

MANUFACTURING MATTERS

October 2015 | Issue 4

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Feature

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NOTE FROM EDITOR...

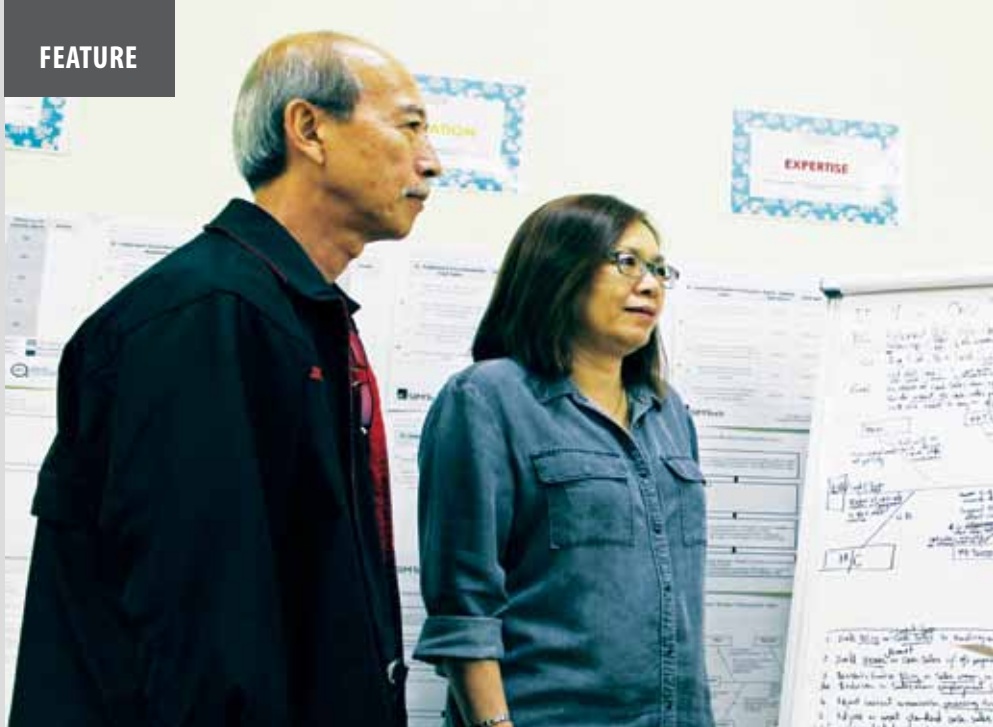
Dear Friends and Industry Partners,

To help Singapore industry raise productivity, SIMTech launched the Workskills Qualifications (WSQ) Operations MaNagement Innovation (OMNI) Methodology Programme with the Singapore Workforce Development Agency (WDA) in 2010 to train Professionals, Managers and Engineers (PMEs). The Programme is a case-based course to transfer knowledge in operations management and use of OmniMethodology. The on-site module of the programme involves project mentoring, identifies areas for improvement, generates suitable initiatives and develop implementation plans for the company.

To date, 34 batches of 403 productivity champions are trained from 130 companies which participated in the OMNI programme. Apart from its own efforts, SIMTech reaches out to companies in this initiative through the Association of Singapore Marine Industry and the Singapore Chinese Chamber of Commerce and Industry. Companies participated in this programme have seen their productivity improve from 20 per cent to 259 per cent.

You can find more details about enhancing productivity in your company in the feature story.

Swee Heng



CONTINUING ASSISTANCE FOR PRODUCTIVITY JOURNEY

OMNI-LITE, following the success of OMNI programme, reaches out to more manufacturing and service companies

The Workforce Skills Qualifications **Operations MaNagement Innovation—Lean Improvement Towards Excellence (OMNI-LITE)** Programme, a joint initiative of A*STAR SIMTech and the Singapore Workforce Development Agency (WDA), was launched by the Minister for Manpower, Mr Lim Swee Say at the Manufacturing Productivity Technology Centre (MPTC) Annual Conference 2015 on 8 October.

The OMNI-LITE Programme is aligned with the Ministry of Manpower Lean Enterprise Development (LED) Scheme's objective to support SMEs that aspire to become more productive, more innovative and more manpower-lean. The Programme equips Professionals, Managers, Engineers and senior management of manufacturing and service sectors with the necessary knowledge and tools to systematically use OmniMethodology™ to be technology innovators who can help their companies achieve operational excellence. The programme can benefit PMEs from the supply chain, logistics, manufacturing, marine, retail and service sectors.

OMNI-LITE, a shorter version of OMNI consists of 10 half-day sessions over 1 month, enables more PMEs to be trained. Mentorship of trainees includes scheduled sessions over 2 weeks to identify operations hotspots for



Equipped with the necessary methodology and tools, OMNI-LITE spurs local enterprises to create a culture of ongoing productivity improvements and drive productivity growth

improvement, create suitable initiatives and develop implementation plans.

Already, companies are embarking on OMNI-LITE. The OMNI Partnership Agreement which includes OMNI-LITE was signed by SIMTech with Singapore Chinese Chamber Institute of Business, Singapore Business Advisors and Consultants Council, Electronics Industries Training Centre, Kaizen Consulting Group and Alpha Consulting & Training at the MPTC Annual Conference 2015.

SUCCESS STORIES

Some examples of companies which have successfully implemented OMNI in their organisations are highlighted.



Wah Joo Seng International Trading Pte Ltd

Wah Joo Seng (WJS) is a leading distributor and hose assembly manufacturer in industry hydraulic and special hoses and couplings, with key capabilities in fluid transfer solution products and services. It implemented OmniMethodology™, a proven Operations MaNagement Innovation (OMNI) methodology that trains key personnel to become technology innovators in the quest for operational excellence.

Arising from the implemented initiative to sort hoses and couplings inventory, kitting time was reduced by 33 per cent from 1.5 hours to an hour. The implementation of visual boards for hose assembly lowered assembly and testing cycle time by 50 per cent from 2 days to a day. WJS continued its productivity journey with Lean Implementation and R&D for new products with over 40 years of field experience.

“OMNI Programme is rewarding and practical. It equips us with the skills to identify hotspots in different functions and departments, setting the right directions and brainstorm for possible solutions in an effective and efficient manner”

Miss Evelyn Kuah, Managing Director,
Wah Joo Seng International Trading

Enercon Asia Pte Ltd

The local systems integrator for engine/generator control for power generation plants also provides technical services to industrial, municipal, engineering and institutional clients. After embarking on OMNI, the successful implementation of visual board for project management minimised 33 per cent of design approval time from 21 to 14 days per project. Production and overtime man-hours dropped 38 per cent from 304 to 188.

“The success of OMNI motivated us to continue with more productivity initiatives such as the implementation of Leader Standard Work”

Mr Lim Mun Hey, General Manager,
Enercon Asia

For enquiries, please contact

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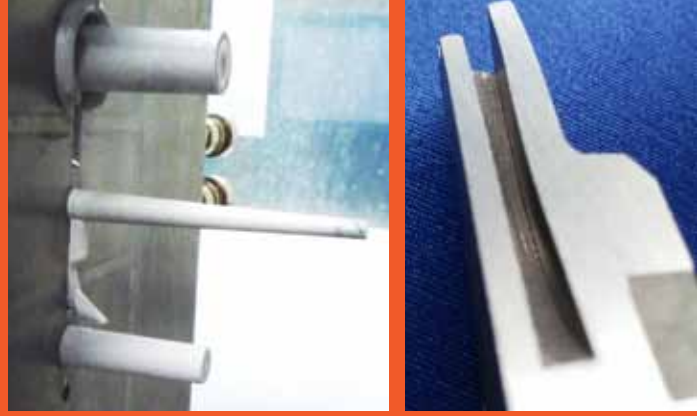
Web: www.SIMTech.a-star.edu.sg/MPTC

MPTC Manufacturing Productivity
Technology Centre

Enhancing Manufacturing Productivity



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POWDER OVER-INJECTION MOULDING TECHNOLOGY: A BETTER CHOICE FOR HYDRAULIC PUMP

Shrouded impellers used in hydraulic pump system are normally manufactured by traditional sand casting process, which is extremely harsh and highly labour-intensive. The imperfections in the sand casted products and poor strength of internal geometries have constricted the overall efficiency and consistency of the whole pump system. Exploring alternative advanced technologies to improve product design flexibility and system efficiency has become the target of a local Oilfield Service Company.

With the in-house capability on powder over-injection moulding (or over-PIM), SIMTech collaborated and assisted the company in exploring the novel over-PIM technology combined with sacrificial materials to fabricate rotating pump components with complex internal features. Moreover, the viability to produce more complex internal features, such as 3D profile, was also demonstrated by combining PIM and sinter joining processes. The powder over-injection moulding process can be automated to produce shrouded pump components and replace the existing labour intensive sand casting technique.

Highly automated process, smooth surface of the products, multi-material selection for higher strength and corrosion resistant, and more flexible product design from the over-PIM process have the potential to improve operational efficiency and effectiveness, repeatability and consistency of the pump system production

NO MORE CHATTER

The industry often faces surface quality problems due to machining vibration despite significant improvements in high-speed machining and tooling technology to make mechanical components. To equip the companies with the necessary knowledge and tools to systematically overcome these, machine dynamic analysis technology was applied to improve productivity and quality of milling operations. Wong Hing Long Technologies Pte Ltd, specialist in sheet metal fabrication and precision engineering and producer of precision parts for global markets, is one of the beneficiaries of this technology.

SIMTech provided an easy-to-use scientific solution to solve a complex mechanism of milling dynamics by considering tool run-out as well as different dynamic status of the spindle systems. To achieve this, the company staff and process engineers were trained on the scientific method and approach to improve productivity.

A customised quick milling vibration solver was developed for engineers to prevent vibration issues and optimise machining conditions. Providing a scientific method, the customised quick milling vibration solver replaced the previous trial and error approach.

As a result, machining chatter is reduced by over 50 per cent and machining time is shortened by more than 30 per cent

For more information, please contact **Dr Mehrdad Zarinejad** at 6793 8513 or email to mehrdad@SIMTech.a-star.edu.sg

For more information, please contact **Mr Tan Chee Tat** at 6793 8576 or email to cttan@SIMTech.a-star.edu.sg



(From L-R) Dr Lim Ser Yong, Executive Director, SIMTech and Dr Gog Soon Joo, Group Director, Training Partners Group, WDA with recipients of Best Industry Partner Award, Mr Vincent Tan, Mr Shai Soloveizik and Mr Jimmy Chua

PE WSQ TRAINING & PROGRAMMES GET THUMBS-UP

Trainees and Industry Partners praise relevance and usefulness

445 participants from 191 companies graduated at the 2015 Precision Engineering WSQ graduation ceremony.

Three winners of the **Most Inspiring Trainee Award** and **Best Industry Partner Award** give the thumbs-up to the SIMTech-WDA WSQ training programmes.

MOST INSPIRING TRAINEES

"The PE WSQ OMNI programme has helped me initiate steps to improve the Galley Manufacturing Process and increase output by 33 per cent. The

positive experience has inspired me to continue my learning journey with SIMTech. I encourage others to do the same."

Mr Anthony Soon Beng Hock, Manager, Materials Planning, Jamco Singapore Pte Ltd

"After attending the PE WSQ LEAN Programme, I decided to produce our films in-house. This has already seen a 20 per cent improvement in our lead time and almost \$60K savings per year. I used to hear that Lean was not for the creative industry but now, together



Recipients of the Most Inspiring Trainee Award, Mr Ong Eng Seng (2nd from left), Ms Wincey Woon (3rd from left) and Mr Anthony Soon (5th from left) with Dr Lim and Dr Gog

with my company and SIMTech's LEAN mentors, we have proved them wrong!"

Ms Wincey Woon Shi Noi, Design Manager, Axxel Marketing

"I am grateful to the SIMTech mentors of the PE WSQ Programme in OEE who have helped me push for productivity improvements. We have reduced machine down time and electrode set-up time by 26 per cent."

Mr Ong Eng Seng, Senior Tooling Manager, Univac Precision Engineering Pte Ltd

INDUSTRY PARTNERS

"Huatiang Group sent 15 candidates for a corporate batch of the PE WSQ OMNI Programme in 2014. Together with the mentors, our staff identified and implemented 20 productivity initiatives. We achieved productivity improvements of about 30 per cent."

Mr Jimmy Chua, CEO, Huatiang Holdings Pte Ltd

"This year, we have Kulicke & Soffa employees graduating from SIMTech's Carbon, OMNI, Metal Manufacturing, and Mechatronics courses and we are very proud of each of their achievements."

Mr Shai Soloveizik, VP Equipment Manufacturing/GM Singapore, Kulicke & Soffa Pte Ltd

"MTQ Engineering sent a full corporate class to attend the PE WSQ Lean Programme. A total of more than 50 projects were received to date. A significant number of these have been implemented. Our productivity has increased and the man-hours in some processes have also reduced significantly. The programme is beneficial to us. I am sure other companies will benefit too if they embark on this programme."

Mr Vincent Tan, Managing Director, MTQ Engineering Pte Ltd

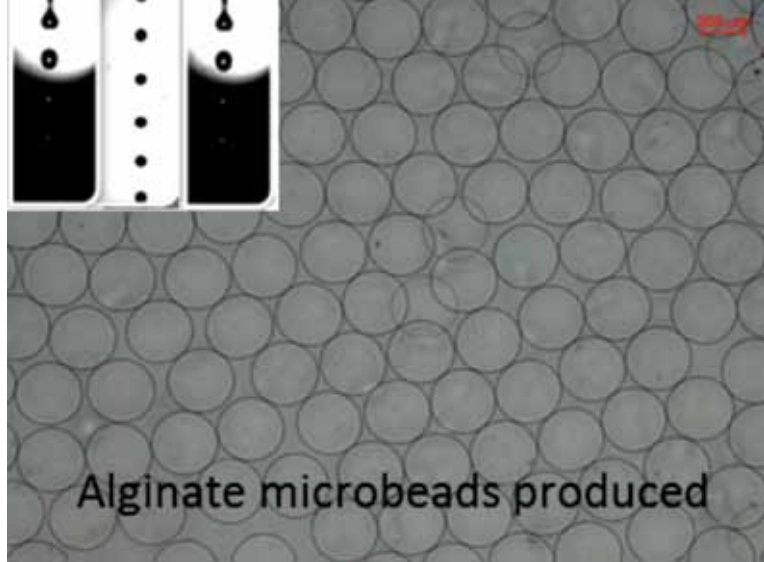
For enquiries, please contact

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Alginate microbeads produced

SMART SOLUTION - MICROFLUIDICS

Microfluidic Droplet Generator complies with Good Manufacturing Practice, meeting stringent international standards of healthcare and pharmaceutical industry

When Austrianova, a life science and biotech company with a global footprint that encapsulates living cells in bio-inert polymers, was looking for a solution for Good Manufacturing Practice (GMP) compliant cell encapsulation process, microfluidics approaches were conceptualised and proposed.

Contamination-free is highly important for cell encapsulation in the pharmaceutical industry. In healthcare, cell encapsulation is used to facilitate the safe implantation of cells allowing long-term production of therapeutic molecules in patients. Strict rules and procedures requiring tedious cleaning and sterilisation processes have been implemented in the manufacturing to ensure the cells encapsulated in polymer beads can be used as drugs without contamination. These significantly slow down the production process which requires skilled professionals in manufacturing.

To alleviate the challenges, Austrianova engaged SIMTech to design and develop a customised high throughput droplet encapsulator using a single-phase-flow microfluidic droplet generation technique developed and patented by SIMTech.



The concept of the microfluidic chip was implemented into cell encapsulation production. The microfluidic chips are fabricated through plastic injection moulding to achieve low cost production. Chips are pre-sterilised through gamma irradiation and packed according to the requirements of European Pharmacopoeia Standards (EPS). The chips are well integrated into SIMTech's droplet formation system to achieve highly uniform droplet formation. Scale up of droplet formation is achieved by multiple channels running in parallel to achieve a high throughput production of capsules.

The microfluidic droplet generator is not only contamination-free but also meets stringent international bio-manufacturing compliance. The software programme and hardware of the droplet formation system are designed to fulfill the requirements of EPS and United Pharmacopoeia Standards (UPS). Printers and cameras are integrated into the system for real-time monitoring and parameter recording to ensure cell encapsulation quality which fulfills Food & Drug Administration requirements.

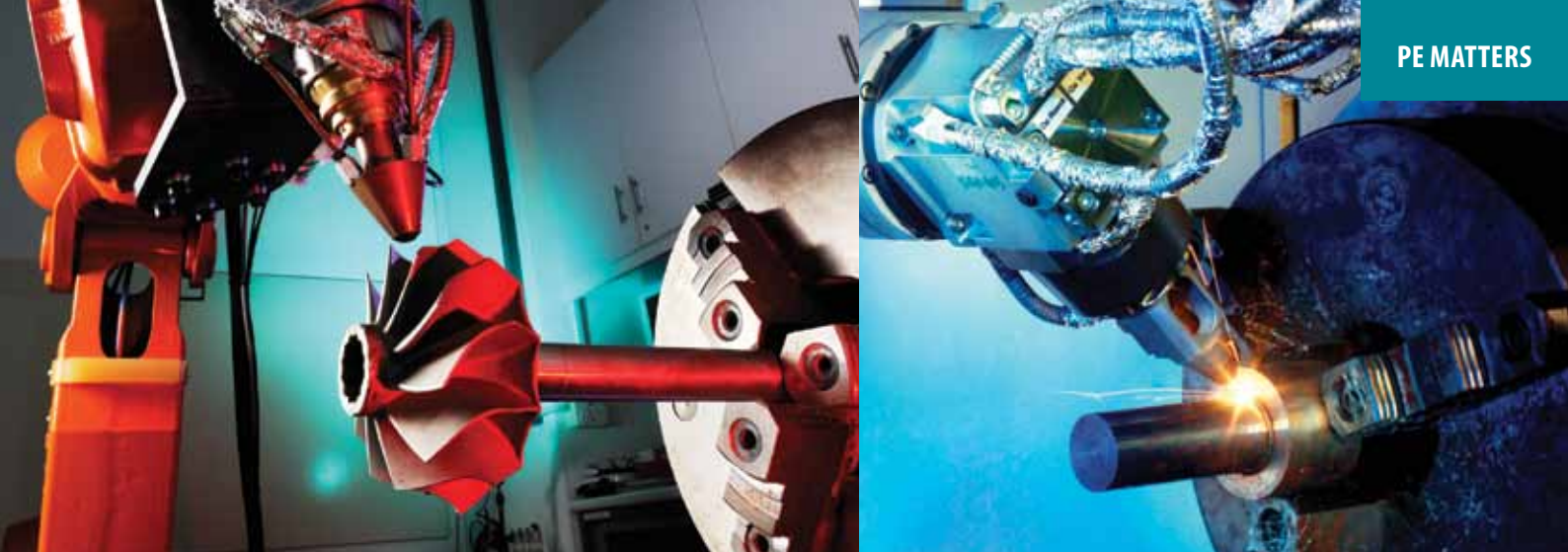
As a result of the collaboration, Austrianova has successfully used the new droplet generation systems in their overseas manufacturing plant

For enquiries, please contact
Mr Rick Yeo, Director
Email: ricky@SIMTech.a-star.edu.sg

EAC Emerging Applications Centre
Seeding and Growing Emerging Industries



Scan for more information on SIMTech Microfluidics Foundry



HELP TO MAKE **HIGH VALUE** PRODUCTS

Collaborative Industry Project to build capabilities in laser cladding of corrosion resistant alloys

For products to operate under extreme High Pressure High Temperature, chemically and abrasively corrosive environments in the marine, offshore, oil and gas sectors, laser cladding is often used to improve their mechanical properties and corrosion resistance. To achieve this, the powdered or wire feedstock material is deposited to coat or make a part. The material is melted and consolidated by a laser.

Laser cladding has many advantages over traditional welding processes. This method reduces significantly excessive exotic material wastage, pre-heating, cladding, machining and post-weld heat treatment costs, time and effort. Despite of these advantages, many PE companies lack such capabilities, limiting their opportunities to capture market value in these sectors. To address the capabilities gap, this Collaborative Industry Project (CIP) targets to equip participating companies with the relevant advanced laser-based techniques and integrity validation capabilities for the manufacture of high value Corrosion Resistant Alloy (CRA) clad pressure vessels, oilfield equipment, heat-exchangers and pipelines.

To enable participating companies confidently apply the technology implementation on shop floor, 1-to-1 consultancy in technology, operational and effectiveness assessment and road-mapping; resource and capabilities requirements for implementation and growth are covered in the CIP

This CIP is relevant for Oil field equipment and pipeline manufacturers, service providers and their sub-contractors; Marine and offshore companies, service providers and their sub-contractors; Specialty CRA powder and substrate material manufacturers and distributors including Laser, system integrators, specialty nozzles, machine tool and automation equipment manufacturers and builders to establish a local eco-system.

Participating companies can expect to benefit from the building up of expertise and knowledge to laser clad materials such as Inconel, Stellite, Titanium and Stainless Steel. Validation and characterisation of material properties; welding and test procedures are also taught to comply with international

Application Programme Interface, American Society of Mechanical Engineers, American Welding Society and National Association of Corrosion Engineers standards. Case study with assessment of hardness at heat affected zone, diffusion level, pore sizes, micro-macro structures, fracture strength, yield strength and metallurgical properties will be included.

For enquiries, please contact

Dr John Yong, Director

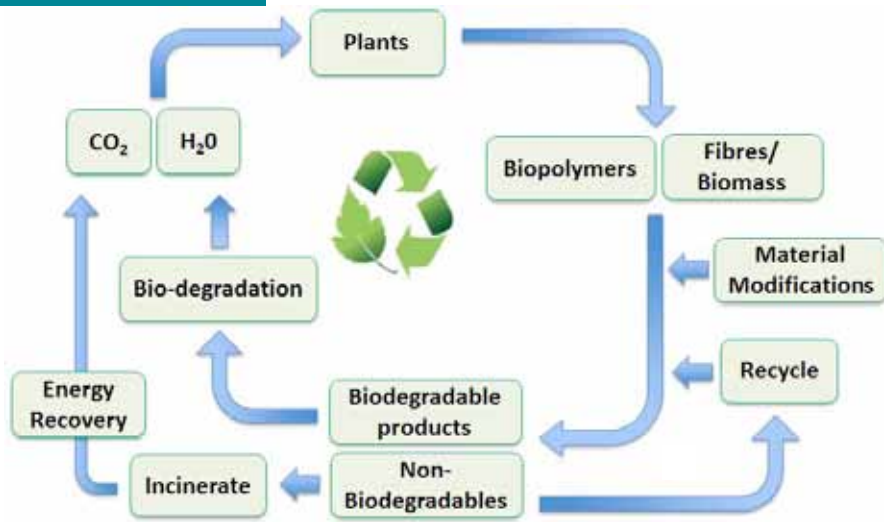
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Web: www.SIMTech.a-star.edu.sg/PECOI

PE COI Precision Engineering
Centre of Innovation
Sustaining and Advancing PE Industry



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on Precision Engineering
Centre of Innovation



A life cycle model for sustainable polymers and composites from plants illustrates how carbon-based natural materials are produced and recycled back into the environment sustainably

NEW POSSIBILITIES WITH PLANT - OR RECYCLED-BASED MATERIALS

Lightweight natural fibre composites to extend into aerospace and automotive applications

Manufacturers are looking for new, renewable materials that are also lightweight, exhibits high technical performance, low carbon-footprint and multi-functional properties. These innovative green materials need to be profitable, unrestricted by import/export controls, and fit well into the web of eco-responsible practices already established within the existing supply chains spanning across countries.

To address these trends and needs, SIMTech has been working on eco-friendly blends to improve the processability of green polymers (bio-derived polymers and recycled polymers), developing high quality intermediate materials like thermoplastic prepregs, and also

SIMTech research outcomes demonstrate that composites designed with long continuous plant fibre reinforcements can yield similar or better performance than short-glass-fibre reinforced polymer composites for certain properties

studying multi-material composite constructions that incorporate continuous aligned natural fibres. The long-term objective is to progressively reduce mankind's dependence on non-renewable resources (crude oil) to provide the polymer-based materials needed in manufacturing. Using a combination of materials from natural plant fibres with plant-derived or recycled polymers, SIMTech aims to

develop eco-friendly composites to the highest performance possible to further extend the range of their current applications.

Towards this, SIMTech is investing its efforts to:

- address the technology needs and challenges of manufacturing polymers and composites derived from sustainable biological sources to improve performance
- develop a holistic approach that combines sustainable materials with sustainable/efficient manufacturing and design, and
- promote greater use of bio-derived polymers, natural fibres and recycled products in the packaging, construction, agriculture, transport and medical sectors, amongst others.



(From L-R) Natural fibre composites can be produced in the form of thermoplastic impregnated sheet, composite panel and sandwich composite laminate

Switching to natural fibre reinforcements can help to reduce components' weight by 10 to 25 per cent, depending on the thickness required to meet load bearing requirements. Just like how metal components in planes are being replaced with carbon composites to achieve structural light-weight, natural fibre composites can provide the same benefits to parts made from neat and glass fibre reinforced polymers, with the additional advantage of being greener at the same time.

For enquiries, please contact **Dr Chen Wei Long**, Director
 Email: wlchen@SIMTech.a-star.edu.sg
 Web: www.SIMTech.a-star.edu.sg/SMC

Typical range of performance of short-glass-fibre and long-plant-fibre reinforced composites

	Short-Glass-Fibre Reinforced		Long-Plant-Fibre Reinforced	
	Injection Moulded Thermoplastics	Non-woven Thermosets	Unidirectional Thermoplastics	Unidirectional Thermosets
Tensile Modulus	2-9 GPa	12-28 GPa	14-25 GPa	16-40 GPa
Tensile Strength	30-100 MPa	130-230 MPa	150-250 MPa	150-400 MPa

SMC Sustainable Manufacturing Centre
 Embracing Sustainable Manufacturing



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WORLD FIRST - DIRECT MACHINING OF METAL MOULD FOR RADIAL FRESNEL LENS

The innovation includes design, manufacturing process and testing

SIMTech has developed a novel ultra-precision machining process to produce a metal roller mould that is used in Roll-to-Roll (R2R) manufacturing of high-quality optical Fresnel lens film.

Fresnel lenses are widely used in advanced lighting systems, magnification and concentrated solar power systems, due to their compact size, reduced bulkiness and excellent optical performance. Currently, these lenses are fabricated individually using ultra-precision diamond turning, or batch by batch through plastic injection moulding.

As an advanced continuous manufacturing method, R2R manufacturing is able to produce large-volume micro/nano structures on flexible film with an extremely low cost and high throughput compared to traditional manufacturing processes. Unfortunately, as the micro-structured roller mould cannot be fabricated using normal machining processes due to the fixed tool orientation and limited degrees of freedom, R2R manufacturing is unable to produce high-quality Fresnel lens film. Nowadays, the industry adopts an indirect method by transferring the Fresnel lens structures using electroplating and wrapping,

The developed novel ultra-precision machining process, Rotating-tool Diamond Turning (RDT), introduces a 4-axis synchronised tool-workpiece motion to achieve ultra-precise machining of Fresnel lens microstructures by continuously changing the tool orientation to maintain a constant cutting angle

which results in large assembly errors and deteriorated optical performance.

Developing the tool path generation method from geometrical modelling, taking into consideration the lens design, the tool geometries and the roller parameters, the roller mould patterned with most kind of Fresnel lenses can be fabricated in SIMTech now.

Both linear and radial Fresnel lenses pattern are designed and successfully machined on roller moulds with high machining accuracy and surface quality. SIMTech has also developed the complete manufacturing cycle for R2R manufacturing of optical Fresnel lens polymer film including optical lens design, roller mould fabrication, Roll-to-Roll embossing, film quality and functionality test.

The developed R2R manufacturing technology using mould fabrication can be used for other applications such as ultra-precision machining, and functional film printing. It is critical for the advancement of low-cost optics manufacturing in the future. The work has been published in "CIRP Annals" and "Optics Express" recently.

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



Machined linear/radial Fresnel lens roller moulds

A number of events were organised in 2015 to engage the industry and forge partnerships

SIMTech Annual Manufacturing Forum (AMF) 2015, 23 July

SIMTech flagship Conference received an overwhelming 439 attendees from industry, associations, government agencies and institutes of higher learning. With the theme Future of Automation—more than robotics, the 10th SIMTech AMF'15 is a platform to capture the state-of-the-art automation technologies, exchange ideas and initiates collaborations and partnerships. The Singapore Workforce Development Agency is a partner of this event in collaboration with the Singapore Manufacturing Federation and Employment and Employability Institute.

Prof Dr-Ing Peter Gutzmer, Deputy CEO and CTO of Schaffler Group, Germany and Dr Andreas Schick, CEO of Asia-Pacific, Schaffler Group, Germany presented the keynote lecture on Future of Mobility, Manufacturing and Automation. Dr K C Ang, Senior Vice President & General Manager, Singapore Operations, GLOBALFOUNDRIES shared on Automation in Semiconductor Manufacturing where the level of mechanisation and data automation is highest.

Technology futurists and leaders highlighted their views and thoughts on future automation from two perspectives: smart automation tools and data automation embracing Industrie 4.0.

To mark Singapore's 50th anniversary, a panel discussion reviewed the evolution of industrial automation locally in its past 50 years and to foresee the future and challenges of automation in Singapore. Dr Michael Teng, Assistant Secretary-General of Singapore Manufacturing Federation and Ms Fong Pin Fen, Deputy Director of Economic Development Board shared their views with the audience.

The event was complemented by an exhibition where companies and government agencies showcased their robots, software, technology capabilities and training programmes. Some participants are ABB, Aitech Mechatronics, Fanuc Corporation, KUKA Industries, CAD-IT Consultants Asia, SeaCAD Technology and government agencies, Singapore Workforce Development Agency and Employment and Employability Institute.



SIMTech-WDA PE WSQ Graduation Ceremony 2015, 13 August



The fourth Precision Engineering WorkSkill Qualifications graduation ceremony marks the successful completion of the various SIMTech-WDA WSQ training programmes. 445 participants from 191 companies graduated at the event. The highlights of the event were the three winners of the Most Inspiring Trainee Award and the Best Industry Partner Award (see pg 5 for details).

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



Application of Printed Electronics in Print & Media

22 October 2015

This CIP assists member companies to establish the basic techniques in application of printed electronics in design and prototyping of integrated system for Smart Poster and other Print & Medium products for advertisements.

For enquiries, please contact **Mr Rick Yeo** at
Tel: 6793 8227 | Email: rickyao@SIMTech.a-star.edu.sg

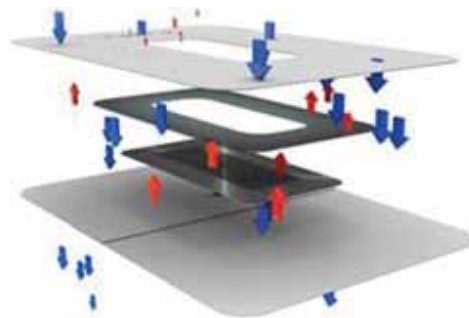


Item Management and Tracking System

Ongoing

This CIP aims to help companies deploy a RFID/barcode based Inventory Tracking System (ITS) to better manage, track & stock take their Inventory so as to help improve productivity, traceability and minimise errors.

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



Deformation-based Surface Texturing for Functional Applications

Ongoing

This CIP aims to design, develop, and test incremental micro/nano hot embossing system for functional applications on planar parts, micro form rolling surface texturing system for friction reduction on cylindrical parts, and micro rolling system for thermal conductivity enhancement on thin metallic foils.

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



Laser Surface Texturing for Improving Surface Functional Performance

Ongoing

This CIP aims to develop laser surface texturing process and transfer the laser produced micro/nano surface textures onto the components and products so as to generate new and/or improve its functional performance.

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

SMC Annual Conference 2015: Circular Economy - Sustainable Business Trends for Tomorrow's Manufacturing

5 November 2015 | 8.30am - 4.00pm | SIMTech Auditorium, Tower Block

This event leverages on circular economy to redefine consumer satisfaction to add value to products and Singapore companies. It also provides an overview of technologies and systems for circular economy including industry cases. The conference features speakers from LVMH, Autodesk and SIMTech, to name a few.

For enquiries, please contact **Mr Lee Hock Wee** at Tel: 6793 8456 | Email: hwlee@SIMTech.a-star.edu.sg

Lab-on-a-Chip Asia 2015: Microfluidics, Point-of-Care Diagnostics and Organ-on-a-Chip

19-20 November 2015 | 8.30 - 6.00pm | Singapore

Co-organised with SIMTech, attendees will benefit from insights from industry, research institute and academia. The speakers' line-up is from QuantuMDx Group Ltd, InSilixia Inc, Micronit Microfluidics, Microfluidic Chip Shop GmbH, SIMTech Microfluidics Foundry, CSEM, NTU, NUS and University College London.

For enquiries, please contact **Dr Jeffery Chen** at jfchen@SIMTech.a-star.edu.sg or 6793 8259



Scan for more events

PE WSQ Operations Management Innovation (OMNI) Programme (Batch 35)

12 October 2015 | 8.30am - 1.30pm, SIMTech, Tower Block

PE WSQ Graduate Diploma in MedTech Manufacturing**Module 1: MedTech Regulatory Overview**

26 October 2015 | 6.30pm - 9.30pm, SIMTech, Tower Block

PE WSQ Graduate Diploma in Manufacturing Operation Management (MOM)**Module 5: Inventory Management**

2 November 2015 | 6.30pm - 9.30pm, SIMTech, Tower Block

PE WSQ Graduate Diploma in Advanced Welding Technologies**Module 3: Review Welding Operation & Quality Control**

5 November 2015 | 6.30pm - 9.30pm, SIMTech, Tower Block

PE WSQ Graduate Diploma in Metal Manufacturing**Module 4 Perform Integrated Forming Process****Technology for Metals**

5 January 2016 | 6.30pm - 9.30pm, SIMTech, Tower Block

PE WSQ Graduate Diploma in Precision Measurements and Characterisation**Module 3: Dimensional Metrology, Instrument, and Measurement Standards**

12 January 2016 | 6.30pm - 9.30pm, SIMTech, Tower Block

PE WSQ Graduate Diploma in Advanced Welding Technologies**Module 4: Adopt Friction Stir Welding and Diffusion Bonding**

26 January 2016 | 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



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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 400 researchers, we are committed to serving the manufacturing industry to develop the human, intellectual, and industrial capital in Singapore.

