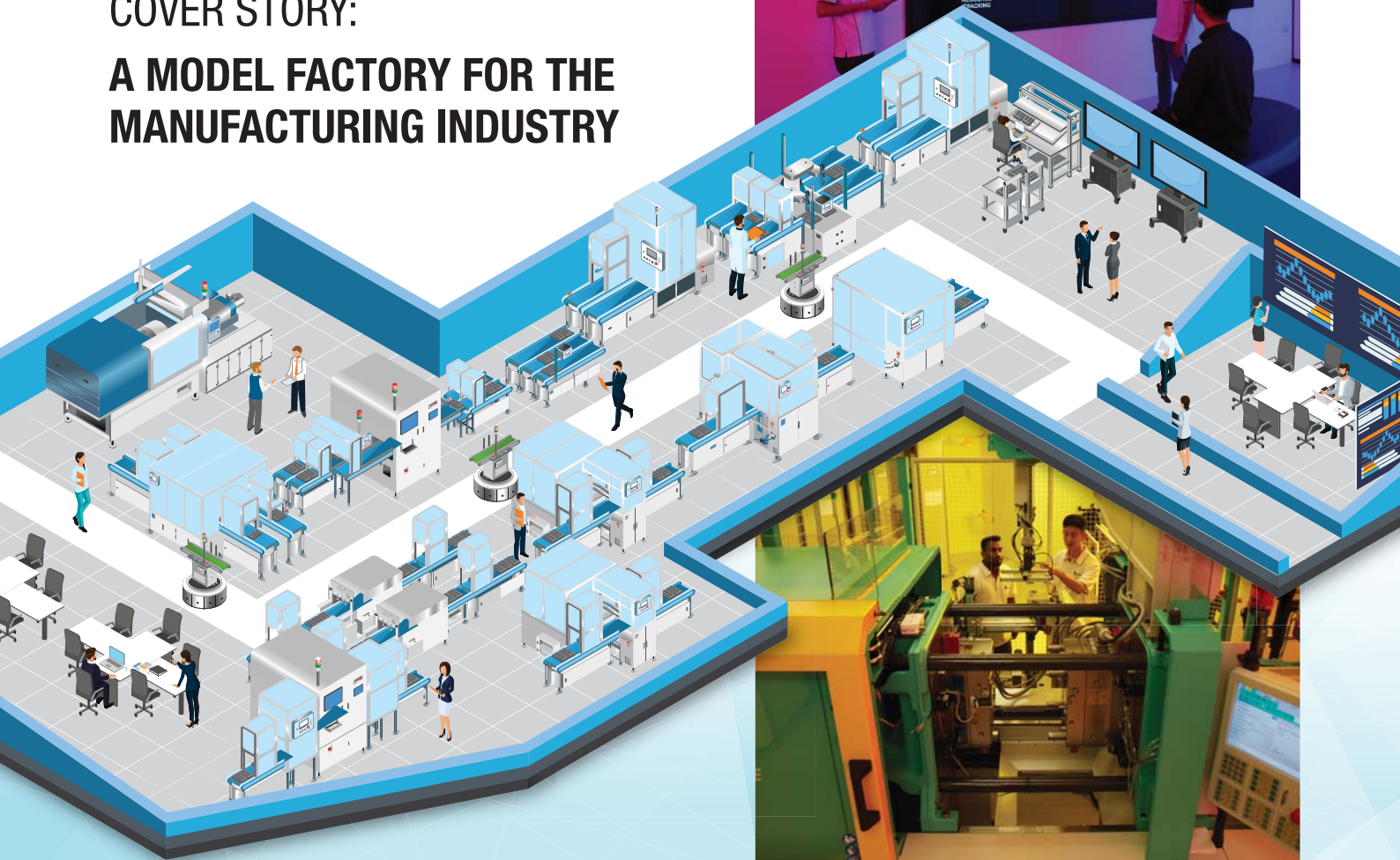


THE SINGAPORE ENGINEER

May 2018 | MCI (P) 009/03/2018

COVER STORY:
A MODEL FACTORY FOR THE
MANUFACTURING INDUSTRY



PLUS

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CONTENTS

FEATURES

COVER STORY

27 A model factory for the manufacturing industry

A*STAR's Model Factory@SIMTech will facilitate the development and testing of technologies and solutions before implementation.



DIGITALISATION

32 IoT strategies enabling the Smart Factory

Major changes are taking place in the manufacturing environment.

34 From subtractive to additive - a new era for manufacturing

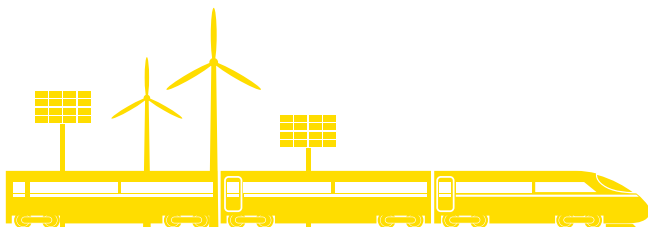
The new technology could soon be used for high-volume production.



PRECISION ENGINEERING

36 Digital precision for industrial 3D printing

Siemens' Additive Manufacturing Experience Center in Erlangen, Germany, provides the opportunity to learn more about this increasingly important technology.



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PRECISION ENGINEERING

- 38 Achieving superior cleaning efficiency**
A few products designed for industrial application are presented.

BIOMEDICAL ENGINEERING

- 40 Doctor Robot will see you now**
With its beneficial impact already visible, robots are poised to play an even greater role in the future.

EDUCATION

- 42 The science of making engineering a more attractive profession**
Efforts are underway to identify the challenges and overcome them.



REGULAR SECTIONS

- 04 INDUSTRY NEWS
20 EVENTS
45 IES UPDATE

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SERIS CELEBRATES A DECADE OF RESEARCH EXCELLENCE AND INNOVATION

The Solar Energy Research Institute of Singapore (SERIS) at NUS commemorated its 10th anniversary on 5 April 2018 with a full-day event to celebrate its achievements and showcase its cutting-edge research capabilities.

The institute was established on 1 April 2008 by its founding Director Professor Joachim Luther, a global authority on solar energy, with a mission to be Singapore's national institute for applied solar energy research.

Supported by NUS, the National Research Foundation (NRF), and the Economic Development Board (EDB), the institute has played an integral role in stimulating the development of Singapore's cleantech sector, growing to become a global leader in applied solar technology.

SERIS has also trained 110 PhD students, many of whom are now contributing to the domain; with some founding their own start-ups. Additionally, it has established strong collaborations with solar companies here and beyond, garnering SGD 30 million in research funding from industry thus far.

Since its inception, SERIS has kept a strong focus on innovation and pushing boundaries for industry-relevant solar technologies. In 2012, the institute developed the world's first all-back-contact silicon solar cell using low-cost screen-printed metallisation. The technology was successfully transferred to pilot production at an industrial partner.

From 2014 to 2016, SERIS supported REC Solar in the development of its TwinPeak solar module. The panel's world-class efficiency of up to 18 per cent makes it the world's highest-performing multicrystalline silicon solar panel, with a greater power output than its standard contemporaries.

In 2017, SERIS commercialised and licensed an advanced tool design and layer formation method for silicon solar cells, with passivated contacts, to a large European photovoltaic equipment manufacturer.

Other SERIS-developed innovations include the world's first full-size bifacial module with interdigitated back contact solar cells, as well as a proprietary real-time monitoring system that is the backbone of the well-known "Live irradiance map of Singapore".

SERIS also designed, implemented and constantly moni-

tors one of the best-performing PV systems in the world, which is installed within the NUS Kent Ridge Campus. Despite the tougher tropical climatic conditions of constant high temperatures and humidity, this system has been able to achieve a 90 per cent performance ratio, with little degradation.

The knowledge gained operating this system has subsequently been shared with the local PV system integration community through workshops. In a similar fashion, SERIS is working closely with government agencies and the private sector to enable the SolarNova programme, which aims to install 350 MWp of PV systems on government-owned buildings by 2020.

Additionally, in close collaboration with PUB, SERIS operates the world's largest testbed for floating PV in Singapore, comparatively testing and evaluating 10 different floating PV installations from around the world.

To further strengthen and deepen its capabilities, SERIS has launched three new flagship R&D projects:

- A collaborative research project with NTU and NRF's Campus for Research Excellence to develop a 30 per cent efficient thin-film-on-silicon tandem solar cell.
- Low-cost, high-efficiency building-integrated PV (BIPV) modules and systems to replace parts of the building envelope with PV, including facades.
- A multi-purpose floating PV system that is suitable for off-shore applications in sheltered waters like Singapore.

These projects will complement SERIS' international R&D leadership in the fields of industrial silicon wafer solar cells, industrial PV module development and testing, "Urban solar", variability management for PV grid integration, and PV quality assurance.



Prof Armin Aberle, CEO of SERIS, explaining the institute's solar research capabilities to NUS President Prof Tan Eng Chye (centre) and Mr Hugh Lim, CEO of the Building and Construction Authority (right). Photo: NUS

AIRBUS FOUNDATION PARTNERS AUTODESK

TO BRING AEROSPACE TO THE CLASSROOM

The Airbus Foundation is teaming up with engineering software provider Autodesk to launch Discovery Space, a digital portal with educational animations and interactive aerospace-themed lessons in 3D design.

In an effort to inspire students to pursue science, technology, engineering and math (STEM) careers, the site's interactive curriculum brings aerospace into the classroom by teaching students about space exploration, including what it takes to survive in space and fly a mission to the moon.

Dr Tom Enders, Chairman of the Airbus Foundation, said: "Youth development is at the heart of the Airbus Foundation's mission. It is all about the future. We strive every day to stimulate and inspire young minds through STEM and are proud to add the Discovery Space website as an additional educational."

The Airbus Foundation Discovery Space project offers students

the opportunity to build their own virtual spacecraft in Autodesk software, factoring in parameters such as robustness to break through Earth's atmosphere, trajectory and impact for landing on the moon.



Image: Airbus Foundation

Students can also build portfolios and submit designs to win the "Mission to the Moon" challenge. In addition, the Airbus Foundation Discovery Space project includes step-by-step guides and inspirational videos.

Discovery Space can be accessed online at www.airbus.com/company/discovery-space.html.

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MICRON BREAKS GROUND ON NEW FLASH MEMORY FABRICATION FACILITY HERE



At the ground-breaking ceremony held on 4 April were (from left) Mr Wayne Allan, Senior Vice-President (VP), Global Manufacturing, Micron; Mr Ng Lang, CEO, JTC; Mr Manish Bhatia, Executive VP, Global Operations, Micron; Mr S. Iswaran, then-Minister for Trade and Industry (Industry); Mr Sanjay Mehrotra, President and CEO, Micron; Dr Beh Swan Gin, EDB Chairman; Mr Chen Kok Sing, VP and Singapore Country Manager, Micron; and Mr Gursharan Singh, Senior VP, Backend Operations, Micron. Photo: Micron Technology

Micron Technology will be adding new cleanroom space in Singapore to enable continued technology transitions and to expand research and development capabilities.

The company reached an agreement with the Economic Development Board to invest in the new space, providing Micron with the flexibility to meet future 3D NAND manufacturing requirements.

In a press statement, Micron said that the new facility will be a “multibillion-dollar investment” and will be equipped over the next five-plus years. It will create more than 1,000 new jobs.

Construction of the cleanroom facility is expected to be complete in mid-2019, with initial wafer output expected in the fourth quarter.

The expansion is expected to occur in phases to closely align with future 3D NAND technology node manufacturing and market requirements. No new wafer capacity is currently planned.

“The decision to expand fab cleanroom space adjacent to our existing NAND Center of Excellence provides us with the best opportunity to successfully implement advanced 3D NAND technology node transitions, while leveraging the infrastructure and manufacturing expertise we have established in Singapore,” said Micron President and CEO Sanjay Mehrotra.

Singapore is Micron’s primary manufacturing location for leading-edge NAND technology nodes.

According to the company, future generations of 3D NAND flash memory, with increasingly complex architectures, will require more processing steps, and hence more cleanroom space, to deliver cost effective and high capacity memory products.

The existing Micron fabrication facility on North Coast Drive will be the site of this expansion. Micron will also broaden its Singapore R&D capabilities in line with its global technology development expansion strategy.

A*STAR TO SET UP BATTERY RESEARCH LAB WITH CANADA’S LARGEST ELECTRICITY PRODUCER

A*STAR’s NanoBio Lab and Canada’s Hydro-Québec have signed a Memorandum of Understanding (MOU) to finance USD 20 million for a joint laboratory for battery research.

Announced in early April, the new facility will focus on developing new nanomaterials and nanotechnologies for electric vehicles and batteries that are safe, efficient and cost-effective. It aims to improve solid-state batteries, a safer alternative to lithium-ion batteries since it does not use flammable liquid electrolytes.

The joint laboratory be housed in Biopolis and will employ over 30 researchers. It marks a new phase of partnership between NanoBio Lab and Hydro-Québec, who have worked together on advancing battery performance and safety since 2011.

Hydro-Québec is a global leader in battery materials research

and Canada’s largest electricity producer.

“Through in-depth technology exchange, we have created many interesting new materials, and we are delighted to significantly expand our collaboration in order to accelerate our technology R&D efforts towards commercialisation,” said Professor Jackie Y. Ying, who heads NanoBio Lab.

A*STAR Chairman Lim Chuan Poh extended his congratulations to both parties on the collaboration, and noted that battery materials technology was an emerging field that could pave the way for more clean and renewable energy sources to power next-generation devices and vehicles.

“We look forward to developing and commercialising innovative energy storage solutions through this collaboration,” he added.

NUS 8TH IN LIST OF GLOBAL ENGINEERING EDUCATION LEADERS

A recently-commissioned report from the Massachusetts Institute of Technology (MIT) on global engineering education has placed NUS Engineering in eighth place, ahead of the University of Cambridge.

It is the only university outside of US and northern Europe to feature in the top 10. Topping the list were Olin College, MIT and Stanford University.

The report, titled "Global state of the art in engineering education", examined worldwide trends in the changing landscape of engineering education, pinpointed leaders in the field, and described some of its future directions.

It was informed by interviews with 178 thought leaders with knowledge of and experience with world-leading engineering programs, combined with case studies from four different universities.

The report also identified three trends that were likely to define the future of engineering education: A greater emphasis on engineering education leadership outside of U.S. and northern European institutions, a shift toward programmes that integrate student-centred learning with a curriculum oriented to the pressing challenges of the 21st century, and the emergence of a new generation of leaders who will be able to deliver student-centred curricula at scale.

Commenting on the news, the Dean of NUS Engineering, Professor Chua Kee Chaing, said, "It is gratifying to see our efforts in making engineering education more holistic being recognised. We firmly believe that a holistic engineering education is the right approach to training engineers with strong technical skills, creativity, and innovativeness needed to tackle complex social, economic and environmental problems of the 21st century."

ST MARINE LAUNCHES

SIXTH LITTORAL MISSION VESSEL

Singapore Technologies Marine has successfully launched the sixth Littoral Mission Vessel (LMV), Fortitude, designed and built for the Republic of Singapore Navy (RSN).

The LMV was launched at ST Marine's Benoi Yard by Mrs Michelle Ng, wife of then-Minister for Education (Schools) and Second Minister for Transport Ng Chee Meng, who officiated the ceremony.

Fortitude is part of an eight-vessel LMV programme started in 2013 and is slated to replace the RSN's current fleet of Fearless-class Patrol Vessels, also designed and built by ST Marine in the 1990s. The LMVs are 2.5 times larger, and possess better sea-keeping capabilities to operate in higher sea state conditions, amongst other attributes.

ST Marine has delivered four vessels (LMV Independence, LMV Sovereignty, LMV Unity and LMV Justice) till date. The fifth vessel, LMV Indomitable, was launched in 2017; the keel was laid for the seventh LMV and steel was also cut for the eighth LMV last year.

"The launch of the sixth LMV Fortitude today brings us another step closer to the completion of

the LMV programme. The milestones to date could not have been achieved without the collaboration of the DSTA, RSN and our industry partners, and I extend my warmest appreciation to them," said Mr Ng Sing Chan, President for ST Marine.

"We are honoured to be able to contribute to RSN's robust seaward defence of Singapore, which will be strengthened further when all eight LMVs are delivered in 2020."



LMV Fortitude is the 6th in its class. Like her sister ships, she can be quickly configured with mission modules for a wide spectrum of operations and is equipped with both lethal and non-lethal options to respond to various threats. Photo: ST Engineering

STARHUB, SUNSEAP TEAM UP TO ENTER OPEN ELECTRICITY MARKET

StarHub, together with sustainable energy firm Sunseap, have partnered up to enter Singapore's Open Electricity Market, which soft-launched in Jurong in April.

This has enabled residents to switch out of their existing electricity retailers and power their appliances using solar power from the two partners. According to their press statement, consumers will be free to choose their desired electricity retailers according to their usage patterns and prices offered, with a seamless, non-disruptive switching process.

As part of this joint operation, StarHub and Sunseap are collaborating on various fronts which include customer service, billing and sales. Both companies are also exploring opportunities in smart energy and Internet of Things solutions to bring continued benefits to customers.

"Working together with Sunseap, we are excited to offer households a compelling way to live a lower carbon footprint lifestyle using the Sun's energy. Leveraging each other's expertise, we will bundle essential services from

mobile, pay TV, broadband and electricity in attractive packages for customers, who are becoming more environmentally-aware," said Mr Howie Lau, Chief Marketing Officer, StarHub.

Two clean energy subscription plans are currently on offer: Green Life and Green Save.

Customers on the Green Life plan receive electricity fully produced by Sunseap's solar systems at no additional cost. Electricity will be charged at the usual regulated electricity tariff.

The second plan, Green Save, allows customers to take a step towards becoming more environment-friendly while enjoying some savings. With this plan, customers will receive 5 per cent clean energy and enjoy a 20 per cent discount off the regulated tariff.

Non-Jurong residents can visit www.starhub.com/energy to register their interest. StarHub will notify registrants when they are able to switch electricity retailers.

SUPPLIERS COMMIT TO SUPPLY SPARE PARTS TO 3RD PARTY CONTRACTORS FOR HDB LIFT MAINTENANCE

BNF Engineering and C&W Services Operations, which provide the BNF and ULift-series elevators respectively, have voluntarily committed to supply lift spare parts to third-party lift maintenance contractors.

This was to address competition concerns from the Competition Commission of Singapore (CCS), which had been investigating alleged refusals to supply lift spare parts for the maintenance of lifts in HDB estates.

"If a lift company or distributor does not provide proprietary but essential lift spare parts to third-party lift maintenance contractors, other lift maintenance contractors may be prevented from effectively competing for contracts to maintain and service lifts of that particular brand in Singapore," said the CCS in a statement.

Following feedback received during public consultations, BNF Engineering and C&W Services Operations amended and finalised their commitments, which were accepted by the CCS in late March this year.

The voluntary commitments, proposed separately, provide that both companies will undertake to sell lift spare parts of the relevant brands to a purchaser on a fair, reasonable and non-discriminatory basis, subject to certain terms and conditions.

The CCS further noted that it was the lift owners' responsibility to exercise due care in ensuring the proper training and competence of their engaged maintenance contractors, and that it would be prudent for lift owners to ensure that their appointed lift maintenance contractors maintain sufficient inventories of spare parts.

PSA REVENUE GROWS IN 2017

Port operator PSA International recently posted a revenue of SGD 3.97 billion for the 2017 financial year, a year-on-year growth of 7.8 per cent.

This was due to the resurgent global economy and “ubiquitous consolidation of shipping alliances which hub their services in PSA terminals”, according to Group Chairman Fock Siew Wah.

PSA’s flagship Singapore terminals contributed 33.35 million Twenty-foot Equivalent Units (TEU) in container throughput, increasing 9.0 per cent over 2016, while those outside Singapore delivered a total throughput of 40.89 million TEUs, increasing 10.4 per cent over the same period.

Commenting on the operator’s plans for 2018, Mr Tan Chong Meng, Group CEO of

PSA International, said, “As we witness the current wave of digitalisation and acknowledge the increasing quest for cargo flow visibility, we believe PSA can work with our customers and partners to create a new suite of solutions that exploit the opportunities which digitalisation offers, taking advantage of the fact that PSA already operates at key nodes of global trade and supply chains.”

(\$ Million)	2017	2016	Growth %
Revenue	3,968	3,680	7.8
Profit from Operations	1,697	1,617	5.0
Finance Costs	(169)	(173)	-2.6
Profit Before Taxation	1,528	1,443	5.9
Income Tax Expense	(236)	(216)	9.1
Net Profit for the year (after Tax)	1,292	1,227	5.3
Non-controlling Interests	(59)	(54)	9.1
Net Profit for the year	1,233	1,173	5.1

PSA International Pte Ltd and its subsidiaries’ results for the year ended 31 December 2017.
Source: PSA International

APPOINTMENT OF BOARD MEMBERS TO ENTERPRISE SINGAPORE

The Ministry of Trade and Industry (MTI) has appointed 18 board members to Enterprise Singapore. Enterprise Singapore (ESG) was established on 1 April 2018 following the merger of SPRING Singapore and International Enterprise (IE) Singapore.

Mr Peter Ong and Mr Png Cheong Boon, appointed to the positions of Chairman and Chief Executive Officer (CEO) of ESG respectively, began their duties on 1 April.

According to a press statement from MTI, the board members will work closely with Mr Ong and Mr Png in providing greater support and assistance to Singapore companies looking to equip themselves with new capabilities, innovate and expand overseas.

MTI also thanked the outgoing chairmen of the two parent agencies for their service.

Mr Loh Khum Yean, Permanent Secretary for MTI, said, “Over the years, both Mr Philip Yeo and Mr Seah Moon Ming have played a key role in leading SPRING and IE



Mr Peter Ong (left) and Mr Png Cheong Boon, the newly-appointed Chairman and CEO of ESG respectively. Photos: MTI

Singapore to provide strong enabling support for many Singapore companies to build up their capabilities and expand into international markets. I would like to express MTI’s deep appreciation for their invaluable contributions.”

For the full list of board members, visit <http://bit.ly/ESGboard>.

READY FOR THE AEROSPACE INDUSTRY

Praised as the ‘aerospace city of the future’, Singapore plays host to one of the widest range of aerospace-related industries and companies in Asia, with over 130 entities involved in this field. Recently, a new aerospace industry transformation map (ITM) that aims to create over 1,000 jobs by 2020 and generate over S\$4 billion in value-add, was launched by Minister for Trade and Industry (Industry) S. Iswaran. The ITM identified three key areas: pursuing operational excellence, driving innovation in emerging technologies, and equipping Singaporeans with relevant skills to support the continued success of the aerospace industry.

Within this landscape, the BEng (Hons) in Aeronautical Engineering and BEng (Hons) in Aerospace Systems degrees offered by the University of Glasgow, in collaboration with Singapore Institute of Technology (SIT), have been providing quality graduates to the aerospace sector since 2012.

Aeronautical Engineering is an advanced engineering discipline concerned with the theory, design, manufacture and testing of flight vehicles. These range from fixed-wing to rotary-wing aircraft, such as helicopter or modern-day quadcopter. In Aeronautical Engineering, mathematics and physical laws are applied to design flight vehicles or to understand the advanced behaviour of flight vehicles. Aeronautics is a fascinating subject area involving a diverse range of subjects including jet/rocket propulsion, aerodynamics, flight mechanics, aircraft structures and flight testing. The analytical and problem-solving skills of Aeronautical Engineering graduates are highly sought after by employers.

Aerospace Systems are a fusion of aeronautical, electrical and systems engineering concepts. The professional Aerospace Systems engineer requires a sound knowledge in aeronautical engineering, together with a detailed understanding of simulation and control, as well as electrical and electronics engineering principles, in order to form aircraft systems that augment aircraft performance and operations. An engineer should also be an effective communicator, manager and team player, and be aware of issues relevant to modern industry. The Aerospace Systems degree allows its graduates to confidently embark on a career in the aerospace industry.

In both programmes, students demonstrate their skills through final year projects (FYP). About 40% of these FYPs are projects that are industry-based. Recently, we worked with organisations such as Sembcorp Marine, Housing Development Board, National Parks Board, Garuda

Robotics, ST Aerospace, Tropical Marine Science Institute and DNV-GL on a wide range of research projects. These collaborations with industry ensure that our graduates are industry-ready.

Our students also take part in several renowned competitions. Since 2013, we have participated in the design, development and demonstration of unmanned aerial vehicles (UAVS) in Singapore Amazing Flying Machine Competitions (SAFMC), Autonomous Aerial Vehicle Challenges (AAVC) in Thailand and the Korean Personal Aerial Vehicle (K-PAV) Competition where we have received several accolades. We consistently showcase our achievements in aerospace-related exhibitions, such as the Singapore Air Show and CAAS Aviation Open House, to reach out and connect with industries as well as future aerospace engineers.



SIT-UofG students at the Autonomous Aerial Vehicle Challenge 2017 held in Thailand.

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EVONIK OPENS ASIA RESEARCH HUB IN SINGAPORE

Germany-based specialty chemicals company, Evonik, recently opened its first research hub for resource efficiency topics in Singapore, thereby internationalising its research on functional surfaces and additive manufacturing. Furthermore the new R&D hub will be the home for Evonik's Tissue Engineering Project House which is under the leadership of Creavis, the strategic innovation unit of Evonik.

Located in Biopolis, the new hub is the result of Evonik's strategic decision to expand its research and development activities, globally.

"Innovation is an integral part of our growth strategy", said Dr Harald Schwager, Deputy Chairman of the Board, Evonik Industries, during the opening ceremony.

"We are actively pursuing new opportunities to boost our international R&D activities and the opening of this research hub is a significant contribution to these efforts. By focusing on promising research areas for the future, this hub will strengthen our position as a global leader in specialty chemicals", he added.

"This research hub is ideally located to drive innovation for our Resource Efficiency segment, by developing forward-looking solutions and technologies for our clients in all global markets", said Dr Claus Rettig, Chairman of the Board of Management, Evonik Resource Efficiency GmbH.

"With this new hub, we are taking advantage of a new approach to research - enabling a creative environment for innovations and encouraging agile, flexible working", he added.

With the research hub, Evonik is also expanding its collaboration with public and private research institutions and organisations. The company has formed a partnership with Nanyang Technological University, Singapore, to develop novel technologies in additive manufacturing for industrial application.

"Evonik has been present in Singapore for more than 20 years and our strong regional footprint has positioned us as a market leader in the speciality chemical industry, particularly in Asia", said Mr Peter Meinshausen, President, Evonik Asia Pacific South.

Evonik in Asia Pacific South

A world leader in speciality chemicals, Evonik has a strong presence in the Asia Pacific South region, with more than 1,600 employees and production sites, sales offices as well as innovation and technical service centres located in Australia, Bangladesh, India, Indonesia, Malaysia, New Zealand, Pakistan, Philippines, Singapore, Thailand and Vietnam.



At the opening of the Evonik Asia Research Hub are, in the front row, from left to right, Dr Beh Swan Gin, Chairman, Singapore Economic Development Board and Dr Harald Schwager, Deputy Chairman of the Executive Board, Evonik Industries AG; in the middle row, from left to right, Dr Claus Rettig, Chairman of the Board of Management, Evonik Resource Efficiency GmbH and Dr Ulrich Sante, Ambassador of the Federal Republic of Germany to Singapore; and in the back row, from left to right, Dr Gerd Loehden, Senior Vice President of Innovation Management, Evonik Resource Efficiency GmbH; Mr Peter Meinshausen, Regional President, Evonik Asia Pacific South and Dr Ulrich Kuesthardt, Chief Innovation Officer, Evonik Industries AG.



The opening of the research hub gives a significant boost to Evonik's R&D activities.

The company's core activities in the region cover feed additives, lubricant additives, hydrogen peroxide, precipitated and fumed silica, acrylic resins, personal and household care additives, coating additives, performance and speciality monomers, moulding compounds, and high performance polymers.

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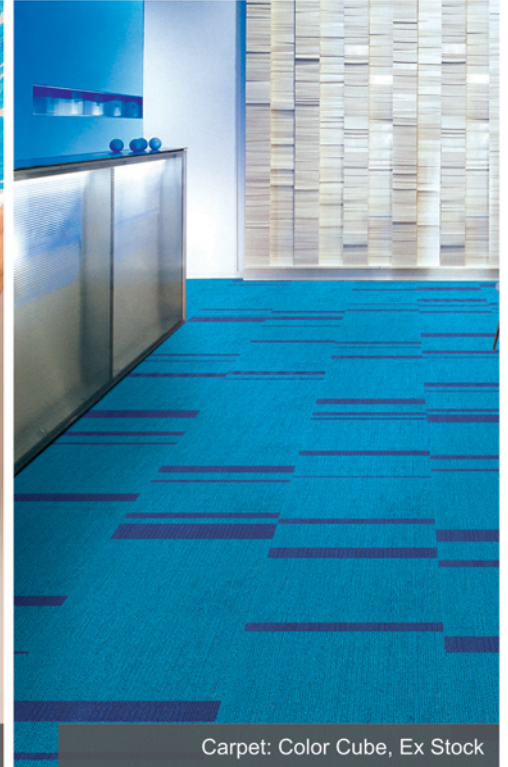
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That is how Bosch imagines future factories will be. At Hannover Messe 2018, in line with the slogan 'Factory of the future. Now. Next. Beyond', Bosch presented the smart, lean, and flexible factory of the future as well as connected solutions that are already in operation today, in manufacturing and logistics. Both scenarios have something in common - the interplay of hardware, software, and services, orchestrated by people.

Among the products presented, the APAS mobile production robot works closely with human colleagues, without coming into physical contact with them. Meanwhile, the ActiveCockpit intelligent communications platform keeps production workers permanently up-to-date on the status of operations, while an autonomous transport robot not only carries parts from A to B, but also works on them en route.

At Hannover Messe 2018, Bosch also presented its new Nexeed software portfolio which encompasses software and services for the entire value stream. The company has systematically taken the comprehensive domain knowledge from its more than 270 plants and trans-

formed it into software solutions. Specialists in manufacturing, logistics, and software have worked together to create solutions that both simplify workers' daily routines and make manufacturing and logistics more efficient, flexible, and eco-friendly.

The Nexeed Production Performance Manager ensures systematic improvements in production by helping quality and maintenance operatives make decisions quickly and easily. To do so, it gathers and harmonises real-time production and machine data from a variety of sources in the manufacturing environment, gives it a clear structure, and presents it to workers on their mobile devices. This saves both time and money.

Nexeed Track & Trace is a solution for monitoring the flow of goods. Sensors fitted to the goods themselves autonomously report their position and condition via the cellular network to the cloud. This means logistics personnel can trace each product and each carrier. It also means users can call up the precise delivery time and optimise their material and capacity planning. This also saves time and money.



The Nexeed Production Performance Manager ensures systematic improvements in production by helping quality and maintenance operatives make decisions quickly and easily.



The APAS mobile production robot works closely with human colleagues, without coming into physical contact with them.



Sensors fitted to goods autonomously report their position and condition to the cloud, via the cellular network.

AUTOMATION READINESS INDEX LAUNCHED

ABB and The Economist Intelligence Unit recently released the Automation Readiness Index (ARI) and the report 'The Automation Readiness Index (ARI): Who Is Ready for the Coming Wave of Innovation?'

The report, which surveyed and ranked 25 countries on their automation readiness, listed South Korea, Germany, Singapore, Japan, Canada, Estonia, France, the UK, the US and Australia, as the countries best-positioned to embrace automation.

The report states that even the best-prepared countries must develop even more effective education policies and training programmes, as well as place new emphasis on continual learning, to ensure that people are prepared for the more human-oriented jobs that will be created, as

robots and algorithms take on more of the routine tasks.

The analysis in the report is based on a new index created by The Economist Intelligence Unit, as well as a series of in-depth interviews with subject matter experts from around the world. Rankings were determined, based on a total of 52 qualitative and quantitative indicators, selected in consultation with relevant experts.

ABB and The Economist Intelligence Unit plan to conduct the ARI research annually.

ABB is a technology leader in electrification products, robotics and motion, industrial automation and power grids. The Economist Intelligence Unit (EIU) is the research and analysis division of The Economist Group.



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ENVISION UNVEILS STRATEGIC PARTNERSHIPS WITH LEADING SINGAPORE COMPANIES

Envision, owner of EnOS, a leading intelligent Internet of Things (IoT) platform, and the second largest smart wind turbine manufacturer in China, recently signed a Memorandum of Understanding (MOU) with En-trak Pte Ltd, an award-winning Smart Building IoT technology company, to jointly explore collaboration and development opportunities in smart building energy management applications in the region, using the EnOS platform. En-trak currently manages over 100 GWh of energy annually for over 300 clients across Asia Pacific.

On the occasion, Envision also hosted a seminar addressing the theme 'The IoT Era - The Future is Now'.

Envision is currently cooperating with world-class enterprises and higher education institutions in Singapore including Keppel Urban Solutions Pte Ltd (KUS), a wholly-owned subsidiary of Keppel Corporation; Ascendas-Singbridge Group; Solar Energy Research Institute of Singapore; and Nanyang Technological University.

KUS is developing a digital operating platform and will integrate EnOS to provide smart energy solutions from planning and implementation to operations. The first application of the platform will be in the Saigon Sports City project in District 2 of Ho Chi Minh City, Vietnam. The solutions for Saigon Sports City will cover clean energy generation, smart energy management, performance optimisation of environmental infrastructure and smart building management, with the aim to create a truly human-oriented, technology-driven and sustainable smart city.

Envision has established its Digital Hub in January this year and will form a 200-staff R&D team in Singapore. This team will largely be responsible for product development, in response to the needs of intelligent IoT platforms, including artificial intelligence, data processing, power generation forecasting, virtual power plant algorithms etc.

"Envision is building up the IoT innovation ecosystem in Singapore, based on Envision's EnOS platform. This will enable local companies with strong technology support to increase global

business opportunities. These companies and even start-ups are able to create synergy with other applications and create smart city solutions and products, which could be duplicated worldwide", said Mr Lei Zhang, Founder & CEO, Envision.

"Envision has created the world's largest energy IoT platform, connecting and managing over 100 GW of energy assets globally. By working with global enterprises headquartered in Singapore to gradually achieve smart management of homes, buildings, transportation facilities and industrial parks, based on EnOS, Envision will help Singapore turn the Smart Nation strategy into reality", he added.



At the signing ceremony are, seated, from left, Mr Lei Zhang, Founder & CEO, Envision and Mr Vincent Chow, Founder & CEO of En-trak. Standing, from left, are Mr Michael Ding, Global Executive Director, Envision; Mr Lim Kok Kiang, Assistant Managing Director, Economic Development Board; Mr Cesz Zhang Chunlin, Country Manager, En-trak; and Ms Paige Liu, Strategy Business Development Director, Envision.



Envision concurrently hosted 'The IoT Era - The Future is Now' seminar.

ABB ESTABLISHING GLOBAL DIGITAL SOLUTIONS CENTER IN SINGAPORE

ABB is setting up a new Digital Solutions Center in Singapore to drive innovation and bring pioneering solutions to its customers worldwide. As part of ABB's Control Technologies business, the centre will develop innovative solutions, merging cloud, information and operational technologies (IT and OT). These developments will help customers harness digitalisation to improve energy efficiency and increase operational agility across a number of industries.

The centre will use a mix of ABB's own technology and the results from new research and development. This approach will allow customers to have access to solutions that suit their needs, ahead of schedule, and under budget. It will include key technologies from the company's

comprehensive digital offering, ABB Ability, ranging from ABB Ability System 800xA distributed control system to ABB Ability Data Center Automation for control, monitoring and optimisation of mission-critical infrastructure.

In addition, ABB Ability Manufacturing Operations Management offers end-to-end visibility of industrial operations.

The global Digital Solutions Center is the latest development strengthening ABB's strategic presence in Singapore, adding to its advanced manufacturing footprint that already includes a Regional Robotics Application Center and Marine Collaborative Operations Center. In Singapore, ABB employs over 1,000 people, about one-third of whom work in digital and software areas.



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SAP LEONARDO CENTER SINGAPORE LAUNCHED

SAP, a market leader in enterprise application software, recently announced the launch of the SAP Leonardo Center Singapore. The centre has been established to help customers, partners and the broader ecosystem of universities and start-ups across the Asia Pacific Japan (APJ) region to deliver faster innovation with less risk. This launch expands SAP's innovation footprint in the region, adding to the three Innovation Centers and four SAP Labs in APJ.

The SAP Leonardo Center Singapore is the fifth in the global network of SAP Leonardo Centers. The other four centres are located in Bangalore, India; New York, USA; Paris, France; and Sao Leopoldo, Brazil.

The SAP Leonardo Center Singapore is designed to serve as the 'front-end' for APJ customers and partners to accelerate their digital innovation journeys using the capabilities of SAP Leonardo and Design Thinking. SAP Leonardo brings together Internet of Things (IoT), Machine Learning, Blockchain, Big Data, Analytics and Data Intelligence on the SAP Cloud Platform. It also applies SAP's leading technology capabilities and deep knowledge of 25 industries, in a live technology-delivery environment to deliver the 'Intelligent Enterprise' for every customer.

"The SAP Leonardo Center in Singapore will showcase the art of the possible in digital innovation and help our customers scale quickly, easily and effectively", said Mr Scott Russell, President, SAP APJ.

"Together with our customers and partners, we aim to leverage the SAP Leonardo Center Singapore as a think tank to drive purpose-led innovation that will ultimately improve the lives of one billion people and deliver the Intelligent Enterprise for over 70,000 customers in APJ by 2022. The SAP Leonardo Center in Singapore will play a key role in realising our growth strategy and drive customer success in the new Intelligence era", he added.

Collaborative business environment

The SAP Leonardo Center Singapore aims to foster a collaborative environment for businesses, start-ups as well as small and medium-sized enterprises to experiment and innovate.

One of SAP APJ's first SAP Leonardo customers is Hanon Systems. Headquartered in South Korea, Hanon Systems is a global leader in automotive thermal and energy management solutions, and an early adopter of SAP Leonardo in APJ. With insight into the benefits of digital manufacturing, the company identified manufacturing performance and equipment health as areas of measurement to pilot the Leonardo platform at one of its plants in Europe.

Mr Robert Oh, Chief Information Officer and Business Transformation Executive at Hanon Systems, believes a supplier's ability to compete in today's automotive mar-



Mr Scott Russell, President, SAP APJ, delivering the opening address at the launch of the SAP Leonardo Center Singapore.



The SAP Leonardo Center Singapore will help customers and partners to accelerate their digital innovation journeys.

ket is no longer measured by just its product offering.

"At Hanon Systems, we believe our digital transformation can change the way we manufacture in a positive way to improve our productivity, increase our overall efficiency and further strengthen our customer relationships", he said.

Hub for digital technology ecosystem

The SAP Leonardo Center Singapore also serves as a hub for SAP's broader digital technology ecosystem which includes universities, startups, tech communities and accelerators. SAP APJ prepares the next-generation innovators with knowledge and skills for the digital future through the SAP University Alliances Program which exposes 1.7 million students in educational institutions in APJ to innovative technologies. SAP APJ has established 13 Next-Gen labs in APJ, with plans to open more in the future.

SINGAPORE INTERNATIONAL WATER WEEK 2018



THE GLOBAL PLATFORM TO SHARE AND
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8 – 12 July 2018
Sands Expo & Convention Centre
Marina Bay Sands, Singapore

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Be part of the Singapore International Water Week!

WATER LEADERS SUMMIT: 8-10 July (By-Invite Only)

An exclusive high-level gathering of global water industry leaders for exchanges with government regulators and policy think-tanks to discuss solutions to pressing water issues. This year, the summit has a new session where delegates can discuss cross-cutting solutions with urban and environmental representatives at high-level sessions over the 3-day programme.

WATER CONVENTION: 8-11 July

The Water Convention welcomes water practitioners and leaders to share their best practices, strategies and applied technological solutions which address the challenges and provide opportunities from four main themes. Besides the technical sessions and presentations, don't miss the opportunity to learn about hot and trending water issues and topics such as portable reuse where recycled water brewed beer testing will be available at Hot Issues Workshops.

TECHXCHANGE: 8 July

Designed to connect innovators with partners, buyers and investors to accelerate commercialization of new water technologies from lab to market, TechXchange encourages interactive debates, generates networking opportunities, presents innovative technologies and facilitates discussions hosted by industry leaders. Don't miss the opportunity to gain insights from successful small and medium enterprises (SMEs) on challenges encountered and opportunities available in different geographical markets this year.

YOUNG WATER LEADERS SUMMIT: 8-10 July

Designed by young water professionals for fellow professionals, this 3-day programme brings together water leaders of the future and seeks to influence, equip and transform them to become effective catalysts of continuous change in their home region and in the wider water world. The programme this year is closely integrated with the Water Leaders Summit, offering more opportunities to learn from and network with senior leaders. Apply today to be selected for registration. Application ends 30 April 2018.

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HANNOVER MESSE 2018 AND CEMAT 2018

PRESENT LATEST TECHNOLOGIES IN MANUFACTURING AND LOGISTICS



HANNOVER MESSE 2018 and CeMAT 2018 attracted 210 000 visitors.

HANNOVER MESSE 2018, this year's edition of the world renowned trade show on industrial innovation, and CeMAT 2018, this year's edition of the leading international trade fair for materials handling / intralogistics and logistics, were held in Hannover, Germany, from 23 to 27 April 2018.

Organised by Deutsche Messe AG, under the theme 'Integrated Industry - Connect & Collaborate', the event featured the displays of 5,800 exhibitors, which addressed topics like machine learning, artificial intelligence, industrial IT platforms, the expansion of power grids for eMobility, the use of robots and autonomous systems in production and intralogistics, and the role of workers in the integrated factory.

Mexico was this year's featured Partner Country. More than 160 Mexican businesses were at the fair to present their products and innovations.

HANNOVER MESSE 2018 and CeMAT 2018 attracted 210 000 visitors, more than 70,000 of whom came from abroad, which means that the international component of the visitorship was 30%. The largest number of foreign visitors was from China (6,500), followed by the Netherlands (5,300), Poland (2,700) and the US (1,700). A total of 1,400 visitors came from Mexico.

Central trends highlighted at Hannover this year included the ongoing convergence between IT and mechanical en-

gineering, industrial IT platforms and other new business models, and the imminent impact of artificial intelligence on the factory environment. The exhibitors in the automation halls profiled drive technology and fluid power as key drivers for digitalised and integrated manufacturing.

The close integration of production and logistics was a key topic in the CeMAT halls. This was not surprising since the digital factory simply cannot work without intelligent logistics systems. Product highlights included industrial trucks, autonomous shuttles, order-picking robots and complete systems.

Further highlights consisted of assistance systems like exoskeletons, AR goggles and, above all, robots. Agile fabrication and intralogistics rely on autonomous transport systems, drones and intelligent personal assistants (IPAs). The continuing trend towards human/machine collaboration was also emphasised.

Meanwhile, displays in the energy-related halls centred on energy efficiency in direct correlation with climate protection. The focus was on decentralised, smart energy systems and infrastructure solutions for environment-friendly mobility in the future.

Subcontractors and development partners also presented impressive innovations, with approaches to connecting operations with customers for seamless efficiency. Multi-material and lightweight concept designs are

opening the way to a complete rethinking of structural components, resulting not just in cost-cutting and greater efficiency, but also in improved performance.

“Technology is not about competing with us humans. It is about assisting us. That is the core message conveyed by this trade fair, which has again underscored Hannover’s reputation as a global hotspot for the digital transformation of industry,” said Dr Jochen Köckler, Chairman of the Managing Board at Deutsche Messe, at the close of HANNOVER MESSE 2018 and CeMAT 2018.

“The focus here has clearly been on the human element. We are the ones making the decisions and setting the course. The interaction of humans with machines and IT adds up to a huge competitive gain across manufacturing, logistics and the energy industry”, he added.

“Businesses have successfully negotiated the first steps on the path towards digitised, connected production and are now firing up for the second stage of the journey”, said Mr Thilo Brodtmann, Executive Director of the German Engineering Federation (VDMA).

“New platform-based business models, the use of digital twins and initial experiences with machine learning - all of this is set to play an increasingly important role in the mechanical engineering sector. HANNOVER MESSE is a place where people present and discuss the shape of things to come, and we are once again highly satisfied with the outcome of the show. VDMA believes that automation, software and intralogistics would continue to define the character of HANNOVER MESSE”, he added.

“HANNOVER MESSE has once again confirmed it is the definitive home base for the global transition to Industry 4.0. Extended value creation networks, new forms of human-machine collaboration, and the increasing integration of artificial intelligence into production operations - these remain the key features of digitisation and connectivity, and were once again first unveiled here in Hannover. All of this requires even more connectivity, which is why the German Electrical and Electronic Manufacturers’ Association (ZVEI) has been calling for an industry-capable 5G network right from the start”, said ZVEI Executive Director, Dr Klaus Mittelbach.

“This trade show has conveyed two other key messages. First, that we can only advance down the road to technological progress and

social prosperity by teaming up and working together - not by protectionism or isolation. And second, that bringing young students into direct contact with technology - as we have done at this event - is a great way to kindle their interest. And we have to do even more to attract their attention, for they represent tomorrow’s urgently needed workforce”, he added.

The next HANNOVER MESSE will be staged from 1 to 5 April 2019, with Sweden as the official Partner Country. The next CeMAT will run parallel to HANNOVER MESSE, from 20 to 24 April 2020.



The latest technologies were presented at the event.

SINGAPORE COMPANIES EXHIBIT

AT HANNOVER MESSE 2018

To support Singapore companies in capturing new markets, innovation and partnerships, Enterprise Singapore (ESG) and the Singapore Precision Engineering and Technology Association (SPETA), in partnership with the Singapore Economic Development Board (EDB), led 39 Singapore companies to Germany on business missions and to participate in Hannover Messe 2018. This was the first-ever Singapore Pavilion at the top industrial technology show. Enterprise Singapore and the Asia-Pacific Committee of German Business (APA) also organised the biennial Germany-Singapore Business Forum 2018 (GSBF 2018) at Hannover Messe 2018.

This significant partnership between ESG, EDB, SPETA and APA is aimed at facilitating collaboration between Singapore SMEs and German Mittelstand (small and medium-sized companies in Germany), thereby helping more Singapore SMEs expand their global networks, learn best practices, access new capabilities, form new partnerships and tap new customer segments.

Nineteen companies showcased their advanced manufacturing products and services within the two Singapore Pavilions at Hannover Messe. After the show, 22 companies from the manufacturing and energy sectors continued on two business missions. Over 180 delegates from Singapore and Germany attended GSBF 2018 which featured panel discussions on co-innovation and partnerships to tap business opportunities in ASEAN, followed by B2B business matching sessions.

Singapore has developed a vibrant innovation ecosystem with strong manufacturers and manufacturing solution providers, as well as startups and research institutes. The country's strengths in innovation, along with its track record in manufacturing and business networks in Asia, make its companies, including startups, ideal partners for German companies seeking expansion into Asia.

Partnership with German Accelerator

To improve market access for startups from both countries and promote Singapore as an ideal regional launch pad for German startups, ESG signed a Memorandum of Understanding (MOU) with German Accelerator at GSBF 2018. Both organisations will facilitate bilateral partnerships for innovation, knowledge exchange and the sharing of best practices.

The MOU signing was witnessed by Mr S Iswaran, Minister for Trade and Industry (Industry), the Guest-of-Honour at the event.

New Singapore-Germany partnerships formed

Two new partnerships were also announced at GSBF 2018, with the MOU signings witnessed by Minister Iswaran.

ESG facilitated SPETA's partnership with German industry association IVAM FACHVERBAND Für MIKROTECHNIK (IVAM) to collaborate on the adoption of Industry 4.0 technologies and microtechnology. As a start, each party will have the particulars of its members also listed in the other party's directory of members. This will further enable companies to connect with potential partners.

Composite Cluster Singapore (CCS), Sakura Tech and German companies Covestro and Hufschmied signed a MOU to establish a Composite Application Centre (CAC) in Singapore as a regional centre of excellence. The CAC will work closely with international leaders in composites research and provide a platform for companies to tap the latest technologies and create industry solutions. The four parties will drive innovation efforts and promote their products and services in overseas markets, especially in Asia.



Nineteen companies showcased their advanced manufacturing products and services within the two Singapore Pavilions at Hannover Messe 2018.

SINGAPORE INTERNATIONAL WATER WEEK 2018



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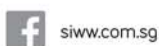
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INDUSTRIAL TRANSFORMATION

ASIA-PACIFIC 2018 TO BE HELD IN OCTOBER

The inaugural Industrial Transformation ASIA-PACIFIC, organised by SingEx Exhibitions and international partner, Deutsche Messe, will be held at Singapore EXPO, from 16 to 18 October 2018. The first-of-its-kind trade show for the Asia-Pacific region will present the 4th Industrial Revolution to this region's manufacturing community which is showing readiness for the next wave of transformational change.

An immersive learning journey

This inaugural trade event will create a platform that evolves with the industry and is shaped by leaders and experts responsible for transformative initiatives. Industrial Transformation ASIA-PACIFIC 2018 will provide insights ranging from Industry 4.0, advanced manufacturing and smart supply chain management, to R&D, technology transfer and workforce development.

The event will serve industry sectors such as aerospace, automotive, biomedical sciences, chemical engineering, consumer goods manufacturing, electronics, marine & offshore and precision engineering, amongst others.

The event's 'Learning Journey' approach will engage the community, based on where they are in their current journey, under categories such as beginners, early adopters or trailblazers. This will inspire learning, deepen understanding and enable relevant collaborations and ideas to take shape.

While new entrants to Industry 4.0 can glean insights from simplified tracks with access to recommended solution lists and specially curated demonstration areas, trailblazers will benefit from content and solutions related to transitional phases of Industry 4.0 and future proofing businesses. Through keynote sessions and sandbox presentations, market leaders and innovators will share adoption experiences with the community, as well as contribute perspectives in advanced domains targeting product lifecycle solutions and skills training.

Industry insights

Steering and advisory committees have been formed to provide counsel and guidance for the achievement of regional strategic and business objectives via Industrial Transformation ASIA-PACIFIC 2018.

The steering committee consists of representatives from Singapore Economic Development Board; Enterprise Singapore; Singapore Tourism Board; and Agency for Science, Technology and Research (A*STAR). Members of the international advisory committee include representatives from ABB, Accenture, Beckhoff, Bosch, Dematic, Emerson, Fraunhofer Singapore, National Additive Manufacturing Innovation Cluster (NAMIC), Pepperl+Fuchs, Schneider Electric, Siemens, Singapore

Industrial Automation Association (SIAA), Singapore Manufacturing Federation (SMF), Singapore Precision Engineering and Technology Association (SPETA), TÜV SÜD and Yokogawa.

The inaugural event is projected to attract over 200 exhibiting companies, as well as more than 10,000 attendees, from over 30 countries.

Activities and programmes

Industrial Transformation ASIA-PACIFIC 2018 will include the following activities and programmes:

- The Showcase - An exhibition and demonstration of the applications of Industry 4.0 technologies and solutions on Industrial Automation, Additive Manufacturing, Digital Factory and Smart Logistics.
- The Career Forum - Showcasing career options in the development of future talent.
- The Knowledge Exchange Platform - Helping to close the knowledge gap, with multiple conference tracks covering business and leadership insights, technical and technology applications, case studies, panel discussions and practical approaches for Industry 4.0.
- The Learning Lab - An engaging demonstration area curated to showcase the applications of innovative ready-to-market products and solutions around the themes of Industrial Automation, Additive Manufacturing, Digital Factory and Smart Logistics.
- The Sandbox - Featuring presentations driven by communities, and driving conversations as well as debates addressing challenge statements and practical solutions for the progressive adoption of Industry 4.0.
- The Learning Journeys - Customised and curated journeys offering immersive experiences for attendees to better understand the value and benefits of Industry 4.0.
- The Startup Forum - Helping to forge links between young enterprises and potential investors, customers and partners.
- The Networking Platforms - Presenting opportunities for attendees to engage with peers and potential customers/partners at hosted receptions or during lunch breaks.
- Hosted Site Visits - To innovation centres in Singapore for attendees and conference delegates to get a first-hand experience of innovation in practice.
- The Interchange - A digital community platform to bring different industry players and communities into a common space, to address challenges or problem statements together, as part of an expanded ecosystem.

ATTEND TWO EVENTS IN ONE!

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People at the heart of digital railways



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EUROBLECH 2018

FOCUSES ON 'THE DIGITAL REALITY'

EuroBLECH 2018, the 25th International Sheet Metal Working Technology Exhibition, will be held from 23 to 26 October 2018, at the Hannover Exhibition Grounds, Germany.

Six months ahead of the show, around 1,400 exhibitors from 38 countries have already confirmed their participation at the event, taking up almost the same amount of space as the previous edition of the event which was held two years ago. EuroBLECH 2016 featured the products and services of 1,505 exhibitors from 41 countries, showcased over a net exhibition space of 87,800 m².

This year, the exhibitors will come mainly from Germany, Italy, Turkey, China, the Netherlands, Spain, Switzerland, Austria and the US.

Visitors to EuroBLECH, held biennially, include design engineers, production managers, quality managers, buyers, manufacturers, technical directors and experts from associations and R&D organisations. Visitors to this year's show can expect the complete spectrum of intelligent solutions and innovative machinery for modern sheet metal working, which will be presented via numerous live demonstrations at the exhibition stands.

Digital transformation and higher levels of automation are resulting in significant benefits to the industry, including increased efficiency and improved maintenance. These developments are reflected in this year's motto for EuroBLECH - 'Step into the digital reality'.

Industry 4.0 has become a major focus in sheet metal working, especially for small and medium-sized companies planning to invest in these technologies in the near future, in order to gain a competitive advantage in their markets.

The EuroBLECH exhibit profile covers the entire sheet metal working technology chain, including sheet metal, tube and sections (ferrous and non-ferrous); finished products, components and assemblies; handling; separation and cutting; forming; flexible sheet metal working; tube / section processing; machine elements; processing of sheet metal / plastic hybrid structures; joining, welding and fastening; additive manufacturing; surface treatment of sheet metal; tools and dies; controlling, regulating, measuring and testing; quality assurance; data pro-

cessing, hardware and software; factory and warehouse equipment; environment protection and recycling; safety at work; and research and development.

"The digital transformation is at the moment an important topic in the industry. This requires a close collaboration along the entire value chain, from production control to maintenance. The biggest challenge for companies in the sheet metal working industry is to create an intelligent manufacturing environment which is based on the secure exchange of data and the networking of machines and processes. EuroBLECH 2018 offers its visitors the possibility to find solutions for these challenges and to connect with business partners to help them with the integration of these processes, machines and systems into their production", said Evelyn Warwick, Exhibition Director, EuroBLECH, Mack Brooks Exhibitions, organisers of the event.



Two of the many exhibits at EuroBLECH 2016, the previous edition of the event.

A MODEL FACTORY FOR

THE MANUFACTURING INDUSTRY

A*STAR's Model Factory@SIMTech will facilitate the development and testing of technologies and solutions before implementation.

The Singapore Institute of Manufacturing Technology (SIMTech), a research institute under the Agency for Science, Technology and Research (A*STAR), launched The Model Factory@SIMTech in October 2017.

The A*STAR Model Factory initiative will allow companies to experience advanced manufacturing technologies, first-hand, in a learning environment, as well as collaborate with stakeholders to test-bed and jointly develop innovative solutions. The initiative will also be key to upgrading the skills of Singapore's manufacturing workforce, so that they are compatible with the latest Industry 4.0 (Smart Manufacturing) technologies.

As at 18 May 2018, the Model Factory@SIMTech has attracted, since its opening, a total of 2,781 visitors from 836 organisations, including 140 visitors from 48 overseas organisations.

Another model factory, the Model Factory@ARTC (Advanced Remanufacturing and Technology Centre), will be opened later this year.

MODEL FACTORY@SIMTECH

Located in the Synthesis Tower at Fusionopolis Two, in the one-north area, and covering 604 m² (6,500 ft²) of space, the Model Factory@SIMTech showcases cutting-edge, industry-ready, automated technologies that can be demonstrated in a 'lights-out' production environment. The factory has been built, utilising research knowledge and technologies from different disciplines such as manufacturing processes, automation, systems, and even microfluidic science.

The factory is a catalyst in the digital transformation of the manufacturing industry in Singapore.

PILOT-SCALE PRODUCTION LINE

A key feature of the model factory is its pilot-scale discrete production line which serves several functions.

Experience and experiment

SIMTech's advanced manufacturing technologies, collectively known as Manufacturing Control Tower (MCT) technologies, are demonstrated on a pilot production line that has the capability to make actual products, making it one of the few facilities of its type in the world.

This capability range extends from make-to-stock products, where similar products are made and stored in anticipation of customer orders, to make-to-order prod-

ucts, where parts are differentiated and made, based on specific customer orders which could even include a lot size of one.

Visitors to the model factory can better understand how MCT technologies can digitalise an actual production environment and transform it into one that can sense and think. Modelled on the concept of an airport control tower, MCT technologies collect, consolidate and display real-time data, together with relevant data analysis, on a centralised dashboard, customised to a specific company's needs.

This allows users to view all the real-time data at a glance, and make informed business decisions in a timely manner. Users can also leverage the 'what if' analysis feature to evaluate the effectiveness of their proposed measures before implementation.

The operational dashboard even allows organisations to do real-time monitoring on their mobile devices to allow for on-the-go decision-making processes.

Racer Technology, a local medical device manufacturing SME (small and medium-sized enterprise), was an early adopter of MCT technologies to track stoppages and efficiencies of machines, automatically generate production schedules that could react to unplanned production changes, and run customised workflows on mobile devices for prompt status updates. The company reported a 15% to 20% output improvement, and has set an improvement target of 30% to 40%, with the continued use of MCT technologies.

CKE Manufacturing Pte Ltd, a Singapore company specialising in precision machining services, was another early adopter of MCT technologies. Utilising these technologies to track machine yield, the company saw its manpower usage efficiency improve by 50%. CKE expanded its adoption of MCT technologies which now also track its energy usage and the performance of five of its shop floor machines, in real-time. The goal is to link up to 85% of its machines to the MCT, to continue boosting efficiency and growth.

The adoption of MCT technologies can also help in the performance of Quality Management, through tracking the quality of the product during the manufacturing process. The data generated allows users to take immediate remedial measures, whenever products do not meet the quality standard, thus reducing wastage of energy and resources.





*The A*STAR Model Factory initiative will allow companies to experience advanced manufacturing technologies first-hand in a learning environment, as well as collaborate with stakeholders to test-bed and jointly develop innovative solutions. The initiative will also be key to upgrading the skills of Singapore's manufacturing workforce so that they are compatible with the latest Industry 4.0 technologies. The Model Factory@SIMTech aims to achieve these objectives through its key feature - the pilot-scale production line.*

MCT's predictive capabilities can utilise historical data on the machines and information acquired in real-time, to predict when maintenance will be required and ensure minimum disruption to the production operations.

Companies interested in adopting the technologies can also test the solutions in the production line before implementing them on their own production floors.

Immersive learning

Classes held at the model factory incorporate live demonstrations and hands-on training on the production line. This provides companies with an immersive learning environment.

Exploring and co-creating

Using the production line as a test-bed, SIMTech will work with partners to explore and co-create new technologies through multi-disciplinary research teams or industry joint labs. The aim is to encourage public-private partnerships to benefit the local R&D ecosystem.

TWIN FACTORIES

Model Factory@SIMTech and Germany's Die Lernfabrik der Technischen Universität Braunschweig (The Learning Factory of the Technische Universität Braunschweig) are 'twin factories' that allow interested industry visitors at each location to leverage the complementary capabilities of both factories, for their potential adoption on their own production floors. For example, an SME concerned about the energy efficiency within its factory, would be able to access the complementary energy management capabilities of both SIMTech and TU Braunschweig, a member of the TU9 alliance of leading Institutes of Technology in Germany.

SIMTech's Energy Efficiency Monitoring and Analysis System (E²MAS) can assess the energy usage of machines in real-time and identify hotspots of excessive energy usage. Users can analyse the gathered data to develop

effective energy reduction measures. While SIMTech's production line allows users to trial the proposed measures at the machine level, users can also tap on TU Braunschweig's learning factory to trial the measures at the factory level.

The German learning factory is connected to supporting facilities such as air-conditioning and cooling towers, thereby simulating an actual factory environment and thus enabling users to obtain a more holistic feedback on the impact of the proposed measures.



The production line helps users to experience and experiment with advanced manufacturing technologies, benefit from immersive learning, as well as explore and co-create.



Cutting-edge, industry-ready, automated technologies can be demonstrated in a 'lights-out' production environment.

PARTNERSHIP WITH BOSTON CONSULTING GROUP

The partnership between SIMTech and Boston Consulting Group (BCG) allows BCG to help manufacturing companies improve their operations by tapping on MCT technologies. Concurrently, SIMTech leverages on BCG's experience with other model factories, to further improve its model factory. This enables SIMTech to strengthen the competitiveness of its offerings.

SINGAPORE INSTITUTE OF MANUFACTURING TECHNOLOGY

Singapore Institute of Manufacturing Technology (SIMTech) develops high-value manufacturing technology and human capital to enhance the competitiveness of Singapore's manufacturing industry. It collaborates with multinational and local companies in the precision engineering, medtech, aerospace, automotive, marine, oil & gas, electronics, semiconductor, logistics and other sectors.

With a pool of more than 400 researchers, SIMTech is committed to serving the manufacturing industry to develop the human, intellectual and industrial capital of Singapore.

PILOTING SMART MANUFACTURING TECHNOLOGIES

SIMTech has been promoting the use of Smart Manufacturing technologies to forward-looking companies in Singapore, including the SMEs. In 2017, more than 20 implementations of such technologies took place.

The institute helps to lower the barrier of adoption of Smart Technologies. For the companies, the

modular technologies offered are easy to understand, adopt and use. SIMTech helps companies overcome the complexities of these technologies, by providing a standards-based approach for interfacing with legacy systems. Companies now have the flexibility to choose to test and develop bite-size technologies, based on their needs.

FUTURE PLANS

SIMTech will continue to partner forward-looking companies to spearhead the adoption of Smart Manufacturing, including creating new digital technologies for the manufacturing industry through joint collaborative research projects.

The institute expects its model factory to be the place for companies, researchers and innovators, to co-create, testbed and develop manufacturing-related technologies for use in the industry in Singapore and beyond.

All images by A*STAR



A dashboard displays real-time data, together with relevant data analysis, customised to a specific company's needs.



The model factory will enable companies, researchers and innovators, to co-create, testbed and develop their manufacturing-related technologies for use in the industry in Singapore and beyond.

IOT STRATEGIES ENABLING THE SMART FACTORY

by Vincent Tang, Regional Vice President, Asia, Epicor Software

Major changes are taking place in the manufacturing environment.

Machine-to-machine integration and the Industrial Internet of Things (IIoT) are reinventing manufacturing as we know it, by giving birth to the Smart Factory that is connected, intelligent and aware - thereby enabling newfound levels of productivity and predictability to be reached.

While manufacturers have been collecting information from across the manufacturing floor, for decades, in recent years, the cost of installing smart sensors has gone down significantly, and analytics capabilities have grown extensively. As a result, today, we have the technology to go beyond data capture, to extrapolate and obtain 'near real-time' insights to inform and optimise processes for better outcomes. This is the concept of the Smart Factory.

Manufacturers can gain a lot from being more in tune with machines.

In its landmark study, 'The Internet of Things: Mapping the Value Beyond the Hype', the McKinsey Global Institute proclaimed the greatest potential for creating value from IIoT, for manufacturers, will be in operations optimisation - making the various processes within the factory more efficient. This includes using sensors, rather than human judgement, to adjust the performance of machinery. It also involves use of data from production machinery to adjust workflows, to eliminate unproductive practices, capacity erosions, inefficiencies and line performance bottlenecks. This is done by remotely tracking, monitoring, and adjusting machinery, based on sensor data from different parts of the plant (and even across plants). Researchers say IIoT applications in operations optimisation have the potential to create value of USD 633 billion to USD 1.8 trillion per year in the factory setting, by 2025.

Monitoring machines to harness and understand data can help manufacturers optimise machine performance by enabling more proactive, predictive maintenance. Using sensors to determine when machines need servicing can prevent breakdowns and save on routine maintenance costs.

Connecting equipment with sensors through a common platform can provide invaluable data about the ongoing condition of equipment, that can be analysed to predict potential points of failure, leading to equipment breakdowns and production shutdowns. In the event a breakdown does occur, organisations can analyse this data to determine the root cause and take corrective actions to prevent such occurrences in the future.

Monitoring can also deliver improved quality and production throughput, through greater uptime and overall equipment effectiveness, less scrap and rework, and

lower operating costs. Additionally, these efforts can support continuous improvement initiatives and contribute to heightened workforce engagement, by keeping front-line workers and management informed.

Remote monitoring, tracking, and control of equipment and workflow can also support additional efficiencies in optimised energy usage. The cost savings in this regard can be considerable.

Process control and traceability are essential, and IIoT can help manufacturers to 'level up'. Using sensor technology, manufacturers can track serialised and non-serialised components as they are received, warehoused and used to construct sub-assemblies and finished goods. Prior to the start of processing, traceability and production control can ensure that the correct part is being run, the correct machine program type is being used, the part was not previously rejected as bad, the part is at the correct operation (no process was skipped), the parts are not subjected to the same operation a second time, and that part orientation is correct for processing.

Inventory represents a significant cost for most manufacturers and an IIoT approach can reduce the potential of excess inventory via automated replenishment - where machines on the factory floor can signal when quantities are low and even 'order' more raw materials to ensure the line never shuts down, and that inventory is managed in a just-in-time, cost-effective manner.

Via IIoT, manufacturers can gain powerful capabilities to understand the overall health of operations, minute-by-minute, to take advantage of opportunities and mitigate threats, to support growth and profitability in today's fast-moving, ultra-competitive and highly complex manufacturing environment. However, the velocity and volume of data on the manufacturing floor can create hardship to manufacturing organisations that do not have the right technology infrastructure in place. Having the right software foundation to capture, analyse and act, is critical.

A unified reporting framework to simultaneously view and easily discern information from multiple, disparate data sources is just the beginning. Manufacturers need to have the operational agility to act on this data and



Mr Vincent Tang

apply these insights across design, engineering, manufacturing, delivery and servicing, and deliver immediate and actionable information to the relevant departments with greater speed, accuracy and efficiency, than ever before.

Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) systems take on newfound relevance in the IoT era and help manufacturers realise the

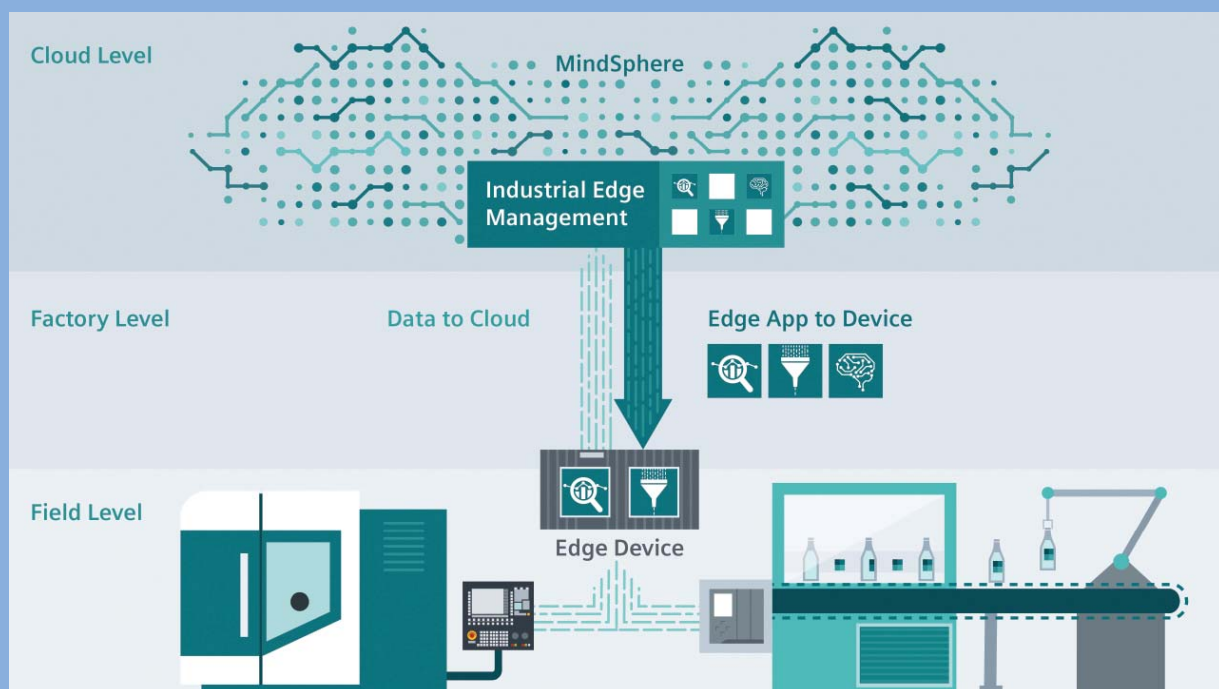
full value-add of big data/IoT initiatives as well as contextualise data and integrate it into downstream process flows. Functioning as the fabric that connects people, processes, data and things, in an intelligent and strategic manner, MES/ERP systems allow manufacturers to create value from new data streams, in order to succeed in achieving their most critical objectives.

Industrial Edge from Siemens adds benefits from the cloud at the field level

Siemens has introduced a digitalisation platform to the market, in the form of Siemens Industrial Edge. This extends automation devices by providing data processing at machine level and by bringing highly developed analysis technology and the intelligence of edge computing to the manufacturing area in a secure way. Siemens Industrial Edge offers users the possibility of executing a range of descriptive, diagnostic, predictive and prescriptive analytical applications. This allows cloud connectivity (data to cloud) to be used in combination with edge apps from Siemens, third party providers or end-users themselves, in an integrated hardware and software ecosystem (edge app to device) for automation components.

With Siemens Industrial Edge, Siemens is offering users the chance to close the gap between classic, local data

processing and cloud-based data processing to suit individual requirements. Edge computing allows large volumes of data to be processed locally. To this end, Siemens is releasing a broad spectrum of applications to users, including data processing, data visualisation via webservers, data transfer to the cloud or IT infrastructures, and quick innovation cycles in the development of apps. There is also an additional reduction in memory and transfer costs as large volumes of data are pre-processed and only the relevant data is finally transferred to a cloud or IT infrastructure. Siemens Industrial Edge supports cloud transfer protocols for MindSphere, Siemens' own open, cloud-based operating system. In the future, it will also support Message Queuing Telemetry Transport (MQTT), making data transfer safe, secure and effective.



Siemens Industrial Edge offers users the possibility of executing a range of descriptive, diagnostic, predictive and prescriptive analytical applications. This allows cloud connectivity (data to cloud) to be used in combination with edge apps from Siemens, third party providers or end-users themselves in an integrated hardware and software ecosystem (edge app to device) for automation components.

FROM SUBTRACTIVE TO ADDITIVE - A NEW ERA FOR MANUFACTURING

by Alvin Ng, General Manager, Jabil Singapore

The new technology could soon be used for high-volume production.



Mr Alvin Ng

For the past half-century, traditional manufacturing processes such as machining and injection moulding have been industry standards for high-volume production, due to their high quality, low cost and high speed. Additive manufacturing, also referred to as 3D printing, was then relegated to rapid prototyping and low-volume production runs.

Today, businesses are facing incredible time-to-market and cost pressures amidst increasingly compressed product life cycles and demand for product personalisation, thereby rendering traditional manufacturing technologies less effective. Couple that with the rapid progress that 3D printing has made in recent years, in the areas of equipment and materials, and it is no surprise that 3D printing has taken off in such a big way, going beyond manufacturing into markets such as healthcare. Considering the dazzling array of objects that can be 3D printed - from nanoscale metal structures and food to human body parts, buildings and potentially entire cities in the future - the possibilities for 3D printing seem endless.

Transforming manufacturing

The correlation between time-to-market and profitability is undeniable in the digital economy. Businesses are in a constant race to match consumer expectations and speed up delivery of products to the market. Relying on traditional manufacturing technologies to do so is no longer sufficient. Digital technologies, such as 3D printing, are key to helping companies survive and thrive in this challenging business climate.

3D printing empowers businesses to innovate and completely rethink the way they design and deliver products. With 3D printing, new product introduction (NPI) timelines can be substantially shortened. Designs can be accelerated through rapid prototyping techniques where multiple iterations can be tested quickly and efficiently while avoiding costly tooling. 3D printing can also remove many of the design constraints of traditional manufacturing, allowing parts which previously could not have been made, due to high tooling costs, to be made cost-effectively, now.

3D printing also provides the freedom to design complex and intricate parts without many of the constraints of moulding or subtractive processes. And it creates the potential for designing sub-assemblies that can be printed as a single part. In this era of product personalisation, the ability of 3D printing to make unique or customised parts in a lot size of one to a few, provides an unbeatable advantage over traditional manufacturing.

3D printing can also play a role in equipment maintenance management, allowing replacement parts to be cost-effectively built with 3D scanning technologies and 3D printing, thereby cutting inventory and storage costs.

Distributing manufacturing

Distributed manufacturing is changing how companies are incorporating 3D printing into their digital strategies. Distributed manufacturing enables the final product to be manufactured closer to the end-consumer via decentralised production. With 3D printing, manufacturers can better connect the physical supply chain with a continuous digital thread and manage products more efficiently, from concept to end-of-life. Manufacturing can be distributed to any location that has digital manufacturing systems in place, simply by sending a file. This enables more collaborative, transparent and efficient supply chain orchestration.

When coupled with an intelligent digital supply chain, 3D printing can magnify distributed manufacturing practices and overall success. With real-time insights into the health of supply chains, companies can analyse historical data and utilise predictive analytics to proactively respond to changing market conditions.

The next frontier

Using 3D printing to make production parts has been the subject of an ongoing conversation for the last few years, and it is only just beginning to make inroads on the manufacturing floor, largely due to existing 3D printing issues, such as print consistency, reliability of material and build properties, and material selection. According to a recent survey sponsored by global manufacturing solutions provider, Jabil, only 29% of surveyed manufacturers are currently using 3D printing for production parts.

Jabil and HP are collaborating to make 3D printing for production a reality. To demonstrate 3D printing's readiness for manufacturing, Jabil expedited the production of HP's Multi Jet Fusion 3D Printing System, by 3D printing parts for the printer after confirming that a wide range of components in the printer were candidates to be cost-effectively 3D printed. Comparing 3D printing and injection moulding, for the volumes desired, the difference in production costs was also carefully evaluated.

The results were remarkable. The design cycle was accelerated, achieving 19 design iterations for a part, in the

same amount of time that it would take to develop one using traditional manufacturing methods. In addition, a USD 20 printer part, made with traditional techniques, could be printed for less than USD 6 with the Multi Jet Fusion, while being 70% lighter.

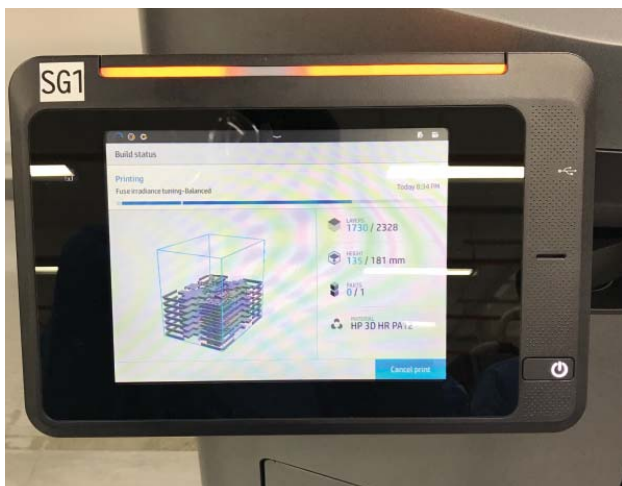
In addition to lowering time-to-market and cost barriers, there was also significant design flexibility. Components that once had to be separated into sub-parts with different screws and assembly requirements could now be produced as a single, 3D-printed part. These significant speed and cost-saving gains validated Jabil's belief that 3D printing is ready for manufacturing applications beyond prototyping.

A 3D-printed future

The outlook for 3D printing is exceedingly positive. The industry is set for healthy growth, with MarketsandMarkets valuing the global 3D printing industry at USD 32.78 billion by 2023, at a CAGR of 25.76%, between 2017 and 2023. As 3D printing technologies continue to break new ground and offer more practical applications for industries and consumers, the way we make and distribute goods in the future will truly be transformed.



Multi Jet Fusion printing in progress



A display screen shows the printing status.

Jabil introduces Additive Manufacturing Network

Jabil has recently introduced its Additive Manufacturing Network to drive greater manufacturing speed and agility while helping customers improve how they design, make and deliver products.

The Additive Manufacturing Network comprises a growing ecosystem of additive manufacturing capabilities and over 100 3D printers that are currently in operation at six Jabil facilities, located in the US, Mexico, Spain, Hungary, China and Singapore. A variety of 3D printing machines, that are capable of high-speed sintering, fused-filament fabrication, polymer and metal-laser sintering and other processes, have been installed to address growing customer needs in the footwear, industrial machines, transportation, aerospace and healthcare industries.

Through the network, Jabil's product designers in Silicon Valley collaborate with manufacturing teams in Singapore to accelerate the distributed manufacturing of products developed, using HP Multi Jet Fusion technology, including parts for HP's 3D printers. Jabil is currently producing over 140 parts for HP's Jet Fusion 300/500 printers, using the combination of Multi Jet Fusion technology and the Additive Manufacturing Network.



HP's Multi Jet Fusion 3D printers at Jabil's Singapore facility.

DIGITAL PRECISION FOR INDUSTRIAL 3D PRINTING

Siemens' Additive Manufacturing Experience Center in Erlangen, Germany, provides the opportunity to learn more about this increasingly important technology.



The Additive Manufacturing Experience Center features interactive screen presentations, besides a range of exhibits.

Siemens has opened the Additive Manufacturing Experience Center in Erlangen, Germany. The competence centre will serve to educate visitors, with a hands-on integrated approach to industrial 3D printing.

The Additive Manufacturing Experience Center targets machine builders, machine operators and companies who use 3D printing to design and construct workpieces. The new centre is designed to showcase Siemens' holistic approach to digitalisation in the field of industrial additive manufacturing, and features a range of exhibits and interactive screen presentations. Covering digital product design and development through preparation for printing to actual industrial 3D printing, the new competence centre offers customers the opportunity to learn more about the process, experiment with additive manufacturing machines and robots, and work with Siemens experts to devise their own solutions.

Additive manufacturing is revolutionising industrial production for machine and product manufacturers, poised at the transition from prototype and small series produc-

tion, using stand-alone machines, to fully industrialised series manufacturing. What counts here are productivity, process stability, end-to-end data chains, speed and quality, as well as IT security. Additive manufacturing provides the answer for highly flexible, fast and efficient production.

The 3D printing of workpieces enables even the most complex designs to be seamlessly manufactured in a single process, in a shorter period of time. It allows the creation of contours and shapes with a degree of precision and complexity that are not possible to achieve using conventional methods of manufacturing. Digitalisation has a central role to play here. Using integrated software and hardware solutions for every value creation phase, the entire digital additive manufacturing process chain can be depicted in a single, integrated software environment. The workpieces are digitally designed and their production is simulated and tested in the digital world, before the order to print is sent to the 3D machine. The tools used for engineering, simulation, production preparation and 3D printing are collated in a single inte-

grated system, and operated using a standardised user interface. This eliminates the need for data conversion with all the associated potential for loss of information content. Just how this works in practice will be demonstrated in the new Additive Manufacturing Experience Center, using equipment including a hybrid 3D printing machine using laser technology and a multi-axis robot with print head.

Also supported is the complete range of processes from design through engineering and production to the manufacture of spare parts, using data from MindSphere, the open cloud-based IoT operating system from Siemens. This allows process data to be collated and evaluated, resulting in continuous process improvement. The Siemens approach to additive manufacturing entails continuous product and production optimisation. This is achieved with the help of the digital twin which incorporates all the data and information relating to the product, its production and its performance.

As a result, industrialised additive manufacturing is no longer just a futuristic vision, but has already become a reality.

There are thousands of additive manufacturing machines already in operation performing industrial applications around the world. Siemens is also making intensive use of additive manufacturing machines in its own production plants, and playing a leading role as a provider of additive manufacturing and associated services. The company plans a significant expansion of its activities in the field of industrial additive manufacturing.



The equipment within the Additive Manufacturing Experience Center includes a Lasertec 65 Hybrid 3D printing machine using laser technology, from DMG Mori (on top), and a multi-axis robot from Comau, that runs via Run MyRobot /Direct Control (below).

Exceptionally long service life

Siemens offers its customers a wide range of services beyond the procurement of software and/or hardware. This includes 'Long Life Repair' - an extended service package of up to 25 years for machine components and plants in, for example, the automotive industry. Benefits for the customer include advantageous pricing, due to low-cost repair work, product upgrades and extended plant availability.

Sustainable machine use

The 'Long Life Repair' service is available for selected Simodrive modules, Sinamics S120 6SL modules and, in the near future, also for Sinumerik NCU. Siemens is thus offering a complete solution which includes short delivery times, long-term availability of original spare parts, cost-efficient repairs, and service cover for up to 25 years. The objective is to increase the productivity of the components as well as to operate a sustainable and cost-efficient business. In addition to this, customers benefit from avoiding component failure due to wear, constant service and support, and the option of bridging the time to retrofitting or new procurement.



With the 'Long Life Repair' offering, Siemens is providing customers with the reassurance of an extended service package for plant components.

ACHIEVING SUPERIOR CLEANING EFFICIENCY

Water-based cleaning with alkaline, neutral and acidic media is the technology most frequently employed in industrial processes. They include automobile manufacturing or the production activities of supplier industries, medical equipment production, mechanical engineering, machining, punching, drawing or bending of components, precision mechanics or optical devices.

Ecoclean offers an extensive range of both standard water-based cleaning systems and customer-specific designs.

EcoCflex 3 robot cell

Short cycle times and high flexibility have made robot cells an important item in preliminary, intermediate and final cleaning of engine and transmission parts, such as cylinder heads and crankcases in automotive manufacturing. In the EcoCflex 3M/3L, from Ecoclean, the SCARA manipulator, developed specifically for use in cleaning equipment, has replaced the adapted, six-axis, articulated arm robot. The unit's rugged design, based on the use of high-strength aluminium and high-grade steel, augmented by an IP 69 protection class rating, enables it to resist high-pressure water jets and makes it submersible. The robot and its control system have been matched to the application, and the assembly can be operated conveniently via the CNC controller of the cleaning machine. The need for a separate PLC controlling the robot, has thus been eliminated. Equipped with application-specific innovative process technology, the EcoCflex 3 enables high and low pressure processes as well as injection flood washing to take place, flexibly, in one cleaning station.

Chamber systems

The diverse tasks related to degreasing, intermediate and fine-cleaning of parts across a broad range of general industry applications, are covered by Ecoclean with a range of different water-based cleaning systems. The EcoCube, an optimum entry-level model, is suitable for a variety of functions. With installation dimensions of only 2100 mm (L) x 1630 mm (W) x 1855 mm (H), in addition to low weight, this compact unit can be integrated into a manufacturing line easily and in minimum time. It reaches the operating temperature quickly and in an energy-efficient manner.

The EcoCwave with its vacuum-tight work chamber is designed for immersion and spray processes, ranging from coarse through intermediate to ultra-fine cleaning. It is equipped with two or three tanks as standard, depending on the application. These tanks are mounted upright and have a flow-optimised design, to prevent the formation of chip or dirt pockets. In addition, each tank has its own separate cleaning fluid circuit, with full-flow and bypass filtration. Thanks to an optimised rollover

unit in the work chamber, the fluids and mechanical cleaning devices, eg ultrasonic units and spray nozzles, can reach the product effectively from all sides. This helps to improve cleaning quality and increases the fluid lifetime, thereby reducing cleaning costs.

The EcoCmax systems can be easily adapted to the contamination type and specified cleanliness level, by adjusting the cleaning programme. A single-chamber system for three-stage cleaning processes plus drying, it features full-flow filtration in the work chamber filling and draining circuit, as well as continuous bypass filtration on all flood tanks for reconditioning the rinsing baths via an integrated evaporator with heat recovery.

Process reliability

Starting out from a specific part geometry, material, contamination and cleanliness requirement, UCM AG, the precision applications business unit of the SBS Ecoclean Group, develops made-to-measure cleaning processes and corresponding ultrafine cleaning equipment based on ultrasound technology. These ultrafine cleaning systems are built to deliver high levels of cleanliness, reliably and efficiently. To this end, they are equipped with UCM's proprietary four-sided overflow system as standard. Another feature of these machines is that all components, eg tanks, storage vessels, pipelines etc, come with a flow-optimised design to prevent accumulations of foreign matter or stagnant water.



EcoCflex 3 robot cell sets are used in the cleaning of automobile engine and transmission parts. Image by Ecoclean.



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DOCTOR ROBOT

WILL SEE YOU NOW

by Swaminathan Vangal-Ramamurthy, General Manager, Robotics Business Division, Omron Asia Pacific

With its beneficial impact on the healthcare industry already visible, robots are poised to play an even greater role in the future.



Mr Swaminathan Vangal-Ramamurthy

The healthcare industry, which is facing a severe human resource crunch, is getting a shot in the arm in the form of automation technology. Now, there are automated equipment, and even robotic workers. Will robot scientists be next on the horizon?

Medical workers face immense pressure at work, especially in hospital and critical care environments where many workers work shifts and manage patients who need constant medical attention. Add to this a severe shortage of skilled healthcare workers at many of these facilities, especially in rapidly ageing societies like Hong Kong, Japan, Singapore and the United Kingdom, and you have a 'pressure cooker' industry.

Robotic technology may just be the answer to some of these challenges in the healthcare industry. Robotic equipment with Internet of Things (IoT) connectivity can communicate with other devices to coordinate and synchronise data directly. Advanced sensors also allow robots to independently perform mundane, rudimentary and time-consuming tasks. With Artificial Intelligence (AI) technology developing rapidly, there is a rising possibility that robots can take on much of the work that needs to be done in healthcare.

Smarter connected equipment

The proliferation of connected devices, or what is now commonly called IoT (Internet of Things), is changing the way we work, live and play. For example, our smart phones are more than just telephones and personal digital assistants - they have also become our entertainment centres, primary information and news outlets, messaging and video conferencing tools, and so on. We have come to completely rely on IoT devices.

Smarter connected devices are also quickly being adapted in the healthcare environment, often replacing traditional equipment that are susceptible to unexpected and undetected failure. Smarter equipment can be programmed to quickly alert staff on equipment faults, so that they are corrected and the equipment is functioning well, when needed, thereby ensuring the accuracy of patient data.

In a more futuristic setting, smarter beds can help staff accurately monitor patient progress by tracking their

movements, sleeping patterns and vital signs like heart rate and blood pressure, thereby helping to ease manpower requirements. In another example, smart labels can be applied on medication to allow for automated tracking of stock. This way, inventories can be updated in real-time, with orders automatically placed when supplies run low.

Robots as support staff

Beyond smart connectivity technologies, robots can play a significant role in helping to ease the resource crunch by driving up efficiency and boosting productivity. Many robots are already deployed in healthcare facilities to take on mundane, rudimentary or time-consuming tasks.

Omron mobile robots, for example, function as autonomous vehicles, helping to quickly and safely move items, such as case files, bulky equipment, patients' meals or medicine, from one location to another, in hospitals.

Many hospitals across Japan are already using robots to deliver medicine in the night. In Singapore, where the Health Ministry estimates that it needs to fill 9,000 medical support positions by 2020 to meet rising demands of an ageing population, robots are also being tested in hospitals, especially for porter services - delivering items from point to point.

Autonomous vehicles equipped with advanced sensors can navigate hospital corridors and navigate around obstacles. Some are also capable of communicating with other hospital equipment or robots to inform on routing or call for the next available robot when service is required.

Robots are particularly useful for their ability to operate 24/7. Automated robots do not require much human intervention, and units can be replaced when they require maintenance or servicing. This way, they free up human workers so that they can attend to more complex tasks that require some form of cognitive analytical input or decision-making.

More than just logistics

Robots are not limited to performing mundane tasks such as transportation, however.

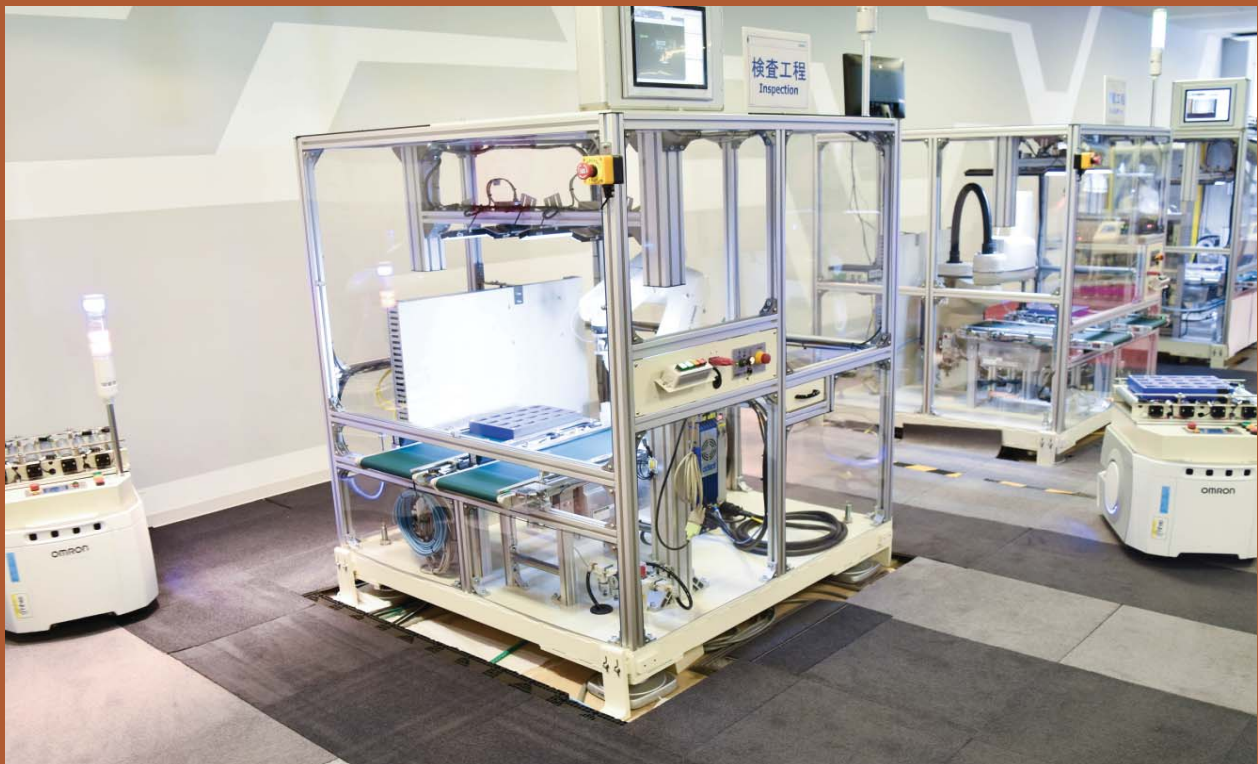
A robot 'scientist' named Eve could go into the history books for playing a pivotal role in the discovery of a possible antimalarial drug. The robot spotted Tricolan, a common ingredient in toothpaste, that could possibly limit the growth of the malaria parasite. This incredible feat was made possible due to Eve's ability to automate and accelerate the discovery process.

Another important sub-sector of healthcare that stands to benefit from robots is elder care. Nursing homes in China have started using robots to provide care for the elderly, whose numbers are increasing within the country. These robots are able to assist doctors and nurses monitor blood pressure and other health information. Robots also help to provide companionship to the elderly in nursing homes.

What is next?

The fact is that robots are going to be a mainstay in the healthcare and medical industry. They are already making an impact at basic porter services levels, and making a difference in drug discovery and care for the elderly. The true value that robotics bring to the industry will be hard to determine. For instance, robots now free up manpower that can be reassigned to focus on more value-added tasks. They also speed up many medical processes and have proved to be important assets to medical practitioners.

Needless to say, robotics technology will certainly continue to advance. Across the globe, thousands of malaria patients could benefit from Eve's discovery in time to come. With teams in corporate and university research labs making progress daily, in robotics, we may just be a day away from the next breakthrough.



Robots will play an increasing role in the healthcare industry. For example, they can function as autonomous vehicles that transport material, intelligently navigating around people and unexpected obstacles.

THE SCIENCE OF MAKING ENGINEERING

A MORE ATTRACTIVE PROFESSION

by Dr Jeffrey Tung, Head of R&D, 3M Singapore and South East Asia Region

Efforts are underway to identify the challenges and overcome them.



Dr Jeffrey Tung

The Smart Nation initiative is here to stay. From building greener homes to expanding transport networks, Singapore needs strong capabilities in science and engineering to take its development forward. In response to this agenda, Singapore has ramped up its efforts to grow talents and capabilities in science and engineering, such as the opening of the Singapore University of Technology and Design (SUTD) in 2012.

But despite efforts to groom more engineers in the nation, a recent survey [1], conducted by global science company 3M, revealed that fewer Singaporeans believe traditional science-related fields, such as engineering (15%) and physical science (4%), would lead to a satisfying career, in comparison to non-traditional science disciplines like business (32%), IT (26%) and education (23%). This brings up the following questions:

- Why is an engineering career lagging behind other fields?
- How can we better attract students and graduates to study and work in the sector?

Perception that engineering is still targeted at males

While engineering is enjoying the participation of more women now, it is still a field that is perceived to be male-dominated. In 2014, the Agency for Science, Technology and Research (A*STAR) reported that females comprised only 29% of research scientists and engineers.

According to Harvard Business Review [2], the core component of being an engineer lies in collaboration and teamwork. However, many female engineers are treated in gender stereotypical ways by their peers. For instance, some have been assigned routine managerial and secretarial jobs by either their male project mates in school or bosses at work, which excluded them from the spirit of an engineer's work.

Females are also more likely to revisit their ambitions when the engineering profession does not involve 'socially conscious' engineering work. Divergence in expectations is another reason female engineers end up leaving the profession before even starting their careers.

I believe one way to attract more females to the engineering field is through science outreach programmes

with education institutes. These are good platforms to spark students' interest through application-based learning regardless of gender.

At 3M, we run a similar initiative called the '3M Science Outreach Program' to champion science and engineering, in partnership with schools and universities. Through the programme, I have seen many participants, particularly female students, come up with innovative solutions. Overall, I believe such programmes will help the public minimise the gender stereotypes in the engineering field.

STEM is taken for granted in developed economies like Singapore

Perhaps ironically, I have observed that students who have grown up in more developed countries are more likely to take science and engineering for granted, as they pursue interests in other areas. Unlike students in less developed economies, who see science and engineering as a way out of poverty, students in Singapore are presented with more choices to pursue interests outside of STEM (Science, Technology, Engineering, Mathematics)-related fields.

For example, the 3M State of Science Index found that only 42% of Singaporeans see science as very important to their everyday lives, compared to 74% of people in India. Similar results were observed when we compared Japan (15%) against Brazil (72%).



A '3M Science Outreach Program' session in progress

NED

National Engineers Day 2018

Unlocking a Smart Future through Engineering Innovations
26 – 28 July | 9 am – 6 pm
Suntec Singapore, Level 3



Talks and Workshops

Available on 26 & 27 July



Lego Mindstorms
Workshop



Building
Structures
Workshop



F1 in School
Workshop



Rolls Royce AR
Workshop

National Engineers Day and Energy Innovation Challenge

The Institution of Engineers, Singapore (IES) is organising the 9th NED to celebrate the achievements of engineers, inspire young engineers and intrigue the young generation in engineering. NED comprises a series of fun and enriching activities demonstrating the ingenuity of engineers and the myriad of possibilities of an engineering career. Hence, do join us at Suntec Singapore from 26 to 28 July for a series of activities to know more about engineering.

This year marked the 4th run of the Energy Innovation Challenge inviting students from Secondary Schools, Junior Colleges, ITE, Polytechnics and Universities to work with professional engineering and business mentors to design or invent a product to solve and demonstrate the use of an alternative source of energy focusing on "smart engineering solutions" in the areas of mobility, living, services and health.

Mr Heng Swee Keat, Minister for Finance, will be gracing the Prize Presentation Ceremony on 28 July, as Guest-of-Honour.

Check out more information about NED at www.ned-ies.org.

For enquiries and sponsorship, please contact:

- Bai Fong at +65 6461 1255 or email to tan.baifong@iesnet.org.sg
- Spencer at +65 6461 1227 or email to spencer.soh@iesnet.org.sg

Experts and engineering professionals will be speaking on the following topics:

- 5 Reasons to Love Engineering
- Engineering in Natural Disasters
- Role of Engineering in Air Quality Control
- Magic and Engineering
- Structures & Design
- Artificial Intelligence for Engineering

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3M collaborated with a group of students to develop the 'Tesselations of Time' light installation displayed at SNF 2017.

Multidisciplinary programmes, blending science, engineering and art, are fun ways to reach out to the public and highlight the fact that STEM and the arts are two closely related disciplines. Such platforms include the Singapore Night Festival (SNF), i Light Marina Bay, and VisualSG.

Last year, we collaborated with a group of students to develop a light installation for SNF 2017. Leveraging on 3M science in film and light management, they created an interactive experience that brought 3M science to life in a fun way.

Once an engineer - always an engineer

There is also a perception that engineers are not able to venture out to try new disciplines. Er. Edwin Khew, President, Institution of Engineers, Singapore, mentioned that many engineers leave the industry after a few years in practice because of factors including the lack of effective career planning and job rotation [3].

Cognisant of this fact, 3M allows employees to gain exposure in different functions, businesses and geographies, and enables them to acquire diverse skill sets and experiences. Such employees could include those who are consistently high performers, key talents, high-potentials or who are ambitious to grow and stretch themselves. There have been many examples of R&D engineers moving to roles in business and other functions.

3M has also put in place a dual career ladder that allows upward mobility for its R&D employees. The dual career ladder is a way for the company to advance engineers and scientists with deep technical skills without moving them to management. Such engineers would enjoy the same benefits and prestige as managers.

This dual career ladder helps 3M retain talent within the company, while giving engineers opportunities to pursue a fluid career progression beyond the engineering field. In fact, just recently this year, 3M was voted the top

company to work for, in the engineering sector in gradsingapore's Singapore 100 Leading Graduate Employers survey.

Gap between scientists and society at large

A final reason why I think science and engineering lag behind other fields, in terms of attractiveness, is the lack of communication between engineers and the public. Good communication is crucial for engineers to promote their work beyond the scientific community.

In Singapore, our engineers may not necessarily communicate as well as international pop culture icons and scientists like the late Stephen Hawking or engineering entrepreneur Elon Musk. Or, it may simply be because they would rather focus on their research work than communicate, relying on their work to speak for itself.

I think engineers in Singapore can improve their communication skills by speaking publicly on their research. This can take the form of blogging, teaching, running lab tours for visitors, volunteering as guides for public exhibitions, giving public seminars, participating as panellists for roundtable discussions, mentoring youths, and even filming.

I strongly encourage members of our R&D team to improve their communication skills through multiple internal and external platforms, from hosting tours at the 3M Customer Technical Centre and labs, to conducting external talks and participating in panel discussions, such as the recent 'What's the Future of Science in Singapore' community discussion hosted by 3M and TEDxSingapore. For me, I also take on media interviews, such as a recent interview with a radio station to discuss the state of science in Singapore. These initiatives aim to give engineers and scientists platforms to champion science and engineering to the man on the street.

Optimism about the future

Fifty years ago, science and engineering were important to take us from 'third world' to 'first world' status. Fast forward to today, these disciplines have not lost their relevance and are crucial for spearheading Singapore's journey towards becoming a Smart Nation. By tackling the challenges described above, I believe that science and engineering can better its position among various options for a fulfilling and satisfying career.

References

[1] https://www.3m.com.sg/3M/en_SG/company-sg/about-3m/state-of-science-index-survey/?utm_medium=redirect&utm_source=vanity-url&utm_campaign=3m.com.sg/scienceindex

[2] <https://hbr.org/2016/08/why-do-so-many-women-who-study-engineering-leave-the-field>

[3] <https://www.straitstimes.com/lifestyle/so-who-wants-to-be-an-engineer>

EAB CONDUCTS ACCREDITATION EXERCISE FOR ENGINEERING PROGRAMMES

The Engineering Accreditation Board (EAB) has completed the first round of accreditation activities for the various engineering programmes offered by institutions of higher learning here.

These include the civil and environmental engineering programmes at NUS and NTU, biomedical engineering programme at the former and information engineering programme at the latter.

Each team of assessors comprises experienced local academics and industry players, as well as experts from overseas universities such as the University of New South Wales, University College London, and The University of Hong Kong.

The assessed programmes will be granted accreditation for up to five years depending on the outcome of the assessments.

Further accreditation exercises will be conducted in July, September and October for programmes offered by NUS, SIT and SUSS.

Set up in May 2002 by IES, the EAB accredits engineering programmes that are delivered and awarded in Singapore.

It helps to ensure that accredited programs are benchmarked to meet the standards of bilateral or global mutual recognition agreements, such as the Washington Accord.

Accreditation assists stakeholders, potential students and their parents, professional societies, and potential employers in identifying specific engineering programs that meet the minimum criteria for accreditation. This allows all parties to make informed decisions related to higher education, hiring, and so on.

Among other things, the accreditation exercises provide feedback to educational institutions for improving and developing educational engineering programs that can better meet the needs of the local industry.



A dinner was hosted at NUS for the assessors to interact with faculty in a relaxed and informal setting.

ER. KHEW RECEIVES NTUC AWARD

On 5 May 2018, IES President Er. Edwin Khew received the Working People's Advocate Award from the National Trades Union Congress (NTUC), during its annual May Day Awards ceremony, held at Mediacorp's MES Theatre.

The Working People's Advocate award category is for leaders of associations and organisations who have demonstrated and supported the Labour Movement values.

Er. Khew was nominated for the award by NTUC U Associate (UA), where he serves as the Chief Fellowship Officer amongst U Associate leaders.

"He is always the go-to person when there are challenges and follows through projects with NTUC by providing valuable advice to the joint working-level team. He also went the extra mile to lead the UA leaders on new initiatives like UA Exchange and bonding activities to have a balance of work and play.

"IES is a strategic partner of UA and Edwin is the pivotal person in his role as a Steering Committee member for all IES-NTUC engineering sectoral programmes. He (also) ensures that the quality of the programmes and speakers are of professional standards," said his citation.

Congratulations to Er. Khew for receiving this award!



Er. Khew received his award from then-Secretary-General of NTUC, Mr Chan Chun Sing. Photo: NTUC

THUMBS UP FOR BUILDING FACADES AND FIRE SAFETY SEMINAR

Last year, building fires at Toh Guan Road in Singapore and Grenfell Tower in London took the media spotlight, especially in the case of Grenfell, with its rapid spread and large number of casualties.

The cause of these high-profile incidents were reportedly linked to the use of non-compliant cladding for the building facades.

To facilitate knowledge-sharing between the industry and academia in the field of fire safety and facade engineering, *The Singapore Engineer* organised the inaugural Building Facades & Fire Safety Seminar on 19 April 2018.

Held at Copthorne King’s Hotel, the seminar attracted some 140 participants who were practicing engineers and fire safety managers in both the public and private sector, among others. Due to overwhelming response, many who were interested had to be put on a waiting list.

MP for Nee Soon GRC Er. Dr Lee Bee Wah was the guest-of-honour for the event. In her welcome address, Er. Dr Lee, who is also an IES Honorary Council Member and Past President, urged all stakeholders to “adopt a good practice to strengthen fire safety”.

“We must have pride in our work. Checks must be thorough. Fire systems must be in good working order. Staff must be vigilant and continuously upgrade their knowledge,” she added.

The invited speakers provided valuable insight into various issues, such as fire safety engineering, material performance and testing, as well as standards development.

Over the course of the full-day seminar, participants picked their brains on these matters in two moderated panel discussions. It was extremely well-regarded and many suggestions for improvements and future seminar topics were received.

The Publications Committee would like to thank all sponsors (Mitsubishi Electric Asia; Standards Development Organisation @ IES; 3M), supporting partners (e2i) and participants for making the seminar a resounding success.

Technical summaries of the topics discussed during the seminar will be published in upcoming issues of *The Singapore Engineer*; so do stay tuned!



Dr Tarek Haddad, CEO, Architecture & Display Asia, 3A Composites, shares his insight on fire retardancy considerations for the use of aluminium composite materials in building cladding.



The speaker panel for the first half of the seminar taking a question from the floor.



The seminar venue was filled to capacity.

IES MEMBERS NIGHT:

WILL WRITING RETURNS FOR A SECOND RUN

Back by popular demand, Mr Yeo Wee Khin's talk on will writing was held again for the third Members' Night this year on 15 March 2018.

With his kind sponsorship, members were able to enjoy both the complimentary talk and networking dinner. His lively and engaging manner of speech ensured that a great deal of knowledge was passed to our members, such as:

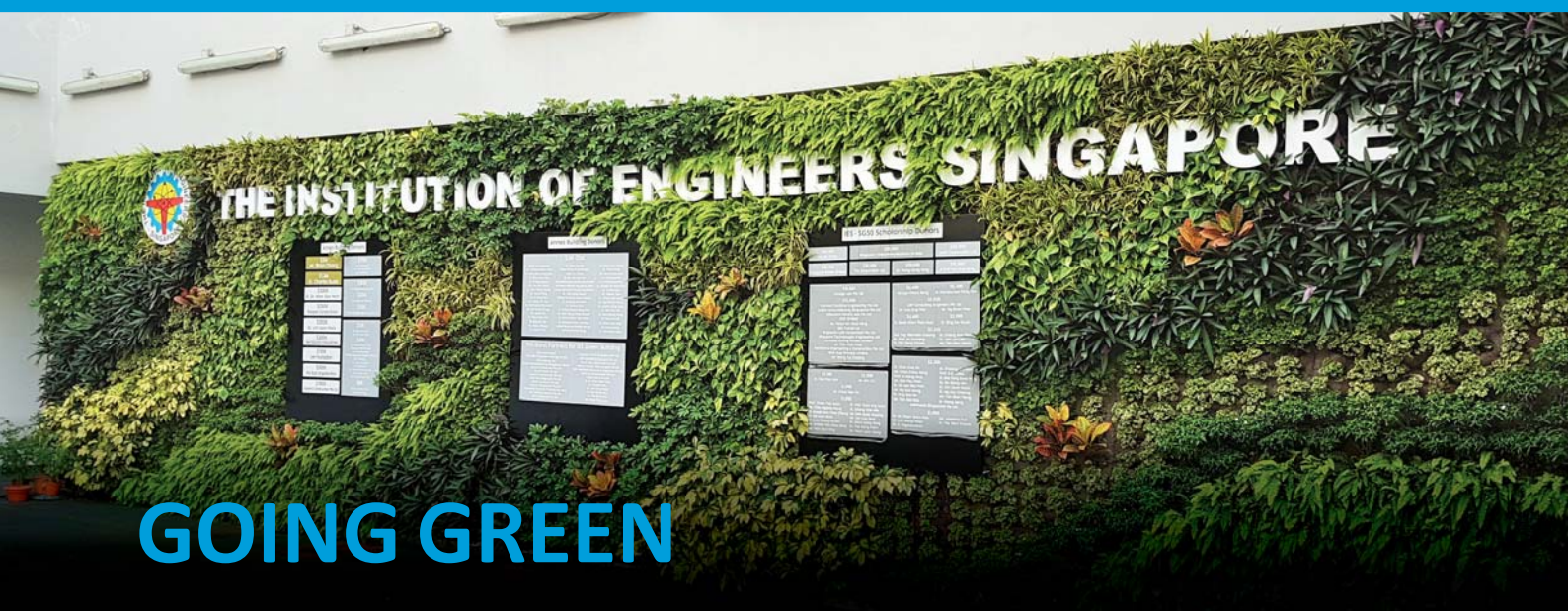
- Both the Lasting Power of Attorney (LPA) and Will are legal documents which set to distribute one's estate to one's appointed beneficiaries. A LPA operates after the donor loses his mental capacity, while a Will operates only after the will-maker's death.
- To be valid, the LPA document must be registered with the Office of the Public Guardian (OPG).
- Without a Will, a person's estate will be distributed in accordance to Singapore's Intestate Succession Act, except for those of Islamic faith.
- With a Will, one can specify his/her beneficiaries and what they will receive; appoint guardians for children



Mr Yeo Wee Khin illustrating his points with real-life examples.

who are minors to ensure that their health and education are taken care of, and enable beneficiaries to get a Grant of Probate to administer the estate in just 3 months (compared to over a year without a Will)

IES is grateful to all participating members for greatly supporting this event.



GOING GREEN

We've spruced up the wall facing the boardroom on Level 2, and now our donor boards are ensconced within fields of green! This vertical green wall forms part of our efforts to introduce more plant life into our environs, and... even better; there's going to an exciting gardening project that will be set up on the roof soon!

Do drop by and check it out!



Mr Tan Yoong Heng,
Arup, Singapore Office Leader

WHAT MAKES A CITY RESILIENT?

Cities are a thriving hub of economic activity, opportunity and innovation. But given increasing population density, cities are also places where the accumulation of stresses and occurrences of sudden shocks may result in serious damages including social breakdown, physical collapse or economic deprivation. Unless they are resilient, cities in the 21st century face greater risks due to the complex web of urban systems and uncertainty associated with many hazards – notably climate change.

Singapore has been spared from natural disasters, but in recent years we have also felt the effects of changing weather patterns. Increased ambient temperature adds stress to our buildings and infrastructure, while the risk of slope failures and floods are higher due to intense rainfall. These changes strain our urban systems, which will be disruptive to many aspects of society if not thought about critically.

Singapore’s tagline “Not if, but when” is not just an effective counterterrorism measure, but also the city-state’s pragmatic and pre-emptive approach and attitude toward resilience. This strength is evidenced by our ‘hard’ approaches to mitigate, for example, the threat of floods attributed to climate change.

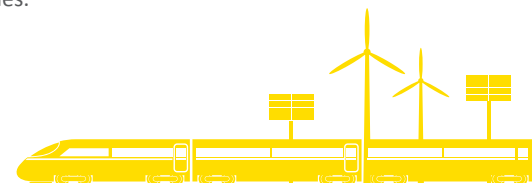
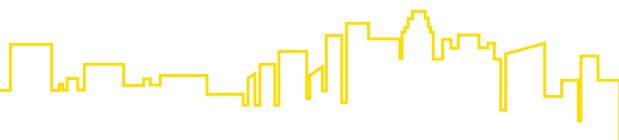
Authorities have led the way, collaborating with the public and private sector on feasibility studies for underground drainage and reservoir systems, and coastal adaptation measures. We are also building detention tanks, diversion canals, widening drains, and raising ground levels not just to protect buildings and roads, but also our MRT and air transport networks. The new Changi Airport Terminal 5 will be constructed 5.5 metres above sea level as a flood prevention measure; drainage systems serving the terminal and runways will also be upgraded.

Yet as systems become increasingly interdependent, there is a pressing need to think about resilience not just as a symptomatic measure against a single problem, but as holistic, cross-disciplinary one for governments, corporates and even individuals to tackle.

Rotterdam’s integrated approach to flood resilience showed how an environmental problem could be turned into an opportunity to do better socially and economically. Strategies were developed to ensure measures employed are both socially and environmentally inseparable and sustainable. A national GPS-guided app was developed so that residents constantly know how far below the sea they are. To access public pools, children also need to earn diplomas that require swimming in clothes and shoes. Where climate change tends to be discussed in back-page editorials, scholarly articles on changes to the Arctic ice cap make front-page news. Climate change is everyone’s business in the Netherlands, and has become an economic export as countries tap into their expertise.

They have gone beyond engineering hard approaches to inculcating a sense of shared ownership amongst its people – an aspect that falls under one of the four dimensions mapped out in the City Resilience Index (CRI). Developed by Arup, in partnership with the Rockefeller Foundation, the CRI provides a comprehensive, technically robust, globally applicable basis for measuring city resilience.

The environmental, economic, political and social dynamics are different in each city. Every urban area should have a unique, integrated urban resilience strategy. Cities need to start thinking, talking and planning for resilience as it is not only central to the natural and built environment, the economy, but as a way of life, for the wellbeing of its urban communities.



ADVERTISERS’ INDEX

B P (Systems) Engineering Pte Ltd	Page 15
CAFEO	Inside Back Cover
CMCEE 2018	Inside Front Cover
Goodrich Global Pte Ltd	Page 13
Mitsubishi Electric Asia Pte Ltd	Outside Back Cover
MultiNine Corporation Pte Ltd	Page 39

National Engineers Day 2018	Page 43
Singapore Institute of Technology	Page 10 & 11
Singapore International Transport Congress and Exhibition 2018	Page 25
Singapore International Water Week 2018	Page 19 & 23
Singapore University of Social Sciences	Page 01
ST Synthesis Pte Ltd	Page 17



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