the identity of a virtual state? Whatever happens to national identity it has the potential to become very rich.

31. Meanwhile the real GDP of Singapore increased by about 10% in 1994, a similar rate to 1993's. The balance of payments is in surplus year after year. Population (1994): 2.8 million, growth rate 2%. Population literacy 92%. Inflation 3.6% (surprisingly high, perhaps pushed by wages, but in any case affordable, and Asiaweek for 15 March 1996 gives an inflation rate of 0.9%); unemployment 2.6% (again surprisingly high given the acute labour shortage but depending on its nature it might be the minimum which allows some flexibility in the labour market). (Source EDB).

32. Manufacturing establishments 4,130; output S$99,980 million; workers employed 422,500; value added S$31,911 million. Investment commitments in manufacturing S$5,764.7 million, of which S$1,437.2 million local. (1994 figures, source EDB).

33. GDP per head in purchasing-power-parity dollars: $21,493. (Cf. Germany $20,165, Hong Kong $23,080, United Kingdom $18,138, Philippines $2,800, China $2,660, India $1,280). (Source Asiaweek, 15 March 1996 "compiled from latest available data")

6. Relevance of Singapore's TEVT policy and practice to the Philippines

34. The differences between Singapore and the Philippines are so great in every respect that it is scarcely, if at all, useful to identify detailed models of TEVT policy and practice in one country for adoption in the other. Nonetheless there are four points about Singapore which might be borne in mind in the Philippines.

35. The first point is that, contrary to current orthodoxy, Singapore is willing, and has been willing for thirty years, to invest public funds in education and training of all kinds without direct measurement of short-term financial return, and apparently without measurement of the longer-term social return except by observation of the general success of economic and social policy. This policy is carried out even though beneficiaries are not only individual citizens but also the great many MNCs which invest in Singapore.

36. The second point, again contrary to current orthodoxy, is that very detailed manpower planning is carried out. This is done on the basis of careful research not only at the sectoral level but at sub-sectoral level, and incorporates the results of contacts directly with companies, especially newly investing MNCs. Such planning is of course only feasible or effective within a small and coherent state.

37. Thirdly, the EDB's identification of and support for PLEs, or "promising local enterprises", might be noted.

38. The fourth point, which is more operational, is that machine manufacturers and software producers are more than willing to provide their new products to training centres (without transferring ownership) for use as real-life training equipment, thus ensuring that the training itself is up to date and of course saving a great deal of capital expenditure on the part of the government.

39. It is questionable whether any of this is transferable, given the much larger size of the Philippines, the different structure and play of interest groups, "short-termism", and the tendency to democratic disputatiousness. On the other hand the experience of Singapore could encourage the Philippines not to be afraid of a strong role for the public sector in education and training, provided of course that quality can be assured. Public finances in Singapore are in good order, with an annual budget surplus, and the financial backing for a strong but non-inflationary public role in the Philippines would have to be differently procured.

The possibility might also be examined of developing "islands" of government support to HRD in industrial branches which show promise as contributors to upgrading the performance and reputation of Philippine industry and to the achievement of Philippines 2000. Any such policy could only be implemented with the agreement of the industrial branch concerned and with at least the acquiescence of other branches and all the other groups with real or factitious interest in such a policy.

7. Assessing the feasibility of branch-specific and advanced training centres: framework for case studies

Data

.Current operational budget, detailing expenditure by budget head and all sources of income

.Financial accounts for the two preceding financial years

.Organisational chart

.List of training activities

.Number of participants in each programme during the current year and the two previous years

.Details of capital expenditure and its sources:
(a) when the centre was first established
(b) over the last five years

.Any outstanding proposals for capital expenditure

.The current corporate plan and (if available) proposals for the next corporate plan

.All available statistical data concerning the current and project demand for labour and skill upgrading in the industrial sector(s) served by the centre.

Questions

40. When and why was the centre first established ?

41. What were the initial intentions of those setting up the centre ?

42. How have the centre's objectives changed since it was first established?

43. Who determines the centre's policies and outcomes ?

44. How is the centre managed ?

45. Who is the chief executive answerable to ?

46. What are the main sources of centre funds, and how have they changed in recent years ?

47. In what ways have the centre's patterns of expenditure changed in recent years - and why ?

48. In what ways have the centre's customers (trainees and firms) changed in recent years ?

49. How are new activities (training programmes etc) identified and planned?

50. Who is the most influential in determining the activities of the centre - the government, an industry association, individual firms, or centre staff ?

51. What are the most cost effective and least cost effective activities currently undertaken by the centre ?

52. Is the centre under pressure to improve its cost effectiveness ? If so, from whom ?

53. What are main ways in which industry association(s) and individual firms affect the work of the centre ?

54. What actions are currently being taken or are planned to improve the centre's cost effectiveness ?

55. What have been the centre's major contributions to the industrial sector it serves over the last five years ?

56. What are likely to be the major contributions to that industrial sector over the next three or four years ?

57. In what ways are the funding, the customers and the activities of the centre likely to change over the next three or four years ?

58. What are the main trends within the industrial sector served by the centre ? How is the centre likely to respond to those trends ?

59. What are the main advantages of a branch/sector specific training centre over a general-purpose training institution ?

60. If the centre did not exist: - who (if anyone) would undertake the activities carried on here ?
- what would be the effects be on the industrial sector it serves ?
- would there be a strong demand to establish such a centre now in 1996 and if so from whom ?

8. "Feasibility" case study: Precision Engineering Institute, Singapore

(Information from the Deputy Training Manager, supplemented by PEI brochures and some information from the Institute of Technical Education.)

Data

.Current operational budget entails expenditure for the year of approx S$4 million, of which S$2½ million goes on staff costs. Income earned from sale of products and training services amounts to about $1 million. The balance of about S$3 million is met by the Institute of Technical Education (Ministry of Education).

.Financial accounts not published and not available

.Organisational chart not drawn up. The Institute is headed by the Training Manager (a professional trainer) who reports to a Divsional Director in the Institute of Technical Education. There is a Deputy Training Manager, and Administration Unit and three training departments.

.Training activities:

-Industrial Technician Certificate in Manufacturing Engineering
2 years
Entry - 3 O-levels, English, Maths and a relevant science subject

"At the end of the course the student should be able to:

-produce precision components using CNC machines
-use precision tools and equipment for measuring components
-prepare planning and production schedules
-design and manufacture and industrial product using a CAD/CAM system

"Some job titles held by ... graduates include:
-Engineering assistant
-Manufacturing engineering technician
-Quality control technician
-Production supervisor
-Production technician
-Tool designer"

-National Technical Certificate Grade 2 (NTC-2) in

Precision Machining
Precision Tooling (Injection Mould)
Precision Tooling (Press Tool)
Tool and Die Making (General)

All 2 years
Entry "Completed" O-level or N-level (not further specified). (N-level is "Normal level", a new more technical O-level)

NTC-2 Precision machining

"At the end of the course the student should be able to:

-interpret blueprints and mark out work pieces prior to machining
-set up and operate precision machine tools to produce a variety of precision metal components which require advanced machining skills
-program, set up and operate CNC machines to produce a variety of precision metal components
-use precision measuring instruments to check measurements
-use CAD software

"Some of the job titles held by graduates include: CNC Machining (Production) Technician; CNC Machine Programmer; Precision Machining Technician"

NTC-2 Precision Tooling (Injection Mould)

"At the end of the course the student should be able to:

-interpret blueprints and mark out .. (as above)
-set up and operate precision machine tools to produce a variety of precision metal components
-set up and operate precision toolroom machines to repair or produce a variety of precision metal tools and injection moulds
-set up injection moulding machines to test moulds
-use precision measuring instruments to check instruments
-use CAD software

"Some of the job titles held by graduates include: Injection Mould Technician; Jigs and Fixtures Technician; Precision Machining Technician"

NTC-2 Precision Tooling (Press Tool)

"At the end of the course the student should be able to:

-interpret blueprints and mark out ... (as above)
-set up and operate ... (as above)
-set up and operate precision toolroom machines to repair or produce a variety of precision metalpress tools, jigs and fixtures
-set up power press to try out press tools
-use precision measuring instruments to check measurements

"Some of the job titles held by graduates include: Jigs and Fixtures Technician; Precision Machining Technician; Press Tool Technician"

-National Technical Certificate Grade 1 (NTC-1) in

Precision Machining Technology
Precision Tooling Technology
Precision Tooling Design

All 1 year
Entry NTC-2 in Precision Engineering + 3 yrs relevant experience

(NB: NTC-3 semi-skilled courses not offered at PEI, nor at the other ten ITE Technical Institutes. NTC-2 said to be equivalent to German Facharbeiter, and NTC-1 to German Meister in terms of skill and knowledge, but without the training skills which a Meister must have.)

For the above courses the PEI adopts the "teaching factory" concept, with a 44-hour week. No training machinery. Formal training takes up 18 months and for the last six months students work in real-life workshops making products ordered by customers (not for stock).

For graduates of ITC and NTC-2 courses various "progression paths" are set out which depend partly on whether or not a Certificate of Merit has been achieved. (This is all very well but if the graduates do progress to Polytechnics etc they are lost to industry as technicians.)

-**Upgrading courses** of about 40 hours each:

Customisation and Programming in Autocad Module II
Programming and Operating the CNC EDM Wire-Cut
Programming and Operating the CNC EDM Die-Sinking
Programming and Operating the CNC Mill
Programming and Operating the CNC Lathe
Microcam
Measuring and Gauging
Statistical Process and Quality Control
3D Coordinate Measuring Machine

-**Customised courses**

The PEI also has a number of "transnational partnerships" with firms which provide their own equipment and some training is carried out using this equipment. For example the last three upgrading courses listed above are run in the Mitutoyo-ITE Metrology Laboratory. According to the prospectus "the major cooperation projects within PEI include:

Siemens-Nixdorf Computer-ITE Centre for Advanced Tool and Die Making
Mitutoyo-ITE Metrology Laboratory
Bridgeport (UK!)-ITE CNC Laboratory
Sodick-ITE CNC Laboratory
AutoDESK-ITE CAD/CAM Laboratory
Nissei Plastics (S) Cooperation Project
Charmilles Technologies Cooperation Project"

.Number of participants not divulged in detail. Total enrolment in full-time courses is about 350, out of a capacity of 800. Mostly 16-yr-old school-leavers, less than 5% girls. A few company-sponsored trainees up to 30 yrs old. (NB Boys of 18 have to do two years' military service.) Annual NTC-1 enrolment is 20-25. About 300-400 participants a year in 40-hr upgrading and in customised courses.

.Capital expenditure amounts not available. Source (a) Singapore government (with technical assistance from German camera manufacturer Rollei), and (b) Singapore government. Specialised equipment provided by transnational partners as described above, but this does not form mainstream capability.

.No outstanding proposals for capital expenditure.

.No corporate plan is made by the PEI. Requests for capital expenditure are made ad hoc to ITE as needs emerge.

.Singapore suffers a labour shortage at the levels of the PEI output and imports foreign technicians. It is said that PEI final-year students are courted by employers and each one will have a choice of five or six jobs. No change is foreseen. Detailed statistical data not obtained.

Answers to questions

61. Early 1970s, to fill a shortfall, or projected shortfall, of engineering technicians in accordance with government policy established at the time of independence in the 1960s to invest heavily in education and training as a means of attracting foreign investment.
62. See above.
63. No change in objectives, although the emphasis has changed from the provision of a reserve of critical skills to filling actual demand.
64. PEI is under the direction of the ITE, which itself has a Board of Governors with strong industry representation, and a number of technical committees. PEI itself has an (advisory only) management committee on which employers are represented (for the most part smaller employers who know what they want). The PEI also maintains continuous contact with industrial firms.
65. The PEI is managed by its Training Manager under direction from ITE in accordance with Singaporean practice which does not allow much room for autonomy.
66. To the ITE Divisional Director.
67. Government. No change. See 'data' above.
68. Not known. The PEI is pressed by ITE to reduce costs especially in the light of falling enrolment but is reluctant to save on staff costs, which account for the major part of expenditure. Staff are well paid, up to industry level, and high priority is given to staff upgrading. The impression is that this pressure from the ITE is something of a formality, and it contrasts with repeated assertions that government is not cost conscious regarding education and training. ITE's training philosophy, moreover, is on "total" training, i.e. with an educational element which does not directly enhance employability, and in the current labour market situation this attitude can well be afforded.
69. Emphasis in schools has changed and is now more on academic success and the continuing academic ladder. This is partly a question of curricula, and partly of attitude. Students at PEI are less willing and able, and the change shows up in not such good test results at the end of PEI courses. The question under discussion is whether PEI has itself changed adequately in response.
70. Through contact with firms mentioned above, and through ITE's own research. The main cause of change is technological development.
71. Mostly collaboration between government (ITE) and individual firms. Institute staff express views based on direct contact with firms. Industrial associations are least important and would be represented by the same people as the employers. (Small total number in the industries.)
72. Cost effectiveness not measured. Cost per student is high (highest of all the ITE institutes) but training is reputedly of high quality. Attrition is less than 5%: at the start some students are on a kind of informal probation for three months and may be recommended to quit - but with the current shortage of applicants every effort is made to avoid this. Later on some of the brightest students are lost to Polytechnics.
73. As indicated above the ITE presses for cost reduction but this seems to be in absolute terms as much as in unit costs.
74. Industry associations not relevant. Firms actively maintain contact and indicate technology intentions. They also readily employ PIE graduates, and use PIE courses for upgrading.
75. Maximise utilisation. Recruitment to all ITE institutes is run by the Ministry of Education and the ITE. (There is a joint admission scheme.) The Economic Development Board is apparently interested in attracting foreign trainees to PIE - who would then work in Singapore.
76. PIE graduates have reached key positions in production engineering. More generally the Institute continues to support manufacturing in Singapore and the high international reputation of its workforce.
77. Who knows ? The PEI does not appear in the ITE's "future" list of training institutes and although this was not mentioned either at the PEI or at the ITE perhaps the PEI is under sentence of death. At least its fate is uncertain.
78. Not known. See 17 above. Technology change likely to be the major

influence.

79. Technological development may make some skills redundant and there may be a further shift to brain-intensive work.

80. Perhaps demand was not previously not large enough to support dispersion of PIE subjects and skills to other institutes.

81. (a) presumably one or more other ITE institutes, some of which already offer some precision engineering as part of wider curricula.

82. (b) further imports of required skills, unless available from the other ITE institutes as in (a). (c) probably not: establishment required particular foresight in very different conditions.

9. "Feasibility" case study: German-Singapore Institute, Nanyang Polytechnic

(Information from the Joint Director and from Nanyang Polytechnic brochures, with some background from Economic Development Board. The Joint Director was not prepared to go through the "data" and "questions" methodically although they had been submitted in advance. It should be understood that the German-Singapore Institute (GSI) is now virtually integrated into the Polytechnic as the manufacturing engineering department.)

Data

.Current operational budget not available. The only public information (still quite useful) is that training cost per Polytechnic student is S$10,200 a year, of which the government pays a Tuition Grant of S$8,600 in respect of Singapore citizens and permanent residents and S$7,800 for others. Students pay the balance, as well as minor fees amounting to S$95.63, although various sources of support are available to them.

.Financial accounts not published and not available.

.Organisation not set out in chart form. GSI staff listed as follows:

Director (German)
Joint Director
General Administration Officer
Technical Adviser (German)
Manager/CIM Centre
Manager/Precision Engineering Centre
Manager/Robotics and Automation Centre and Industrial Project Group
Manager/Plastics Technology Group
Section Heads/Special Projects

CIM Centre:	3 lecturers
Precision Engineering:	4 Section Heads
	1 Development Engineer
	13 Lecturers
	14 Teaching Associates
Plastics Technology:	2 Section Heads
	4 Lecturers
Automation Technology:	3 Section Heads
	14 Lecturers
	2 Teaching Associates
Industrial Project Group:	1 Section Head
	4 Development Engineers/Lecturers
Training Support and Related Studies:	4 Lecturers
	1 Teaching Associate
Communication Skills:	2 Lecturers

.Training Activities

Diploma in Manufacturing Engineering

"The main areas of focus are:

Factory Automation
Advanced Manufacturing Technology
Manufacturing Software
Plastics Manufacturing Technology"

3 years for O-level holders. Must include English, Maths and relevant science subject.

2 years for A-level holders, ITC with Certificate of Merit or NTC-2 Craftsman Certificate. (For more about ITC and NTC-2 see PEI case study.)

"Opportunities for graduates: ... may work as supervisors and technical specialists in manufacturing system design and development, precision engineering, product/process design and development, manufacturing software and plastics manufacturing ... graduates with excellent academic results may be accepted into local and foreign institutions of higher learning at advanced entry levels."

The frontier between graduates of this course and university degree holders is indistinct and the Joint Director could only refer vaguely to "depth". There does seem to be more practical work in this diploma course - students actually building machines which they design. But from bought-in parts, not made by students.

The GSI "is known for its "Teaching Factory" concept which entails providing an industrial-like environment, practice-oriented training and industrial project for students to learn in a realistic setting."

Continuing Education Courses

"Topics covered include:

Laser Cutting Technology
Robotics and Factory Automation
CAD/CAM/CAE
CNC Technology
Fibre Reinforced Plastics
Computer Aided Process Planning with Computer Vision
Control Engineering"

The above comes from the GSI prospectus. The separate prospectus for the Professional Development Centre lists 37 courses under the heading "Engineering (Manufacturing)" with durations between 18 and 45 hours.

The GSI has over 20 "technology partners" who provide machinery for use by students. Cooperating firms with facilities in Singapore also provide OJT places and experts. Not all of these are German. Six are identifiably Japanese.

.Total enrolment in School of Engineering 3,652 in November 1995. Number of participants in Dip. Mfg. Eng. courses 1068 in July 1994, of whom 428 in first year. (No information on 2-yr and 3-yr enrolment.) 310 students graduated from the 3-yr diploma programme in 1994. In 1995 227 graduated (not stated whether from 2-yr or 3-yr course). (Decline not explained.) It was stated that the GSI has no difficulty in recruiting for all available places. Girls account for about 24% of the engineering students in Polytechnics, compared with 17% five years ago; not known whether GSI ratio is in line.

.Amounts of capital expenditure not available. Sources (a) government and (b) government. (German technical assistance up to 1987.)

.No outstanding proposals for capital expenditure. When it is required an ad hoc request is submitted to the Ministry of Education.

.No corporate plan.

.No statistical data available. It is stated that the output of the GSI is more than readily absorbed by industry and that this situation is not expected to change unless there are major changes in the external political or economic environment.

Questions

83. In 1982 by the Economic Development Board in collaboration with the Federal German government (together with France-Singapore Institute and Japan-Singapore Institute. The Institutes were transferred to Nanyang Polytechnic in April 1993.) In order to increase supply of manufacturing technologists towards meeting demand. Ready supply of high quality workforce (still) seen by EDB as investment incentive.

84. See above

85. They haven't.

86. An intricate arrangement no doubt reflecting Chinese preference for close personal relationships.

    The GSI has a Management Council, of which the Principal of the Polytechnic is Chairman. Six of the 11 members appear to be German.

    The School of Engineering has an Advisory Committee, the Chairman of which is Senior Vice President of Transpac Capital Pte Ltd and also a member of the Polytechnic Board of Governors. (This person, Mr Wong Lin Hong, is also a member of the Board of Governors of the Institute of Technical Education.) Of the 10 members one might be Dutch, one German and one Japanese.

    The Chairman of the Board of Governors is Chairman of Schroder International Merchant Bankers Ltd. One of the 14 members is a Deputy Secretary at the Ministry of Education and she might well be very influential given that most funds come from her Ministry, but we have no information to support this inference.

    The Board of Governors has a Development Committee and the Polytechnic also has a Senate chaired by the Principal and comprising senior staff members.

87. As part of the School of Engineering.

88. Head of School of Engineering. (No formal responsibility to any German network or authority.)

89. Ministry of Education. No change.

90. Not answerable.

91. On the trainees' side, plenty of demand reflects continuing emphasis on raising educational standards and ambitions. From the firms' side the impact comes from increasing manufacturing investment in Singapore and continuous technological development.

92. Through the management mechanism described above and through constant contacts with firms, especially those with technology partnership contracts.

93. Probably individual firms and the government.

94. Cost effectiveness not measured.

95. Apparently not.

96. Firms through constant contact. Industrial associations not important.

97. Apparently none.

98. Provision of well qualified technologists who attract new inward investment and facilitate technological upgrade in manufacturing.

99. Same, as far as can be predicted.

100. No particular change foreseen. As to activities, they will continue to be affected by technology development. The current German collaboration contract expires in 1997 but although it is not known what it comprises it does not seem to be very significant. Technology partnerships are subject to time-limited contracts and some changes may be expected in the list of partners if not in the system itself.

101. The main trends are in technology development and in the gradual concentration of high MVA in Singapore, while lower MVA activities will move to other countries. All being well Singapore will lead or participate in major Asian development in coming years. The GSI can be expected to develop the quality and quantity of its graduates as far as the limited supply of Singaporean young people allows. Although no mention was made of it at GSI they may find themselves training more foreigners for work in Singapore or in S. projects elsewhere. This would please the EDB.

102. Question not really relevant to GSI.

103. (a) Other Polytechnics ?
(b) If not replaced, increased import of foreign labour, reduced enthusiasm for investment in Singapore.
(c) Something of the sort would be necessary. Prime mover would probably be Economic Development Board as originally.

(NB: Q21 was not specifically discussed.)

Persons consulted

Ms Anne Koh
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Corporate Communications
Corporate Services Division
Economic Development Board

Mr Koh Chung King
Planning Officer
Institute of Technical Education

Mr Ho Hooi Min
Joint Director
German-Singapore Institute
Nanyang Polytechnic

Mr Anthony Woon
Manager/Robotics and Automation Centre
German-Singapore Institute
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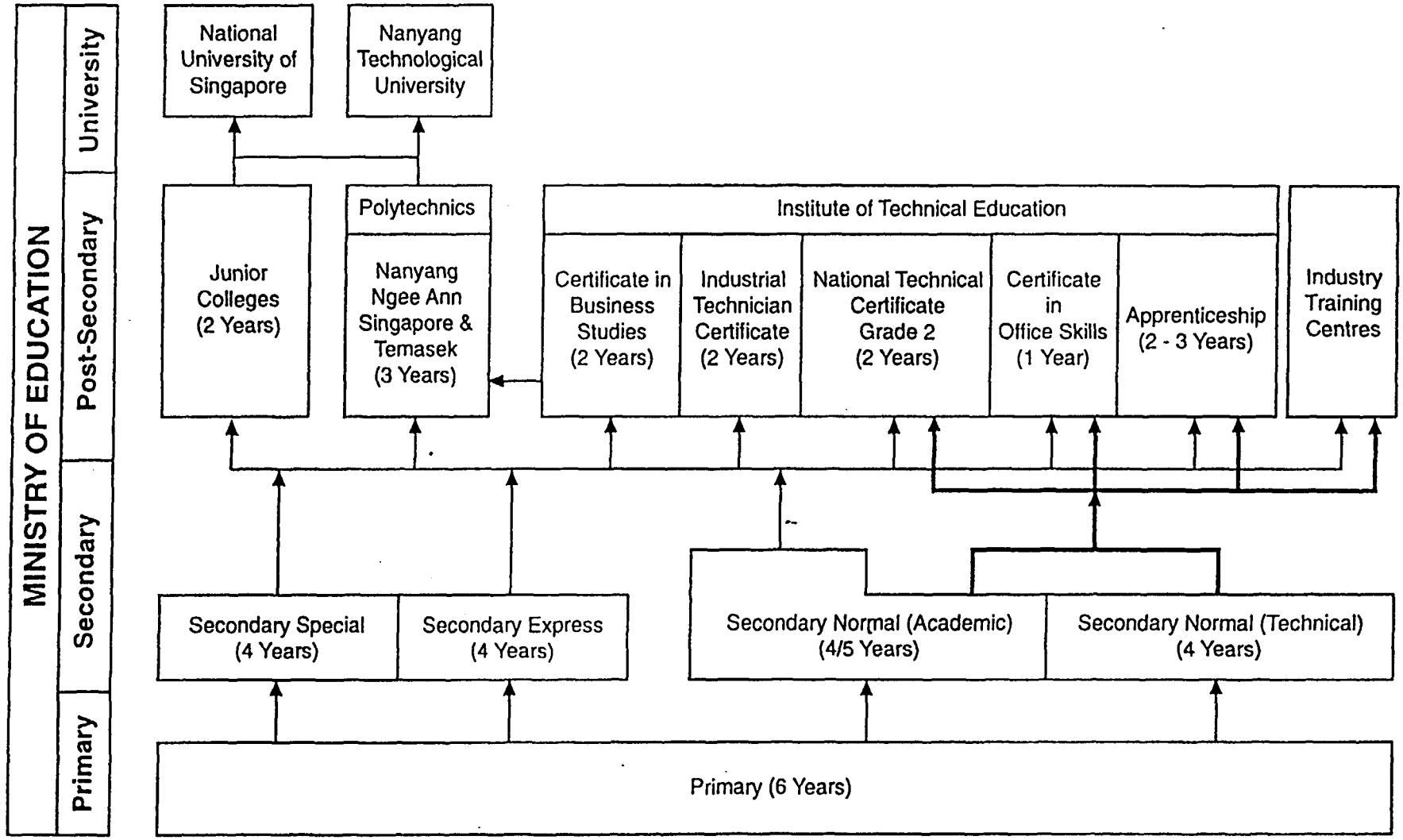
Mr Kung Siak Yong, Jeffrey
Manager/Business Development
Professional Development Centre
German-Singapore Institute
Nanyang Polytechnic

Mr Yeo Tang Lin
Deputy Training Manager
Precision Engineering Institute

Education and Training in Singapore



ITE (Singapore)
Approved Training Centres

Annex 3

	COMPANY
1	PRMARY PRODUCTION DEPT
2	BORNEO MOTORS (S) PTE LTD
(3) ?	AIR ENGINEERING TRAINING INSTITUTE
4	CYCLELINK (S) PTE LTD
5	VICOM PTE LTD
6	PORT OF SINGAPORE AUTHORITY
7	SINGAPORE TECHNOLOGIES AEROSPACE LTD
8	SINGAPORE BUS SERVICE (1978) LTD
9	TIBS MOTORS PTE LTD
10	SUM CHEONG CORPORATION PTE LTD
11	TAN CHONG & SONS MOTOR CO (S) PTE LTD
(12)	ELECTRONICS INDUSTRIES TRAINING CENTRE
13	INTERNATIONAL VIDEO PRODUCTS PTE LTD
14	M C PACKAGING PTE LTD
15	FUJITEC SINGAPORE CORPN LTD
16	PUBLIC UTILITIES BOARD
17	PRECISION OPTICS TRAINING CENTRE PTE LTD
(18)	JEWELLERY INDUSTRY TRNG CENTRE OF S'PORE
19	COLOURSCAN CO PTE LTD
20	INTERNATIONAL PRESS CO PTE LTD
21	SNP CORPORATION LTD
22	SHELL EASTERN PETROLEUM (PTE) LTD
23	SINGAPORE PRESS HOLDINGS LTD
24	TIEN WAH PRESS PTE LTD
25	TOPPAN PRINTING CO (S) PTE LTD
26	THE EAST ASIATIC CO (S) PTE LTD
27	SHATEC SERVICES PTE LTD
28	SINGAPORE RETAILERS ASSOCIATION
29	THE RESTAURANT ASSOCIATION OF SINGAPORE
30	FAR EAST LEVINGSTON SHIPBUILDING LTD
31	INSTITUTE OF NAVAL ENGINEERING (INE)
32	SEMBAWANG CORPORATION LTD
33	JURONG SHIPYARD LTD
34	HITACHI ZOSEN SINGAPORE LTD
35	CENTRE FOR TOURISM RELATED STUDIES P LTD
36	KODA WOODCRAFT PTE LTD
37	SINGAPORE CORPORATION OF REHABILITATIVE
38	TOA PAYOH GIRLS' HOME
39	TRACTORS SINGAPORE LTD
40	KYODO PRINTING CO (S'PORE) PTE LTD
41	PICA COLOUR SEPARATION PTE LTD
42	SINGAPORE MEDICAL ASSOCIATION
43	THOMSON MEDICAL CENTRE PTE LTD
44	EAST SHORE HOSPITAL PTE LTD
45	NATIONAL UNIVERSITY HOSPITAL (S) PTE LTD
46	SAF ORDNANCE ENGINEERING TRNG INSTITUTE
47	SAF SCHOOL OF MILITARY MEDICINE
48	SINGAPORE TECHNOLOGIES AUTOMOTIVE LTD
49	KEPPEL CORPORATION LTD
50	ESSO SINGAPORE PTE LTD
51	MOUNT ELIZABETH HOSPITAL PTE LTD
52	SINGAPORE BOYS' HOME
53	GENERAL AUTOMOTIVE SERVICES PTE LTD
54	BAXTER HEALTHCARE PTE LTD
55	SEAGATE TECHNOLOGY INTERNATIONAL
56	SGS-THOMSON MICROELECTRONICS PTE LTD
57	WESTERN DIGITAL (SINGAPORE) PTE LTD

Diploma in Manufacturing Engineering

offered by

Nanyang Polytechnic
German-Singapore Institute (GSI)
Jurong Campus
10 Science Centre Road
Singapore 2260

THE PROGRAM

Established in 1982 under the Economic Development Board as a cooperation project between Singapore and the Federal Republic of Germany, the GSI has been working closely with institutions and industry leaders to introduce new technology, technology applications, and training systems into Singapore. The GSI was transferred to Nanyang Polytechnic effective February 1, 1993. Under the School of Engineering of the Polytechnic, the GSI plays an instrumental role in developing technologists with specialized knowledge in manufacturing and in introducing the latest manufacturing know-how to Singapore.

At the school, pains are taken to create a "Teaching Factory" environment to provide effective and realistic learning experiences. Within this environment, students are given hands-on training on advanced high tech equipment and systems, and real life experiences on industrial projects that meet competitive specifications, quality and delivery standards. The program philosophy states that the best teaching aid is the machine which the students will use in industry. After two years of broad-based, hands-on training, students specialize in high value-added areas of development and manufacturing activities such as Industrial Automation and Robotics, Advanced Manufacturing Technology, Plastics Manufacturing Technology, and Manufacturing Software. All students must complete a full-time 18-week project phase, either in-house or with industry.

• *the best teaching aid is the machine which the students will use in industry*

THE DELIVERY

The Institute's organizational structure is geared to industrial standards. For example, students and teachers are required to be present for 44 hours per week. There are only two weeks leave between semesters. When students enter or leave the Institute, they must clock in and out. In fact, the entire equipment set-up of the GSI is more akin to that of a modern industrial enterprise than to a school.

• *students and teachers are required to be present for 44 hours per week*

In addition to supervised work during the semester, there is a major examination at the end of each semester which determines whether the student will be promoted. After the formal training is concluded, the project phase begins. Students form teams, and each team works on a complex technical project for industry or the Institute, according to stringent specifications and deadlines. In this phase, companies such as Hewlett-Packard often bring equipment to the Institute and supervise the project.

SPECIALIZED RESOURCES

Similar to a modern manufacturing company, the Institute has areas for manufacturing and technical laboratories. These include the Department for Product Development and Design; various production workshops for metal machining, CNC Technology, Laser Cutting, and Plastic Technology; workshops for Tool & Die Manufacturing and Heat Treatment; and laboratories for Materials Management, Materials Handling, Automated Assembly, and Robotics.

However, the most interesting element in the system is the model Computer Integrated Manufacturing Centre (CIM Centre), established to enable staff and students to develop their robotics technology skills in an environment that has integrated the various technologies relating to business, engineering, and production. The physical layout consists of two cells: the Flexible Machining Cell (FMC) and the Flexible Assembly Cell (FAC); and a Flexible Material Handling and Storage System (FMHSS). The FMC incorporates two CNC machining centres, a CNC turn-mill and a coordinate measuring machine (CMM). Assembly and disassembly activities are carried out by the BOSCH and SKILAM robots in the FAC. The FMHSS consists of one automated storage/retrieval system (AS/RS) and two bi-directional automated guided vehicles (AGV). Both AGVs have different configurations in handling material transfer due to the requirements of the two cells. Thus, each AGV is dedicated to one cell in order to transport materials between the components of the cell and the AS/RS. Other features of this Centre include MAHO 5-axis machining centres and the Carl Zeiss Coordinate Measuring Machine.

UNIQUE ELEMENTS AND BENEFITS

The full-time 18 week project phase involves teams of four to six students assisted by a coordinator. The students work on projects such as the independent design, construction and manufacturing of a complex technical system for the field of applied automation. One example would be the development of a unit for the automatic assembly of a packaging machine. Additional work to be performed by the teams includes scheduling and organization of production, purchasing of supplies, as well as cost calculation. The results of the project are documented in a comprehensive project report and form part of the final examination. At the end of the semester, the project is presented to an examination board which evaluates and marks the performance according to fixed criteria. The students' performance, the results, and their work attitude and social behaviour in the team is evidence that this project-oriented phase of learning is an excellent training technique.

With its strong multi-disciplinary approach, the CIM Centre serves a unique purpose within GSI. CIM covers all activities related to the manufacturing business including evaluating and developing different product strategies, analyzing markets and generating forecasts, designing components for manufacturing, and evaluating and/or determining batch sizes, manufacturing capacity, scheduling and control strategies related to design and fabrication processes.

DURATION OF TRAINING

The program includes two and three year courses leading to the award of the Diploma in Manufacturing Engineering. The semester is broken into two terms of practical and theoretical work. The first term consists of eight weeks of instruction with a one week break followed by seven weeks of instruction and three weeks of study and examinations. In the final year, students must complete the eighteen week project phase.

PARTICIPANTS

Currently, the enrolment figure for the full-time diploma program in Manufacturing Engineering is 964. GCE 'A' Level holders with at least two Advanced Level passes, including a Mathematics subject, plus a pass in a General Paper (English) or a good pass in English Language at GCE 'O' Level, may apply for the two year program. GCE 'O' Level holders may apply for the three year program provided they possess a minimum of three passes in required subjects.

ROLE OF PARTNERS

GSI at Nanyang regards its active and close collaboration with its transnational cooperation partners - governments, organizations, institutions, and industry leaders both local and international - as strategic and central to its mission to provide "Education for The Next Lap" (the Singapore Government's vision for the next stage in its industrial and business development).

The importance attached to links with industry is not just a theoretical concept, but a concrete day-to-day reality in Manufacturing Engineering at GSI. For example, the Industrial Project Group (IPG), structured like a business, oversees projects developed by a team of full-time engineers and designers, and supported by final year students. In 1992, the IPG successfully completed 54 projects with clients such as Hewlett-Packard, Philips, Apple Computer, and Maxtor Singapore. In addition, the advisory board consists of distinguished representatives from Material Handling Engineering, Pepperl + Fuchs Mfg., Festo Private Limited, and SFK Manufacturing. GSI also actively collaborates with technology partners such as Autodesk Inc., Carl Zeiss Pte. Ltd., Mitsubishi Heavy Industries Ltd., Seiko Instruments Singapore Pte. Ltd., Siemens Nixdorf Information Systems, and Traub AG.

• the Industrial Project Group (IPG) completed 54 projects with clients such as Hewlett-Packard, Philips, Apple Computer, and Maxtor Singapore

To enhance the training further, staff are sent on attachments to organizations and companies locally and overseas to gain first-hand experience. Some of the overseas partners include China, Vietnam, France, Australia, the U.K., and Germany. There is a program that brings directors, managers, engineers, and teachers from China to participate in GSI training. Some of the institutions involved are the Chinese-German Vocational Centre of Tianjin, the Precision Machining Centre of Beijing, and the Chinese-German Training Centre of Beijing.

TESTIMONIALS

The German-Singapore Institute of Nanyang Polytechnic's School of Engineering achieved distinction in October 1991 when it became the first institution outside Germany to win the prestigious German Mechanical Engineering Award conferred by the German Machinery and Plant Manufacturers' Association (VDMA). The citation states:

> *Its didactic concept, its project-oriented approach to training within a comprehensive and practice-oriented environment,...its future-oriented curriculum have made GSI an internationally exemplary institution,...the concept of a "teaching factory" enables students to study, construct and work like a modern production facility under realistic conditions.*

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Precision Tooling/Machining

offered by **Precision Engineering Institute (PEI)**
15 Kallang Junction
Singapore 1233

THE PROGRAM

The Precision Engineering Institute (PEI) specializes in the training and development of skilled manpower for the precision engineering industry, training which is critical for the manufacturing and supporting industries in Singapore. PEI uses the "teaching factory" concept in its approach to training. Under the supervision of experienced staff, the training is conducted in a simulated modern shop environment within the institute. PEI incorporates actual manufacturing processes into the practical projects.

Industrial partners, through various cooperative projects with PEI, support the training program by providing machinery that features the latest in technological developments. PEI staff maintain close rapport with companies to keep pace with the changes in economic direction and development and, as the needs of industry change, PEI adapts.

• *industrial partners support the training program by providing machinery*

At PEI, the training year is comprised of two, twenty-five week terms in order to reflect industry practices.

THE DELIVERY

Basic theory is delivered in a traditional classroom setting; however, the majority of the training is completed using practical exercises on the shop floor. Job-related discussions of theoretical concepts take place right at the machine work-stations.

A student may be located at a single machine for up to one week before moving to the next in the sequence. Staff supervise the shop as they would supervise on the job. A unit manager handles the logistics of the floor and the progression of the students. Students of varying levels interact with each other, as they would in a factory. Adaptability is a primary concern in PEI's program.

SPECIALIZED RESOURCES

Within the "factory," there are standard, up-to-date basic turning, milling, grinding, and drilling machines. PEI also has some of the most powerful and modern equipment found in any institution, through various agreements. For example, Bridgeport Machines Limited (UK) provided for the installation of the latest Bridgeport CNC Machining Centre model VMC 560 with two units of 2-station training consoles, Heidenhain 2500 & 407 Controls, E-Z Cam software and a Renishaw Digitizing package. Autodesk Incorporated (US) equipped PEI with seventy-five sets of

AutoCAD Kelease 12 (version C2) and twenty-five sets of Manufacturing Expert J2 software at a substantial discount.

Saeilo Japan Incorporated has recently equipped PEI with two software packages of CIMATRON 90. This superior and powerful software is an integrated 3D CAD/CAM System for mould & model making, which allows users to do Surface Modelling, NC programming and solid modelling. With the software, users can eliminate "prove out cuts" and modify tool paths when their design model changes. Immediate graphic verification allows the user to see the cutter section, on-screen, before the first cut is made.

UNIQUE ELEMENTS AND BENEFITS

• *leading-edge machine tools are used in the training program*

One particularly outstanding feature in the PEI training environment is the use of leading-edge machine tools in the training program.

Also, transnational partnerships in the form of cooperation projects with specialized manufacturers and multinational companies, such as those mentioned in the specialized equipment section, keep PEI at the forefront of the industry. Further, these projects enable full-time students at the institute and industry personnel, who come for short, specialized courses, to be exposed to the latest application technologies.

PEI's goal is to develop practical specialists in Precision Engineering thereby meeting the labour requirements of local industry. This is accomplished by developing real-life industrial project exercises with actual cost, quality, and delivery schedule constraints. Although mass production is not done at PEI, students do progress from drawing to prototype and production on industrial machines used in industry.

DURATION OF TRAINING

The length of training for the National Technical Certificate Grade 1 is one year of full time study. For Grade 2, it is two years of full time study. Each year, students train 44 hours per week for 50 weeks.

PARTICIPANTS

Students must have completed secondary education at GCE 'O' or GCE 'N' Level. For NTC-1, students must have completed NTC-2 in Precision Engineering courses with three years of relevant experience.

ROLE OF PARTNERS

PEI is proud of its skill oriented factory concept and works in close collaboration with industry in many ways. Staff attachments range from Germany and the U.K. to the U.S. and Japan. These attachments expose PEI staff to the latest methods used in different engineering environments. Staff then transfer this knowledge to the students.

PEI also hosts seminars involving organizations such as the Singapore Institute of Standards and Industrial Research, Singapore Precision Engineering and Tooling Association, Traub-Heckert-Klink, INMAC Singapore Pte. Ltd., and Erowa Inter AG. PEI's partners are leading specialized manufacturers and multinational companies located in Singapore. These include Siemans Nixdorf, Mitutoyo, Bridgeport, Sodick, AutoDESK, Nissei, and Charmilles.

Many of PEI's industry partners provide production jobs for application training, and many sponsor students who, after completing the training, return to these companies as full-time employees. Companies that hire PEI students include Microfits & Methods Pte. Ltd., Matsushita Technical Centre Pte. Ltd., and LeBlond Makino Asia Pte. Ltd. These partners ensure that PEI staff and students are at the cutting edge of modern technology.

• *partners ensure that PEI staff and students are at the cutting edge of modern technology*

TESTIMONIALS

Manfred Schuetz, Managing Director of Wild (S) Pte. Ltd., describes the value of PEI.

> *The high standard of training in PEI is one of the major factors which made the production of our precision instruments in Singapore possible and successful. PEI upgrades its training consistently and thus we have no difficulty implementing and utilising the latest production technologies.*

Lim Cho Koen, Managing Director of LeBlond Makino Asia Pte. Ltd. comments on the training program.

> *The well structured and intensive training programs in PEI make their trainees very versatile in meeting the varied operational needs of our work stations. The trainees' versatility has also facilitated our implementation of technology-transfer programs speedily.*

Jimmy Chew, Managing Director of Microfits & Methods Pte. Ltd., describes how he relies on PEI.

> *Microfits has grown 5-fold over the past six years. We specialise in designing and fabricating high quality IC moulds, supplying to the world market. Today, 95% of Microfits' skilled manpower are graduates from PEI. These hardworking, smart and well-trained people are able to handle modern machine tools such as CNC, EDM and CNC Mill with minimum in-plant training efforts. This facilitates the introduction of new technology that is imperative for productivity improvements.*

• *95% of Microfits' skilled manpower are graduates from PEI*

And finally, K Kondo, Managing Director of the Matsushita Technical Centre (S) Pte. Ltd., says,

Since the start-up of Mastec's operation in Singapore eight years ago, the core of our skilled workforce has been mainly recruited from PEI. We find that these trainees are able to adapt and perform their jobs effectively and in a short period of time within the company.

CONTACT

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