

# MANUFACTURING MATTERS

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## Dear Friends and Industry Partners,

The Manufacturing Productivity Technology Centre (MPTC), hosted at SIMTech, was established on 7 October 2011 to assist industry develop and adopt technology to improve productivity through ensuring effectiveness, enhancing efficiency and engineer value creation. To date, seven initiatives were rolled out by MPTC. The Centre is also tasked to promote the adoption of SIMTech technologies by industry with the launch of the A\*STAR Technology Adoption Programme last year.

To reach out to industry, MPTC has established strong partnerships with industry associations such as the Association of Singapore Marine Industries and the Singapore Chinese Chambers of Commerce and Industry. More inroads are being made with other relevant industry associations.

The MPTC has helped more than 500 companies to boost productivity through collaborative industry projects (see Feature story and page 3 for details).

Do contact us at [yseow@SIMTech.a-star.edu.sg](mailto:yseow@SIMTech.a-star.edu.sg) to take the first step in your company's productivity journey.

**Ms Lee Swee Heng**

# TRANSFORMING SMEs

Seven initiatives were rolled out for industry to begin their productivity journey holistically. Results of productivity gains range from 30 per cent on average.

Companies can start their productivity journey by approaching the Manufacturing Productivity Technology Centre (MPTC) which is an avenue for manufacturing industries to use technologies, techniques, innovations and manufacturing capabilities to improve productivity for economic growth and sustainability. SMEs in the marine, precision engineering, construction and medtech industry besides general manufacturing, food manufacturing, retail, service and distribution have tapped its capabilities and benefitted from its assistance.

MPTC has developed seven initiatives since 2011 and has helped more than 500 companies improve productivity with these initiatives. These are:

- **Operations Management Innovation (OMNI) Initiative** to systematically guide industry participants identify productivity issues and generate productivity gains through classroom and practical sessions.
- **High-Mix Low-Volume (HMLV) Manufacturing Initiative** helps companies to improve their operational efficiency and service level through production planning, scheduling and shop floor tracking.
- **Lean Manufacturing Initiative** applies lean tools, techniques and concepts to identify and eliminate wastes through continuous improvement.
- **RFID for Resource Tracking Initiative** provides real-time visibility of personnel movements in access points at confined spaces in underground construction sites.



- **RFID for Supply Chain Track and Trace Initiative** provides track and trace for companies' operations and supply chain to increase visibility and productivity.
- **Industrial Automation Initiative** enhances productivity through the intuitive robotic path teaching software toolkit for the welding industry.
- **Overall Equipment Effectiveness Initiative** helps industries in improving machine performance, machine utilisation and quality of parts.

CKE Manufacturing is one of the SMEs that has benefitted from adopting the initiatives.

## CKE Manufacturing

A provider of precision machining services for the local and regional industries, CKE Manufacturing has been servicing various industries ranging from Oil & Gas, Marine & Offshore, and Aerospace to Semiconductor, Electronics, and MedTech. CKE Manufacturing implemented four of the seven productivity enhancement initiatives from 2011 to 2014.

MPTC, through SIMTech, trained productivity champions on the OMNI methodology by mentoring and guiding CKE Manufacturing staff to apply the methodology in the company to achieve plans for productivity improvements.



“**OMNI methodology is more holistic and suitable for SMEs. It has also fostered an active learning culture throughout the organisation**”

Mr Li Kwan Feng, Director,  
CKE Manufacturing

Arising from the training, CKE Manufacturing formulated and implemented an Enterprise Resource Planning system, the High-Mix, Low-Volume Production Planning & Shopfloor Tracking System and Lean Manufacturing Initiative.

The Production Planning & Shopfloor Tracking System of the High-Mix, Low-Volume Initiative provides total shop floor visibility and control, allowing CKE Manufacturing to respond to customers' requests effectively and improve resource utilisation on the production floor. Production planning is reduced and efforts to retrieve order status shortened using the system.



“**The new system has boosted labour productivity by 33 per cent**”

Mr Kwan Li Feng, Director,  
CKE Manufacturing

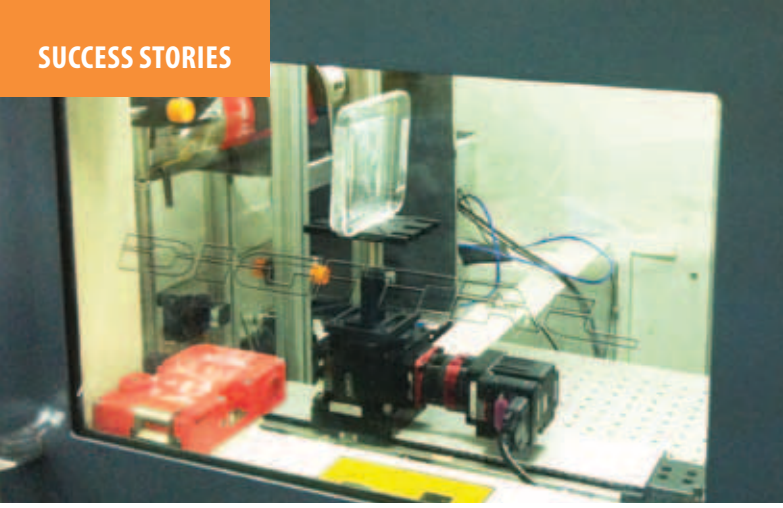
In Lean Manufacturing, trainees are equipped with the necessary knowledge and techniques to systematically use SIMTech lean implementation approach to continuously improve the company's operations. Lean techniques reduce waste and improve productivity on-site. As a result, on-time delivery improved.

Motivated by the productivity gains achieved through the initiatives, the company went on to implement the Overall Equipment Effectiveness (OEE) initiative to analyse individual machine performance and achieve marked improvement in the “up-time” of the machine. OEE champions were trained in addition to performing OEE data collection and OEE analyses on CKE machines. Throughput increased and manpower needed to man machines also reduced.

For enquiries, please contact  
**Dr Lee Eng Wah**, Director,  
Manufacturing Productivity  
Technology Centre  
Email: ewlee@SIMTech.a-star.edu.sg  
Web: www.SIMTech.a-star.edu.sg/MPTC

Scan for more information on  
Manufacturing Productivity  
Technology Centre





## NEW BUSINESS OPPORTUNITY IN X-RAY STERILISATION FOR SMES

A Collaborative Industry Project (CIP) on X-ray Sterilisation was successfully completed by SIMTech with 14 companies ranging from MedTech device makers, food and herb suppliers and X-ray source manufacturers to systems integrators, sterilisation service providers, and certification agencies.

Current sterilisation methods are costly and have limited local SMEs' ability to meet the high demand for sterilisation of medical devices and food related products. This CIP develops a cost effective alternative to the capital-intensive traditional methods. SIMTech's R&D team has determined that X-ray provides a good alternative to present sterilisation methods as it offers excellent dose-uniformity performances compared to other current technologies.

The CIP findings provided the specifications to customise an X-ray sterilisation system for the MedTech and food industries. An open platform of X-ray sterilisation systems, capable of controlling and measuring dose and dose rate for material sterilisation, was developed. It also demonstrated the feasibility of using a lower dose to sterilise medical devices and food packaging compared to the conventional radioactive sterilisation approaches that use gamma rays.

This CIP paved a new way of sterilisation that is suitable for in-situ applications without using radioactive materials. Since launching the CIP, a participating company has proceeded to set up an X-ray sterilisation facility. The novel system design creates a potential market for complex equipment manufacturing.

For more information, please contact **Dr Alex Thoe** at 6793 8571 or email to [tbthoe@SIMTech.a-star.edu.sg](mailto:tbthoe@SIMTech.a-star.edu.sg)

## NEW BUSINESS OPPORTUNITY IN POWDER INJECTION MOULDING



With technical support and consultancy from SIMTech's researchers, Dynacast Singapore developed a powder injection moulding (PIM) process for mass production. During the one-year collaboration, optimal processing parameters for new products to achieve maximum production yield were established. PIM technology was transferred to Dynacast to manufacture more than 10 different components with complex geometries.

Following this project, Dynacast invested in a new technology for PIM process in Singapore, hired 10 new staff, and set up a new production line.

**“ This is the most significant development into a process since the launch of aluminum diecasting in 1989, and I am convinced that Dynacast will be the largest global Metal Injection Moulding producer within 5 years ”**

**Mr Simon J Newman, CEO,  
Dynacast International**

Ms Zhang Xu Xia, whose research interest is powder over-injection moulding of metallic and ceramic materials, is seconded to Dynacast Singapore to further the development of PIM.

For more information, please contact **Mr Foo Yeong Han** at 6793 8350 or email to [yhfoo@SIMTech.a-star.edu.sg](mailto:yhfoo@SIMTech.a-star.edu.sg)



# COLLABORATIVE CAPABILITIES TO VENTURE INTO PRINTED ELECTRONICS APPLICATIONS

Creates an industry value chain using Roll-to-Roll Manufacturing to make Functional Films and Printed Electronics

Involving 12 SMEs and MNCs engaged in advanced inkjet and printing equipment, surface coatings, nanomaterials, and interconnecting materials, the CIP on Roll-to-Roll Manufacturing of Functional Films and Printed Electronics provides a cost-effective alternative to the capital-intensive traditional methods and materials.

“For an upstream material supplier like Cima NanoTech, working closely with consortium members, researchers and engineers in the supply chain can allow us to speed up the new applications development process”

Jax Lee, Director of New Business Development, Cima NanoTech.

Participating companies will have an opportunity to master the technology capabilities of roll-to-roll manufacturing through knowledge and technology transfer by SIMTech, enabling them to participate in the growing applications of printed electronics.

Three main applications are focused:

- **Flexible Transparent Conductive Film** will explore the development and manufacturing of various alternative transparent conductive films to replace expensive ITO film, which cannot be thermoformed and cracks easily, with SIMTech Roll-to-Roll Slot Coating.
- **The Flexible Printed Lighting or Electroluminescent Lighting (EL)** for outdoor advertising, displays, buildings, architectures, furniture and automotives is a rapidly growing market. The panels can be easily adjusted to fit precise shapes and are easily installed and maintained.
- **Flexible Printed Electrodes** comprising applications in

multi-touch capacitive sensing and printed antenna, that is expected to grow rapidly with the strong demand for near-field communication antenna for hand-held portable devices.

Members will benefit from key deliverables in the development of:

- Application Development Kits to capture applications opportunities
- Process Development Kits to transfer key roll-to-roll manufacturing processes to members, allowing them to become future manufacturers of printed electronics and functional films using SIMTech-developed technologies.

Members will be working with SIMTech's researchers and trained in SIMTech to acquire the technologies during the 18-month programme.

For more information, please contact **Mr Rick Yeo** at 6793 8227 or email to [ricky@SIMTech.a-star.edu.sg](mailto:ricky@SIMTech.a-star.edu.sg).



Scan for more information on Large Area Processing Programme



# ACCELERATING THE GROWTH AND DEVELOPMENT OF THE MICROFLUIDICS INDUSTRY

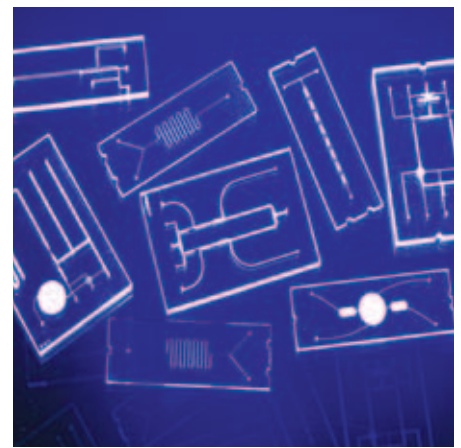
The global microfluidics market is witnessing significant growth

Microfluidics is the science of designing, manufacturing, and formulating devices and processes that deal with volumes of fluid in the order of nanolitres or picolitres. The polymer-based microfluidics device market valued at an estimated US\$1.08 billion in 2013, is expected to reach US\$2.7 billion by 2018 at a Compounded Annual Growth Rate of 20.3 percent, due to rising awareness of microfluidics products and growing investments in this market.

InziGn Pte Ltd, Austrianova, and the QuantuMDx Group each partnered with SIMTech in the transfer, licensing, and research collaboration in microfluidics technology. These partnerships will allow cost effective and novel solutions to be made available to the industry, and the development of commercially unavailable microfluidic devices.

Going forward, SIMTech will transfer a complete set of microfluidics

**“ The SIMTech Microfluidics Foundry nurtures and grows the microfluidics industry by supporting the business and research community in the development of microfluidic technology and applications ”**



manufacturing technology to InziGn for the mass production of microfluidics devices. Through this partnership, InziGn will benefit from an enhancement to its manufacturing capabilities and will be able to expand into mass production of complex diagnostic devices. SIMTech's Microfluidics Foundry – primarily a microfluidics research foundry– will continue to provide design, prototyping, and pilot production services to industry and academia to speed up the development of microfluidic products, while InziGn will provide high-quality mass production services.

A licence has also been signed between Exploit Technologies Pte Ltd (ETPL), the technology transfer arm of A\*STAR, and Austrianova to use SIMTech's microfluidics-based single phase droplet generation technology for living encapsulated cells.

The research collaboration agreement with QuantuMDx Group is for the development of a portable Point-Of-Care (POC) assay cassette for its Molecular Diagnostics (MDx) platform, suitable for 'in-field' use in resource limited settings or countries, such as Africa. Such a device is not available commercially at the moment.

For more information, please contact **Dr Jeffery Chen** at 6793 8259 or email to [jfchen@SIMTech.a-star.edu.sg](mailto:jfchen@SIMTech.a-star.edu.sg)



Scan for more information on SIMTech Microfluidics Foundry



## SIMTech TECHNOLOGY IMPROVES MACHINING PRODUCTIVITY AND QUALITY

### Technology enables chatter and vibration-free machining

Although high-speed machining and tooling technology to manufacture mechanical components have improved significantly, the industry often encounters surface quality problems due to machining vibration. To meet tight surface tolerances, productivity is often sacrificed as it is difficult to optimise cutting conditions with high productivity.

The solution to this is the SIMTech

Quick Machining Vibration Solver Toolkit for machining dynamics optimisation. The technology can be applied to Computer Numeric Control multi-axis machine tools or even manual machine tools. It is a machining vibration solver and optimiser based on a scientific approach to achieve high productivity with good surface quality and high geometrical accuracy. The technology can be further customised to suit a company's machining

strategy. On-site training is provided to assist users achieve their machining efficiency for specific applications.

The Toolkit consists of a portable machining modal parameter identifier and software module for machine optimisation. This toolkit can quickly extract the vibration parameters of a machining system and identify the stable cutting conditions, which can enhance machining quality and increase the material-removal rate.

**“ Companies can improve machining productivity significantly, from 20% to 50% on their existing machine tools through machine dynamics analysis and characterisation ”**

With a chatter and vibration-free process, the PE industry can:

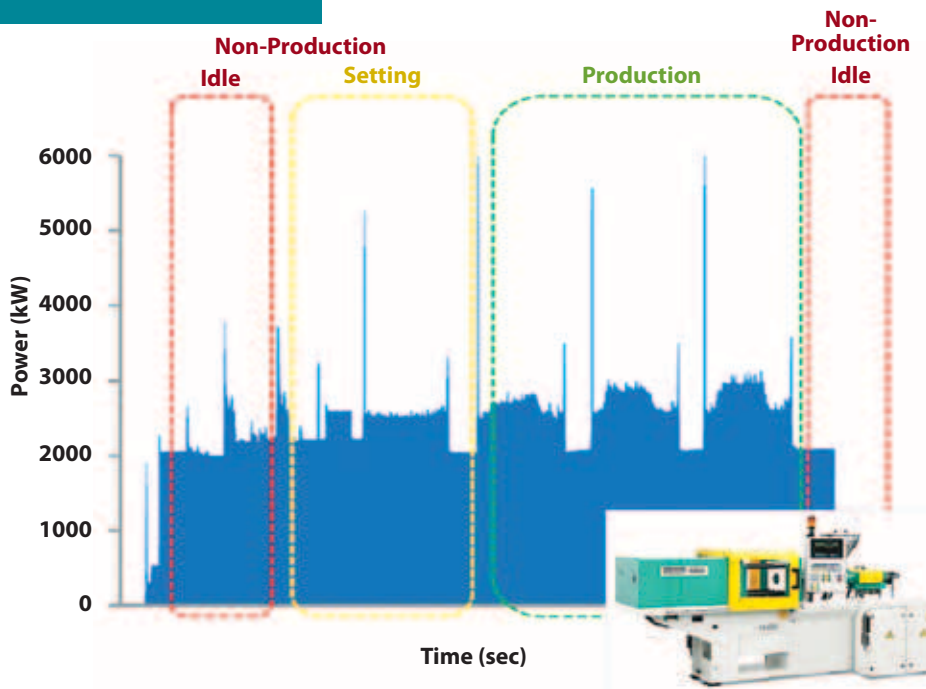
- Improve machined surface quality against machining chattering marks
- Enhance productivity and machining know-how
- Reduce workpiece damage and tooling/spindle wear

The technology has been licensed to more than 16 companies and has achieved outstanding productivity improvements. Eligible SMEs, who are interested to implement this technology, may apply for a SPRING grant.

*For enquiries, please contact*  
**Dr John Yong**, Director,  
 Precision Engineering Centre of Innovation  
 Email: [msyong@SIMTech.a-star.edu.sg](mailto:msyong@SIMTech.a-star.edu.sg)  
 Web: [www.SIMTech.a-star.edu.sg/PECOI](http://www.SIMTech.a-star.edu.sg/PECOI)

Scan for more information  
 on Precision Engineering  
 Centre of Innovation





# E<sup>2</sup>MAPS: ENERGY EFFICIENCY MONITORING, ANALYSIS, PLANNING SOLUTIONS

An effective tool to help reduce energy cost for the manufacturing industry

Although energy is consumed across manufacturing process activities, few in the operation have an overview of its consumption details to reduce cost.

To assist the industry in this area, SIMTech developed a set of manufacturing energy efficiency

solutions - E<sup>2</sup>MAPS. With E<sup>2</sup>MAPS, manufacturing companies in Singapore can achieve higher energy efficiency. The Singapore Employment and Employability Institute (e2i), the leading organisation to create solutions for better employment and employability to create better jobs and better lives for workers, will fund up to 50 per cent of the programme fee.

E<sup>2</sup>MAPS assists companies in four easy steps:

### MONITORING of Real-time Energy

Real-time Energy Efficiency Monitoring and Analysis System (E<sup>2</sup>MAS) software collects and analyses real-time power consumption data captured from machines via commercial off-the-shelf power meters.

### ANALYSIS of Power Patterns

E<sup>2</sup>MAS correlates power and energy consumption profile according to

the various machine stages unique to manufacturing. This step allows users to understand the energy consumption pattern and identify energy waste. The results from this step will be used to identify areas for energy efficiency improvements.

### PLANNING through Energy Efficiency Roadmapping

A review of energy data will be carried out to identify energy efficiency improvements opportunities. Improvement action plans with quantitative reduction goals will be proposed. This roadmapping exercise will provide companies a clear grasp of energy efficiency issues or hotspots on the manufacturing shopfloor operations.

### SOLUTIONS by providing consultancy

Relevant domain knowledge experts will be deployed to help companies in their solutions implementation.

**“ E<sup>2</sup>MAPS aims to help companies to improve energy efficiency through a step by step, top-down & bottom-up real data analysis approach ,”**

E<sup>2</sup>MAPS is a continuing energy efficiency improvement tool. Through this, companies will develop capabilities in real-time energy monitoring and be equipped with the analyses tools for their continuing energy efficiency improvements.

For enquiries, please contact  
**Dr Chen Wei Long**, Director,  
 Sustainable Manufacturing Centre  
 Email: [wlchen@SIMTech.a-star.edu.sg](mailto:wlchen@SIMTech.a-star.edu.sg)  
 Web: [www.SIMTech.a-star.edu.sg/SMC](http://www.SIMTech.a-star.edu.sg/SMC)



E<sup>2</sup>MAPS – Suite of EE Solutions for the Manufacturing Industry



Scan for more information on Sustainable Manufacturing Centre





Dr Lim Gnian Cher, Dr Wang Xincai, Dr Zheng Hongyu and Dr Wang Zhongke from SIMTech receiving the IES Prestigious Engineering Achievement Award on 18 July 2014 from Mr Heng Swee Kiat, Minister for Education

## A WINNER: NEW TECHNOLOGY TO DICE THINNER SILICON WAFERS

Technology advances the use of thinner and higher density micro-chips for producing faster processing speed, more powerful and versatile functionality, and higher miniaturisation of electronic products.

Thanks to the SIMTech team, an innovative high-speed, debris-free dicing of silicon wafers using laser-induced thermal cracking technology has been developed. This technique is superior to the traditional technique and the conventional laser dicing technology. It addresses the industry woes of fracturing thinner and delicate silicon wafers and delamination of material layers during sawing in the traditional way, not to mention the high cost in diamond saw replacement. Although the conventional laser

dicing techniques have provided potentially effective solutions to these problems, these techniques produce molten debris and micro-cracks with potentially excessive heat-affected zones along the dicing path. These laser dicing methods may also require the use of inert gases, flowing water, and protective coatings or coolant, adding to the operational costs.

The innovative technology is based on a mechanism of laser-induced thermal cracking in a silicon wafer without the

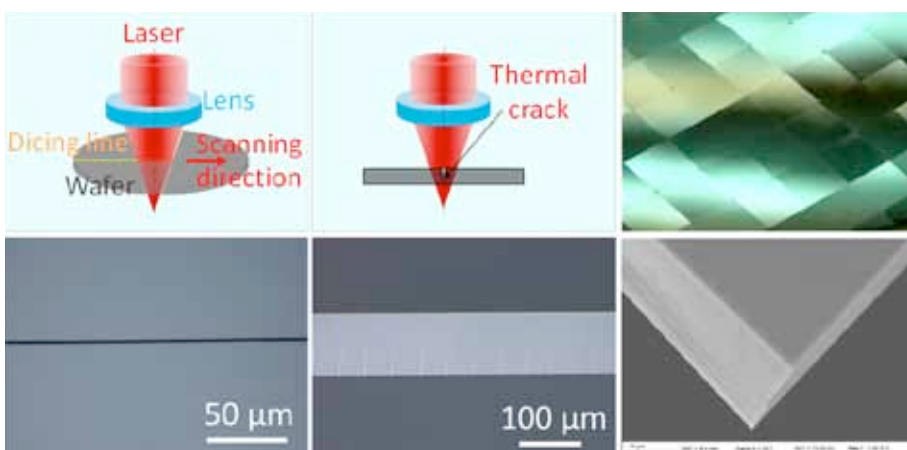
need for secondary processes. A near-infrared laser beam heating through the wafer thickness causes compressive stress during laser pulses and tensile stress during the subsequent cooling in a silicon wafer. As the dicing method relies on laser-induced thermal cracking to separate the silicon wafer, no debris and chipping are produced at the singulated edges, yielding a smooth surface finish, and eliminating the need for secondary processes. The much-reduced energy requirements to effect cracking allows high-speed wafer dicing, which is 10-20 times higher than the current sawing and laser ablation processes for thin silicon wafers. A single scan of the laser beam is sufficient to cause the wafer separation. It offers higher productivity with more silicon dies per wafer.

**“ This technique is superior to the traditional technique and the conventional laser dicing technology ”**

Furthermore, this dicing technology uses a relatively low-power fibre laser that requires minimum secondary support facilities, as well as low operational and maintenance costs. It is a green and sustainable dicing process using minimal consumables and no chemicals and water.

Several patents have been filed for this innovative dicing technology. The innovativeness of the technology also won the Institution of Engineers of Singapore Prestigious Engineering Achievement Award 2014 for the team.

For enquiries, please contact **Dr Wang Zhongke** at 6793 8499 or email to [zkwang@SIMTech.a-star.edu.sg](mailto:zkwang@SIMTech.a-star.edu.sg)



Scan for more information on SIMTech Awards



A number of events were organised in 2014 to engage the industry and forge partnerships.

## Third SIMTech-WDA PE Workforce Skills Qualifications (WSQ) Graduation Ceremony, 10 July



472 participants from 391 companies graduated last July at the third SIMTech-WDA Precision Engineering Workforce Skills Qualifications (PE WSQ) graduation ceremony.

The SIMTech-WDA WSQ training programmes were initiated in 2008 with the launch of the first PE WSQ Specialist Diploma Programme to transfer knowledge to industry through case-studies and hands-on practical training to meet technology and relevant skills gap of PMETs. Today, there are 18 courses and programmes available in 7 areas to meet the varied needs of industry in manufacturing processes, automation and systems

technologies. Three Most Inspiring Trainees and Best Industry Partners received their Awards from Mr Goh Eng Ghee, Deputy Chief Executive of the Singapore Workforce Development Agency and Dr Lim Ser Yong, Executive Director of SIMTech, respectively.

## SIMTech Annual Manufacturing Forum 2014, 23 July

In its ninth edition, AMF'14 is the flagship manufacturing conference at SIMTech. With the theme, Digital Manufacturing, the one-day event congregated technology and industry leaders who shared new insights and developments. More than 270 attendees from industry and the research community gained new insights from keynote speakers, Dr Walter Johnson, Vice-President and Director of the Intelligent Systems laboratory at PARC, a Xerox Company and Prof Jay Lee, Ohio Eminent Scholar, L W Scott Alter Chair Professor and Distinguished University Professor, University of Cincinnati.



## SIMTech-CSIRO MOU Signing, 22 August

SIMTech and the Commonwealth Scientific Industrial Research Organisation (CSIRO) of Australia signed an agreement to collaborate on research to develop additive manufacturing of metal parts for the Aerospace, Oil & Gas, MedTech and Precision Engineering industries. SIMTech will be developing additive manufacturing using laser, as well as material and post-process developments. CSIRO will focus on additive manufacturing using electron beam melting as well as new alloy design and metal powder processing. Spanning two years, the projected outcomes of this collaboration will comprise new metal alloys and processes for high-performance additive manufactured parts.



Photo Source: Ministry of Foreign Affairs Singapore

Collaborative Industry Projects (CIPs) are cost-effective R&D platforms where groups of companies facing similar issues work jointly with SIMTech to develop manpower and technology.



## High-Mix Low-Volume (HMLV) Lite Programme CIP

October 2014 | SIMTech Training Room

This CIP trains production planners and production supervisors in key planning concepts and shop floor tracking concepts respectively.

For enquiries, please contact **Mr Chua Tay Jin** at:  
Tel: 6793 8397 |  
Email: tjchua@SIMTech.a-star.edu.sg

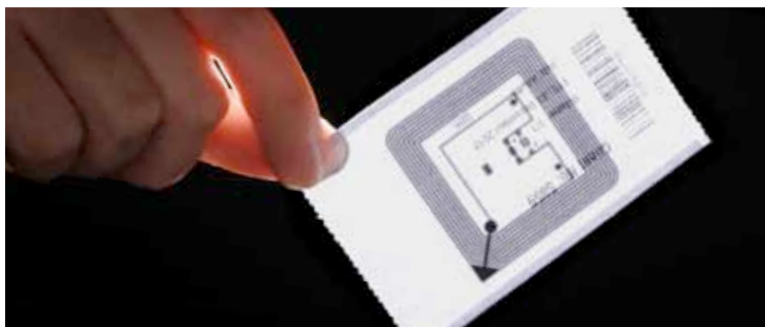


## Item Management and Tracking System

October 2014 | SIMTech Training Room

The programme aims to help companies deploy an RFID/barcode-based Item Management and Tracking System (IMTS) to better manage, track, and audit their assets to improve productivity, traceability, while minimising errors. This package comprises training sessions and on-site mentoring, including the hardware and software required for pilot system implementations over two months.

For enquiries, please contact **Mr He Wei** at:  
Tel: 6793 8969 | Email: whe@SIMTech.a-star.edu.sg



## RFID-based Field Worker Identification and Tracking System (FIT)

October 2014 | SIMTech Training Room

This CIP helps companies deploy an RFID-based FIT to identify and track attendance of workers using RFID-enabled smart device technology and the Internet for visibility of field workers' whereabouts anytime, anywhere as well as to improve project productivity.

For enquiries, please contact **Mr Wong Ming Mao** at: Tel: 6793 8381 |  
Email: mmwong@SIMTech.a-star.edu.sg

## Unsupported Gun Drilling Customised Tool Grinding, and Apex Measurements

October 2014 | SIMTech Training Room

The CIP aims to create a collaborative platform to effectively develop the capabilities and further extend the operational efficiencies and effectiveness of PE companies in providing deep hole gun drilling, customised tool grinding, and measurement services to the Oil & Gas sector using a conventional Computer Numeric Control machine or specialised grinding and measurement equipment.

For enquiries, please contact **Dr Lim Beng Siong** at:  
Tel: 6793 8370 | Email: bslim@SIMTech.a-star.edu.sg

## Advanced Metal Forming

November 2014 | SIMTech Training Room

This CIP develops combined sheet and bulk forming processes for the cost-effective forming of high-precision and high value-added metal components for the local PE industry. Participants will benefit from SIMTech expertise in combined sheet and bulk forming technologies, including processing, simulation, and tooling design to achieve near-net shape with minimum material wastage and maximum productivity improvements.

For enquiries, please contact **Dr Mehrdad Zarinejad** at:  
Tel: 6793 8513 | Email: mehrdad@SIMTech.a-star.edu.sg

**SMC Annual Conference 2014: Shaping Enterprise's Value Creation**

6 November 2014 | 9:15am - 3.00pm | SIMTech Auditorium, Tower Block

The theme of this year's conference is creating value through sustainable manufacturing design and resource efficiency to positively impact companies' image and product branding. The conference features speakers from Nike, Autodesk, Schlumberger as well as local companies like LHT as they share their experiences in value creation through adopting sustainable practices.

For enquiries, please contact Mr Jason Yip at: Tel: 6793 8430 | Email: [kwyip@SIMTech.a-star.edu.sg](mailto:kwyip@SIMTech.a-star.edu.sg)

**Seminar on Elastomeric Polymer Materials: Properties, Process and Simulation**

18 November 2014 | 9.00am - 1.30pm | SIMTech Auditorium, Tower Block

This seminar will present the key research trends as well as the latest research outcomes in elastomeric polymer materials. The presentation topics will feature state-of-the-art of elastomeric polymer materials as well as their applications. It will also cover technology development in polymer nanocomposites, process and process simulation.

For enquiries, please contact Dr Yu Suzhu at: Tel: 6793 8373 | Email: [szyu@SIMTech.a-star.edu.sg](mailto:szyu@SIMTech.a-star.edu.sg)

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more events

**PE WSQ in Improve Productivity through RFID-enabled Workflows Innovation Framework**

13 October 2014 | 6.30pm - 9.30pm, SIMTech, Tower Block

**PE WSQ Customised Modules in Corrosion and Corrosion Prevention****M1: Implement Fundamentals of Corrosion and Corrosion Prevention**

15 October 2014 | 6.30pm - 9.30pm, SIMTech, Tower Block

**PE WSQ Graduate Diploma in MedTech Manufacturing****M5: MedTech Device Design Innovation and Development**

15 October 2014 | 6.30pm - 9.30pm, SIMTech, Tower Block

**PE WSQ Graduate Diploma in Metal Manufacturing Processes****M3: Review Heat Treatment Process for Metals**

20 October 2014 | 6.30pm - 9.30pm, SIMTech, Tower Block

**PE WSQ Customised Modules in Corrosion and Corrosion Prevention****M2: Apply Electro-chemical Processes and Coatings for Wear and Corrosion Protection**

21 October 2014 | 6.30pm - 9.30pm, SIMTech, Tower Block

**PE WSQ Carbon Management Programme****M1: Apply Carbon Footprint Assessment Methodology**

19 November 2014 | 9:00am - 5.00pm, SIMTech, Tower Block

**PE WSQ Graduate Diploma in Precision Measurements and Characterisation****M3: Dimensional Metrology, Instrument, and Measurement Standards**

6 January 2015 | 6.30pm - 9.30pm, SIMTech, Tower Block

**PE WSQ Graduate Diploma in Precision Mechatronics****M1: Precision Machine Design**

19 January 2015 | 6.30pm - 9.30pm, SIMTech, Tower Block

**PE WSQ Graduate Diploma in Advanced Welding Technologies****M4: Adopt Friction Stir Welding and Diffusion Bonding**

22 January 2015 | 6.30pm - 9.30pm, SIMTech, Tower Block

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

For general enquiries, please contact Tel: 6793 8383 |  
Email: [kto-enquiry@SIMTech.a-star.edu.sg](mailto:kto-enquiry@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 electronics, semiconductor, precision engineering, medtech, aerospace, automotive, marine, oil & gas, 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 400 researchers, we are committed to serving the manufacturing industry to develop the human, intellectual, and industrial capital in Singapore.