

# MANUFACTURING MATTERS

October 2018 | Issue 4

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## FEATURE DIGITAL TRANSFORMATION AND INNOVATION JOURNEY MADE EASY AT MODEL FACTORY@SIMTECH

**EMERGING APPLICATIONS  
MATTERS**

SKIN-ON-CHIP USING MICROFLUIDICS  
FOR BETTER STRUCTURE AND  
PERFORMANCE

**SKILLS MATTERS**

OUR JOURNEY IN WORKFORCE  
DEVELOPMENT AND TRAINING  
FOR INDUSTRY

**RESEARCH SPOTLIGHT**

TURNING ORDINARY CELLS  
INTO TINY LASERS

## NOTE FROM EDITOR...

Dear Friends and Industry Partners,

“Industry 4.0” or “Digital Transformation in Manufacturing” is no longer a future trend. Commonly referred to as the fourth industrial revolution, the current trend of automation and data exchange in manufacturing technologies which include cyber-physical systems, the Internet of Things, cloud computing and cognitive computing, is already causing large-scale and sweeping transformation across multiple aspects of business, providing unparalleled opportunities for value creation, delivery, and capture. Companies need to embrace the fast evolving digital technologies to respond to the increasingly demanding customers’ expectations in order to remain competitive and relevant.

Aware of this need, the Singapore Institute of Manufacturing Technology (SIMTech), a research institute of the Agency for Science, Technology and Research (A\*STAR) and SkillsFuture Singapore (SSG) initiated the Digital Transformation & Innovation™ (DTI™) Programme. Its purpose is to train and guide key personnel of organisations to be **Digital Transformers** in leveraging digital technologies to transform the business value proposition, organisational processes, and staff, using the SIMTech-developed **Digital Transformation & Innovation™ (DTI™) Methodology**.

The DTI Programme details and benefits are highlighted in the opposite pages.

*Swee Heng*

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# DIGITAL TRANSFORMATION AND INNOVATION JOURNEY MADE EASY

Programme with many benefits prepares industry to be future-ready

Companies today face ongoing daunting challenges in the business environment ranging from volatile global business trends, disruptive technologies to meeting increasingly demanding expectations of customers. To become more competitive, many industry and business leaders are looking for a structured approach in exploiting digital technologies to transform their business. Easier said than done, a successful digital transformation demands changes to several aspects of the business such as operating model, process, revenue stream, products and services.

Help is now at hand for local companies to navigate through the complexity of the digital transformation journey. SIMTech launched the Digital Transformation & Innovation (DTI) Programme. It uses a proprietary methodology for this purpose. Under this programme, the participants are trained to become Digital Transformers and systematically achieve digital transformation in five stages to integrate information flow, systems and decision-making across the business value chain. The first stage of the



journey determines the objectives of the company's business. This is followed by understanding the business activity landscape and system architecture. Identifying transformation areas for the business is the next phase of the journey and initiatives are generated once the transformation areas are known. An action plan will be developed to initiate the transformation and innovation journey.

With the rapid advancement of Internet of Things (IoT) technologies and cloud computing, companies today have unprecedented access to a huge amount of data. The key challenge is to turn this data into actionable insights. Through the DTI Programme, participants will learn a methodical approach in analysing the information flow, generating business insights, and developing initiatives that will truly transform their business models. In addition, the programme provides a suite of digital use cases that help participants to think out of the box and envision how "technology can help

businesses to do things differently", which according to George Westerman, a Principal Research Scientist with the MIT Sloan Initiative on Digital Economy, reflects the true "value of technology" and the purpose of digital transformation.

The DTI Programme training is carried out in a learning environment where immersive learning is conducted at the Model Factory@SIMTech which allows companies to experience and experiment advanced manufacturing technologies first-hand, as well as collaborate with stakeholders to test-bed, and jointly develop innovative manufacturing innovative solutions. During the immersion, the participants can also tap on SIMTech's expertise in implementing various technologies for business use and experience in setting up a "smart factory".

Currently, SIMTech has started the DTI Programme with Teckwah Industrial Corporation Limited and Toshiba TEC Singapore Pte Ltd. Several companies,

such as Heraeus Group and CIBA Vision Asian Manufacturing and Logistics Pte Ltd are in the pipeline for subsequent participations.

To help more local companies to embark on digital transformation, SIMTech is partnering with the Singapore Precision Engineering and Technology Association (SPETA) and the NTUC LearningHub to expand the outreach of the DTI Programme.

In addition, the NTUC LearningHub will launch a series of training programmes such as Leadership, Visioning and Change Management to complement the DTI Programme. These soft skills are equally critical, especially for businesses that have very deep legacy and cultural roots.

**The DTI Programme trains and guides company key personnel to be Digital Transformers, using SIMTech-developed Digital Transformation & Innovation™ (DTI™) Methodology, to transform the business value proposition, processes and staff**



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3D Model of Planned Warehouse Layout Created During T-Up Programme



## IMPROVING EFFICIENCY OF WORKFLOW PROCESSES

Tan Teck Seng Electric (Co.) Pte Ltd [TTS] has been a supplier of electrical products to contractors and sub-contractors in the construction and building industries for more than four decades.

To constantly improve and keep up to date, TTS participated in the T-Up Programme where a SIMTech researcher was attached to the company to beef up its workflow processes. This resulted in better efficiency of the supplier ordering processes, increased visibility of inventory metrics, and analysis of warehouse space utilisation.

Harnessing the use of technology, TTS moved from faxed handwritten reports to more timely electronic reports of supplier's stock availability, allowing TTS to have a better gauge of the delivery lead time and to adjust orders accordingly. TTS also helped its supplier to automate their order processing, reducing admin processing time from approximately 10 to 2 minutes.

Through the T-Up Programme, TTS gained the capability to analyse and optimise inventory placement by using sales data and ordering patterns to create heat maps. This aids in visualisation of the order picking traffic and highlights any areas of congestion. 3D modelling simulation also allowed the study of warehouse space utilisation and layout to potentially increase warehouse space by up to 15 per cent.

Stock-aging analysis reports were also created to quickly identify fast-moving and high-margin items to be placed at the main warehouse. This reduces picking distance from approximately 50 to 5 metres and warehouse operators now spend less time and effort restocking fast-moving items.

“ The OMNI Programme has helped us identify, drill down, and resolve multiple problem areas through the use of different tools. The T-UP engagement enabled us to capitalise on the talent offered by SIMTech, who shared knowledge and insights with us. TTS has gained capabilities in managing our supply chain and warehousing space better as a result, allowing for greater improvement in operations and future growth ”

Ms Jane Tan, Organisation Change Manager, Tan Teck Seng Electric

*Note: The T-Up initiative, a multi-agency effort by A\*STAR, the Economic Development Board, SPRING Singapore (now Enterprise Singapore), IE Singapore (now Enterprise Singapore), and the Infocomm Development Authority (now Media Development Authority), involves seconding RSEs to local enterprises to access the pool of R&D talent in Research Institutes.*

For more information, please contact **Ms Ta Susiwati** at [ta\\_susiwati@hq.a-star.edu.sg](mailto:ta_susiwati@hq.a-star.edu.sg)

## FLYING HIGH AFTER OTR

Skyfy Technology (S) Pte Ltd, a vehicle telematics company that specialises in Fleet and Vehicle Management Systems (VMS), participated in the Operations and Technology Roadmapping (OTR) programme. Skyfy was determined to move up the value chain and become a product owner of their own Vehicle Management System (VMS v2.0) and aims to expand the business regionally.

After the OTR, Skyfy embarked on a Technical Feasibility Study, working with SIMTech to integrate the institute's On-the-go Planning and Monitoring Solution (OPMS) into their VMS v2.0, since renamed the Last Mile Logistics Management (LM2) product. Skyfy licensed the OPMS technology to be an integral part of their LM2 product due for launch in 2018.

“ It cannot be imagined how great the OTR can change the way company management works and thinks ”

Mr Joseph Ng, CEO, Skyfy Technology

Other initiatives implemented are their Mobile Digital Video Recorder (MDVR) and its mobile app, including the shift towards enterprise sales that target higher-value clients. To support these initiatives, Skyfy has added 20 jobs and continue to engage SIMTech and Republic Polytechnic to enhance their product's capabilities.

True to its intention, Skyfy expanded into Indonesia and Malaysia. It invested in Customer Relationship Management and payroll consultancy, as well as automating their sales channels to increase productivity. From these initiatives, a 20-30 per cent increase in sales in 1-2 years is projected.

For more information, please contact **Mr Jeffrey Pan** at [sppan@SIMTech.a-star.edu.sg](mailto:sppan@SIMTech.a-star.edu.sg)



## SKIN-ON-CHIP USING MICROFLUIDICS FOR BETTER STRUCTURE AND PERFORMANCE

The skin-on-chip provides substitute to animal testing for pharmaceutical and cosmetic products

Current state-of-the-art alternatives to animal testing for the development of pharmaceuticals and cosmetics have drawbacks. These three-dimensional tissue models generated from static cell cultures on a collagen matrix readily shrink and have low barrier function. This gives rise to uncertainties during permeation and irritation tests.

To overcome these challenges, a multi-disciplinary team from SIMTech and A\*STAR's Institute of Medical Biology produced a scalable credit-card sized device that simultaneously facilitates skin culture and testing. Skin cultured in the microfluidic device showed enhanced maturation of the top protective layer of the skin resulting in nearly two-fold increase in thickness compared to skins grown in standard static systems. The enhanced skin yields lower chemical permeability. As such, the skin-on-chip platform offers better structure and performance in permeability functions. It can also facilitate



downstream laboratory investigations using commercially available skin or natural skin. For the latter purpose, it has been used for testing of formulations for URAH Transdermal Pte Ltd and Denova Sciences Pte Ltd.

These enhancements are made possible by the use of microfluidics. In the microfluidic chip, a continuous flow mimics the function of blood stream, and generates pressure that induces fluid flow around cells. The stimulation promotes the formation of a superior basement membrane that anchors the top skin layer to the connective tissues, providing more reliable skin reconstruct.

**The researchers are currently automating the system, working to improve their model to better mimic natural human skin and providing a user-friendly, high-throughput platform for cosmetic and skin-care product screening tests**

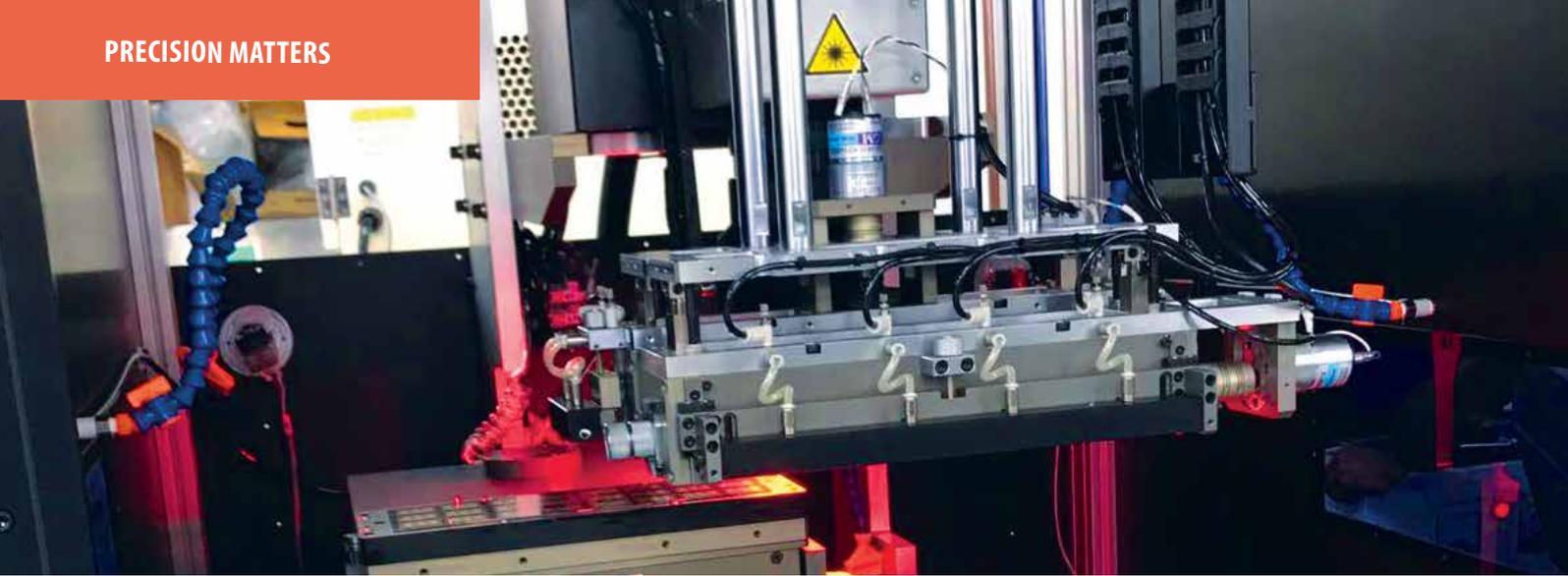
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# LASER MACHINING TECHNOLOGY FOR SINGULATION OF IC PACKAGES

Laser singulation is an attractive alternative to mechanical methods

Singulation of IC package is one of the critical processes in its manufacturing. These include singulation of Quad-Flat No-leads strips, Ball Grid Array packages, MicroSD, Interposer attached packages, MEMS chips, ND fan-out wafer/panel level packages. However, the current mechanical sawing of mould compound substrate electronic packages causes edge chippings, edge cracks, copper smear, edge copper burr and solder bridging, etc. Importantly, wet chemical slurry or cutting water causes current leakage during sawing. Other issues are the mechanical saw wear which caused unstable chip dimensions and slow the dicing speed.

It is not surprising that laser has emerged as an attractive alternative to mechanical methods for singulation of IC packages. However, this solution gives rise to edge thermal effect, material burning and ablation causing ejected material re-deposition which are the barriers for dicing of mould compound electronic packages. To overcome these challenges, SIMTech has successfully developed a proprietary singulation process for singulation of various lead frame MEMS substrates.

SIMTech co-developed a pulse width tunable nanosecond Near Infrared (NIR) fibre laser singulation system with Genuine Solutions Pte Ltd (GSP) whose business is in the trading, as

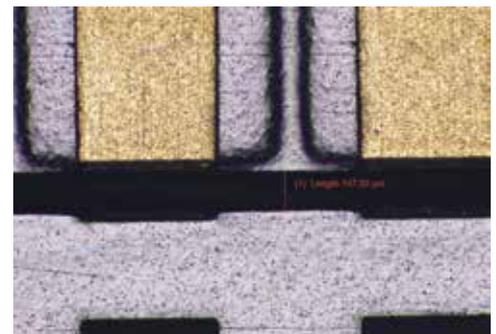
“ This project with SIMTech helped GSP gained technical recognition from our customer as a potential solution provider for laser applications in advanced package singulation on existing and new products development ”

Mr Sardjono Chainur, Director,  
Genuine Solutions Pte Ltd

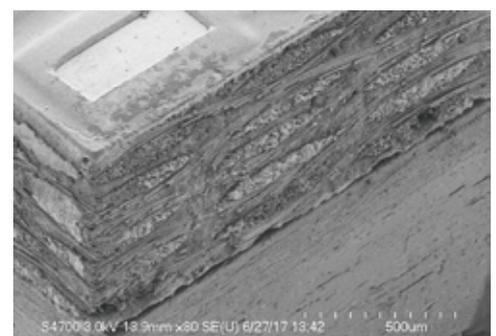
well as manufacturing and repair of semiconductor process and testing equipment. SIMTech transferred the technology to GSP for singulation of more than 15 types of lead frame packages.

The developed technology resolved the issues of copper lead smearing, edge burr, and edge chipping produced in conventional diamond sawing process. It is the first dry process to singulate Organic Land Grid Array (OLGA) flashlight package which avoid wet dicing liquid seeping into the packages causing reliability issues.

The collaboration enabled GSP to set up a laser singulation system in their customer premises. This is a new technology adopted for singulation process by this customer.



Top Surface of Interposer



Singulated Corner of Interposer with OLGA

For enquiries, please contact

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# ENERGY-EFFICIENT PROCESS FOR CERAMIC PARTS

## Gelcasting is a low-cost ceramic forming process

The industry is expecting an increasing demand in the manufacturing of ceramic high-end parts due to their various capabilities in performing under extreme conditions, with greater degree of industrial efficiency. The heavy machinery, automotive, energy, cutting tools and defence industries are some of the heavy users (Source: Global Advanced Ceramic Market Industry Report 2018-2024).

Although the ceramic industry is set for further growth, there are still challenges in achieving large and complex parts with low energy usage. For example, to produce a square ceramic plate of 200mm x 200mm x 5mm by the usual Powder Injection Moulding (PIM) process, a very high pressure and high temperature in injection moulding stage are required to create the green part, which consumes high energy. In addition, the equipment to do this is also expected to have a big footprint. Added to the higher cost of mould insert, is the corresponding increased parts complexity.

To address these challenges, Gelcasting

- an innovative way of processing ceramics with low energy consumption was developed.

Similar to conventional casting, the Gelcasting process makes use of a polymer binder system and a solvent to convert the ceramic powder into a slurry which is then poured into a mould. When the slurry is polymerised, it hardens and is strong enough to form a green part. The binder in the green part is further removed through a de-binding process before it is sintered to form the final product.

As such, Gelcasting has these advantages over the compaction or PIM process:

1. Faster process as additives need not be added homogeneously into the slurry
2. Follow-up finishing work is not required as the process is near net-shape
3. Significant wearing off of the cutting tools is non-existent. The

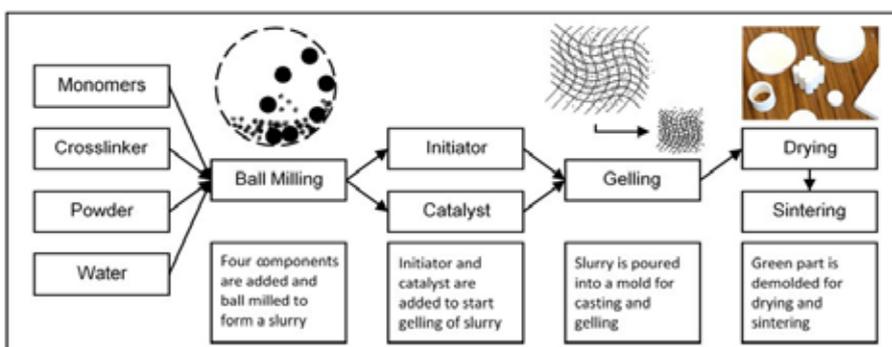
Gelcasted green parts are strong enough and yet not too hard to be machined to required shape

4. Energy consumption for Gelcasting is very low. Gelcasting requires only low curing temperature which makes polymer crosslinked to three dimensional structure and trapped ceramic particles to form green parts

5. Only "soft" moulds made of cheaper aluminium or plastics are required

SIMTech has demonstrated the potentials of the Gelcasting process in producing quality alumina ceramic parts, achieving high density of up to 97 per cent. The process can produce various shapes, forms with intricate features and the potential of larger than 90mm diameter parts with higher complexity.

**Gelcasting is especially suitable for ceramic products to be manufactured in high-mix and low-volume**



Flowchart of the Gelcasting Process

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## OUR JOURNEY IN WORKFORCE DEVELOPMENT AND TRAINING FOR INDUSTRY

New initiatives and programmes are set to upskill and upgrade PMETs and organisations for the next lap

The SIMTech-SSG WSQ training programmes were initiated in 2008 with the first PE WSQ Specialist Diploma Programme to transfer knowledge and capability to industry through case-studies and hands-on practical training to meet the technology and skills gap.

### Achievements

Since then, we have launched 23 WSQ Programmes with more than 4,300 PMETs (Professionals, Managers, Engineers and Technicians) trained, and over 6,600 SOAs awarded. More than 1,500 local companies from industry have benefited. Of these, about 70 per cent are Small and Medium Enterprises (SMEs), many of which give priority to manpower development and have repeatedly sent their employees to SIMTech for skills upgrading and learning.

The recent SIMTech-SkillsFuture Singapore (SSG) PE WSQ graduation ceremony celebrated the accomplishments of 620 graduands from 15 WSQ training programmes. Among them, 56 graduated with full PE Graduate Diploma qualifications, and 564 received their certificate(s) of Statement of Attainment. 210 companies were involved in this cohort of graduates.

For the second time, we celebrated 15 Manufacturing R&D Certificate (MRDC)

Programme graduates, who have completed their two-year programme, and are ready for deployment to the industry. The MRDC Programme, supported by SSG, was launched in 2015 to address gaps in equipping fresh graduates with industrial R&D experience and skills.

To ensure the relevance and demand of the training programmes, SIMTech actively engaged the industry for course promotion and contextualisation. A case in point is the collaboration with NTUC LearningHub which contextualise the OMNI programme for the F&B, Services and Logistics industry sectors to address their specific needs. About 100 productivity champions have been trained through this collaboration.

### New Initiatives and Programmes

To prepare for a future-ready workforce and industry, new skill sets or capabilities are required in the complex ever-changing manufacturing environment. In partnership with SSG, SIMTech is establishing new training programmes under SSG's Advanced Manufacturing Series to support local companies to embark on their journey for digital transformation. These include a graduate diploma programme in Industrial Automation, modular programmes in Advanced Manufacturing Processes, and a portfolio of Learning Programmes in

Digital Manufacturing. More details of these new initiatives and training programmes will be provided in due course.

Another new initiative, Training Extension Partnership or TEP, is set up to leverage the strength of Institutes of Higher Learning and private adult training providers for workforce development and training. A Memorandum of Understanding (MOU) was signed with the Singapore Polytechnic and Temasek Polytechnic on productivity improvement collaboration through training for industry. The other MOU is with The Boston Consulting Group on Industry 4.0 and digital manufacturing.

### Acknowledgements

These positive outcomes would not have been possible without the strong support of SSG, constantly working out new ways and programmes jointly with SIMTech, to meet industry needs. Industry participants have also been very forthcoming in their support. Companies sent their employees to our training programmes, particularly those which have chosen us as their corporate training partner and repeatedly sent their staff to SIMTech for skills and competency upgrading.

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## Major corporate events were organised to engage industry and forge partnerships

### SIMTech Annual Manufacturing Forum (AMF) 2018, 18 July

With the theme, **Technology Partnership for Impact**, SIMTech's flagship conference was attended by 250 representatives from 175 organisations. In the Annual Manufacturing Lecture, Dr Lim Ser Yong, SIMTech's Executive Director, shared the Technology Extension Partnership Programme as the institute's future strategy.

The event also focused on the value capture of SIMTech-industry collaborations. Mr Ching Boon Khian, Senior Director-Garment Care Innovation, Philips Electronics (S),

spoke on Material Innovation: Key Success Factors in Partnering to Build New Capability. Product Innovation: Partnership with SIMTech to build the world's first 3D inspection system was presented by Mr Berne Chung, Managing Director, Component Technology Pte Ltd. A Memorandum of Understanding was signed with six Technology Extension Partners who adopt SIMTech's technology to develop products, solutions and services for end-users in different industries and domains.



MOU Signing at SIMTech AMF'18

### SIMTech 25th Anniversary Gala Dinner, 2 August

SIMTech's Silver Jubilee Gala Dinner graced by A\*STAR Chairman, Mr Lim Chuan Poh, was attended by 260 invited guests. In his welcome remarks, Dr Lim Ser Yong, SIMTech's Executive Director thanked partners, associations and related government agencies which contributed to the institute's growth and achievements.

A\*STAR Chairman highlighted SIMTech has played a strong role in assisting industry through technology development, technology transfer and knowledge transfer in his address. Chairman was presented the SIMTech 25th Anniversary Commemorative Publication which highlighted some of the institute's collaborations with industry. Thirteen industry partners, featured in the commemorative publication, were honoured with the SIMTech R&D award for their impactful partnerships.



SIMTech 25th Anniversary Gala Dinner

### SIMTech-SSG PE WSQ Graduation Ceremony 2018, 16 August

Graduands who have completed their respective SIMTech-SkillsFuture Singapore (SSG) Precision Engineering (PE) Workforce Skills Qualifications (WSQ) Programmes and the Manufacturing R&D Certificate Programme celebrated their graduation recently. Mr Ng Cher Pong, Chief Executive, SkillsFuture Singapore, graced this happy occasion.

Winners of the Most Inspiring Trainee Award were honoured. They are Mr Kwek Kok Kwong, Chief Executive Officer, NTUC LearningHub Pte Ltd; Mr Low Suan Teng Nicholas, EHS & Facility Specialist, Bell Helicopter Asia Pte Ltd, and Mr Sundaram Sampathkumar, QA Manager, Moveon Technologies Pte Ltd. The Best Industry Partner Award goes to NTUC LearningHub Pte Ltd, Mr Kwek Kok Kwong, Chief Executive Officer; Markono Print Media Pte Ltd, Mr Edwin Ng, Managing Director; ASM Technology Singapore Pte Ltd, Mr Kenny Kwan, Vice President, Technology and ZACD Group Ltd, Mr Darren Chew, Executive Director and Chief Operating Officer.



SIMTech-SSG PE WSQ Graduation Ceremony

### EAC Annual Conference 2018, 12 September

Industry attendees to this conference, themed **Building Flexible Hybrid Electronics Eco-system for Singapore Wearable Tech and Other Industries**, were kept abreast of the best practices and technological progress in Flexible Hybrid Electronics for Wearable Tech and other applications. Mr David Anthus, Senior Director of Engineering and Strategic Development, Jabil USA, presented on How Wearables are Driving Connected Health. Mr Abhay Bangi, Healthcare and Lifesciences Partner from Ernst & Young, spoke on the 1000 Wearables Medtech: Where the Future of Health is. Stretchable and Deformable Materials and Devices for Wearable Tech was shared by Prof Lee Pooi See, School of Materials Science and Engineering, Nanyang Technological University.

260 attendees from 140 companies also benefited from the networking and learnt about the showcased Wearable Tech Products Innovation by the SIMTech Collaborative Industry Project (CIP) participants on Smart Wearable Product Innovation.



EAC Annual Conference 2018

Collaborative Industry Projects (CIPs), initiatives, programmes and ready-to-go technologies are available to assist industry



## Inventory Planning

Inventory planning development to control rightsizing inventory and maximise performance.

For enquiries, please contact **Mr Chai Lai Sing** at [lschai@SIMTech.a-star.edu.sg](mailto:lschai@SIMTech.a-star.edu.sg)

## Manpower Scheduling

Manpower optimising tool to help planners in shift scheduling and manpower allocation to minimise labour cost.

For enquiries, please contact **Mr Marcus Chern** at [marcus\\_chern@SIMTech.a-star.edu.sg](mailto:marcus_chern@SIMTech.a-star.edu.sg)

## Real-Time Dashboard

A real-time dashboard that is customised to suit the company's needs and to connect multiple sources for congregation and analysis of real-time data.

For enquiries, please contact **Mr Gary Kwok** at [gary\\_kwok@SIMTech.a-star.edu.sg](mailto:gary_kwok@SIMTech.a-star.edu.sg)



## Last-Mile Logistics

A planning and tracking solution to improve the management of drivers/vehicles to effectively meet customer imposed pick-up and delivery requirements amidst recourse constraint.

For enquiries, please contact **Mr Gary Kwok** at [gary\\_kwok@SIMTech.a-star.edu.sg](mailto:gary_kwok@SIMTech.a-star.edu.sg)



## SIMTech Scalable Mobile Platform (SMP) Programme

This programme aims to enable the development of customised mobile platform to suit different needs, and to realise high mobility critical for easy maneuvering in cramped spaces and for effective docking.

For enquiries, please contact **Mr Tan Chee Tat** at [cttan@SIMTech.a-star.edu.sg](mailto:cttan@SIMTech.a-star.edu.sg)

## Functional Coatings for Glass and Ceramics

Functional coatings provide additional functions apart from protection and decoration. Glass and ceramics are used to assist companies in developing coatings for various functional purposes.

For enquiries, please contact **Mr Jason Goh** at [jason\\_goh@SIMTech.a-star.edu.sg](mailto:jason_goh@SIMTech.a-star.edu.sg)

## 3D Marking and Surface Engraving for Medical Devices

This programme aims to demonstrate 3D laser marking and surface feature engraving on complex surfaces with various base materials for medical devices.

For enquiries, please contact **Mr John Lim** at [kylim@SIMTech.a-star.edu.sg](mailto:kylim@SIMTech.a-star.edu.sg)

## Large Format 3D Printing with Laser Aided Additive Manufacturing (LAAM)

The LAAM technology utilises high energy laser beam for material deposition which enables 3D additive manufacturing, surface modification and repair with high flexibility to achieve good mechanical properties, wear and corrosion resistance.

For enquiries, please contact **Mr Tan Lye King** at [tanlk@SIMTech.a-star.edu.sg](mailto:tanlk@SIMTech.a-star.edu.sg)

## SIMTech Sustainable Manufacturing Centre Annual Conference 2018

2 November 2018 | 9.00am-5.30pm | Matrix, Biopolis Singapore, Breakthrough and Discovery Theatres, Level 4

This year's conference theme is **Resource Efficiency in Manufacturing**. Delivering the keynote presentation is Dr Martin Vogt, Managing Director of VDI Resource Efficiency Centre (Germany), a competence centre of the German Association of Engineers (VDI) focusing on promoting resource efficient technologies and processes in small and medium sized businesses.

There will be a post-conference Master Class on Resource Efficiency in Manufacturing – Methodologies and Industry Practice by *Dr Martin Vogt*. Both events are complimentary. For registration, please visit <https://appsvc.a-star.edu.sg/ERP/EventRegistration.aspx?EventID=2018082915090427>

For enquiries, please contact **Mr Lee Hock Wee** at [hwlee@SIMTech.a-star.edu.sg](mailto:hwlee@SIMTech.a-star.edu.sg)



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### PE WSQ Apply Integrated Carbon Footprint Assessment Methodology (i-CARE)

8 October 2018 | 9.00am - 6.00pm, SIMTech, Fusionopolis 2

### PE WSQ Understand the Microfluidics Manufacturing Processes

8 October 2018 | 6.30pm - 9.30pm, SIMTech, Fusionopolis 2

### PE WSQ Graduate Diploma in Additive Manufacturing Module 1: Smart Additive Manufacturing System

23 October 2018 | 6.30pm - 9.30pm, SIMTech, Fusionopolis 2

### PE WSQ Implementation of Fundamental Lean at Workplace

24 October 2018 | 8.30am - 12.30pm, SIMTech, Fusionopolis 2

### PE WSQ OMNI Programme

29 October 2018 | 8.30am - 12.30pm, SIMTech, Fusionopolis 2

### Master Class in Mastering Sales and Operations Planning (S&OP) Process to Align Strategies for Operational Excellence

29 - 30 October 2018 | 8.30am - 5.30pm, SIMTech, Fusionopolis 2

### PE WSQ Graduate Diploma in Advanced Welding Technologies

#### Module 1: Design Arc Welding

20 November 2018 | 6.30pm - 9.30pm, SIMTech, Fusionopolis 2

### Master Class in Supply Chain Analytics – Descriptive, Predictive & Prescriptive Analytics

21 - 22 November 2018 | 8.30am - 5.30pm, SIMTech, Fusionopolis 2

For course details and registration, please visit <http://kto.SIMTech.a-star.edu.sg>

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#### About SIMTech

The 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.

SIMTech is a research institute of the Agency for Science, Technology and Research (A\*STAR). With a pool of more than 450 researchers, we are committed to serving the manufacturing industry to develop the human, intellectual, and industrial capital in Singapore.

