

MANUFACTURING THE FUTURE WORKFORCE

VISIT REPORT: SINGAPORE 



In partnership with

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INTRODUCTION

STRUCTURE OF REPORT

Each meeting report summarises general discussions, additional observations and further background information provided by the hosts about their organisation and its involvement with wider vocational and professional education and training systems and Centres of Innovation.

Individual meeting reports also ‘highlight’ good practice and useful counsel captured during discussions then subsequently explored in delegate group de-briefs. These highlights are brought together using headings common with other visits in the closing section of this report to support further analysis and leading to recommended actions.

This document and its references are an appendix to the overall *Manufacturing the Future Workforce* report.

The full report is available to download at: hvm.catapult.org.uk/mtfw

VISIT ITINERARY 2ND TO 6TH JULY 2018

1. [Rolls-Royce](#) Aerospace Crescent
2. [A*STAR](#) Connexis, I Fusionopolis
3. [ARTC](#) Cleantech Two
4. [High Commission](#) 100 Tanglin Road
5. [SIMTech](#) Kinesis, 4 Fusionopolis
6. [PECOI](#) Innovis, 2 Fusionopolis
7. [Institute of Technical Education](#) 2 Ang Mo Kio Drive
8. [Singapore Polytechnic](#) 500 Dover Road
9. [SkillsFuture Singapore](#) 500 Dover Road

Delegates

Ian Collier – HVM Catapult *

Phil Cooper – TWI *

H K Park – Institute for Manufacturing (IfM)

Paul Rowlett – Advanced Manufacturing Training Centre (AMTC)

Daniel Sandford Smith – Gatsby Foundation

Paul Shakspeare – HVM Catapult *

Martyn Wright – TWI

(*Only delegates to attend High Commission)

MEETING REPORTS

ROLLS-ROYCE SOUTH EAST ASIA

2nd July 2018

1 Seletar Aerospace Crescent Singapore 797565

www.rolls-royce.com/country-sites/sea/our-locations/singapore.aspx

Hosts

Bicky Bhangu, President for South East Asia, Pacific and South Korea

Anne Benguerba, External Relations Manager

Background

One of five RR Regional Centres, Singapore work includes civil and defence aerospace, marine and power systems. Staffed by 2,500 people in Singapore and 3,500 in the wider region. RR is reshaping globally to include digital and electrification as well as thermal and mechanical competences. The March 2017 strategy is driving embedded generators and hybrid power systems. RR locally focus on Research & Technology, Manufacture, Assembly and Testing, MRO and Power (Land and Marine) – all increasingly digital. Regional presence is successful because of market base, good national governance (including IP protection) and technology alignment for manufacturing, electrical, materials and repair and computation. The regional supply chain is being developed to include a broader base of companies. 1/3 of global output of fan blade manufacturing is now from Singapore.

4,000 UK companies have a footprint in Singapore – attracted by access to government relations / support and revenue opportunities.

RR Discussion

RR SG work with 4 universities and 5 polytechnics to align skills outputs with their needs. (Nb. also work with ITE for Technicians). RR's largest UTC (research hub) is at Nanyang with 293 people. ARTC (set up on AXRC model – cf. AMRC at Sheffield University) bridges technology gaps, initially in maintenance and repair, now also manufacturing.

RR are heavily engaged with universities and polytechnics to provide input on what future skills are needed to deliver 'match ready recruits' and to support the right frameworks and funding.

8-month training programmes are run for engine assembly and test technicians – the initial batch of 500 were sent to UK with costs covered by Singapore Government (Nb. There is a continued presence of UK technicians). RR sought to reduce the overall duration by

improving college element but it remains at 8 months. The course is 10% classroom, 20% learning from others, 70% in the workplace and is EASA regulated.

View on different levels of Singapore training and education performance:

- Train technicians with SSG courses at colleges, provide industry attachments and internships; 90 interns 78% graduates, 4,00 training seats in regional training centre – Good
- Developing Engineers post graduate and career development – OK
- Leadership – Needs action

ARTC is focussed on areas that matter for RR: Linking manufacturing to MRO and sharing technology and integrating the 'technology signal', hence technology push comes from ARTC activities. ARTC may develop industrial leadership academy to extend this support.

Emerging Comments on Singapore Workforce Development Ecosystem

- National population of 7m, 2/3 Singapore to 1/3 International workforce ratio is maintained and increasingly accesses Asian regional talent.
- Tripartism in Singapore with Ministries of Trade (EDB), Manpower (NTUC), Education (SSG) all aligned to deliver the national plan.
- Singapore success is seen to be based on the talents and efforts of individuals – the 'human capital'. Hence investment in up-skilling and re-skilling for workers who will become displaced by leading demand and funding the skills of the future workforce.
- Maintain High Value Manufacturing at 20% of economy.
- Singapore has deep conversations about 'where we need to get to and how do we get there' (unlike UK) and is much easier to navigate with more ministerial conversation with Industry about delivery of industrial strategies. EDB's mid-term thinking is 30yrs – S\$4.5bn 5-year Industrial Transformation Map plan for engineering and manufacturing.
- Singapore technical workforce development is more focussed at Polytechnics than Universities and is working to ensure that vocational and technological routes are attractive. Government recognise the need for workforce development and de-risks upfront investment with up to 90% of cost of learning from SMES paid for through SSG.
- Cultural drive for personal development contrasts with UK, i.e. 10 years in same job compared with 2 years in Singapore – UK pride in consistency compared to SG ambition to improve prospects.
- National service of 2 years for men interrupts flow into workforce after technical education and causes problems.
- The strong didactic education approach constrains innovation (PhD students as examples). This may need to the curriculum to be revised to enable greater innovation.

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- Singapore is experiencing the social paradox of industrially useful Polytechnic 'outcomes' (ready for work) compared with socially advantageous university 'outputs' (qualifications) unrelated to local economic needs.
 - Singapore looking at UK apprenticeship programme which is seen as strong.

Rolls-Royce Highlights

- RR IP remains in UK, with manufacturing now moving close to customer base with process innovation emerging locally – but continuing need for UK founded shop-floor skills that align with ongoing technology and methods.
- Ability to influence technology funding may be greater than achievement of workforce change in the mid to short term.
- (The visit did not include R&T activities.)

A*STAR – AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH

3rd July 2018

Connexis North Tower 1 Fusionopolis Way, Singapore 138632

www.a-star.edu.sg

Hosts

Tan Ying Kiat, Director (Science and Engineering Research Council)

Daniel Kuek, Deputy Director (Industry Development Group)

Dr Benny Chew, Assistant Head (Science and Engineering Research Council)

Background

2017 Singapore GDP S\$447bn, 3.6% growth, 5.6m people (3.9m residents), 19% Manufacturing.

The 2016 to 2020 period has a national Research Innovation Enterprise (RIE) investment of S\$19bn and includes S\$4.5bn in the Advanced Manufacturing and Engineering domain. Recent Industry Transformation Maps (ITM) cover R&D, Product / Supply Chain and Internationalisation. A mid-term review with international experts is introducing more competitive basis of funding in future and will allow Universities to apply.

A*STAR fund 21 independent research Institutes which employ a total of 5,800 (38% international) with some 4,100 scientists and engineers. It generates 2,800 papers, 200 licenses, >270 patents and >1,700 projects per year and on average one scientist or engineer leaves to enter industry each day. 55% of work is with multinational companies (MNC), 7% with local, large enterprises (LLE), 38% with SMEs.

The A*STAR Graduate Academy funds scholarships, overseas and internal – all are expected to work for a number of years in Singapore to build up the scientific talent pool for the nation. Companies also sponsor but are largely subsidised by EDB (Economic Development Bank).

A*STAR Discussion

The Institutes don't generally focus on knowledge transfer activities in the sense of training, except those involved in advanced manufacturing – SIMTech and now ARTC. Some ITMs have workforce elements but at varying depths. RIE money to A*STAR is not for workforce development but more bite-sized and hands on knowledge transfer as necessary. A*STAR sits on many faculty panels to advise others about curriculum needs.

ARTC operates on a consortia and controlled IP model attractive to MNCs. In contrast to SIMTech which retains and promotes IP for wider use that favours SMEs.

A proposed Advanced Manufacturing Training Academy (AMTA) will provide graduate level up-skilling for people in the workforce, initially as a first point of contact to direct and advise. Aimed at practitioners and conversion, delivery might combine Nanyang Technical University for theory (and others), AMTA directly for organisational and supplementary management subjects and ARTC with supporting technical specialists. Delivery to be approved by SSG to secure funding and will operate under independent governance once agreed. (Related to David Low and Peter Tan recent visit to UK.)

Currently SIMTech is one of many training providers to SSG which provides a route to state funding for individuals and industry. Training is a significant revenue stream but can lead to conflict with education institutions. Institutes working with large companies understand workforce needs more clearly.

Emerging Comments on Singapore Workforce Development Ecosystem

- Ministry of Trade and Industry operates through 3 departments, each with funding powers: A*STAR – Research and Innovation, EDB – Anchoring FDI, Enterprise Singapore – Growing local enterprises – SME focus.
- driving trends: Disruption due to advanced manufacturing and I4.0 and retraining requirement as sectors move from old economy to new.
- Large number of SMEs needing to invest in workforce development.
- SSG (SkillsFuture Singapore) has now moved from Ministry of Labour Workforce Development Agency to Department of Education, operates at all levels and roles, hence universal source for upskilling.
- WSG (Workforce Singapore) remains in Ministry of Labour to fund displaced workers and conversion programmes.
- Mostly low level of skills shortage. Pockets include Digital and AI.
- Industrial attachments now becoming a standard part of the last year(s) of courses with industry engaged and mentoring students.
- PACE / NTU looking at ‘stackable modules’ within SSG framework leading to formal vocational qualifications at higher levels.
- German apprenticeship dual model seen as best in class.

A*STAR Highlights

- 350 trained and experience scientist / engineers annually move into industry (8.5% of total staff group).
- Industrial Transformation Maps (ITMs) are defined and funded on ‘total capability’ basis – including workforce requirements.

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- The move towards competitive research and development funding will bring Universities into competition with Institutes such as SimTech.
 - Strategic workforce focus is on conversion / upskilling with SkillsFuture Singapore adopting a modular philosophy within the Ministry of Education (previously Labour).
 - Driving trends: Disruption due to advanced manufacturing and I4.0 and retraining requirement as sectors move from old economy to new.

ARTC – ADVANCED REMANUFACTURING TECHNOLOGY CENTRE

3rd July 2018

3 Cleantech Loop #01-01, CleanTech Two (S) 637143

www.a-star.edu.sg/artc/About-ARTC/Overview

Hosts

David Low, CEO

Bertil Brandin, Strategic Development Director

Alastair Scott Johnson, Deputy Director, Industry Partnerships, Business Development

Murali Das, Deputy Programme Manager (Smart Manufacturing)

Background

ARTC is constituted as a consortia and public / private partnership with 61 members carrying out work at TRLS 4-6 in sectors including aerospace, heavy machinery and consumer goods. T1 membership costs S\$400k per year with 50% spent on collaborative projects, T2 costs S\$75k, T3 costs S\$30k – all spent on collaborative work. Anchor Members have veto over membership.

Technology focus is on remanufacturing, surface enhancement, robotic applications, product verification, manufacturing industrialisation, smart manufacture.

211 staff, including 56 Interns.

ARTC Discussion

A \$20m Factory of the Future (gearbox line) has been installed to show the themes associated with I4.0 and is intended to accelerate adoption, provide a training ground, share best practice and foster industry and HE alignment. Working in partnership with McKinsey (useful to persuade senior management), the system is networked into other Institutes globally.

Not yet using Digital Twins for training since data is unidirectional at present but do see it coming. A McKinsey factory in a box (lemonade line) is used for awareness raising (McKinsey also running digital transformation workshops).

ARTC have recently started to develop courses under SSG approval (and funding to 70% of cost for SMEs) in the Advanced Manufacturing Series for: robotised polishing, Factory in a Box, manufacturing leadership, additive manufacturing.

Training needs integration with research activities to promote emerging knowledge and to provide projects for trainees (real problem-based learning) as well as promoting 'digital confidence' and talent readiness. The ARTC training approach is to deliver courses at ARTC and satellites; form partnerships with education to boost continuous learning and implement work study programmes; develop curriculum and pedagogy; and provide facilities for hands on learning.

Emerging Comments on Singapore Workforce Development Ecosystem

- Nanyang has Fraunhofer connection.
- SIMTech seen as very focussed on precision engineering.
- ARTC Roadmapping process for the Technology plan includes workforce development.

ARTC Highlights

- Limited training course delivery ambition within ARTC, focus is on establishing a new adjacent facility
- 20% of staff are interns.
- McKinsey model factory in a box site and a substantial Factory of the Future (Learning Factory) with a major role in workforce development.

HIGH COMMISSION

3rd July 2018

100 Tanglin Road, Singapore 247919

www.gov.uk/world/singapore

Hosts

Scott Wightman, British High Commissioner to Singapore

Christopher Pook, Director for International Trade, Investment and Prosperity, SE Asia

Hanbin Zheng, Science and Innovation Officer

Background

The meeting was arranged at short notice by Bicky Banghu (RR).

In summary, there was an element of 'reporting-in', with interest about the intent of the study in connection with role of Catapults.

Some UK universities – Coventry – have opened specialist research activities in Singapore.

High Commission Highlights

- Singapore interest in UK Apprentice model.
- Strength of residual UK Professional Body reputation and value (Law, Accounting, etc.).
- Caution about comparative level of SG / UK funds.

SIMTECH – SINGAPORE INSTITUTE OF MANUFACTURING TECHNOLOGY

4th July 2018

Kinesis Tower, 4 Fusionopolis Way, Singapore 138634

www.a-star.edu.sg/simtech

Hosts

Dr Lim Ser Yong Executive Director

Dr Zeng Xianting, Knowledge Transfer Office

Dr Ng Huey Yuen, Manufacturing Operations Management

Background

SIMTech has a total staff of around 460 with 89% scientists and engineers, in addition there are 62 Doctorates, 39 Masters and 60 Bachelors students in training from national and international Universities as well as a number of visiting fellows. SIMTech supported 590 SMEs, 100 MNCs, 30 LLEs in 840 projects in 2017. There a believed to be some 9,000 SMEs in SG manufacturing sector, with a growing recognition of the importance of workforce skills.

4 Research areas cover: discrete manufacturing processes, automation, systems and emerging applications. Each is run as an independent department with separate teams. These are fronted by 4 Innovation Centres to provide market interface (pull) and link into research areas for projects: manufacturing productivity technology centre; precision engineering (backbone of singapore's national engineering capability), sustainable management and emerging technologies.

SIMTech Offers:

- Industry assistance – project collaboration, facilities and expertise
- Knowledge transfer with a strong case study base for training, all projects include capturing and transmitting knowledge to deliver impacts of projects directly in industry
- Technology transfer – SIMTech controls IP (not consortium as ARTC) through licensing and negotiated risk sharing in start-ups
- Manpower sharing and transfer – companies borrow staff using the T-Up scheme (70% funded for SME) or as direct 'Externships', often results in recruitment leading to 10% staff turnover in SIMTech
- SIMTech trains and issues manufacturing R&D diploma certificates for future SIMTech and industry employees
- Industry intelligence – through membership, forums and international workshops (Industry Intelligence Unit)

Funding (SIMTech receives more funding than other A*STAR Institutes since it operates closer to industry)

- Core funding from Government
- Competitive from Government - 5yr block RIE fund - 4 domains (with A*STAR managing one of the four)
- Industrial funding
- Training funding indirectly from trainees funded by SSG

SIMTech Discussion

Human capital purpose:

Knowledge Creation – core to SIMTech business

Knowledge Transfer: demand driven, knowledge intensive, technology focussed, supported by case studies, hands-on practice in State-of-the-Art facilities, Evening classes, SSG partnership

Knowledge Use: On-site support – guidance and mentoring, problem-based learning and projects

Analogy of climbing Everest to publish a scientific paper or report which is only useful if you can get back down safely to deploy knowledge in industry.

SIMTech staff need 3 to 5 years' experience before teaching to post-employment groups which is more challenging than for young people. Each takes a Teaching Diploma of 1 year, 5 modules of 40 hours to secure SSG accreditation for training delivery (and funding for industry).

SIMTech delivered courses have degree or diploma learning pre-requisite for delegates and are aimed at Engineers/Professionals. Training Model: Learn – Practice – Implement to secure sound learning and value transfer to industry – same SIMTech scientist or engineer completes all stages. (Instruction = breadth of knowledge, Problem base = depth of understanding.)

The growth of the University Sector and entry into competitive development funding projects was noted.

Singapore is seeking to avoid South Korean problem where 90% of the age cohort take degrees leading to under-employment in the workforce – reflection of parental aspiration. Foreign universities are setting up in Singapore as well other 'commercial' training providers – but are poorly organized and controlled.

SIMTech has training delivery capacity constraints, hence needs partners in the educational space – polytechnics and universities – to leverage capacity especially for post-employment training. SSG is seeking partnership with Polytechnics to mitigate constraints with

discussions ongoing to establish Training Extension Partnerships. Many SimTech courses are delivered as part-time, evening classes.

SIMTech has delivered Professional Management and Executive Training (PMET) since 2008. 548 graduates in 2017, 60% SMEs, 49 Full Diplomas and is in partnership with WMG (Warwick University) for a joint Masters Programme with Singapore Institute of Management. This has 40 students in engineering management and supply chain / logistics, ongoing although not publicly funded.

OMNI is a business productivity and competitiveness programme to aid companies to prepare for the future before taking on new technologies and combines guided mentoring from industry retirees and problem-based learning 'teaching how to fish' so new skills and culture lead technology change.

The demand for training and knowledge transfer emerges from relationships with SMEs, government bodies. SME leaders concerned by loss of people after training, however 'bonding' of employees is not common outside of Government appointments. There is considerable value to SIMTech from the network of Alumni feeding back intelligence.

The SIMTech Knowledge Transfer Officer checks / assures all courses / activity for quality and to avoid duplication with Universities' and Polytechnics' courses. SIMTech courses are industrially focused and delivered, resulting in a diploma accredited by SkillsFuture or Workforce Singapore. These are not directly associated with academic awards but do attract funding at varied levels with strong SME bias. Encouragement and mandating of more on-line content are anticipated.

SIMTech remit is end to end innovation projects with knowledge transfer and training implicit. Courses are founded on technology development and are de-sensitised to meet IP challenges

Emerging Comments on Singapore Workforce Development Ecosystem

- The single Workforce Development Agency within Ministry of Manpower (for post-employment learning) & Department of Education (for pre-employment) has now been re-structured with SkillsFuture Singapore (SSG) moved to Education, Workforce Singapore (WSG) remains in Manpower.
- WSQ (Workforce Qualifications) is being redefined by SSG (who also accredit training for skills-based qualifications that Graduate students would use to increase their qualification) with Standards available across all occupations.
- CET – Continuous Education and Training combines SSG funded courses, PCP – Professional Conversion Programmes and may include WSG funding salary as well.
- SSG new initiative of the 'SF Advanced Manufacturing Series' has a digital focus – Robotics in Industry, Industry 4.0 and Digital Manufacturing and Automation using the

digital model factory for immersive learning leading to digital transformation and innovative methods. SIMTech model factory is close to being linked with others in Germany and USA.

- Importance and roles of the three separate Ministries: Manpower, Education, Trade & Industry.
- Post-employment training is less well organised with growing range of 'un-controlled' providers.
- A relatively recent international review panel recommended that Universities take a bigger role in post-employment training (inc VC of Cambridge).
- Technician shortage responded to by international short term workers.
- Declining birthrates and reducing interest in engineering and manufacturing reflected in declining cohorts.

SimTech Highlights

- 26% of SIMTech staff are in-learning, many go on to work in industry, there is more than 10% turnover of employed staff.
- Knowledge capture, transfer and training are baked into development processes – with the same people working on projects end to end.
- Contrast of SIMTech and ARTC IP models and potential impact on knowledge transfer and training
- Partnership and competition with Institutes and Polytechnics.
- OMNI improvement programmes relate to SIG/NMCL etc.
- Funding routes for training courses driven by SSG accreditation and leadership.
- Focus on modular pre and post-employment delivery
- Digital Learning Factory includes supply chain and is open for schools

PECOI – PRECISION ENGINEERING CENTRE OF INNOVATION (PART OF SIMTECH)

4th July 2018

Innovis, 2 Fusionopolis Way, #08-04, Innovis, Singapore 138634

www.a-star.edu.sg/simtech-pecoi

Hosts

Dr John Yong, Director Industry Development Office

Tan Chee Tat, Deputy Director, Industry Development Office

Background

The PECOI mission is to sustain and advance Singapore's precision engineering industry (which underpins a significant proportion of the manufacturing sector) by showcasing and promoting processes, products, materials and innovation. It is now some 10 years old with core funding having ceased in 2016 and is now self-sustaining (no mechanism discussed but includes capability development grants).

As part of SIMTech, it has access to technology development, knowledge transfer and training resources. There is a growing reservoir of IP that is made available to industry (IP generated by staff on secondment generally remains with recipient company). PECOI have access to expert consultants who mentor and advise SMEs and lead to business and technology development projects. This group of experienced industrialists and academics also support SIMTech researchers and assist with course development and delivery.

PECOI Discussion

John Yong has recently changed roles and has responsibility for delivery of Manufacturing ITMs and the growth of new capability across related supply chains and workforce. This involves working collaboratively to identify opportunities within the national strategy and to work with companies already in the sector to outsource current products locally so they can take on higher value work to the overall benefit of the economy.

Example of oil & gas drill head supply chain capability needing complex gun-drilling for sensor placement to meet Halliburton needs This should bring high value work to Singapore directly and in addition provide technology transfer for extended supply chain capability development (resulting from publicly held IP) to create a market with other primes. Supply push translating to demand pull.

Process:

- Identify growth sector (international intelligence, discussions with primes)

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- Form task force drawn from SIMTech, supply chains, users and Government (EDB, SSG, etc)
 - Establish supply chain capability gaps including workforce skills, through value mapping
 - Set up collaborative and overseen programmes - demand drivers/suppliers/technology and knowledge providers/educational institutions

In some cases, early production can take place within SIMTech and other public facilities. This also enables new skills to be developed, both factors reduce risk to supply chain take-up.

Use an extended 'T-Map' (Developed by IfM) to produce a delivery planning tool that supports collaborative work. This includes workforce activities which because of clarity of dependencies and lead times, appear as early actions. This was not a requirement of the process but is a consequence of thorough analysis.

Additive Manufacturing

Well developed in Singapore with a view that the machine makers are the only ones making significant money so far and are providing much of the training input to date. Market gap has been identified as certification for marine, medical and precision engineering (inc. aero), hence emphasis on leading the development of standards (JY Chairs group) which in turn will feed into curriculum and workforce programmes.

NTU currently has a budget of S\$100m and 100 professors working on AM. Singapore aims to remain second to China in the technology.

Emerging Comments on Singapore Workforce Development Ecosystem

- Role of Engineers in detail economic planning and programme delivery.
- High levels of intelligence gathering before action – EDB.
- Move away from innovation being used to sustain current industrial base towards disruptive innovation leading to new and high value markets.
- Many disruptive technologies seem to avoid workforce and asset constraints due to I4.0 potential, conversely a high level of supply chain integration is necessary with the right skills in place early.
- MNCs relate to EDB, SMEs relate to ESG.
- The extended T-Map process provides 'evidence' through voting mechanism of early industry demand for workforce development action and investment.
- Although detailed capability plans originate within sectors, workforce outcomes are cross-sector and technology based which further grows market opportunities.

PECOI Highlights

- Access and routing of publicly held IP enables new-to-us innovation.
- Importance of credible, engineering leadership at detail level.
- ‘Total Innovation Capability’, inclusive and collaborative planning and delivery leads to early, evidenced workforce demand.
- Market intelligence is a pre-requisite for action.
- Use of external expertise – not local academics?
- Current, cross-sector workforce focus.
- Government is in the plan, not set apart.

ITE – INSTITUTE OF TECHNICAL EDUCATION

5th July 2018

ITE College Central, 2 Ang Mo Kio Drive, Singapore 567720

www.ite.edu.sg/wps/portal/aboutite/

Hosts

Suresh Natarjan, Deputy Principal, Academic

Dr Lim See Yew, Senior Director, School of Engineering

Background

ITE is a single organisation working on three sites, each providing core subjects (inc manufacturing) with further specialist faculties at each. Founded on 'Hands, Hearts, Mind' model (Reflects German approach) with 30% theory and 70% practical learning. 22% of the national population cohort attends ITE for pre-employment learning (some 29,000) with a similar volume of post-employment learners for continued education and training, all served by 2,600 staff. Very significant investment in ITE Central is evident in the facilities, equipment and surroundings which appear 'University' standard. Measures of ITE brand equity have risen to 72% in 2016 from base levels in 1992 of 35%.

Technical and Vocational Education and Training has been critical for social mobility in Singapore and is now essential to exploit increasing technological opportunities. ITE's 'Trailblazer' plans are aligned to the SkillsFuture Singapore strategy to produce work ready young people who meet industry needs and who continue to learn throughout their working life.

There are 'ladders and bridges' within the College / Polytechnic / University system, where the top 20% of ITE output goes on to Polytechnic not directly to employment and the top 10% of Polytechnic output progress straight to University. (In recognition that 'the lights go on later' for some.)

The National Manpower Council (comprising Ministries of Labour, Education and Industry) review and establish annual recruitment and funding targets by broad discipline for all state education providers, ITE develops detail plans by specialism in consultation with industry councils, Skillsfuture and others. ITE offers 98 courses in 11 sectors working with 8 industry councils (which endorse curriculum) leading to certificate level awards in most cases. Community projects are built into student programmes.

ITE has 23 international VET partners (e.g. Paul Bocaud for cookery, but none in the UK) and delivers a German Diploma in Automotive Technology using an Apprentice model which has yet to fully develop the workplace learning element. Facilities reflect industry needs and standards with similar equipment available for training (machine tools, aircraft, etc.). Courses

are continually reviewed to ensure students meet future needs and so that planned changes to the technology base can be rapidly taken into account by introducing new electives into current courses prior to periodic updates. Post-employment learners take courses based on the same content as pre-employment students. SkillsFuture has an important role in promoting future content, awarding certificates of competence for the new series courses which are filling current gaps – many digital.

Fees are due directly from students for ITE provision but 45% are on financial aid – many more paying less than 10% of the costs. Success rates are 85% (cf. 90% in University), employment outcomes are 90% and training related placements have risen to 60%. Teaching staff come from industry with at least 3 years' experience and are employed as Civil Servants (not a way to get rich but fulfilling).

Some 75% of students undertake a mandatory internship on completion of their college course. However, whilst actively supported by both college and employer, there is little formal assessment of the work-based learning during the placement. 100% of courses are planned to include internships by 2020.

ITE Discussion

ITE Central impresses with significant investment in architecture, facilities and equipment which would be notable even in a high-level university elsewhere. Equally impressive was the strong clarity and leadership in the development of forward-looking training using digital tools to equip the technician workforce to thrive in the context of Industry 4.0. This was planned to be achieved bottom up for small companies by equipping student with the necessary skills and culture to instigate change as opportunities arise.

Little sharing of course content beyond ITE, some sharing of equipment with Polytechnics and Universities. The development of I4.0 content is in parallel with the other learning factory examples was reported.

Emerging Comments on Singapore Workforce Development Ecosystem

SkillsFuture has a key role in re-balancing education outcomes towards ITE and the Polytechnics. Currently 35% go to University – up from 6% 30 years ago – with emerging under-employment of graduates.

Layered employment outcomes:

- ITE / College – Shop Floor
- Polytechnic – Superviso
- University – Engineer

ITE Highlights

- Dr Lim leadership of Technician-based digital change – culture and skills.
- Disproportionate investment in FE institution to aid re-balancing of workforce.
- Dual pre and post-employment training delivery using Skillsfuture approved modular courses.
- Parallel, not dependent generation of I4.0 learning approaches.
- ITE takes all of cohort – no competition for students or dilution of investment.
- No UK names amongst 23 international partners.

SINGAPORE POLYTECHNIC

5th July 2018

500 Dover Road Singapore 139651

www.sp.edu.sg

Hosts

Yew Chiong Loh, Senior Director, Engineering

Helene Leong-Wee Kwee Huay, Director

David Chai, Centre Director, Technology Development Centre

Background

Founded in 1954, three out of ten SP schools are engineering based with the largest overall cohort of 14,300 full time Diploma students, 2,100 part time students on new Continuing Education and Training (CET) programmes. 820 academic staff. 'A Poly for all the ages', 'Life, work and world-ready' with skills mastery, SP is ramping up post-employment re-skilling offers.

Teaching is delivered using Learn, Practice, Implement model with real problems as part of the curriculum.

Singapore Polytechnic Discussion

SP states that it is educating students for a new digital reality with both changing domain and digital layers equally important and requiring changed mindsets, skillsets and behaviours (know/do/be). Pedagogy formed around 'Conceive Design Implement Operate' – originally from MIT and now 100+ partners worldwide (Helene leads developments)

It is important to recognise that smaller companies probably need to go through the stages of the digital journey, i.e. from I2.0 to I3.0 to I4.0, using problem solving steps. SP is partnering with major system suppliers to 'co-qualify' students on specific platforms (but not equipment).

Post-employment courses are offered under the SkillsFuture Extended Learning Programme (ELP) which may follow straight after a more generic diploma qualification, and the Workforce Singapore's Professional Conversion Programme (PCP) for in-career change of direction to reflect re-skilling needs due to strategy and technology updates. Some courses may provide credits against future awards through a recognition of prior learning route.

SP see significant growth in the adoption of digital learning methods – learning factories and on-line content. Example of process supervisor training to Diploma level for Shell founded on

a digital factory built with industry standard control systems to provide simulated scenarios for instruction and problem solving (using SP's previous expertise in marine simulation to assist staff to develop new learning methods). This course is accredited by the UK Institute of Chemical Engineers to EngTech.

SP is working on the co-development of the robotic polishing course with ARTC, both will identify customers.

SP lecturers are from drawn from industry and undertake teaching certification to a standard common across the five Polytechnics, including industry attachments building on a passion and vocation to teach. The changes to digital technologies and learning tools places fresh demands on staff and emphasises the need to develop appropriate pedagogies that can reform learning and make it transportable beyond the region.

Emerging Comments on Singapore Workforce Development Ecosystem

The five Polytechnics are working together with Ministry pressure for them to collaborate, on Polymall a digital learning environment (built on Blackboard) containing shared resources. There are also further discussions ongoing with ITE about the use of AR/VR and the sharing of resources and solutions. Polymall is designed to support self-directed lifelong learning and is anticipated to increase overall delivery capacity for continuing education.

Singapore Polytechnic Highlights

- Polymall shared content development and on-line use.
- Significant work on Pedagogy appropriate for greater digital content and delivery methods.
- Seeking of international connections to support changes to delivery models.
- Embracing of post-employment delivery.
- Respect for UK professional society accreditation and recognition.

SKILLSFUTURE SINGAPORE

5th July 2018

c/o Singapore Polytechnic

<https://www.ssg-wsg.gov.sg/>

Hosts

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Background

'SkillsFuture is a national movement to provide Singaporeans with the opportunities to develop their fullest potential throughout life, regardless of their starting points. Through this movement, the skills, passion and contributions of every individual will drive Singapore's next phase of development towards an advanced economy and inclusive society.

No matter where you are in life – schooling years, early career, mid-career or silver years – you will find a variety of resources to help you attain mastery of skills. Skills mastery is more than having the right paper qualifications and being good at what you do currently; it is a mindset of continually striving towards greater excellence through knowledge, application and experience.'

SSG is a statutory board under the Ministry of Education and coordinates the implementation of the national SkillsFuture movement, promotes a culture and holistic system of lifelong learning through the pursuit of skills mastery, and strengthens the ecosystem of quality education and training in Singapore.

Together with educational institutions and training partners, SSG will ensure that students and working adults have access to high quality, industry-relevant training throughout their lives. SSG will also bring together synergies in continuing education and training (CET) and pre-employment training (PET), so skills requirements will continue to meet the demands of different sectors of the economy.

SSG works closely with Workforce Skills Qualifications (WSQ) to build the skills of the workforce to enable it to be future ready. It also highlights the importance of skills in building one's own future.

Singapore Workforce Skills Qualifications (WSQ) is a national credential system that trains, develops, assesses and certifies skills and competencies for the workforce. Training programmes developed under the WSQ system are based on skills and competencies validated by employers, unions and professional bodies. This process ensures existing and

emerging skills and competencies that are in demand are used to inform training and development under WSQ.

SkillsFuture Singapore believes in making WSQ practical and flexible to help Singapore's workforce adapt, grow and develop. WSQ does this by offering bite-sized training modules to enable learning at the individual's own pace.

Skillsfuture Singapore Discussion

SSG have a role in the delivery of the ITMs through planning and delivering skills programmes to meet future needs, many of which have a shared digital theme. Their sister organisation, Workforce Singapore fund skills transformation and job placements to re-position workers from old to new technology industries. Skillsfuture influences programmes using common skills frameworks for pre and post-employment learners.

Model and Learning factories are an important tool to secure digital transformation are for part of the 'New Series' of modular courses that are being developed by ARTC, SIMTech and others. There has been a deliberate strategy to bring in international best in class (McKinsey) and to fund workshops to raise awareness as well as carry out 'train the trainer' activities.

SkillsFuture Highlights

- Providing leadership to future development of courses and capacity within overall strategy defined by ITMs and aligned to wider capability planning.
- Strong modular concept and multiple use of courses for pre and post-employment.
- Quality assurance linked to funding.

GOOD PRACTICE – CORRELATED HIGHLIGHTS AND COMMENTARY

RELATED TO VISIT REFERENCE (N)

POLICY AND STRATEGY

Global Intelligence and Connections (1, 2, 5, 6, 9)

- Singapore initiatives typically start with an international search for best options and partners with significant funding available to undertake missions and support a global intelligence network. The constant flow of inward talent to fill jobs also brings intelligence (1/3 target of overseas workers as an economic KPI).
- This intelligence provides clarity and awareness of opportunities to feed into ITM / capability building and is the first stage of roadmapping processes.
- UK is low priority as a partner for manufacturing.

Common Purpose and Leadership (1, 2, 3, 5, 6, 7, 8, 9)

- The closely connected roles and responsibilities of Trade, Education and Manpower Departments within Government illustrate that the Workforce is fundamental to economic success.
- There is apparent clarity of a shared industrial mission at political and economic levels within an evolving system and shared focus and leadership to understand and address industrial capability gaps to increase overall supply chain gain.
- Large number of panels, committees, etc. are connected through the same personnel which promotes parallel developments and new-to-us innovation, reducing reliance on ‘flow-out/down’ from Centres of Innovation.
- Skills support for industry does not appear to be driven by outputs (qualifications) but seems to be in pursuit of outcomes which have financial impact both for large and small businesses. This relates to the timely take-up of emerging technologies as well as individuals wishing to maintain their skills currency for the developing-technology jobs market.
- Smart thinking by Government bodies is leading employers needs and supports demand-side skills thinking with supply-side activity.

EDUCATION AND TRAINING PROVISION

Lifelong Upskilling (2, 3, 5, 6, 7, 8, 9)

- Continued Education and Training (CET) course costs are subsidised and Professional Conversion Plans (PCP) provide subsidised wages with subsidies up to 90%.
- SkillsFutures Singapore (SSG) is actively and rapidly driving future technology content into approved and funded courses in the 'New Series' which sits in parallel to previously established programmes. Common, approved modules are shared for both pre and post-employment learners based on standards at both a modular and programme level.
- Reacting to demographics (reducing birth-rate), there is pressure on Polytechnics and Universities to provide more upskilling offers and move delivery to on-line learning.
- Singapore has a strong self-study ethos as a means to greater personal income levels.
- The Polytechnics have a dual role in that they enable 45% of the population to pursue qualifications at Diploma level that lead to Associate Professional and Professional employment with some of this cohort continuing to higher awards and hence using the Polytechnics as a bridge.

Real-Problem Based Learning (3, 5, 7, 8)

- Seen at several levels – SIMTech, Polytechnic, ITE
- Most learning programmes include 'internships' lasting similar time to formal training period. There are some challenges around process and control of in-company work which is not formalised as 'work-based learning' and included in qualifications,
- Provides value beyond training subsidy to SME and provides value to learner as well as a route to employment in most cases

Collaborative Content Development (8, 9)

- Polytechnics are starting to co-develop programmes for future technologies with online materials – 'Polymall'
- The State 'encourages' collaboration through funding mechanisms with a focus on shared approaches to common fundamentals of subjects which differ less from institution to institution.
- Suitable for post-employment learners as well as pre-employment. SSG role to structure and approve qualifications and establish demand levels.

Digital Skills (7, 8, 9)

- Learning directed at Industry 4.0 is not separated from existing programmes but added in as electives to qualification courses or as new modular up-skilling offers. This results in evolution at a pace that leads industry take-up.
- 2 driving trends: Disruption due to advanced manufacturing and I4.0 and retraining requirement as sectors move from old economy to new.

Digital Learning Factories (2, 3, 5, 7, 8, 9)

- At several levels – SIMTech, Polytechnic, ITE – working in parallel with informal connections
- Driving culture change and new-to-us innovation through both education and technology routes
- Includes supply chains as well as making – ‘Control Towers’
- International links - McKinsey

CENTRES AND SOURCES OF INNOVATION

Skills and Economic and Industrial Strategy (2, 3, 5, 6)

- Singapore appears to have got close to balancing skills supply with society and industry demand, however there are clear signs that this may be unstable because of societal pressures which value higher qualifications over those related to the jobs required by the economy.
- Workforce planning uses a demand approach with shared faith and clarity of future economic strategies – industrial and wider.

Total Capability Mapping and Planning (7, 9)

- Evidence of early employer leadership using IfM roadmapping processes, led and convened by Centres of Innovation in an open process and working to high level of detail.
- Ongoing and shared ownership of the delivery plan by all partners to achieve a ‘balanced capability’ of technology, supply chain and workforce.
- Working at high Technology Readiness Levels, mid Manufacturing Readiness Levels and low to mid ‘Workforce Readiness Levels’ and focussed on supply chain, pre-competitive white space for shared overall benefit.

Knowledge Capture / Transfer built into Technology Projects from the Outset (2, 5)

- Researchers are directly responsible for impact in SMEs and build case studies and training throughout to ensure knowledge transfer and access to training funding where possible.
- T-Up – temporary transfer of researchers (but not KTP academic outcomes) to provide necessary short terms skills to smaller businesses and continued access to expert support.
- Engaging with companies identifies need for improved manufacturing fundamentals and business skills (OMNI) as a pre-cursor to new technology take-up.

Increased Learner Ratios in Centres (3, 5)

- A high proportion of learners in Centres are carrying out projects and learning programmes assisted by the acceptance and promotion of industry recruitment of staff.
- Internships and Externships are an important aspect of staff development processes to broaden experience in both directions and to provide value to smaller businesses based on 'Real Problem Based Learning'.



ABOUT THE HIGH VALUE MANUFACTURING CATAPULT

The High Value Manufacturing Catapult creates the conditions for economic growth by enabling UK manufacturers to achieve significant improvements in their performance and productivity. We do this by providing open access to world-class innovation capability and technical expertise, enabling companies to embrace different ways of working, adopt new technologies and achieve step-change in their performance.

To find out more about the High Value Manufacturing Catapult, please visit: hvm.catapult.org.uk

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ABOUT THE GATSBY FOUNDATION

Gatsby is a foundation set up by David Sainsbury to realise his charitable objectives. We focus our support on a limited number of areas: plant science research; neuroscience research; science and engineering education; economic development in Africa; public policy research and advice; the Arts.

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