

The Phoenix: Vocational Education and Training in Singapore

International Comparative Study of Leading Vocational Education Systems

October 2012



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I. Introduction

One cannot begin to appreciate the enormity of the Singaporean achievement in vocational education and training (VET) unless we start at the beginning¹.

For Europe, of course, the story begins with the origins of the guild structure built by the artisans themselves in medieval times. The current European model of VET is the result of a long, slow process of evolution, which developed in tandem with the emergence of capitalism on the Continent. It was only in the very latter stages of that development that government came to play an important role in VET, and, even then, the other players made sure that government would be only a member of the team.

In Singapore, by contrast, we see government leading the charge at every step. As you will see in a moment, the story begins only recently, after World War II, when the fledgling government of Singapore faced a sea of challenges to its very existence, and chose to concentrate on economic development as its strategy for shaping a new national spirit and for meeting the urgent needs of its people. As we all now know, Singapore was not only extremely adept at promoting economic development but, from the beginning, made very aggressive investments in general education and VET a keystone of their economic development strategy. Thus, for countries without a guild tradition, countries that are still at an early stage of the economic development process or are on their way, but still well behind the leaders, the Singapore model may be more relevant than the European one. This is also true because, at every step, Singapore borrowed heavily from models all over the world, including the European model, as it developed its own unique system.

But it would be less than useful to confine our account to a description of the current state of VET in Singapore. That is because each stage of development of the Singaporean VET model was matched to the stage of economic development that Singapore was going through at the time. And each stage of development of the VET system can best be understood only in relation to the parallel development of the general education system. While I will concentrate here on the policies and structures that define the VET system, I will describe not only what it looks like now, but also how it developed, stage by stage, in relation to Singapore's economic development program and its unfolding general education system. See Figure 1 for a graphic depiction of these parallel developments in the Singapore system, starting with World War II in the Pacific.

¹ This is a report of a benchmarking trip to Singapore undertaken by Vivien Stewart, Betsy Brown Ruzzi and the author in May 2012. We are indebted to the many officials of the Singapore government (current and former), educators, business executives, researchers, a reporter and others who spent many hours with us helping us to understand the remarkable achievements of this small powerhouse at the intersection between East and West. A partial listing of those with whom we talked can be found at the end of this paper.

II. A Stunning Success Story

When the Japanese advanced like lightening through East Asia as they entered World War II, the British had a major naval installation in Singapore. Britain was, at the time the greatest maritime power the world had ever seen, and Singapore, though just a little dot on the globe, guarded the strategically crucial straits through which the world's ships must travel between the East and the West, between the countries that line the Indian Ocean and the Arabian Sea and the countries of the Pacific Rim. But they had placed the guns of their massive fort on the assumption that the enemy would come by sea, and the Japanese came instead by land, through Malaysia. British cannons pointed in the wrong direction and the fighting was all but over before it started.

After the war, the British tried to hang on to their colonies, but it didn't work. Singapore became self-governing in 1959. And then a group of formerly independent colonies on the Malaysian peninsula banded together to form a new country. Singapore, a little group of islands at the southern tip of the Malaysian peninsula, with a population then of only 1.6 million (now a little over 5 million) was one of them. In the beginning, there was talk of forming a common market in that part of the world, which would have greatly benefitted Singapore, but the Indonesians, just on the other side of the straits to the south, newly freed from their colonial masters, felt very threatened by the developments on the other side of the straits and cut off exports to the new Malaysian federation, and, with them, any hope of a common market. Because Singapore's business was trade, and no small amount of that trade had been with Indonesia, Singapore was in trouble from the very beginning.

Then, in 1965, disaster befell the Singaporeans. The Malaysians tossed the Singaporeans out of the new federation. The overseas Chinese, a majority in Singapore, were very much resented in that part of the world. Clever and resourceful in business and finance, they held a disproportionate amount of the wealth in the world between China and Australia. So the Malaysians pushed them out.

When the leader of the Singaporeans, Lee Kuan Yew, announced the news to his people, there were tears in his eyes, the only time his people have ever seen them. No wonder. Its land could not support its people. It had no raw materials. It was completely dependent on Malaysia for fresh water. The Indonesians were hostile. Whereas Britain was taking responsibility for Hong Kong, it was not doing so for Singapore. A very large fraction of Singapore's workforce was illiterate. Fewer than half had any formal education at all. In its whole population, there were fewer than 1,000 college graduates. The little cauldron of ethnic rivalries among its ethnic Chinese, Malaysian and Tamil (Indian) residents threatened to tear it apart. Unemployment was very high. Most of its industrial plants were on the other side of the new border and, all of a sudden, no longer accessible.

But the fact that Britain still maintained an enormous naval base in Singapore meant that it was not defenseless against its far larger hostile neighbors to the north and south. And the base provided employment to a large number of Singaporeans who would otherwise have been

added to the already high unemployment rate, to say nothing of all the Singaporeans whose living depended on the people who worked at the base.

And then the other axe fell. Without warning, the British announced that they were closing that base. The jobs of the 30 thousand people who worked there—plus all the others whose jobs depended on them—disappeared overnight. Singapore's economy went on life support. Little Singapore was virtually without expertise, jobs or prospects—and defenseless among much larger hostile neighbors to boot.

Today, Singapore is one of the most successful economies on the face of the earth. It has the third-highest GDP per capita (PPP). Though only five million people, it has the 40th largest economy in the world. It has the world's largest port. Its production growth rate for 2010 was the third highest in the world at 25 percent. It is the Asia region headquarters for many of the world's largest firms, a world leader in digital and electronics manufacturing, and a rising star in pharmaceutical and biomedical manufacturing. Though it has no oil of its own, it operates the world's third largest oil refinery, is a net exporter of oil and is a leading player in the global oil industry.

Despite the prominence of Singapore on the global manufacturing scene, services accounted for 73 percent of the Singapore economy in 2010. It has become a giant of Asia's banking and finance scene. It now operates the world's fourth largest foreign exchange market and is home to more than 200 asset management firms, having become an important factor in the development of the whole of Southeast Asia. It is on its way to becoming a major supplier of education services to the region. Remarkably, Singapore has become an increasingly important tourist destination, too. Tourism, sightseeing and entertainment grew by 1,834 percent in 2010 alone!

For decades, Singapore has had one of the lowest unemployment rates and lowest inflation rates of any country in the developed world. Its stable economy and business-friendly reputation has made it a haven for global business for decades.

How did this happen? And what role did VET play in these remarkable developments?

III. Singapore's Evolving Economic Development Strategies

In the 1950s, during the years leading to independence and nationhood, most of the world's poor countries were, like Singapore, either former colonies or about to be former colonies. Generally, the colonies' economic role had been to supply the mother country with raw materials and purchase the mother country's finished manufactured products (the mercantile system). Because the mother country set the prices for the raw materials and for the manufactured products, the colonies were generally at the wrong end of this system of trade. The conventional wisdom in the international economic development community at the time was that the only way to break this dependency and to grow was for them to substitute their own manufactured products for those supplied by the mother country.

Figure I: Schematic History of the Singapore System

Phase I: Low-Cost, Low-Skill Export Strategy / ca 1945 to mid-1970s

Economic Strategy	General Education	VET
Get on lowest rung of value chain. Offer low-skilled, low-cost labor to multi-nationals. Create attractive incentives to use that labor in highly competitive industrial parks with good infrastructure and first-rate port facilities. Create other incentives for multi-nationals to invest in skills of Singaporeans to get to next stage of economic development.	Great emphasis on improving quantity of provision in this period: Reduce adult illiteracy; increase primary school attendance; greatly raise number of primary school teachers (e.g., training them part-time, putting them in classrooms part-time), build schools; then expand secondary schools, send small numbers to university overseas to train for leadership positions; found university.	'61 Winsemius Report highlights shortage of skilled technical workers. Great expansion of vocational education. Government requires all secondary students to get 2 years of vocational education, after which streamed into academic, commercial or technical upper secondary industrial training centers and vocational institutes built.

Phase II: Capital Intensive, High Tech-High Skill Strategy / mid-1970s to 1990s

Economic Strategy	General Education	VET
"2nd Industrial Revolution" ('81) to provide high technology base for economy. Make Singapore attractive to high value-added global manufacturing firms. Provide new incentives for them to locate in Singapore. Produce home-grown senior and mid-level technical and scientific professionals to reduce need for expats.	Turn to emphasis on quality. Goh Report leads to introduction of New Education System, streaming at end of Gr 4, much higher academic standards for English, Math, Science; radical upgrade of teacher quality, new Curriculum Development Institute, major effort to keep students in school beyond compulsory age. More choice and flexibility for students.	Economic Development Board creates French--Singapore Institute and German--Singapore Institute to create world--class models of voc ed. In 1980, only 5percent of cohort entered universities, 8 percent polytechnics. But number of research scientists and engineers increased by factor of five over whole period. Few important changes in the regular vocation education system.

Phase III: Creativity and Entrepreneurship Strategy / 1990s to Present

Economic Strategy	General Education	VET
Get to top of value chain: World--class producer of highly innovative, high value, R&D--driven products and services. Develop Singaporean--headquartered companies with regional and global reach. Turn Singapore into economic, education, R&D hub for Southeast Asia countries; into Southeast Asia headquarters for global firms.	Thinking Schools, Learning Nation, then Teach Less-Learn More. Shift schooling paradigm from rote learning toward complex skills, creativity. New National Institute of Education develops world-class teacher training system; human resources system rationalized; schools given more autonomy, students given more choice and flexibility.	Vocational education moved out of secondary schools into state--of--the--art post--secondary institutions installed in impressive physical facilities; polytechnics greatly strengthened on factory school model employed in German--Singapore and French--Singapore Institutes. Apprenticeship program continued.

Economic Strategy: Phase I — Low-Cost, Low-Skill Export Strategy/ca 1945 to mid-1970s

But this strategy was not very attractive to Singapore's leaders because Singapore was much too small to constitute a market for its own manufactures. Though there was some hope of a market in the rest of Malaysia before the separation, there was none when the Malaysian door slammed shut. Singapore needed another strategy.

Even before independence, and long before the British closed their naval base, Singapore's leaders chose another direction. In 1961, then Prime Minister Lee Kuan Yew created the Economic Development Board (EDB), giving it a mandate to develop a strong manufacturing sector in Singapore that would reduce their very high rate of unemployment. But the market for those manufactures could not be limited to tiny, poor Singapore. It would have to be the whole world. Singapore would have to grow its economy by exporting what it made and it would have to attract both the capital and the expertise needed to do that. The EDB worked with a United Nations development expert, Albert Winsemius, under the direction of Dr. Goh Keng Swee, then Singapore's Finance Minister, a graduate of the London School of Economics. They created a plan to attract multinational firms to locate their manufacturing facilities in Singapore to take advantage of the low cost of labor, Singapore's strategic location and its fine port facilities. Dr. Goh led the effort to develop a large tract of land at Jurong as a vast industrial park. Included in the development plan were all the residential facilities, schools and transportation and port facilities needed by global firms to set up their factories and house their staff. The government provided very attractive tax and other policies designed to attract global firms.

The government knew, however, that none of this would work unless it addressed the skills problem. Low-wage manufacturing did not require high skills, but it did absolutely require basic literacy, and, beyond basic literacy, a large number of people with strong vocational skills in areas like machining, electrical work, carpentry, welding, simple accounting and so on. Even before Singapore became an independent nation in 1965, this city state was lifting itself up by its bootstraps, working very hard to provide a workforce with the skills needed to make this low-wage, foreign-direct-invested manufacturing strategy successful, a story told in the next section.

At first, not much happened, and Goh became the butt of many jokes. But, in time, Jurong was an enormous success. Jurong was followed by other vast industrial parks and Singapore was off and running.

In the beginning, when Singapore pioneered this strategy, it had the advantages that come with being first. Later, however, when other, larger, nations—particularly China and India—implemented similar strategies, Singapore's leaders realized that success with this strategy required competing with those other nations on the price of labor. Put another way, this strategy would eventually work to keep Singapore's wages down and could actually push them

lower as more and more countries offered more and more cheap labor on the global labor market. Singapore's leaders were determined to improve the standard of living in their country. They wanted to raise wages. So they needed another strategy.

Economic Strategy: Phase II — Capital Intensive, High Tech-High Skill Strategy/Mid-1970s to 1990s

That led to the second stage of Singapore's industrial development. The government understood that the future for low-wage countries was a low standard of living; their aim for Singapore was to have a high standard of living. They knew that they would only have a high standard of living if Singapore could join the high-technology world, producing high-value-added products for which the world was paying high prices. But Singapore was producing mostly low-tech products. The problem it faced was how to acquire the high technologies that held the key to its future. The answer was from foreign high-technology firms themselves. They would become a high-tech, high-value-added manufacturing center by attracting the high-tech, high-value-added firms to Singapore and learn from those firms what they needed to know.

The question was how to do that. Part of the answer was a judicious mix of tax and grant incentives favoring such firms. Part of it was making Singapore increasingly inhospitable to firms that had come just for low-cost labor. Singapore actually took the audacious step of raising salaries, sending the clearest of all messages that foreign companies should not locate in Singapore to get access to a low-cost labor force.

Another example of such policies was Singapore's policy on industrial job training. All firms were required to contribute to a job-training fund. They could get their money back, in fact get even more than they had put in, but they had to write a proposal to the EDB. The winning proposals were those that showed how the money would be used to provide Singaporean workers on their staff with transferable high-tech skills that would enable them to add more value to the products they were making, a proposition very attractive for high-tech, high-value-added firms, very unattractive to low-value-added firms.

Many policies of this sort were implemented, and, over time, the proportion of low-value-added firms relying mainly on low-skill, low-cost labor declined, and the proportion of high-tech, high-value-added firms steadily increased, and with that increase, came a broad rise in the standard of living of Singaporeans. Of course, this strategy, like the previous one, required a determined effort on the part of the Singaporean government to greatly raise the education and skill level of the entire Singaporean workforce to match the needs of an economy based on high technology, an economy requiring world-class skills in many, many domains. The story of what the government did to meet this need is also told below.

One particularly important role in these developments was played by the National Computer Board (NCB), established in 1981. NCB's principal brief was to develop an IT-savvy

workforce, but it also developed a plan to implement a culture of IT throughout the country, to provide high-speed links to the rest of the industrialized world and to provide the same kind of infrastructure within the country. High-tech industrial parks were formed, and alliances between Singapore's universities and polytechnics on the one hand and leading universities and research centers worldwide on the other. No stone was left unturned in the effort to establish Singapore as a global center of advanced information technology and research.

Economic Development: Phase III – Creativity and Entrepreneurship Strategy/1990s to Present

The strategy used in the second phase of Singapore's development, like the earlier one, was successful only for a while. In time, other, previously low-wage, and often much larger countries followed Singapore up the value ladder to become producers of high-tech products for the global market. Once again, Singapore saw that its ability to provide a high standard of living for its citizens would fall victim to competition from lower-wage nations unless it could offer something they could not. Singapore's leaders knew just what that "something" was: innovative, creative products and services that would be in demand worldwide. Singapore would have to become one of the few nations making their living by inventing the future, not just once, but continuously. But the government wanted more than that. They saw a future for Singapore not only as the Asian headquarters of many premier global firms, but, increasingly, as the headquarters of Singaporean firms with a regional and even global reach. Just as Hong Kong had become the finance and management headquarters of the whole enormous Pearl River delta region in China, Singapore could become in the same way the nerve center of much of Southeast Asia. The government knew, as well, that this sort of vision for Singapore, a future that depended on Singapore's ability to lead advancements in many high-tech areas at once and manage a supply chain that extended to many nearby countries, would depend on this little nation becoming a major global center for world-class research and development, finance, technology, education and creative design.

Here again, at this third stage of development, it was clear that everything depended on making, yet again, a giant leap in education and training. None of this could happen unless Singapore was able to convert its education system from one providing a high-quality conventional education for people who largely played supporting roles in foreign-invested firms to a world-class education for people who would be called on to lead global firms to a future they would have to invent. Once again, education and training held the keys to the national economic strategy and the little nation's leaders knew it.

IV. Education Strategies to Meet Evolving Economic Needs

When the new government took over, there was no school system in Singapore. Each ethnic and language community ran its own schools, while the families of the colonial government and others were served by Christian Mission schools and a few government schools. When the British left, the loyalties of each ethnic group ran not to Singapore, but to nations outside the

infant country. The survival of the country depended on creating a national school system that could somehow serve to integrate these rival groups, produce a feeling of loyalty to the new nation and provide a workforce for a new kind of economy.

Education Development: Phase I — To Match the Low Cost, Low Skill Export Strategy/ca 1945 to mid-1970s

In 1961, the government drafted a Five-Year Plan to cope. At the start, the government required only a few schools to teach in English, but increasing pressure from parents to provide instruction in English over the first few years led the government to make a fateful decision to make English the primary language of instruction in the schools. Among the things that contributed to that decision was the realization that Singapore's economic plan would have the greatest chance of success if its workforce could speak English. The government was also aware that choosing any of the rival languages as the national language of Singapore could provoke conflict from which the new country might never recover. All students were to be bilingual, proficient in their home language and in English. The curriculum would be the same for all languages, and that curriculum would emphasize mathematics, science and technical subjects. There would be common national examinations for all primary school students. All schools were to be public, common schools.

But this must have seemed a dream to those responsible for carrying these policies out. Much of the adult population was illiterate. There were only 1,000 college graduates in a population of two-and-a-half million. They lacked the teachers, school buildings, school books, examinations and money to make the dream a reality. Of all these, teachers were by far the most important.

In the beginning and for a long time to follow, teachers were trained as teachers for three years while they served as teachers. Because there were not enough teachers or buildings, the schools were run on double shifts, teachers working both shifts, students only one each day.

Singapore managed to keep up with the exploding demand for primary teachers in this period, but fell behind for secondary teachers, mainly because the expanding industrial economy was competing for the very small number of people with the skills needed by secondary school teachers. The government could not compete with the private sector. The problem was exacerbated by the requirement that they be able to speak English. It was not until the Institute of Education was established in 1973 that teacher training in Singapore, for both primary and secondary teachers, was put on a firm footing.

Education Development: Phase II — To Match the Capital Intensive, High-Tech Economic Strategy/Mid-1970s to 1990s

1979 saw the release of the landmark report prepared by then Education Minister Dr. Goh Keng Swee, referred to ever since as the Goh Report. In this rather candid report, Dr. Goh pointed to the low rates of literacy among graduates, often in both English and their native

languages; the high rates of student attrition, which he characterized as wasteful and inefficient; and the generally low level of quality produced by the system to that point.

He proposed what came to be called the New Education System, in which students would be assessed on their language proficiency at the end of grade four and assigned on the basis of the assessment to one of four streams. The purpose, he said, was to provide more to those students who could race ahead and to give others at the other end of the ability spectrum the extra time they needed to get to high standards. A new standardized curriculum was introduced, set to much higher standards, especially in English, Mathematics and Science, along with an appropriate examination structure. Paths through the system were rationalized. The commitment to English was greatly strengthened.

None of this would have worked without much better teachers and more money for everything that had to be done to upgrade the system, all of which was given a powerful push by the announcement by then Minister for Trade and Industry, Goh Chok Tong, in his 1981 Budget Speech, of Singapore's Second Industrial Revolution, which was to "develop Singapore into a modern industrial economy based on science, technology, skills and knowledge."

But the revolution in education policy and structure that was needed to support the Second Industrial Revolution was already underway. Public expenditures on education rose from US\$21.4 million in 1978-79 to \$US245.38 million in 1982-83, a stunning increase.

But no less important to the outcome was the needed improvement in the quality of teachers. Work in that direction began earlier when, in 1971, the School of Education in the then University of Singapore was closed and Dr. Ruth Wong H.K., who had trained under Prof. Jerome Bruner at Harvard, was appointed to run the Teachers' Training College (TTC). The TTC, founded in 1950, then took over all responsibility for teacher training in Singapore, at both the primary and secondary school levels. She immediately began a substantial upgrade of the quality of teacher training in Singapore.

Dr. Wong took a very traditional third-world teacher training system and turned it into an internationally-competitive, modern one. As early as the early 1980s, Singapore was recruiting the teachers in their two-year training programs only from high school graduates who had their "A" levels, Singapore's top students. This was true for the primary schools, as well as the secondary schools. Beginning in 1980, all teachers were trained full-time, not part-time. By 1986, Singapore was recruiting trained engineers to teach a new program in Design and Technology in their secondary schools. Graduate programs were added for school administrators and secondary school teachers. Increasingly, the teacher training program was informed by the research going on at the world's leading teacher training colleges and graduate schools of education. The standards with respect to what teachers had to know about the subjects they were going to teach and the craft of teaching were raised substantially. Anticipating the work of Stanford Professor Lee Shulman by many years, Dr. Wong introduced the idea of training teachers in the pedagogy specific to the subjects they would be teaching. In

the mid-1980s, with help from England and Australia, the Institute of Education introduced the Practicum Curriculum, intended to greatly improve the connection between theory and practice, by carefully structuring the various roles a teacher must play during practice teaching. Dr. Wong made it clear that teachers, like their students, and like professionals everywhere, were meant to continue their own professional development throughout their career and she began to put in place the tools and resources they would need to do that. Singapore made aggressive use of their continuing education program to upgrade their experienced teaching force even as they radically upgraded the quality of the new teachers coming into the system.

Payday came when the results from the 1995 Third International Mathematics and Science Study were released. Singapore students scored right at the top of the distribution worldwide. Singapore had joined the ranks of the nations with the world's best education systems, a remarkable achievement for a nation that had hardly any education system at all when Singapore became an independent country only 30 years earlier.

Education Development: Phase III — To Match the Creativity and Entrepreneurship Economic Development Strategy/1990s to the Present

But the Singapore education system did not rest on its laurels. It had played a vital role in making Singapore a world leader in high-tech, high-value-added manufacturing. It would play an equally vital role in taking the next step toward making Singapore an international nerve center for an economy based on creativity, innovation and research and development. But doing so meant moving way beyond the system it had developed to meet the needs of stage two of the Singaporean economic development program.

In 1991, the government abolished the Institute of Education, merged it into the National Institute of Education (NIE) and made it part of the Nanyang Technological University (NTU). In doing so, it moved teacher education back into the formal university structure. In moving it into the NTU, it moved it into one of the most prestigious parts of the university structure, an institution that was already getting high marks in international rankings of universities. This would mean that the standard for preparation in the subjects the teacher would teach would be very high, but, because NIE faculty would provide the content and the pedagogy, these two aspects of teacher education, usually very separate, would in Singapore be highly integrated. Teachers at both the primary and secondary levels would learn at the same time what to teach and how to teach it.

Singapore continued, of course, to recruit its teachers from the top echelons of high-school graduates and to pay their beginning teachers at levels comparable to the compensation of beginning engineers. But the new home for teacher training made it easier to raise the standards of teacher preparation even further, to enable the training of classroom teachers in research methods and to develop post-graduate programs for teachers and school leaders. The new emphasis on problem-solving skills, creative and critical thinking skills and collaborative and communication skills required NIE to make major changes in the instruction designed to prepare teachers to teach in the new kind of schools.

Under the leadership of Professor Gloria Lim, Professor Leo Tan and now of Professor Lee Sing Kong, the National Institute of Education has become a world-renowned teacher education and educational research institution.

On 2 June 1997, then Prime Minister Goh Chok Tong delivered a speech on education. It was titled, “Shaping Our Future: Thinking Schools, Learning Nation.” It would set the tone for everything to come. In that speech, he said that “a nation’s wealth in the 21st Century will depend on the capacity of its people to learn.” He then engaged in a shrewd analysis of the strengths and weaknesses of the education systems of the United States, England and Japan. He pointed out that Japan had long had one of the world’s most successful education systems, but had become deeply worried that they would not be able to produce “...the individual creativity, the originality of thought and inventiveness...they need to retain their competitiveness.”

The Prime Minister promised a fundamental review of Singapore’s curriculum and assessment system to develop creative thinking skills and the ability and desire for lifelong learning. The Ministry of Education, he said, was studying how to reduce the expanse of the required curriculum to introduce more choice and more projects of a kind that would enable students to develop the new skills, without lowering their standards. He was clear that it was very important to create a kind of education that would “fire a passion for learning” instead of studying for the sake of getting good grades. In the future, he said, excellence will be defined by the eagerness and capacity to learn, not how much one learned in school, because it will be impossible while anyone is in school to know what that person will need to know in the future.

There were, he said, enormous implications in this for teachers, who would themselves have to become lifelong learners. Schools would have to become model learning organizations. Teachers would have to have the time to reflect, learn and keep up-to-date. Schools would have to have more autonomy to define their own direction. And the Ministry would have to build a feedback loop from the schools back to the Ministry, to make sure that policy was adjusting to the needs and learning in the schools. Singapore would have to “get away from the idea that it is only the people at the top who should be thinking.”

The Prime Minister was announcing a revolution. Thinking Schools, Learning Nation became the driving vision. The next step was the Innovation and Enterprise initiative, summed up in the following list of core life skills and attitudes that the Ministry declared it wanted developed in students:

- A spirit of inquiry and thinking originally
- A willingness to do something differently, even if there is risk of failure
- A ruggedness of character, the ability to bounce back and try again
- A willingness to stand in a team, lead a team and fight as a team
- A sense of “giving back” to the community

And that was followed, in 2004, by Teach Less, Learn More. Perhaps the best commentary on the spirit of Teach Less, Learn More was a speech delivered by then Education Minister

Tharman Shanmugaratnam in 2005. In it, he talks about “developing a spirit of inquiry,... helping our young develop the strength of character that will help them ride out difficulties and live life to the fullest...and injecting fluidity through the system—recognizing more talents besides academic achievements, providing more flexibility in the school curriculum and streaming system and introducing new pathways—all to help our students discover their interests and talents, and know that through our education system they can go as far they can.” He talked about “bottom-up initiative, top-down support.” He described the centralized, exam-focused Asian education systems as first-rate at producing adults who can focus on a task and get the job done, but said that was not enough in a world in which “...the future would be driven by innovation, by doing things differently with verve and imagination, not by replicating what has been done before.” He had just returned from a trip to Japan with Ministry of Education officials. He said the Japanese understood the need for the kinds of changes called for in Thinking Schools, Learning Nation and in Teach Less, Learn More, but they had imposed these changes from the top down, and there was no buy-in from the schools. That would not, he said, happen in Singapore. The goal would be reached with leadership from the schools, and support from the top, or as he put it, “top-down support for bottom-up initiatives.”

From June 1997 to the present, the Ministry of Education has been working hard to implement the vision that unfolded over the years from then Prime Minister Goh Chok Tong’s speech.

V. Vocational and Technical Education: Backbone of Singapore’s Economic Development Strategy

VET Development: Phase I – To Match the Low-Cost, Low-Skill Export Strategy/ca 1945 to mid-1970s

The first government trade school in Singapore was established by the British in 1930. Then, not much happened until they built two secondary Technical Schools in 1956. That was it until the political party that continues to run Singapore was first elected in 1959. That election marked an explosion of vocational and technical education in Singapore. From a standing start of 1,379 students in 1961, there was a 14-fold increase in the number of vocational students in the system by 1967.

The difference was simple. The British were running Singapore as a trade center backed up by their own Navy, and had no interest in raising the standard of living of the natives. The new government, made up of Singaporeans, saw education and training in vocational and technical subjects as the key to their very ambitious economic development plans to improve the lives of their own people. That is just as true today as it was then.

The new government knew that their plan to carve a new industrial development zone out of the jungle in Jurong would come to nothing if they could not provide thousands more carpenters, mechanics, metal workers, machinists, plumbers, shipyard workers, and electricians than they had available, both for the construction of the industrial zone and port and for their

operation, and they knew that Jurong, if successful, would have to be followed by other similar developments if they were to reach their goals for reducing unemployment in Singapore and increasing the standard of living. Singapore's new leaders had discovered that other former colonies that had tried to implement foreign-direct-investment development strategies had failed because they had not attended to the need to develop indigenous workers with the necessary technical skills, and they did not intend to make that mistake themselves.

Between 1962 and 1966, Singapore, with a population then of fewer than 2.5 million, built 40 new secondary schools, of which 19 were secondary technical and secondary vocational schools. The program at Balestier Trade School, the original colonial trade school, gives us a pretty good idea of where Singapore was headed. Its students were studying the “crafts” and crafts were defined as Mechanical Engineering Practice, Electrical Fitting, Electrical Installation, Radio Servicing, Motor Vehicle Mechanics, Refrigeration and Air-conditioning, Plumbing, Woodcraft and Construction, Building Drawing, Shipbuilding, Sheet Metal and Welding and similar subjects. So, even as the new schools were being built at breakneck speed, the old ones were being refitted to meet the needs of Singapore's economic development plan.

Singapore's unemployment rate in 1968 was 9 percent. But these new graduates were offered jobs as soon as they graduated. The plan, evidently, was working just as designed.

The problem, of course, was finding enough teachers for the rapidly-expanding vocational and technical schools. Here again, the government started early. In 1961, two years after the grant of autonomy and four years before independence, the TTC started offering a two-year certificate program for people who wanted to teach technical education. But demand for semi-skilled and skilled labor was so great that, two years later, the two-year full-time training program was changed into a one-year program followed by two years of workshop practice, to get the new teachers into service one year faster. Just like the new programs to train primary school teachers, the idea was to press new teachers into service before they were fully trained and to continue their training after they started work.

That still did not produce enough teachers. So, even as it was working overtime to increase the number of people available to expand the primary schools and the regular academic secondary schools, the government pressed many of the teachers it was preparing for the regular academic classrooms into service as vocational and technical teachers, sending them into the new certificate program. Since the TTC did not have enough capacity to train everyone who needed training, the government sent others to the United Kingdom and other Commonwealth countries such as Australia, Canada and New Zealand to get their vocational training there. Clearly, Singapore, here as elsewhere, was pulling out all the stops, working as hard as it possibly could to produce the avalanche of trained technicians required to substantially lower unemployment and kick-start the economy.

In 1968, the year the British announced that they would close their naval base, the government consolidated responsibility for technical education in a new Technical Education Department (TED) of the Ministry of Education, complementing the Ministry's General Education

Department. One year later, its first director, Lim Ho Hup, finding that the mighty efforts made thus far to prepare a technical workforce adequate to Singapore's needs had still not produced enough trained technicians, took an extraordinary step. He announced that all male secondary school students and 50 percent of the female secondary students would be required to take Metalwork, Woodwork, Technical Drawing and Basic Electricity during their first two years in secondary school. There were not enough teachers to staff these courses in the high schools, so the Ministry set up centralized workshops for this purpose, to which the high school students were transported for these classes. A whole generation of students had their first taste of technical education.

The new program was not very popular at first, but it turned out that many students who had a strong academic record really liked these classes and decided on a technical career as a result. This greatly strengthened the quality of students opting for the polytechnics and undoubtedly contributed to their subsequent success. Because girls were required to participate in this program, the taboo against women in technical careers was broken, another important reason for Singapore's later success. By 1997, half of the applicants to the polytechnics were young women.

But the number of well-trained technicians, though much greater than before, was still small. In 1968, 84 percent of students in schools were enrolled in the academic stream, 7 percent in the vocational stream and 1 percent in the commercial stream. That, of course, was why an introduction to vocational education had been made a required subject for all males and half the females in lower secondary education.

The full-on vocational program was a separate stream for the lowest-ability students in the secondary schools. That had made sense when a large fraction of students left school when they finished primary school, unemployment rates were very high, and these "dropouts" faced a bleak future. But, as the demand for labor skyrocketed, those who left school at the end of primary found jobs, those with more education found much better jobs. Schooling was expanding to meet the demand, the dropout rate was plummeting, the vast majority of students stayed in school beyond the compulsory age, and the policy of using lower secondary vocational education to keep kids in school no longer made sense. In 1969, the Technical Education Department abolished the separate stream for vocational education in the lower secondary schools.

The TED had done a very good job, and its location within the Ministry of Education made sense when success depended on very close cooperation with the regular schools. But, as the initial needs for technicians with the minimum level of competence needed to get started was satisfied, it became more important to make sure that there was a very close level of collaboration between the vocational education system and private industry. That led to the end of the Technical Education Department and the creation in its place of the Industrial Training Board (ITB), in 1973. This new independent agency, constructed outside of the Ministry of Education, had a legislative mandate to focus on Singapore's industrial training needs. Though

the leadership for this whole area had passed to the ITB, the Ministry of Education was still responsible for the technical schools.

Among its other responsibilities, the ITB was tasked with establishing a new occupational skill standards system in close collaboration with industry, a skill standards system that would drive skills training at every level. Training advisory councils that would develop the standards were established with the close participation of industry. A rigorous curriculum development process was created to develop curriculum matched to the standards. Not least important, new structures were developed to produce very close collaboration between the training system and the employers to give trainees access to the state-of-the-art equipment and personnel in industrial plants that were necessary to train candidates up to the standards industry needed. A whole range of schemes was developed by the ITB to make this possible for various groups of full-time students and employed workers, including apprenticeship schemes and on-the-job training programs. Memoranda of Agreement were developed between government and key employers like Bosch, Mitsubishi, Siemens, IBM, Cisco Systems and Sun Microsystems to enable teaching staff to stay up-to-date in leading edge developments in industry so they could pass on what they were learning to their students.

Toward the end of this initial phase in the development of Singapore's technical education system, the ITB created a new system of skills certification, the National Trade Certificate (NTC), which would, in turn, drive its whole system of vocational and technical training. It began with the NTC-3 standard for semi-skilled work and went up from there. The same standards were used for full-time training of new workers in the vocational school system as for the part-time training of employed adults in the adult and continuing education system. The ITB set up a Public Trade Test System, which enabled experienced workers to get credentialed under the new skills certification system at the semi-skilled (NTC-3), skilled (NTC-2) and master craftsman (NTC-1) levels by taking the appropriate tests, without having to take the related courses. Because the standards for this system had been set by the employers, the employers recognized the certificates offered by the trainees. Because the certificates were recognized by the employers and the candidates demanded them, the training institutions designed their courses around the skill standards.

By the early 70s, the ITB had benchmarked the world's leading apprenticeship programs and concluded that they should be the basis for conveying skills to the craftsman level in the NTC system. But apprenticeship training was only available to men who were already out of school and finished with their compulsory National Service and there were, at that time, very few men who wanted to do it. Good jobs were readily available to them without having to go through an apprenticeship, so the incentive to become an apprentice was not great. So the ITB bribed them with the offer of an allowance of \$60 per month (a lot of money back then) over and above the stipend they would get from their employer. That worked pretty well, but not well enough. So then the government offered to defer the required National Service for young men who signed up for apprenticeships, and cancelled the requirement altogether for those apprentices who stayed with the same employer for six years. That worked!

The ITB had designed an apprenticeship program which, in the first year, consisted of full-time training in a vocational institute, followed by two years of on-the-job training in a program approved by ITB. Employers participated because the apprentice was bonded to stay in that company for a specified period of years following the award of a certificate.

The first year the whole ITB training system was offered, enrollment in their first year full-time courses went up more than 15 percent. The number of working adults enrolled in the part-time programs increased by 90 percent. ITB was a great success right out of the box.

But ITB was not the only player on the vocational education scene. As Singapore's new government was getting started, it concluded that it needed a strong, independent government agency to focus on the critical task of attracting foreign multi-national corporations to Singapore. Established in 1961, the new agency, named the Economic Development Board (EDB), moved to set up offices in most highly-developed countries to actively promote investment by firms in those countries in Singapore. At the same time, the new EDB was charged with designing and managing what proved to be the hugely successful development of the Jurong Industrial Town, with its ready-to-move-in factories and wrap-around services. It sold Singapore partly on the basis of low-cost labor, but mainly on the basis of its lack of corruption, great facilities, and strong support services for industry. But they had a problem. The idea was to offer a complete package, everything a multinational company might need to succeed. That had to include the trained labor they would need, so by virtue of its charter, the EDB would come to be centrally involved in the development of Singapore's VET system, too.

Singapore was being advised at that time by the United Nations Development Program, which worked with the EDB, to help Singapore get assistance from Japan, Britain and France, each of which donated both equipment and supplies enabling the Singaporeans to establish industrial training centers in Metal Industries, Prototype Production, Electro-Mechanical, Electro-Chemical, Woodworking and Precision Engineering. From the beginning, training was built in-part around the actual production of components or parts needed by the companies with operations in Singapore, assuring that the training would be grounded in up-to-date requirements and techniques. These training centers were modest in size, producing in four years only 86 graduates (though many were hired by the firms before they could graduate, so great was the demand for skilled technicians). And, because each was provided by a different country, with its own distinct approach, there was little the Singaporeans could do to create a real system of training for skilled technicians then, but, as the reader will see in a moment, these six small training centers turned out to be an acorn from which a very strong tree would later grow.

It was not long before the EDB learned that it was very difficult to attract the kind of companies it wanted to come to Singapore unless it could offer certain specially-trained technicians that were not likely to be provided by the new training programs being managed by the Ministry of Education or the ITB. So the EDB established a new program for industrial training. They did not have the money to set up their own schools, with all the expensive specialty equipment and specialized instructors they would need. But they knew that it was

these companies that had both the up-to-date equipment and the highly trained instructors. So they made a deal with the first companies of the kind they were looking for that were willing to locate in Singapore. Starting with Tata Group of India, they offered the company land and buildings at Singapore's expense for a training center in Singapore, a sum of money for the equipment needed to cover some of the costs of equipping the training center and an amount of money sufficient to cover 70 percent of the cost of its operating costs. In exchange, the company would train not only the people they needed for their own operations, but an equal number that would be available, on graduation, to other firms coming to Singapore. In this way, the EDB managed to create a system that was attractive to the firms, because their own training to meet their own needs would be heavily subsidized and they would get to do it in their own way, but was also a good fit for the Singaporean government, because they could be sure the training would be world class, done with state-of-the-art equipment, at far less cost than if Singapore had set up such a training facility independently.

The training program lasted two years, including one year of basic training and another of production training. Students got a stipend while in the program. Those who successfully completed were awarded an Apprenticeship Certificate. When they got it, they were bound by a bond to serve any company to which the EDB sent them for five years. The program quickly expanded beyond Tata to Rollei and Phillips. It is very unlikely that Singapore would have become a major world center for precision engineering had it not been for this program. But what was learned in this program was to prove quite valuable in the next stage of development of Singapore's VET system.

To get a complete picture of the early development of Singapore's technical education system, though, we have to go back and retrace the development of the polytechnics, that part of the system which sits between the vocational education system just described and the university system. The former is responsible for training the semi-skilled and skilled ordinary workers in the economy, the latter for the engineers, scientists and managers at the very top of the system. The polytechnics train those in between, the people who provide much of the technology know-how and leadership that has enabled Singapore to enter and then dominate one new high-tech industry after another. They have been described as the "backbone" of Singapore's industrial development system.

The Singaporeans have the British to thank for Singapore Polytechnic, the first of the line, opened by the Prince Regent in 1959, the year Singapore gained autonomy from the crown. Most of its 30 full-time and 130 part-time faculty came from Great Britain and other parts of the Empire, augmented by the British who staffed the Singapore naval base. One wonders if the British had somehow peered into the future when they established this institution. They designed it to train people for industry at a time when there was virtually no industry around. Since Singapore was established more than a century earlier, the backbone of the Singaporean economy had been trade, not industry. But industry was to be its future, and Singapore Polytechnic was to prove a very important investment in that future, an injection of highly-trained teachers who could then train their successors, the proverbial acorn from which the proverbial oak tree would soon grow.

A few months after Prince Philip left Singapore, the first Singaporean government was sworn in. One of its first actions was to appoint Dr. Toh Chin Chye, the new Deputy Prime Minister and Chairman of the majority party, as the Chairman of the Board of the new polytechnic. Nothing could have more clearly signaled the intention of the new government to make technical education the linchpin of its economic development strategy.

Dr. Toh cancelled all the classes in typing and stenography and instituted instead a program of technical courses designed to provide the technical skills needed by the kind of industries Singapore wanted to attract from abroad. Then he announced that Singapore would create its own unique skill standards system. He wanted to be sure that Singapore would not depend on skill standards systems devised by other countries, but would instead be free to develop skill standards particularly appropriate for the leading edge industries and firms that Singapore would be going after. This was a remarkably courageous and far-sighted decision. Had Singapore continued to use the British occupational skill standards system, employers everywhere would have known what the qualifications presented by Singaporean vocational education students meant. To abandon that system meant that Singaporean skill standards and the qualifications based on them would not be recognized outside Singapore and, in fact, global employers in Singapore might refuse to recognize them. But neither of these possibilities became reality and the decision to develop a uniquely Singaporean skill standards system turned out to confer enormous advantages on Singaporean workers, for reasons to be revealed below.

The second polytechnic, Ngee Ann, followed in 1963. But even as late as 1980, the proportion of the cohort pursuing full-time study leading to a diploma in these institutions was no more than five percent. But from then on, that changed rapidly. By 2006, there were five polytechnics and they were taking in 40 percent of the cohort. But I am getting ahead of my story.

VET Development: Phase II – To Match the Capital Intensive, High-Tech Economic Development Strategy/Mid-1970s to 1990s

The next phase of development of Singapore's VET system was driven by the Council on Professional and Technical Education, chaired by the Minister for Trade and Industry. The EDB was to play a very important role here.

By the time the first phase of Singapore's development was coming to an end, the EDB had concluded that the development of a highly-skilled technician class would prove crucial to the strategy for the second phase: attracting to Singapore the kind of high-technology, high-value added firms that could serve as the foundation for a high-wage economy. The EDB realized that neither the Ministry of Education nor the ITB would be able to produce by themselves enough of the highly-skilled technicians fast enough to meet the demand for them that the EDB intended to create. So the EDB decided to build the entering wedge of a new system for training highly-skilled technicians that would draw on what it had learned from the training centers it had established earlier, as well as its experience with the industry-operated

apprenticeship program. If this worked, they said, what was learned could be incorporated into the design of the polytechnics.

The EDB went back to the three countries with which it had collaborated on the training centers and asked them to collaborate once again, this time through the medium of renewable five-year agreements, to create a new form of post-secondary school.

These new schools were to be known as the German-Singapore Institute of Production Technology, the Japan-Singapore Institute of Software Technology, the Japan-Singapore Technical Institute, and the French-Singapore Institute for Electro-Technology. The German-Singapore Institute was designed to train the core of the technical workforce for the production of advanced factory automation systems. The French-Singapore Institute produced technologists for the electronics industry. One of the Japan institutes focused on IT and the other on mechatronics. One of the secrets of Japan's stunning success in manufacturing was its marriage of the previously separate disciplines of mechanical engineering and electronics, and this was Singapore's bid to catch the wave. In 1988, a Precision Engineering Institute was set up on the same model.

But the seminal idea animating the design of all the new institutes came not from the sponsoring countries, but rather from an official of the EDB, Lin Cheng Ton. This was the idea of the "teaching factory."

The germ of this idea could be found in embryonic form in both the original EDB training centers and the company training centers that followed. I had the good fortune to visit the German-Singapore Institute in 1989, when I first visited Singapore. My memory of that visit is quite vivid, for it struck me as the best vocational school I had ever seen. The features that made the deepest impression on me were, as it turns out, common to all of these institutions. They were the characteristics of the "teaching factory."

It was a two-year program of studies. Students coming directly from high school had to have their "A" levels, but the school also admitted recent graduates who had experience working in high-tech companies who were nominated by their companies and who had their "O" levels.

On entering the school, I had the impression that I was in a modern factory. The students wore white lab coats and punched a time clock. Everything possible was done to create an environment as much like a factory as possible, in terms of both the physical environment and the way the students were treated.

The first-year program was devoted to basic studies designed to provide a foundation for the applied work to follow in the second year. This included a CAD/CAM course, a course in electronics, another in pneumatics and hydraulics and so on. In the second year, the students worked on factory automation projects. These were not mock ups. Rather, the faculty was responsible for getting contracts from the global firms with facilities in Singapore to build new

factory automation systems for them, which they would use, and for which they would pay the school. The school had to charge market prices for these systems, in order to avoid being charged with undercutting companies in business to provide such systems, so the customers expected a product that would be competitive with the best such systems in the world and would be delivered on time. The faculty supervised the design, construction and testing of these systems, but it was the students who produced them. They worked in teams. Some would work on the mechanical systems, others on the electronic subsystems, others on the pneumatic and hydraulic subsystems and so on. Most projects were completed within the year, but some took longer.

Many of the faculty members were engineers who had degrees from the engineering program at the University of Singapore. Every five years, they were expected to take a year away from the German-Singapore Institute at one of the world's top manufacturers of factory automation systems. On their return, they were assigned to revise the relevant parts of the school's curriculum in light of what they had learned abroad.

The élan of both teachers and students was indescribable. The students felt very lucky to be there, as did the faculty. Both were working very hard. The standards were very high. I had the sense that everyone knew that Singapore's future depended on their success, as indeed it did.

In time, the demands on these training institutes grew to the point that no single company or nation could provide the needed resources. The EDB reconfigured them to draw on all the major industry players in their respective fields. In the case of the German-Singapore Institute and factory automation, Hewlett-Packard, ASEA, Seiko Instruments, Sankyo Seiki, Siemens-Nixdorf and others agreed to join the consortium, loaning experts, training EDB lecturers at the firms' worldwide locations, assisting with curriculum and program development, and donating and loaning equipment and software, and upgrading it when necessary.

As I pointed out at the end of the last section, this phase of Singapore's development was to prove explosive for the polytechnics. At the beginning of this period, there was only Singapore Polytechnic, established in 1954. In 1982, Ngee Ann Technical College was renamed Ngee Ann Polytechnic and Temasek Polytechnic was established in 1990. Nanyang Polytechnic followed soon after in 1992. What is hard to convey is the urgency with which all this was done, and the determination to reach not only large numbers, but also high standards, very, very quickly.

Ngee Ann had a very rocky start as a private college in the mid-60s and did not really get off the ground until it was taken over by the government and turned into a technical college in the late 60s, with programs in Industrial Chemistry, Industrial Electronics, Management Studies and Institutional Management. By the mid-70s, its enrollment had grown to 3,000 students, with a major building program financed in part by the Asian Development Bank. It had forged a close collaboration with Polytechnic of Central London, with three faculty members transferred from that school to Ngee Ann in key positions. By that time, it had an Electrical and Electronic

Engineering Department and a Commerce Department, and very importantly, all of the Ngee Ann diplomas were jointly awarded by Ngee Ann and the Polytechnic of Central London. In the mid-70s, Ngee Ann added two new departments, one for Building Services and another for Shipbuilding and Repair. Singapore had earlier taken over the British naval shipyards and expanded its port facilities to accommodate the needs of the businesses it was recruiting. The Suez Canal had closed, which was forcing ships that would otherwise have gone through the canal to come through the straits and right by Singapore. The extra stress on the ships from going around Cape Horn meant that, by the time they got to Singapore, they were keeping the Singaporean shipyards very busy. And Singapore was beginning to develop its offshore oil business, which also required the kind of technically-trained staff that Ngee Ann was ready to provide.

By 1980, surveys showed that Ngee Ann's graduates were in as much demand as those of Singapore Polytechnic. Its student population rose from 3,000 in 1980 to 9,000 in 1986. Its second five-year plan, scheduled to begin in 1986, was projected to cost \$200 million.

Built into that cost was the construction of a new Center for Computer Studies. The director of the Center was recruited from Huddersfield Polytechnic in England, where he had headed their computer center. All this took place under the watchful eye of the Council on Professional and Technical Education, which was, at the same time, arranging for the creation of the Japan-Singapore Institute of Software Technology, under the auspices of the EDB, thus putting in place all the required elements of a strong core of professionals and technicians to support this crucial new industry in Singapore.

Just as Ngee Ann had arranged for their graduates to earn diplomas in other fields from the Polytechnic of Central London, it had arranged for its graduates in Computer Studies to get the internationally-recognized National Higher Diploma from England at the same time. The engagement of its computer center director from England was not a one-off. Ngee Ann was recruiting its faculty and administration from leading institutions from all over the world. Singapore was determined to show that the graduates of its home-grown institutions could compete with the best anywhere.

By the end of the 1990s, Ngee Ann had programs in Environmental Engineering, Public Health Engineering, Building Services Engineering, Microprocessor Technology, Robotics, Computer Numerical Control Machines, Digital Communication, Plant Engineering, Air Conditioning and Refrigeration, Fabrication Technology, Manufacturing Technology, Flexible Manufacturing Systems, Business Data Processing, Mechatronics, Quality Assurance Engineering and much, much more. And it was busy creating a whole new program in mass communications, which would, among other things, complement EDB's plans to create a new film industry in Singapore.

Ngee Ann was a major achievement for Singapore. But it was only one step in the development of a solid phalanx of polytechnics in this period under the leadership of Dr. Tay Eng Soon,

Senior Minister of State for Education, who was at that time Minister in-charge of the Polytechnics and ITE, and Chairman of the Vocation and Industrial Training Board, soon to become the ITE. I will not describe the founding and growth of the others in the same detail, but there some points about those developments that are important to relate.

In June of 1989, the year I visited the German-Singapore Institute, Dr. N. Varaprasad, the deputy principal of Singapore Polytechnic, was asked to head a team to study the feasibility of creating another polytechnic. Dr. Varaprasad submitted his team's report in November. In December, he was asked to be the first employee and principal of the new institution. He was given six months to open its doors for its first students. Five years later, it occupied a 50-hectare campus in world-class buildings containing almost 2 million square feet of space. The architecture is stunning. By 1995, when it moved into that new campus, Temasek Polytechnic had become one of the world's leading polytechnics. It had by then created many new diploma programs, perhaps the most interesting of which was its Apparel Design and Merchandising program. Singapore's home-grown designers have now taken their place among the world's leading clothing designers. We see here one more example of Singapore's determination to do whatever it would take to create a VET system at lightning speed and, at the same time, to be world class in every arena it took on.

The government chose Lin Cheng Ton, the Director of the Manpower Development Division at the EDB, to head first the planning work and then the new institution itself. The name sounds familiar to the reader because it was this very person that led the development of the new post-secondary institutions designed to produce an elite crew of specialized technicians when he was at the EDB. And it was Lin Cheng Ton who insisted on the use of the teaching factory model as the core design element in the German-Singapore Institute and its sister institutions. You will recall that those institutes were started by EDB in the hope they might serve as models for the construction of a new round of polytechnics. The institutes had proven an unalloyed success. It was time to inject what had been learned into the bloodstream of the major institutions preparing the highly-skilled technicians who would continue to drive the Singapore economy.

Lin Cheng Ton was asked to head the planning committee in August 1991. By April 1992, eight months later, the new Institution was up and running. Mickey Chiang tells a great story about what happened in the meantime. Lin Cheng Ton was able to put together his first operational team, five colleagues from the EDB, only ten days before the annual announcement of the fall program for all the polytechnics had to go out. Half that time would be taken by the printer. They had no program and no one to teach it, let alone a description of it, but failing to meet that deadline would have meant that they would have lost a whole year in opening the new polytechnic. They met their deadline and they were able to use the announcement to recruit a credibly-sized student body to open their new institution in temporary quarters the next fall.

Nanyang Polytechnic started that fall with programs in Occupational Therapy, Nursing, Physiotherapy and Radiography. The following year, all the EDB institutes were transferred from the EDB to Nanyang Polytechnic, and, with that move, Nanyang instantly acquired world-class offerings in factory automation, mechatronic systems, industrial electronics, software engineering, servo-mechanisms and motion control and a score of other key technologies. But it also acquired all the disciplines of the “factory school,” which included not only the design of its heavily applied curriculum and pedagogy, but also the whole schema of methods for closely intertwining the work of the most advanced firms in the world with the work of these schools, virtually guaranteeing that Singapore would continue to have some of the most efficient methods ever developed for making sure that its curriculum for the training of top-level technicians would reflect the most advanced technologies, forms of work organization and training systems on the planet.

In transferring the EDB institutes to the new polytechnic, the government was not just lodging them in that one institution, but rather finding a launching pad to take what they had learned and spread it through the whole mainline career education and training system.

That certainly included the vocational education system supervised by the Industrial Training Board. The ITB had moved mountains in the first phase of Singapore’s industrial development to provide the carpenters, electricians and other semi-skilled and skilled people required by the low-skill, low pay, low-value-added employers that were first attracted to Singapore when the name of the game was to reduce unemployment to acceptable levels. They were doing this at a time when a large fraction of the Singapore workforce was illiterate, and most of those who were literate had not completed a primary school education.

In 1973, the Government decided to greatly expand its vocational education program and formalize it as a pre-employment training system organized outside the school system for those who had left primary school. In 1960, the government had set up the Adult Education Board (AEB) to provide continuing academic education and enrichment programs for the adult population. In 1979, the Industrial Training Board was merged with the Adult Education Board to form the Vocational and Industrial Training Board (VITB), the predecessor of the post-secondary Institute of Technical Education (ITE) formed in 1992. The aim was to create a single consistent framework for the training of both youth and adults, using a common occupational skill standards framework and matching course structure, as described above. The new Board consisted of five representatives from the Government, four from labor and three from employer associations and seven senior business executives. All were high level and well connected in the worlds of business, education and government. Each area of the VITB’s curriculum had an advisory committee composed of experts in the relevant fields, including, but not limited to Automotive, Commercial, Construction, Electrical, Electronics, Fashion Arts, Hotel, Mechanical Engineering, Precision Engineering, Shipbuilding and Repair, Printing and Wood-Based Trade.

Between 1973 and 1991, the ITB and then the VITB trained and certified 150,000 skilled workers. But, by the late 80s, it was clear that the model was no longer working. Employers were less and less interested in hiring those of their certificate-holders who had only a primary school education, followed by the VITB skill training. They wanted workers who had a full primary and secondary education, followed by post-secondary vocational training (in the Singapore context, that meant 10-year schooling through the end of lower secondary school, followed by vocational education).

And there was another problem. Sixty percent of the students coming from primary school into the vocational education program could not successfully complete their vocational courses, because the level of their academic achievement was so low. So Singapore had to find a way, at one and the same time, to make vocational education a post-secondary program and to help the students falling through the cracks to successfully complete both the primary and secondary programs.

This was the point at which the Government engineered a major redesign of the school system. The reader will recall that streaming was introduced at the end of fourth grade and the period of common school was extended through the end of lower secondary school. Vocational education was postponed until the post-secondary years, one option available to students after they had completed their “O” Levels.

The designers of the reforms believed that all or nearly all of the students who had been struggling could succeed against high standards, but would need more time to do so. The lowest stream was designed to give them both more time and more help than other students normally needed.

When I visited Singapore in 1989, I was astonished to find that the primary schools we visited were assigning their most capable teachers to the students in the lowest track. Those students typically had a longer school day than their peers and often came to school at times on the weekends when other students did not. Though the students in the lowest track scored lower on the international tests than their peers in Singapore, we discovered that they were scoring higher than the average for all students in the world’s leading industrial nations. The curriculum these students studied was not as demanding or as rich as the curriculum in the upper streams, but, by global standards, it was demanding enough to enable these students to achieve at very respectable levels, and, most important in the Singapore context, to give these students a very good chance of success in the redesigned—now post-secondary—vocational system. It was, we thought, a remarkable achievement. In effect, all streams were performing above the average for the industrial nations and the top was the equal of the top anywhere in the world. With this accomplishment, Singapore could run a vocational education system attracting the lowest quarter of its graduates and still produce technicians that would hold their own with the world’s best.

And that is just what they set out to do. Singapore's vocational education system was completely revamped. A New Apprenticeship System was launched in 1990. Like the old apprenticeship training program, it was designed to accommodate students who wanted to "earn and they learn" and companies that wanted students trained by their own staff. It would not compete with the system for full-time vocational education, but complement it. One of the new features was the requirement that firms offering the training use instructors from their own staff who had been certified by the Government, after taking a standard course in vocational pedagogy offered by the Government. Under the new scheme, the Government provided higher subsidies than before, allowing the firms to pay more to the apprentices, as well as more support for students who needed basic skills instruction in order to meet the skills threshold that would enable them to profit from the apprenticeship training.

The Government provided guidelines for the compensation of apprentices, and that compensation was quite attractive. The apprentices could choose among 650 companies, sponsoring a total of 70 programs. The Government tested the candidates at the end of their apprenticeship and certified those that met the standards. Courses in the apprenticeship program could be offered in Government-approved Approved Training Centers. To be certified as an ATC, a center had to meet the Government's requirements with respect to curricula and facilities, and the staff had to have completed the necessary training and been certified for the program. A major part of the companies' expenses could be paid through the Skills Development Fund, which was initially run by the EDB and later transferred to SPRING Singapore and the Workforce Development Agency.

For the apprentices, this was very attractive both because they could make good money while getting their training, but also because they had the inside track to good jobs and the prospect of a career with some of the world's leading companies. It worked for the companies because their training costs were heavily subsidized by the Government, they could train the apprentices in their own way of doing things, and they got a chance to look over the candidates without having to commit before they saw the candidate under real working conditions.

But the really big development as the 90s got underway came in 1992, when the Ministry of Education under the charge of the late Dr. Tay Eng Soon, Minister in-charge of Polytechnic and Technical Education from 1981-1993, retired the VITB and created a new post-secondary Institute of Technical Education (ITE) in its place. This was not just a name change, but rather a whole new commitment to vocational and technical education at the level below the polytechnic. It was launched with a capital budget of \$300 million, enough to build campuses for each of ten technical institutes with new quarters that would be equal in architectural excellence to the best universities in Asia and many in the rest of the world, with equipment and staff to match. And that was just the beginning of the Government's financial commitment.

For many years, vocational education was seen by almost everyone as a dead end, the place to which students who had failed in the schools would be sent, the burial grounds for losers.

The Government would change all that, to send a message to Singapore students and their families that, however low in status vocational education used to be, it would be an orphan no longer. The Government would spend whatever was necessary to provide its vocational education students with world-class training, and world-class jobs would await those who took them up on it. They mounted a relentless and sophisticated public relations campaign to make their point. Top government officials made speeches describing skilled technicians as the driving force of Singapore's economic success and encouraged young people leaving school to attend these institutions. They built first-rate facilities and equipped them with the latest machines and a highly-trained faculty. And they worked hard to build a strong web of connections to business.

All of that was terribly important, but this observer guesses that two other things the Government did may have had a greater impact on the attractiveness of these new institutions than any of those things. The first was the sheer size of the investment made by the Government in the magnificent campuses built for the new vocational education system. The second was the fact that the program that awaited the new students at these re-born institutions was far more like one would expect to find in a university than in the old vocational schools. There were beautiful dining halls, extensive libraries, sports programs, arts and music classes. In all these ways, the new dispensation conveyed the message that Singapore really valued the students who chose to go to these institutions and that it intended to place these young people in the center of the new economy, not on its periphery.

The new ITE facilities were sited close to Singapore's industrial parks and to the residences of the workers who worked in them, both to foster close connections between the schools and the businesses they served, but also to make it as easy as possible for the young people and those needing adult education to get easy access to their programs. The New Apprenticeship Program was brought under the control of the new ITE, because the Government wanted the apprenticeship program to complement the full-time training program, and make sure that both were developed as integral parts of one coherent system. It was the ITE that was responsible for the common occupational skills system, the standards for trainers and instructors, the criteria for award of occupational certificates, the testing of candidates, the award of certificates and so on, whether the candidate was a full-time student on its ITE campuses, or the product of the apprenticeship program, or simply taking courses in the adult education system at any of these locations.

But most of the ITE programs were intended for recent high school graduates who would come to one of the ITE campuses for a full-time program of training. These programs did not take the form of a European-style "sandwich" or "dual" program, combining on-the-job training with school-based teaching. Rather, the ITE adopted some features of the "factory model" pioneered in the EDB institutes, as well as created its own Authentic Learning Approach. Programs for hairdressers have working salons, young people training for work in retail train in a real coffee shop that has real customers. Auto mechanics train on new Mercedes and Nissan vehicles and on special cutaway engines provided by those firms, along with the specialized tools

the mechanics-in-training need to work on those cars. Draftsmen-in-training are using state-of-the-art CAD/CAM software and other computer-aided design software. Classroom instruction takes place in the same buildings in which these shops and workshops have a home, so the theoretical and the applied work are closely integrated.

The whole orientation to learning at ITE is heavily applied. The idea was to create an environment in which young people whose academic skills were not very strong could still flourish, an environment that would appeal to youngsters who are much more likely to learn by doing than by studying theory in a textbook. The ITE became one of the world's great laboratories for "experiential learning," a hands-on, sleeves-rolled-up approach to instruction. About 70 percent of the typical program core is taken up with practical training, the rest with theory.

The three new mega ITE colleges completed in 2005, 2010 and to be completed in 2013 under a 10-year Master Plan to upgrade vocational education share a common curricular core in the sense that there are some programs that are offered by all three campuses. But each also has additional programs offered uniquely. The system has a motto—"Hands-On, Minds-On, Hearts-On"—which is meant to convey the idea that it engages head and hand equally, but is about the whole person, which includes not just cognitive development and a very applied approach to the development of technical skills, but also addresses 21st century employability skills, such as motivation, personal and team effectiveness, independent thinking, flexibility, agility, a passion for vocation, confidence, cross-culturalism, and a sense of responsibility for the community.

About 85 percent of the curriculum is offered in the form of modules in career-related skills and 15 percent in life skills, which are mixed and matched to assemble complete programs. The ITE does this to make it easier for individuals to add additional modules as needed over time to adapt to changes in career direction, new technologies and new forms of work organization. Modularizing the curriculum in this way not only makes it easier for graduates to adjust as their career progresses, but also makes for a much more efficient institution. Employability skills are covered under a Life Skills module, mandatory for all students, that includes communication skills, teamwork, thinking and problem solving, sports and wellness, career development and planning and customer service. It takes up about 15 percent of the total curriculum time. The ITE aims to produce "thinking doers." It has developed a process-oriented pedagogic model for this purpose: the Plan, Explore, Practice and Perform Model. The idea is for the student to learn how to focus on a goal, gather the information required, practice what has been learned and then perform "with the competence, knowledge, skills and values he has mastered."

A story told by Chan Chin Bock in *Heart Work* captures nicely what I take to be the spirit of the times and the way the Singapore system fits together. It was the beginning of the 1980s. The EDB was working hard to bring leading global computer firms to Singapore. It had struck out with Wang and Digital Equipment Company—known to the world as DEC—and then went after Apple Computer. Apple was very interested in the Asian market, but it was very

skeptical about manufacturing in third-world countries. But it sent a top manufacturing engineer, John Sanders, to Singapore to take a look. Sanders, still skeptical, agreed to set up a small plant in Singapore to make motherboards to be sent abroad to assembly plants in developed countries. He first arrived in Singapore at 3:00 in the morning to be greeted planeside by the senior EDB official assigned to him. He never forgot that gesture or the service that followed. The company had designed the plant to be very unsophisticated, capable of being operated with the kind of relatively unskilled labor they expected to get, with automation to be slowly implemented over a period of years. The aim was just to get some production experience in Asia. Nonetheless, it was very important to Apple that the plant delivered on time, with high quality output.

Sanders was stunned by the speed with which the facility was built. His next surprise was the quality of construction and services. But the big surprise was the quality of the staff that EDB had trained and provisionally hired for him.

Apple had expected it to take nine months to ramp the plant up to the point at which it was ready to accept the components from California for assembly into motherboards. EDB had enabled him to get the job done in three months.

This experience with Singapore made Apple change its mind about producing in Asia. Instead of just assembling motherboards, the Singapore plant would be responsible for producing the entire Apple II computer. That meant, of course, that much higher manufacturing skills would be required and a much higher degree of automation. But this was what the EDB had hoped for from the beginning. This was their dream for Singapore. And it would enable Apple to save a lot of money, buying and making everything needed for the computer in Singapore rather than shipping it from Silicon Valley.

Over the next five years, Apple's Singapore plant became "the most modern and efficient PC plant in the Apple world. EDB-trained technicians not only ensured that the plant was productive; they introduced process innovations that were later adopted by other Apple computer manufacturing plants elsewhere in the world. To continuously upgrade its highly-skilled workforce, Apple encouraged its workers to sign up for evening classes at EDB's technology institutes. In addition, it also sent bright technicians to the polytechnics, as well as to its plants in the US. [Sanders] had come expecting a Third World operation but, in the end, he had a plant that any production engineer in the world would be proud of. Singapore went beyond just being a great plant itself; it introduced world-class manufacturing innovation to Apple plants elsewhere in the world. For many years, Apple's plant in Singapore became a model and eye-opener for executives of new companies considering investing in Singapore. They were all impressed, especially those from Japanese companies....It encouraged them in their own plans to design more automated plants for Singapore."

VET Development: Phase III – To Match the Creativity and Entrepreneurship Economic Development Strategy/Mid-1990s to the Present

The whole structure of the Singaporean VET system as it exists today had been put in place by the middle of the 90s. Since that time, within that structure, the institutions and their programs have, of course, continued to adapt to changing industrial needs as the Singaporean economy has continued to evolve.

Certain trends stand out. Just as Hong Kong had, over time, become the drive wheel for the whole Pearl River Basin South China economy, the Government was developing a plan to create what they called a “triangle” economy with Malaysia and Indonesia relating to Singapore in much the same way that Guangdong and the rest of the Pearl River Delta economy was relating to Hong Kong. Singapore became the financial center for the whole region, and manufacturers based in Singapore developed supply chains in Malaysia and Indonesia. Much of the relatively low skill work, especially manufacturing work, that used to be done in Singapore moved to the other triangle countries.

As this process evolved, the results were much the same as those in South China. The standard of living in Singapore continued to rise, but, at the same time, the standard of living in the two neighboring countries was rising, too, in tandem with Singapore, but at a lower level. For those countries to play that role well, however, they needed to do what Singapore had done many years before. They needed to greatly raise the education and skill level of their own populations. And Singapore was ready to help. Education and training has now been added to the list of major Singaporean export industries. The ITE and the polytechnics are working with countries in East Asia and Southeast Asia, including China, consulting with them to help them develop their training policies capacity, providing technical assistance as they redesign their systems, providing training for their people in Singapore and on-site in their countries. And more and more of the nationals in those countries are coming to Singapore for their education and training.

As this process I have just described continued to evolve and more and more of the lower-value added manufacturing work went offshore, where it could be done more cheaply, Singapore’s economy began to shift toward services, beginning with finance, but embracing many other kinds of services as well. And Singapore has turned into a major tourist destination, which entailed, among other things, building up its hospitality and gambling industries. Whereas Singapore’s vocational education system started out focused almost entirely on developing the skills needed to support an emerging and increasingly sophisticated manufacturing industry, manufacturing now constitutes a shrinking share of the jobs being trained for, and the focus of Singapore’s training work has shifted accordingly toward services. That is partly because the whole economy has grown, but also because some of Singapore’s manufacturing has been automated and some has been moved offshore to the other members of the “triangle.”

Although the institutional structure of Singapore's vocational and technical education system has remained remarkably stable over the last two decades, the institutions themselves have been adapting to evolving changes rapidly. We will look first at the polytechnics (through the lens of Ngee Ann Polytechnic) and then at ITE.

One of the most important drivers of the changes in the training system has been the Government's commitment to increase the creativity and innovative capacity of its workforce. Part of this has been accomplished by saturating Singapore education and training institutions with information technology (IT). In 2002, ITE launched its eStudent and eTutor systems, which have provided an interconnected personalized, interactive, multimedia, and collaborative learning environment, as well as an administrative support system that can be accessed from any point at any time of day or week. Twenty percent of the ITE curriculum, mostly the part consisting of the theory part of the curriculum, is delivered through the Web. This, of course, makes it available not just to those on campus but to those in the workplace and at home, anytime, anywhere.

But perhaps the best way to capture the nature of the system's approach to the development of the creativity and innovative capacity of its students is to describe the Innovation Modules offered by Ngee Ann Polytechnic's School of Interdisciplinary Studies. This family of modules go under the name of Idea Jumpstart, Idea Blueprint and Idea Launchpad. Idea Jumpstart is given to all year one students. They are offered a series of highly engaging activities which culminate, at the end of the module, in a full day session (the Jumpstart Challenge) in which they compete with others. The challenge is modeled after The Apprentice and Project Runway. Students are given eight hours to solve a real problem and pitch their proposals to the facilitator.

Students get Idea Blueprint and Idea Launchpad in sequence in their second year at Ngee Ann. They are taught to understand user needs, come up with ideas and concepts to address them, and put those ideas into action by creating a prototype of the product. They are encouraged to take risks and are given exercises that build their confidence.

Idea Blueprint gives them a chance to work in groups, exploiting each other's strengths and compensating for each others' weaknesses. After the Blueprint, of course, Idea Launchpad gives them an opportunity to turn the idea into a real product or service and try it out on customers and stakeholders.

Ngee Ann also offers <entrepreneurs-connect@np>, a center providing a wide range of support services for student entrepreneurs, connecting them with people in industry who can provide assistance, helping them to participate in international entrepreneurship competitions, getting funding for their ventures and mentoring them through the process. And then there is Ideawerkz, Ngee Ann's student innovation incubation center, which runs events designed to get students involved in innovative projects and provides them with funding as they get started.

But providing opportunities for students to develop their creative, innovative and entrepreneurial capacities is not the only way that Ngee Ann is adapting to a changing world. They pioneered the use of Mobile e-learning as an integral part of their instructional system as early as 1999. Their whole campus is covered by wireless and all students are required to own laptops, so that instructors can count on students being able to fully utilize a wide range of IT resources, including courseware.

The Government is convinced that Singapore will have a competitive edge to the extent that its students are at ease in a truly global world. So every student is required to participate in at least one overseas-based program before graduating. Thirty percent of the students have overseas assignments lasting between six weeks and six months. The rest last for five days. Every year, 1,000 students head for China for six weeks, focusing both on Chinese culture and their own discipline. Students have to pay for these experiences, but Ngee Ann has a fund that enables them to subsidize the expenses for students with limited resources.

Ngee Ann is no less interested in making sure that its students have experience in industry while they are in school. Every student has to do an internship of two to six months, usually in the third year of the program. Someone from the receiving company is assigned to each student. That person is responsible for grading the student during the work experience period. A supervisor of that person also has input into the grade. The firm is responsible for coming up with a clear plan for the internship, including defining a project the student must do, as well as the deliverable the student will be responsible for producing and the nature of the training the student will receive. The student must keep a journal of the whole experience.

Some of Ngee Ann's students come from the junior colleges with "A" levels, which could have gotten them into university. Most come from the secondary schools with relatively strong grades on their "O" levels. But some come from the ITE. These students came from the bottom quarter of their high school classes and therefore usually do not have as strong an academic record as those coming directly from the secondary schools. For these students, Ngee Ann has a suite of special courses designed to strengthen their skills in English and mathematics.

The students coming into Ngee Ann can be expected to have passed algebra, trigonometry and calculus in school before arriving at the polytechnic. The curriculum at Ngee Ann is both textbook-based and project-based. Final exams are paper and pencil, but teachers assign both small and large projects that are also graded and count in the final grade for the course. These are authentic projects, like a diagnostic device for a bio- medical company, a software application for a bank or a piece of market research for a commercial firm.

Ninety-three percent of Ngee Ann's graduates who look for jobs on graduating find them within three months. Almost 30 percent go on to university directly. More than 50 percent go on to university eventually.

We turn now to the ITE.

The reader will recall that we described the creation of the ITE in 1992 as a major turning point for VET in Singapore, the point at which the government made it abundantly clear to everyone that they would no longer regard the vestige of the old vocational system as a poor cousin, a dead end for the least able, but would instead elevate this part of the system to world-class status by making an enormous investment in university-style buildings and equipment, re-conceiving the technical curriculum to make it an important driver of the new Singaporean economy and re-conceiving the whole program of the institution to address all the needs of the young people it was primarily intended to serve, not just their need for technical skills.

Over the next fifteen years, those promises were more than kept. The transition to the new system was led by Dr. Law Song Seng, its principal architect and Director & CEO of VITB and ITE from 1981-February 2007), and the work continues under the leadership of Mr. Bruce Poh, who took over early in 2007. The choice of Poh is instructive. Poh was a key member of the team who left the EDB to plan the creation of Nanyang Polytechnic. He joined Nanyang's senior staff when it started, taking with him the experience he had gained at EDB, and welding together the development of high-tech industry and its needs with the provision of advanced technical education, to support some of the most sophisticated manufacturing industries in the world. Perhaps not least important, he took with him the idea of the factory school, which, as we have seen, was birthed at the EDB, nurtured at the EDB institutes, and then transferred to Nanyang Polytechnic to inform the development of its whole program. During his 15 years at Nanyang, Bruce Poh headed up one key function of the polytechnic after another, but one assignment, he said, was the high point of his career there: developing a new \$67 million Chemical Process Technology Training Center in Jurong Island. It was the first chemical process center in the world to be built solely for training purposes. It was a shining example of the idea of the factory school.

So Bruce Poh was brought in to further build an institution that was as far as it was possible to get from the first vocational schools in Singapore. The institution would still be responsible for training electricians and enrolled nurses. But it would also be responsible for training highly-sought after skilled professionals to meet high-value-added niche industry needs like biotech laboratory technicians, digital animators, digital media designers, games software engineers, marine offshore technicians, avionics technicians, performing arts technicians and a host of other people whose jobs did not exist until very recently. Far more important, by the time Bruce Poh took over, Singapore was no longer working hard to recruit the people who would lead its VET program from the world's leading centers of VET. It was itself on the verge of becoming one of the world's leading centers of VET, a goal that it has clearly accomplished under Bruce Poh.

When Bruce Poh took over, ITE had already begun consolidating its smaller campuses into new very modern, sophisticated post-secondary college campuses, and had completely revamped and upgraded the curriculum and services of the institution. The first of the new ITE mega

campuses was completed under the leadership of Dr. Law Song Seng. Under Bruce Poh's leadership, two more such mega campuses have been developed, so that all regions of Singapore can be served by ITE. But these institutions, though different from one another, with somewhat different program emphases, are not independent from each other. As the inevitable motto puts it, they constitute "One ITE System, Three Colleges." The first to be built in 2005 is called ITE College East. ITE College West opened in 2010 and ITE College Central will open in January 2013. The model of close industry partnership first pioneered by the EDB has continued unabated. ITE counts among its almost 100 industry partners global players like ABB, Cisco, Conrad Centennial, Hewlett Packard, IBM, Microsoft, Rolls Royce, Siemens, Singapore Airlines Engineering and Yokogawa.

Just as was the case in the original EDB institutes and then in the polytechnics that were modeled on them, ITE requires its staff to go back to industry for a relevant assignment for a minimum of three months. A new Total System Capability Scheme was put in place by Bruce Poh in 2007, targeting 85 percent of its faculty to remain up-to-date by demonstrating ability to "Do or Lead" in consultancy or industry projects. Those who don't do this cannot get promoted. About 100 (6 to 8 percent) go overseas for this purpose; the rest are trained locally.

ITE thinks of its development trajectory as consisting of four waves of transformation, through five-yearly roadmaps. In the first blueprint, ITE 2000 (1995-1999), ITE concentrated on developing the first class it aspired to, and building the infrastructure and systems it would need to develop further. The blueprint for this phase was a very ambitious 10-year physical development plan for ITE. ITE called its second phase (2000-2004) ITE Breakthrough, signifying the passage to world-class status, relying mainly on its global partnerships to get there. It was in this phase that ITE created and implemented its Key Competencies Model, addressing 1) Technical Competency (the technical skills and knowledge pertaining to the occupation being trained for), 2) Methodological Competency (the ability to learn and work independently, with capabilities to plan, solve problems and make decisions), and 3) Social Competency (the ability to co-operate with others, share responsibility and communicate effectively). It also created a new Curriculum and Pedagogic Model relating these three key competencies to the means for achieving them, and putting a plan in motion to create a rich IT environment to support the teaching and learning process, including especially the new eStudent Services System and the new eTutor system.

ITE named the third phase (2005-2009), ITE Advantage. It was in this period that the first mega-campus—ITE College East—was opened. By then, ITE was turning into a global force in VET. And the fourth phase (2010-2014)—the current phase as this paper is written—is called ITE Innovate. This, of course, parallels the efforts in the schools, the economic development agencies and the polytechnics to create the conditions under which Singapore will become known not just for its high competence, but its creativity and innovative capacity as well. As in the polytechnics, this drive for creativity and innovation is making itself felt in both the content and the processes of education and training at ITE.

The evidence suggests that these ambitious plans and the enormous investment made in their implementation have paid off. In 1997, an independent survey of Singaporeans found that only 34 percent viewed ITE favorably. That figure had shot up to 69 percent by 2010. In 1995, ITE was capturing 18 percent of the secondary school cohort. In 2010, one quarter of the cohort chose ITE as their post-secondary education option. In 1995, 60 percent graduated. By 2010, that was true of 83 percent. On average, 90 percent of its graduates received job offers within six months of graduating. ITE had doubled the number of full-time students enrolled between 1995 and 2006. Not least important, over the last several years, Singapore has registered some of the world's lowest youth unemployment rates. The government had succeeded in transforming the ugly duckling of its education system into an institution that many Singaporean youngsters were proud to go to, a place producing graduates who business wanted to hire.

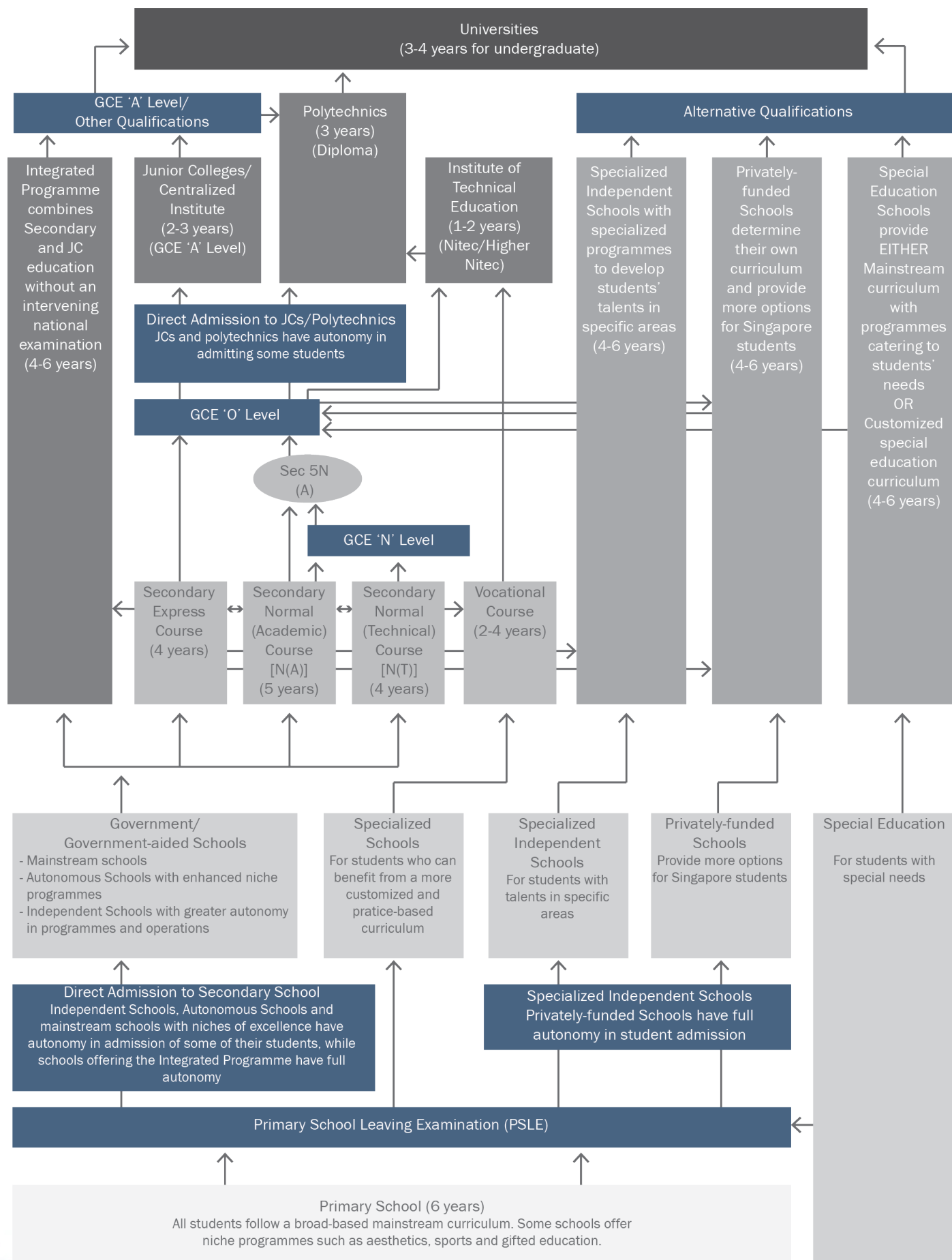
But Singapore had aimed even higher than that. It wanted a world-class VET system, a system that would be admired by the world's leading industrial powers. And it got that, too. By 2011, the Organization of Economic Cooperation and Development (OECD) was hailing it as "perhaps the best in the world." *The Economist* (2011) said that, in ITE, "Singapore has created yet another centre of excellence." The recognition of which ITE is most proud came from the United States. In September 2007, the Ash Center for Democratic Governance and Innovation at Harvard University's John F. Kennedy School of Government announced that ITE was the winner of the IBM Innovation Award in Transforming Government. ITE was recognized as a model program in improving Vocational and Technical Education. The panel for the worldwide competition found that ITE had "created profound impact on the social progress and economic growth of Singapore." And there was more. ITE had "created a highly sustainable model for transforming poorly-performing educational institutions worldwide."

In March of 2011, *The Economist* ran an article about Singapore. In it, the magazine noted that "ITE—originally dubbed 'It's the End' by ambitious middle-class parents— was the dark side of Singaporean education.... Since the 1990s, the government has worked hard to change ITE's image. It has not only spent a lot of money on new facilities and better teachers, but also put a great deal of thought into it.... This attention to detail has paid off. Most of [the new graduates] are snapped up quickly.... Singapore has created yet another centre of excellence."

VI. A Snapshot of the Whole System Today

On the following page, you will find a graphic depicting the flow of students from the Singaporean compulsory education system through the VET system. The chart shows the principal institutions providing education and training, the qualifications required to attend them and the qualifications they provide.

Singaporean children start their formal education at age six. They generally spend six years in primary school, then another four or five in secondary school. Then they sit, at the age of 16 or 17, for their General Certificate of Education (GCE) exams, after which they have three options (see the following chart for a graphic representation of the system).



The reader should bear in mind that the references to the Cambridge GCEs is not a reference to the standard GCEs offered by the University of Cambridge, but rather to customized GCEs that Singapore contracted with the University of Cambridge to produce to standards higher than the regular GCEs.

About 25 percent of the cohort leaving compulsory education enrolls in two-year junior colleges, the primary route to university in Singapore. About 40 percent will enroll in one of the five polytechnics (Singapore Polytechnic, Ngee Ann Polytechnic, Temasek Polytechnic, Nanyang Polytechnic and Republic Polytechnic). Another 25 percent will go to the ITE. Thus, a total of about 65 percent pursue some form of VET. But, within ten years of leaving ITE, about half of the graduates will go back to school, most of them to the polytechnics for a diploma. And a significant fraction of polytechnic graduates will go on to university, either right after they get their diploma or later on.

In the polytechnics, full-time students typically pursue a diploma, normally a three-year program of studies. In the ITE, students are seeking a Nitec (National ITE Certificate) qualification, a Higher Nitec qualification, a Master Nitec qualification or a diploma. The Nitec and Higher Nitec are regular two-year programs for full-time students. The newer Master Nitec is given to students with a regular Nitec plus three years of relevant work experience, roughly equivalent to Germany's Meister qualification, in a program that is run in collaboration with participating employers. There are three new Technical Diplomas offered by the ITE, one in Machine Technology in collaboration with the Ministry of Education, Youth and Sports, in Baden-Württemberg in Germany, another in Automotive Engineering in collaboration with the same German ministry and a third in Culinary Arts, offered in collaboration with the Institut Paul Bocuse of France. Most of these qualifications take two years to get.

This is a relentlessly meritocratic system. The options that are available to a student at any given point in his or her progression through the system are a function of how well that student has performed thus far in that progress. A student who is admitted to ITE or one of the polytechnics on the basis of their prior performance cannot choose any program they wish when they are admitted. Some programs within these institutions are much more difficult to get into than others.

The number of slots available in each sector is not a function of consumer demand, as in many other countries. The National Manpower Council, chaired by the Minister for Manpower, and including participants from many key government agencies, such as the Ministry of Education, the Ministry of Trade and Industry, the EDB, the Public Service Commission and others, analyzes and projects Singapore's manpower requirements into the future and serves as the arena in which all the relevant agencies will align their strategies to meet those projected needs. The allocation of slots to the various education and training institutions and to sectors within these institutions is a function of this process.

As of January 2013, there will be 102 programs in the ITE. The National Manpower Council has divided them into 11 sectors. The Council, through the Ministry, allocates slots to the sectors and ITE then decides how to allocate these sectoral slots to the programs. The process produces a kind of market within the education and training institutions in which highly desired slots can command a high price in terms of the qualifications required to qualify for entrance into a program. Thus the government does not tell anyone what occupation they can or must pursue. But the process aligns the number of slots available to train in any given occupation with the projections of the number of positions that will be available in that occupation, and it sets the level of qualification required to get training in that occupation. It is important to point out here that the government does not simply ask employers what they think they will need in the future. Singapore's government is trying to shape the pattern of that need by being able to offer highly-qualified candidates in areas in which it would like Singapore to have a strong industrial presence. Projected demand will have a role, but it will shape that demand with supply in order to provide Singapore as a whole with the best possible economic opportunities. In this way, the allocation of slots within the Singaporean education and training system is a vital part of Singapore's economic development system, and it plays a no less important role in that system than the provision of education and training itself.

Performance on exams is the basis for selection for three quarters of the ITE programs, with aptitude tests and interviews playing an additional role in the other quarter. That said, though, the government has worked hard over the years not simply to run a sorting system (too bad, you did not do well on your exams, so you're out), but to provide support for young people in school and for adults who have been in the workforce for many years to enable them to succeed (you don't seem to be doing too well, let's see if we can help you do better, much better). Recently, in this vein, the Ministry of Education created specialized schools for the least capable of the graduates who will come into the ITE, to give them extra help and attention for the four years of their secondary education, with additional resources and support intended to increase their chances of success in the ITE. Taken as a whole, ITE can be viewed as a very large effort to provide for the children in the bottom quarter of the distribution options that would give them the kind of support they needed to become strong contributors to the economy and proud members of their society. The way the government looked at it, these people needed the economic opportunity and the economy needed their participation. The same is true of the myriad forms of support available to adults in the workforce who want to go back to school to improve their basic literacy and technical skills, described above as the Basic Education for Skills Training (BEST), the Worker Improvement through Secondary Education (WISE) programs and the Workforce Skills Qualification (WSQ) System.

The strong insistence on meritocratic selection combined with an equally-strong determination to help everyone succeed at some level makes the system seem almost schizophrenic at times, at odds with itself. But it works in practice as a mechanism that continues to drive achievement up for every major group of Singaporean citizens.

We ended our visit to Singapore with a round table conversation with a group of Singaporean business executives.

They described Singapore as a great place to do business. They had strong words of praise for Singapore's government. "Singapore is number one for bright people who think ahead, plan and then orchestrate development. This is unique in Asia." The government, they said, has provided first-rate infrastructures of the kind business needs. "It's a well-oiled machine."

They said that even the mining industry is considering coming to Singapore, even though there is nothing to mine there. They will use it as a hub for buyers and sellers. "All the talent they need is there...." Global companies, they said "don't think of Singapore as a big market, but they come anyway for the talent and the tax benefits."

Singaporeans, they said, are "good at operating with discipline, rigor, depth and follow through." They have strong project management skills, they can multitask with efficiency and they work hard. "Today's university grads are top notch."

Creativity in the Singaporean workforce "was weak up until 10 years ago, compared to the West," they said. At that time, the Japanese were more creative. In design, Japan was ahead. But they reported that creativity is up now in Singapore. Drive is up in China. But in Singapore, they said, it is easier to find competent managers.

The talent they have access to in Singapore, they told us, is as high quality as any they can find anywhere else in the world.

The workforce development system in Singapore is not without challenges. Nearly 20 percent of the population are not citizens. Many are highly educated and very talented people from other countries who are assigned to Singapore by their companies or come to Singapore looking for professional work. But a substantial portion are people who come from China, India, Malaysia and Indonesia, people with very little education or skills looking for the low-wage work, or shift work, that Singaporeans no longer need or want to do. As in other parts of the world, this new underclass is growing and there is no way for them to improve their lot in this little country.

Many people worry that, as the middle class has grown in Singapore, and the people in that middle class learn how to make sure that their children are positioned to get the best that the society has to offer, there will be less and less mobility for those Singaporean citizens who are now at the bottom of the economic and social hierarchy.

Still others worry that Singapore has been remarkably successful at building an education and training system with very high average performance, but not enough peak performance, in global terms. These people wonder whether Singapore will ever produce Nobel-prize winners,

or others who have made truly remarkable contributions of that sort. In the same vein, they worry that Singapore has not yet produced any global companies or major new products.

Still in all, Singapore's accomplishments are themselves truly remarkable. By the testimony of the business executives with whom we talked, people in global firms with global brands whose job is to source the best people in the world for their firms, Singapore has accomplished what it set out to do all those years ago. It is producing world-class talent to meet the needs of every level and every sector of its now very diversified and very high-technology economy.

VII. What Can We Learn from the Singaporean VET System?

A fierce determination to match the performance of the best in the world while constantly learning from the best

The observer is repeatedly impressed by the relentless quality of the story of the Development of Singapore's VET System. Nothing was good enough until they got to the summit, the global benchmarks. In part, the system is as good as it is because the Singaporeans would not settle for less than being the best at what they do. And they got there in no small measure because they are also relentless benchmarkers. They drew heavily, for example, on Germany's Key Competencies Model and their apprenticeship model (the Dual System). Their curriculum development process for VET is adapted from the DACUM model from the United States. The United States was also an inspiration for the design of their health care simulation center and design thinking programs. The design of their diploma-level culinary arts program came from the Institut Paul Bocuse in France. The Singaporeans systematically look the world over for the best examples they can find anywhere of outstandingly successful policies and practices, and then they weave them together with their own ideas in a unique configuration that fits their own circumstances, values, and aims.

Good government

One of the most important reasons that Singapore was able to develop such a successful VET system was the quality of its government. They made smart decisions, one after another, for a long time, as I have repeatedly noted in this report. This is not an accident. As I mentioned above, its first Prime Minister, Lee Kuan Yew, decided early on that he could not succeed in his ambitious aims unless his government consisted of the best and brightest Singapore had to offer. He identified the most promising high school students, and sent them, at government expense, to the finest universities in the world if they promised to return to help run his government. The top ministers in that government today make about S\$2 million a year, which both provides a strong incentive to people who could be top corporate executives to stay in government and reduces the incentives for corruption. They are moved from ministry to ministry, as they ascend the ladder, which removes the postholes that are usually present in government and creates a team that shares a common vision and is able to work closely with one another, not for their ministry, but for Singapore.

Stability

The People's Action Party (PAP) is the only party that has ever held office in Singapore. I am certainly no advocate of one-party government, but there can be little doubt but what the government's ability to both lay and implement long-term plans is due in part to their confidence that they will be around to take credit for their accomplishments. We asked the head of Singapore's teacher union why he chose to work with the PAP instead of playing one party off against another. He said that he had no need to do that, that the door of the Prime Minister's office was always open to him and the ministers, knowing that, were generally eager to solicit his views and pay attention to them. The PAP now gets about 60 percent of the vote. As long as this government continues to avoid corruption and to be reasonably responsive to the needs of its people, it is likely to be around for a while, and the Singaporean people are likely to be able to enjoy the benefits of a government that has a long-term outlook in education and in other arenas.

Step-wise, aligned, coherent planning

The current Singaporean VET did not spring all at once from the head of Zeus. It proceeded in the stages described in this paper. At each stage, the system was coherent and aligned, aligned internally and aligned, very closely aligned, with the contemporary needs of the evolving Singaporean economy. Government did not try to make every major component of the system state-of-the-art at the same time, but instead, invested in cycles. In one five-year period, it might be the vocational education system, in another the compulsory system, in another the polytechnics and so on. But, at every stage, everyone was at the table that needed to be at the table to make sure the system was coherent, efficient and pointed in the right direction. That typically included the Ministry of Education, Ministry of Trade and Industry, Ministry of Manpower, the EDB and the WDA, the people responsible for setting manpower targets, the people responsible for setting qualification standards, for deciding on curriculum, for the quality of the system's human resources, for economic strategy and so on. This created a culture in government that, at one and the same time, provided for an unusual degree of coordination and, as we have seen, action at lightning speed.

A strong link to the national economic development strategy

Any VET program must be linked to national economic strategy to be successful. But Singapore is a textbook case for how to do it. First of all, they have, from day one, had a sound long-range strategy of which the human resources component has been a very important part and have laid detailed plans for achieving it. Because the most senior officials of government have been deeply involved in creating and revising the strategy, including the human resources components, they have provided strong support for the nation's VET program whenever it was needed. But that was also because the VET program delivered. It delivered in part because the policymakers and top managers for the VET program had been deeply involved in making the economic development strategy and knew what they had to do to deliver what the government needed. It was a two-way street. The primary links between economic development policy

and VET policy were formed by the EDB, the Ministry of Education, the Ministry of Trade and Industry, the Ministry of Manpower and other manpower development systems. Countries interested in learning from the Singaporean system for linking VET to economic development would do well to look at the roles played by these institutions in relation to one another as the system evolved over time.

A strong compulsory education system

A senior officer in the Danish government once told me that “you cannot build a world-class VET system on a bed of sand.” He meant, of course, that a VET system can be no better than the compulsory education system on which it is built. In this case, Singapore built a world-class compulsory education system, so the skills and knowledge of those in the lowest quarter of the graduates, the students entering the ITE, measured above the median of the skills in the whole OECD student population. This gave Singapore’s VET system a big leg up on success.

The idea of the “factory school”

Though the ideas that underlie the VET system in Singapore came from all over the world, this one came from Singapore. And it is a very powerful idea. Within the scope of one de-facto policy, it enables Singapore to train its workforce to truly state-of-the-art standards, to engage industry as a close partner in training, to enable students to train in an environment that is designed for training, but which, at the same time, is similar enough to the real thing to present challenges for the students very much like those they will face in the workplace. In many respects, it combines most of the advantages of a first-rate apprenticeship system with the advantages of a first-rate school-based VET system.

A strong link to business

Of course, the factory school model is itself based on and designed to foster close links between the VET system and business. But wherever one looks in the Singaporean VET system, it is clear that a great effort has been made to forge close links to business. The design of the apprenticeship system, the requirement for faculty members in the school-based system to work periodically in a firm in the same field in which that person teaches, the requirement for students to spend time working in firms, as well as the deep involvement of employers in advising the various VET institutions and programs and in setting occupational standards, in assessing candidates for diplomas, in providing state-of-the-art equipment for instruction and in advising on broad program direction all attest to the close ties with business that are a hallmark of Singapore’s VET program.

A determination to do what it would take to change the “brand” of VET in Singapore

All advanced industrial economies, in varying degrees, are challenged by the low status of VET relative to other forms of education and training that provide access to high status professional and managerial occupations requiring a baccalaureate or more advanced degrees. This may

be especially true in Asian countries, where one's educational credentials are more closely tied to social status than is typically true elsewhere. In Singapore, in particular, where vocational education was for a very long time viewed as a dumping ground, the effort that government made to “rebrand” vocational education as a valued and respected option was desperately needed and remarkably successful. This was the result of a very large investment of financial resources, but also of a very carefully planned and very well-executed rebranding campaign. Nations that have a similar problem would do well to study that campaign.

A combination of meritocracy and support

In the preceding section, I described Singapore as having a system that is fiercely meritocratic, while, at the same time, striving very hard to provide extra support to students of all ages to succeed, to make the fullest possible use of whatever talents they have. This is not just a slogan. It is a persistent feature of their system. It is the motive power of the ITE, which is, in many respects, the apple of the eye of the Singaporean VET system. Expecting a lot, even from the young people who have shown the least academic ability, and then relentlessly providing both the financial and non-financial help they need to live up to those expectations, may be the secret weapon of the Singaporean VET system.

A commitment to implementation

Anyone who spends time studying government in Singapore will come away impressed with the attention that the government pays not just to making the right policies, but to making sure that those policies are carefully and completely implemented. That observation holds for the VET system. The Singaporeans leave, it would seem, nothing to chance. They have systems for everything. They have plans and timetables for everything. They think the work is just beginning, not ending, when the policies are approved. The hard work, they believe, is turning policy into action. And they work very hard at it. Studying how they do this is important for anyone who hopes to match their results.

Bibliography and Acknowledgements

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A number of officials with whom we met prepared Power Point presentations on which I relied in preparing this report. Those Power Point presentations were prepared by :

Power point presentation from ITE-Sabrina Loi, Deputy Chief Executive Officer (Corporate), Institute of Technical Education. For ITE, inputs were also obtained from Mr. Bruce Poh, Director & Chief Executive Officer, Institute of Technical Education; Mr. Tan Seng Hua, Deputy Chief Executive Officer (Academic); and Dr. Yek Tiew Ming, Principal, ITE College West

This account drew heavily on three books, each of which is a good source for those who want more detail. They are:

Chan Chin Bock, lead author, Heart Work: Stories of How EDB Steered the Singapore Economy From 1961 Into the 21st Century (Singapore, Singapore Economic Development Board and EDB Society, 2002)

Fascinating stories that take the reader step-by-step, company by company, technology by technology, and training strategy by training strategy through the process by which the EDB lifted the country up by the bootstraps to its current status as a world-class economy.

Mickey Chiang, From Economic Debacle to Economic Miracle: The History and Development of Technical Education in Singapore (Singapore, Times Editions, 1998)

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Lee Sing Kong, Goh Chor Boon, Birger Fredriksen and Tan Jee Peng (editors), Toward a Better Future: Education and Training for Economic Development in Singapore since 1965 (Washington, DC, The International Bank for Reconstruction and Development and the World Bank, 2008)

Very good chapters, by key participants, on each of the major aspects of technical education in Singapore in recent years. Includes compulsory education and the university system as well.

In addition, the following articles and other resources proved valuable: “Case Study on Institute of Technical Education (ITE) Singapore,” Report Commissioned by Asia-Pacific Economic Cooperation (APEC), 2010

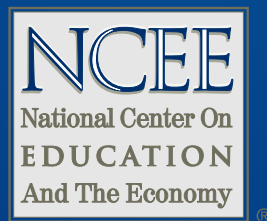
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The Center on International Education Benchmarking, a program from the National Center on Education and the Economy, conducts research on the world's most successful education systems. It offers access to information, analysis, and opinion on the education systems of the top-performing countries through its web portal.

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