Agency for Science, Technology and Research
SINGAPORE

April 2018 - March 2019

ANNUAL REPORT

CREATING GROWTH, ENHANCING LIVES

Contents

Our Mission

The Agency for Science, Technology and Research (A*STAR) drives mission-oriented research that advances scientific discovery and technological innovation. We play a key role in nurturing and developing talent and leaders for our research institutes, the wider research community, and industry.

Our research creates economic growth and jobs for Singapore. As a Science and Technology Organisation, we bridge the gap between academia and industry in terms of research and development. In these endeavours, we seek to integrate the relevant capabilities of our research institutes and collaborate with the wider research community as well as other public sector agencies towards meaningful and impactful outcomes.

Together with the other public sector entities, we develop industry sectors by: integrating our capabilities to create impact with multi-national corporations and globally competitive companies; partnering local enterprises for productivity and gearing them for growth; and nurturing R&D-driven start-ups by seeding for surprises and shaping for success.

Our research, in addition, also contributes to societal benefits such as improving outcomes in healthcare, urban living, and sustainability. These serve to enhance lives in Singapore and beyond.

Our Vision

A global leader in science, technology and open innovation.

A*STAR is a catalyst, enabler and convenor of significant research initiatives among the research community in Singapore and beyond. Through open innovation, we collaborate with our partners in both the public and private sectors, and bring science and technology to benefit the economy and society.

ABOUT A*STAR

Message from the Chairman and CEO

Global R&D spending has been rising steadily with more than $2 trillion being invested for the third consecutive year in 2018. In the same year, 44 per cent of R&D monies were spent in Asia reflecting the region's continued growth and the continued drive to harness technology and innovation for growth. This trend is expected to continue. In Singapore, the government's investment in R&D has catalysed business expenditure on R&D (BERD) with an annual growth rate of 5 per cent for the past five years, a testament to how innovation is becoming more pervasive in Singapore.

A*STAR has supported 400 local companies in adopting A*STAR technologies through a range of research programmes and projects. Through A*ccelerate, our innovation and enterprise office, we are also invigorating the local start-up scene by nurturing new spin-offs, and helping local companies in particular to leverage A*STAR's intellectual property portfolio to boost their competitive advantage.

To support Singapore's drive to transform manufacturing, we have been working with government and industry partners, as well as trade associations and chambers to help our local companies equip themselves for Industry 4.0. We completed the rollout of our Model Factory Initiative last year, and to date 82 companies are working with our research institutes, SIMTech and ARTC, to testbed Industry 4.0 technologies. Our collaborations in this area are continuing to expand from precision engineering, and aerospace and machinery to other sectors such as pharma and fast-moving consumer goods.

The biomedical sciences remain an exciting field. Our investments in this area have resulted in emerging economic outcomes for Singapore, such as more biotech spin-offs, licensing deals, joint labs with companies, as well as attracting private sector investments. Our collaborations with industry and public sector partners are also contributing to national needs such as ageing and wellness, as well as food and nutrition.

We are also ramping up our work with other public service agencies, so as to contribute A*STAR technologies to better serve Singapore and Singaporeans. Whether it's incorporating our technology into police robots, green buildings or citizen services, our science and technology is contributing to the security, success and sustainability of Singapore, for Singaporeans.

We would like to take this opportunity to recognise our previous Executive Chairman Mr Lim Chuan Poh's indefatigable spirit in advancing A*STAR's mission and his contributions to Singapore's research, innovation and enterprise ecosystem. We would also like to acknowledge the support of the A*STAR board and our partners across government, industry, the clinical and academic medical research community, and the institutes of higher learning.

In the year ahead, we will continue to focus on helping our local companies increase competitiveness and productivity, and grow their business beyond our shores. We will also strengthen our partnership with public sector agencies to serve Singaporeans better.

Ms Chan Lai Fung
Chairman
April 2019

Mr Frederick Chew
Chief Executive Officer
April 2019

Board Members (as at 1 April 2019)

Ms Chan Lai Fung

Chairman
A*STAR

Mr Frederick Chew

Chief Executive Officer
A*STAR

Professor Barry Halliwell

Chairman
Biomedical Research Council
A*STAR

Senior Advisor
Academic Appointments and Research Excellence,
Office of the Senior Deputy President and Provost,
Tan Chin Tuan Centennial Professor
National University of Singapore

Professor Sir John O'Reilly

Chairman, Science and Engineering Research Council, A*STAR;
Chairman, NICC (Standards) Ltd

Professor Isaac Ben-Israel

Chairman
Israel Space Agency

Professor Stefan Catsicas

Science and Technology Strategy Advisor
Nestlé S.A

Professor William Chin

Bertarelli Professor Emeritus of Translational Medical Science and
Professor Emeritus of Medicine, Harvard Medical School

Professor Chong Tow Chong

President and Acting Provost,
Singapore University of Technology and Design

Mr Chng Kai Fong

Managing Director
Economic Development Board

Mr Anton S. Huber

Former Chief Executive Officer
Digital Factory Division, Siemens AG

Dr Benjamin Koh Khay Wee

Deputy Secretary (Development)
Ministry of Health

Professor Lily Kong

President and Lee Kong Chian Chair Professor of Social Sciences,
Singapore Management University

Dr Josephine Kwa

Director
Barghest Building Performance

Professor Sir Keith O'Nions

Chairman
Cambridge Enterprise Limited

Dr Omkaram Nalamasu

Senior Vice President and Chief Technology Officer, Applied Materials;
President, Applied Ventures LLC

Mr Quek Gim Pew

Chief Defence Scientist
Ministry of Defence

Professor Tan Eng Chye

President
National University of Singapore

Dr Tatsumi Yamazaki

Distinguished Advisor
Chugai Pharmaceutical Co., Ltd

Professor Subra Suresh

President
Nanyang Technological University Singapore

Mr Yee Ping Yi

Deputy Secretary (Planning)
Ministry of Finance

Key Management (as at 1 April 2019)

Mr Frederick Chew

Chief Executive Officer
A*STAR

Mr Suresh Sachi

Deputy Chief Executive
(Corporate)
General Counsel
A*STAR

Dr Raj Thampuran

Special Advisor
A*STAR

Professor Sir David Lane

Chief Scientist
A*STAR

Professor Barry Halliwell

Chairman
Biomedical Research Council
A*STAR
Senior Advisor
Academic Appointments and
Research Excellence,
Office of the Senior Deputy
President and Provost,
Tan Chin Tuan Centennial
Professor
National University of Singapore

Professor Sir John O'Reilly

Chairman, Science and
Engineering Research Council,
A*STAR;
Chairman, NICC (Standards)
Ltd

Dr Benjamin Seet

Executive Director
Biomedical Research Council
A*STAR

Professor Tan Sze Wee

Executive Director
Science and Engineering
Research Council
A*STAR

Mr Philip Lim

Chief Executive Officer
Accelerate Technologies Pte Ltd
A*STAR

Professor Ng Huck Hui

Executive Director
A*STAR Graduate Academy;
Executive Director
Genome Institute of Singapore
A*STAR

Organisation Chart *(as at 1 April 2019)*

Chairman
Ms Chan Lai Fung
and
Board of Directors

Chief Scientist
Prof Sir David Lane

Special Advisor
Dr Raj. Thampuran

Chief Executive Officer
Mr Frederick Chew

Internal Audit
Ms Karen Chia

Deputy Chief Executive (Corporate)
Mr Suresh Sachi

Operations Group

Accelerate Technologies Pte Ltd

Chairman
Mr Frederick Chew

Chief Executive Officer
Mr Philip Lim

Biomedical Research Council

Chairman
Prof Barry Halliwell

Executive Director
Dr Benjamin Seet

Deputy Executive Director
Dr Patrick Tan

Science & Engineering Research Council

Chairman
Prof Sir John O'Reilly

Executive Director
Prof Tan Sze Wee

Deputy Executive Director
Dr Hazel Khoo

Industry Development Group

Group Director
Mr Liau Eng Soon

A*STAR Graduate Academy

Executive Director
Prof Ng Huck Hui

Deputy Executive Director
(Scholarship Administration)
Ms Ang Ee Luang

Deputy Executive Director
(Scholar Engagement and Development)
Prof Lisa Ng

Corporate Group

Corporate Communications

Group Director
Ms Angelina Fernandez

Finance

Group Director
Ms Goh Mien Zo

Human Resource

Group Director
Mr Timothy Sebastian

Information Technology Shared Service

Chief Information Officer
Dr John Kan

Enterprise Risk Management Office

Chief Risk Officer
Dr Lye Kin Mun

Legal

General Counsel
Mr Suresh Sachi

Office of Science Communications and Archives

Senior Director
Ms Choong Ket Che

Administration and Procurement

Director
Ms Kerin Lim

A* PO

Director
Dr Manjeet Singh

Infrastructure Planning & Facilities Management

Director
Ms Neo Hwee Peng

Planning and Policy Division

Director
Dr Chng Zhenzhi

Organisational Exellence

Director
Mr Dennis Tan

Subsidiary Company

Name of subsidiary company: Accelerate Technologies Pte Ltd (A*ccelerate)

% of shareholdings in company: 100%

A*ccelerate is the commercialisation arm of the Agency for Science, Technology and Research (A*STAR), supporting it in transforming the economy by driving innovation and commercialising its research outcomes.

A*ccelerate aims to be the one-stop open innovation partner of choice to grow businesses in Singapore and beyond through accelerating the translation of inventions and intellectual capital into marketable products, processes and services.

A*ccelerate's IP, technology transfer and commercialisation professionals harness new technologies, increase the value of intellectual property and incubate cutting-edge business ventures to create commercial impact.

Together with industry leaders, mentors, catalysts and the A*STAR research community, A*ccelerate works to build a cohesive ecosystem for Innovation and Enterprise.

For more information, please visit https://www.accelerate.tech/

Our Community *(as at 1 April 2019)*

The A*STAR community spans across a broad range of research areas from the biomedical sciences to the physical sciences and engineering. The community of scientists and researchers, technical and non-technical staff, and industry development and commercialisation staff was more than 5,100 strong as at 1 April 2019.

Biomedical Research Institutes

Bioinformatics Institute (BII)
Bioprocessing Technology Institute (BTI)
Genome Institute of Singapore (GIS)
Institute of Bioengineering and Nanotechnology (IBN)
Institute of Medical Biology (IMB)
Institute of Molecular and Cell Biology (IMCB)
Singapore Bioimaging Consortium (SBIC)
Singapore Institute for Clinical Sciences (SICS)
Singapore Immunology Network (SIgN)
Skin Research Institute of Singapore (SRIS)

Science and Engineering Research Institutes

Advanced Remanufacturing and Technology Centre (ARTC)
Institute of Chemical and Engineering Sciences (ICES)
Institute of High Performance Computing (IHPC)
Institute for Infocomm Research (I^2R)
Institute of Materials Research and Engineering (IMRE)
Institute of Microelectronics (IME)
National Metrology Centre (NMC)
Singapore Institute of Manufacturing Technology (SIMTech)

National Platforms

*These are facilities hosted and managed by A*STAR but funded nationally by multiple public stakeholders and serve specific national capability.*

- Diagnostics Development Hub (DxD)
- Experimental Drug Development Centre (EDDC)
- National Robotics Research and Development Programme Office
- National Supercomputing Centre (NSCC)
- Singapore Biodesign (SB)
- Technology Centre for Offshore and Marine, Singapore Ltd (TCOMS)

KEY ACHIEVEMENTS

Agency for Science, Technology and Research
SINGAPORE

POSITIONING SINGAPORE FOR GROWTH

THROUGH SCIENCE, TECHNOLOGY AND OPEN INNOVATION

A*STAR Outcomes in RIE 2020

Updated March 2019

POWERING INDUSTRY INNOVATION

ANCHORING MNCS TO STRENGTHEN KEY INDUSTRIES

NUMBER OF PROJECTS UNDERTAKEN **>3,630**

NUMBER OF JOINT LABS **29**

>6,200
PROJECTS UNDERTAKEN
with companies and public sector agencies
(average of 2,064 projects per year)

Attracted
S$813m
R&D investment from companies

RAISING LOCAL ENTERPRISES' PRODUCTIVITY & GROWTH

OPERATION & TECHNOLOGY ROADMAP (OTR)

>270 **PROJECTS**
with 140 companies under OTR

SMES AND START-UPS
1,750 projects

LLES
>290 projects

TRAINING

>1,800
PMETs
from companies trained in advanced manufacturing

>180 A*STAR Researchers seconded to industry

>250
TALENT TRAINED
under the Singapore Biodesign programme (SB)

INNOVATING FOR ENTERPRISE

LICENSES

>760 Licenses taken up by companies
- 77% via simplified & express licensing
- 63% to SMEs/spin-offs

PRODUCTISATION + SPIN-OFFS

>50
A*STAR SPIN-OFFS
attracted
S$245m
of follow on funding

>S$40m
in industry co-funding to enhance maturity of A*STAR technologies

S$85m
raised by venture co-creation efforts

A*STAR COLLABORATIVE COMMERCE MARKETPLACE (ACCM)

Agency for Science, Technology and Research
SINGAPORE

Updated March 2019

POSITIONING SINGAPORE FOR GROWTH

THROUGH SCIENCE, TECHNOLOGY AND OPEN INNOVATION

A*STAR Outcomes in RIE 2020

DRIVING THE FUTURE OF MANUFACTURING

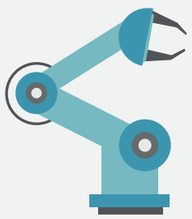
TECH ACCESS

670 WORK-DAYS booked by 85 companies to access A*STAR facilities

TECH DEPOT

557 TECHNOLOGY adoptions of A*STAR innovations by SMEs

MODEL FACTORY INITIATIVE



119 INDUSTRY PROJECTS with 82 companies for A*STAR's Model Factory initiative - designed to provide technological solutions, reduce costs and raise productivity.

To date, A*STAR has engaged over 1,400 companies on its Model Factory initiatives.

GROWING SINGAPORE'S BIOTECH SECTOR

AS OF 2018

ABOUT 100 biotechs incorporated in Singapore

of which

29% are A*STAR spin-offs

ABOUT 50% have collaborations, intellectual property licenses, joint labs with A*STAR, or were incubated at A*StartCentral.

IN 2018, OVER

US$350M deals and investments for Singapore biotechs

GROWING AND TRANSFORMING

SINGAPORE'S ECONOMY FOR THE FUTURE

HARNESSING R&D EFFORTS

Harnessing R&D efforts to seed new growth areas in the food and consumer innovation cluster, and the biopharmaceutical manufacturing sector.

DELIVERING INNOVATIVE PUBLIC SERVICES THROUGH PARTNERSHIPS

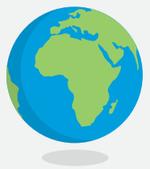
PUBLIC SECTOR AGENCIES

580 projects undertaken

ADVANCING GREAT SCIENCE

7,096 high-impact publications

IN 2017, A*STAR WAS



ONE OF THE TOP 10 PUBLIC RESEARCH organisations in the world

RANKED NO. 1 for commercial impact

Source: Reuters Top 25 Global Institutions (Government) ranking.

243 A*STAR SCHOLARS

have completed their PhD or post-doctoral education, and are contributing to Singapore's research, innovation and enterprise ecosystem in various ways.

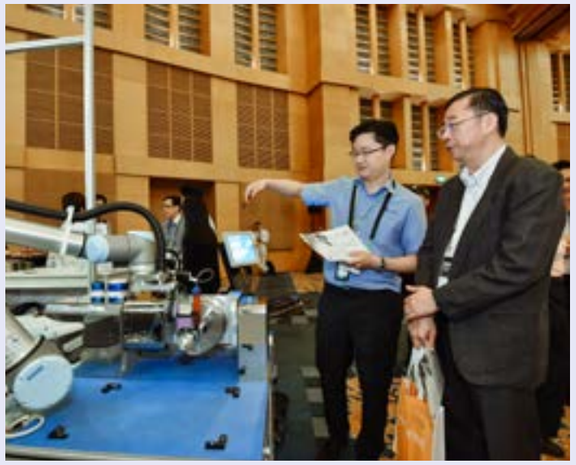
Powering Industry Innovation

We have helped our local enterprises to leverage technology and innovation, improve productivity, grow business opportunities, and create new products and services, through industry initiatives such as the Growing Enterprises through Technology Upgrade (GET-Up) programme, and partnerships with trade associations and chambers (TACs) and fellow economic agencies. In 2018, we introduced the Consortium Operation & Technology Roadmap (COTR) to our portfolio of SME assistance initiatives, to scale up strategic technology and R&D roadmapping across the industry.

Our long-standing partnerships with LLEs such as NTUC FairPrice and DBS have enabled them to tap technology as a key source of competitive advantage. We continue to strengthen key industries in Singapore by collaborating with strategic MNC partners. Our joint laboratory with Rolls-Royce and Singapore Aero Engine Services (SAESL) has produced an automation solution to boost efficiency in aircraft maintenance repair and overhaul (MRO). We have also made a strategic foray into the professional services sector with our partnership with KPMG, to drive digitalisation of the firm's capabilities, products and services.

Through A*ccelerate, and the Diagnostics Development (DxD) Hub, we strengthened the link from research, innovation to enterprise, to deliver impact from commercialising our research outcomes.

BRINGING SMES TOGETHER TO HARNESS TECHNOLOGY & INNOVATION FOR GROWTH



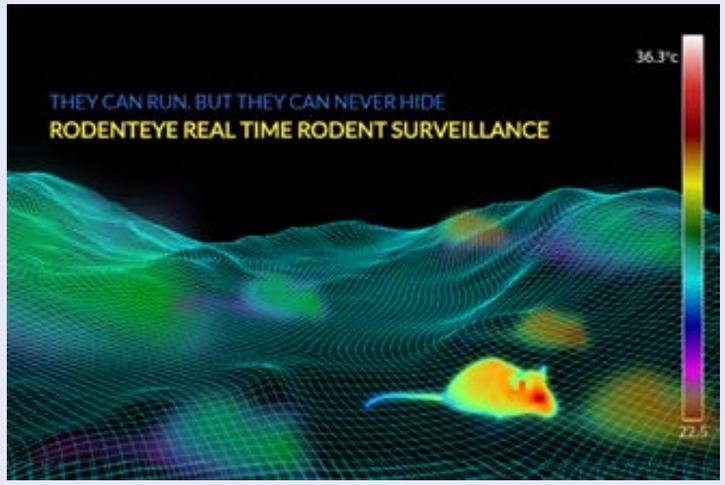
A*STAR and Enterprise Singapore (ESG) co-organised SME Technology and Innovation Day 2018 to showcase various technology-related initiatives, and to encourage SMEs to adopt technology and innovation to develop new and differentiated products, services and processes, and improve productivity.

Since 2003, A*STAR's flagship SME initiative, GET-Up, has been helping companies develop successful growth strategies, improve their innovative capacity and productivity, and create cutting-edge products and services.

The event was graced by Minister for Trade and Industry, Mr Chan Chun Sing, who emphasised the importance of collaboration between the government, research institutions, SMEs, and other technology partners, to ensure that Singapore continues to stay ahead of the competition. He also gave out the T-Up Excellence awards, which recognise the R&D contributions of researchers to local SMEs.

> **"We are now in an era where the effects of technological disruption are touching on all aspects of our lives…**
>
> **Singapore must position ourselves as the Global Asia Node of technology, innovation and enterprise, in order to maintain a vibrant and competitive economy.**
>
> **The government, the research institutes, our SMEs, our local enterprises, our workers must all work closely with one another so that we can stay ahead of the competition."**
>
> - Mr Chan Chun Sing
> Minister for Trade and Industry at
> SME Technology and Innovation Day 2018

SMART PEST CONTROL TECHNOLOGY MONITORS RODENT ACTIVITY 24/7



(Credit: Pestech)

With the aim of expanding its innovation capacity and delivering greater value to its customers, Pestech worked with I²R through T-Up on developing a cost-effective smart surveillance system to monitor rodent activity in real-time. Called RodentEye, the system utilises sensors and data analytics to monitor rodent activity more efficiently than physical surveillance, enabling pest management companies to implement timely and effective intervention strategies. RodentEye is deployed at over 40 sites in Singapore.

> **"Mike Wong (T-Up secondee) has helped Pestech to innovate its work processes, enabling us to overcome high operational costs, and provide higher-value-added service to our clients. With the training provided, our staff has also become more competent in harnessing digital technologies for greater efficiency."**
>
> **- Mr Tong Kien Seng**
> **Founder, Pestech**

TURNING THE TAP ON INNOVATIVE BATHROOM SOLUTIONS

*A*STAR helped Rigel develop a strategic business plan which led to the development of innovative products such as the Smart Mirror which is designed to automatically tilt to various angles, bringing great advantage to children as well as users on wheelchairs. (Credit: Rigel Technology)*

> **"The OTR is very systematic and methodical. They did their best to consolidate our ideas to make the sessions very comprehensive and constructive."**
>
> **- Mr Christopher Ng**
> **Group CEO, Rigel Technology (S) Pte Ltd**

As a provider of eco-friendly bathroom solutions, local company Rigel Technology's goal was to move up the value-chain and become a world-renowned brand powered by smart technologies. To achieve this, the company developed a five-year technology roadmap with A*STAR in 2015.

Since then, Rigel has tapped on smart technologies to develop innovative and environmentally sustainable products that meet an ageing population's needs, and improve its online customer experience. Rigel is already seeing success through productivity gains of 20 per cent per worker, and a revenue increase from 2015 to 2017.

WASTE NOT, WANT NOT: DEVELOPING SUSTAINABLE FOOD WASTE TREATMENT

Digester turns Singaporeans' food waste into fertiliser in just 24 hours

Cheryl Teh

Take a tonne of rice, chicken, fish, noodles and other leftovers from the lunch of a few hundred people.

Put all of that into a machine and, within 24 hours, that mountain of scrap will be turned into fertiliser for gardens.

One such machine is now located at JTC Corporation's Pandan Loop Industrial Estate, which is among several sites serving as a test-bed for new ways to reduce waste. The other sites include Jurong-Clementi Town Council and the Khoo Teck Puat Hospital.

The food digester at the JTC estate was developed in a joint public-private collaboration between the Agency for Science, Technology and Research (A*Star) and Westcom Solutions, which specialises in food waste reduction and recycling services.

This is how it works. The food waste is first dumped into the machine, then microbes – small micro-organisms that break down the food waste into simpler organic materials – are added to the mix.

In the machine, the chemical process of digestion takes one day, while other food digesters in the market take a week or more to do the same.

The microbes used in the machine are specially tailored to efficiently break down the oily and rich food found in the diet of Singaporeans.

The microbes, Westcom Solutions says, work better on Singapore food waste compared with those used to digest leftover rice and fish in other countries like Japan.

Westcom's digesters reduce the volume of food waste by up to 90 per cent, with the remaining 10 per cent converted into an odourless organic fertiliser.

The digester at Pandan Loop has the capacity to produce about a tonne of fertiliser every month – which is repackaged and sold.

"Apart from reducing the need for us to do more incineration and take up precious land from our only landfill, it is also about building an ecosystem for the circular economy where we close the loop of food waste," said Senior Minister of State for Trade and Industry Koh Poh Koon, who visited the Pandan Loop Industrial Estate to view the food digester yesterday.

More than 800,000 tonnes of food waste were generated in Singapore last year, or an estimated 140kg per person on the island. But only 16 per cent of the food waste in the Republic is recycled, said the National Environment Agency.

A staff from Westcom explaining to Dr Koh Poh Koon, Senior Minister of State, Ministry of Trade & Industry, how the microbes in the food digester break down food waste efficiently.

Tuesday, December 11, 2018

When Westcom was founded in 2016, its CEO, Mr David Tan, initially imported food waste processing machines, as well as commercial sources of microbes, from Japan. However these microbes were found to be ill-suited to Singapore due to differences in the food consumption habits and the climate between the two countries. Realising the need to innovate for the local market, Westcom began collaborating with ICES in 2017 to develop a unique microbial treatment which degrades local food waste in a safe, pathogen-free manner. Through T-Up, A*STAR also helped Westcom in setting up a R&D laboratory, and provided training to carry out large-scale production of the microbial solution. Westcom was able to reduce the volume of food waste by up to 90 per cent, and reduced its operating costs by 30 per cent.

TECHNOLOGY ROADMAPPING FOR GROWTH

A roadmapping exercise in progress for industry members from the food manufacturing sector

> **"The COTR process has translated my thoughts into action and reaffirmed our business strategy. I would like to implore traditional businesses to rethink digitalisation as an opportunity for growth and not a threat."**
>
> **- Mr Eugene Tan**
> **Director, Pere Ocean**

To scale up technology roadmaps across sectors and industries, A*STAR's COTR initiative was rolled out in 2017 to help companies deepen partnerships, and close the technology gaps in the industry.

COLLABORATIVE COMMERCE MARKETPLACE

Industry members and partners came together during the annual ACCM Day on 1 Oct 2018, to build on business collaboration opportunities and to explore new areas of collaboration.

> **"As companies listed on the ACCM are verified through a rigorous system, our chances of being successfully connected to MNCs as suppliers increase. With MNCs' needs specified, SIGENIC can expand our product offerings in a more targeted way. ACCM allows us to forge alliance with like-minded companies."**
>
> **- Mr Koh Min Zhuan**
> **Director, SEGENIC Pte Ltd**

The A*STAR Collaborative Commerce Marketplace (ACCM) online platform connects local suppliers, start-ups, MNCs, and public agencies, facilitating partnerships and research and business collaborations.

NEW LOGISTICS SERVICES AND ON-THE-GO PLANNING AND MONITORING SOLUTIONS BOOST PRODUCTIVITY

RFID-enabled automation and tracking system for seafood inventory (Credit: NTUC Fairprice)

To build capabilities in automation for greater operational efficiency and effectiveness, NTUC FairPrice has been working with SIMTech since 2014. SIMTech worked with FairPrice on an RFID-enabled automation and tracking system to better track seafood inventory and eliminate data entry errors. As result of its technology adoption, FairPrice was able to achieve time savings of 75 per cent in data entry and improve productivity of its fresh seafood supply chain, and allocate manpower more efficiently.

(Credit: Grocery Logistics of Singapore)

SIMTech also helped customise its on-the-go planning and monitoring solutions for Grocery Logistics of Singapore (a wholly-owned subsidiary of NTUC FairPrice)'s last-mile logistics planning, dynamic vehicle routing and scheduling engine, with driver app monitoring. This led to a productivity improvement of 79 per cent for FairPrice's delivery routing tasks.

FACILITATING SAFER, SMOOTHER BANK TRANSACTIONS

DBS and I²R embarked on a joint lab collaboration in 2014, to build advanced data analytics capabilities to enhance the bank's internal process in the areas of customer management, risk management, information technology, security and human resource functions. The data analytics solutions developed were operationalised within DBS, leading to smoother operations and higher productivity. It saw an increase in uptime of its automated teller machines by 300 hours per month across its network, and an improvement of 50 per cent in its audit efforts.

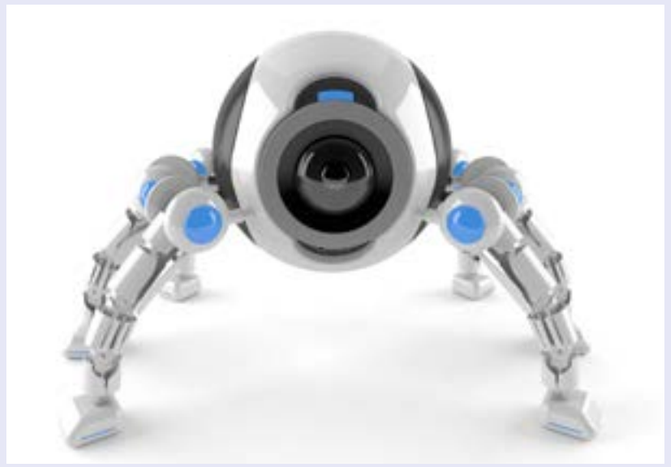
PREPARING THE AIRCRAFT MRO SECTOR TO TAKE OFF WITH AUTOMATION

A robotic spray system for fan blades of aircraft engines
(Credit: Rolls-Royce)

For over 10 years, Rolls-Royce has worked with A*STAR in initiating various R&D initiatives that contribute to the local aerospace industry, one of which is a joint laboratory formed between A*STAR, Rolls-Royce and SAESL in 2017. The five-year collaboration aimed to develop next-generation aerospace manufacturing, as well as MRO capabilities enabled by advanced processes, automation and digital technologies.

One outcome of the joint laboratory is the development of robots to automate spraying protective coatings on fan blades of aircraft engines. The solution was co-developed by ARTC and local SME KA Industrial Engineering, replacing the need for manual spraying, and ensured consistent and high quality of coatings, hence reducing defects and saving costs.

BUILDING DIGITAL CAPABILITIES IN THE PROFESSIONAL SERVICES INDUSTRY



In July 2018, A*STAR formed a three-year research collaboration with KPMG, to drive the digitalisation of the firm's capabilities, products and services. The collaboration included a joint laboratory, focusing on the areas of cyber security, text-mining, machine translation and human resources analytics. The research facility is KPMG's first joint laboratory in Singapore, as well as A*STAR's first foray into the professional services industry.

Tapping on I²R's strength in cybersecurity and data analytics, and KPMG's expertise in professional services, the joint laboratory developed a cyber threat hunting tool that could identify malicious and suspicious activities that would otherwise remain undetected. It extracts and processes digital footprint to help cyber professionals detect abnormal behaviour and suspicious activities in an organisation's network. The cyber threat hunting tool was unveiled in March 2019, and will be deployed for KPMG's interested clients, and could potentially be proliferated within KPMG's international network of professional services firms.

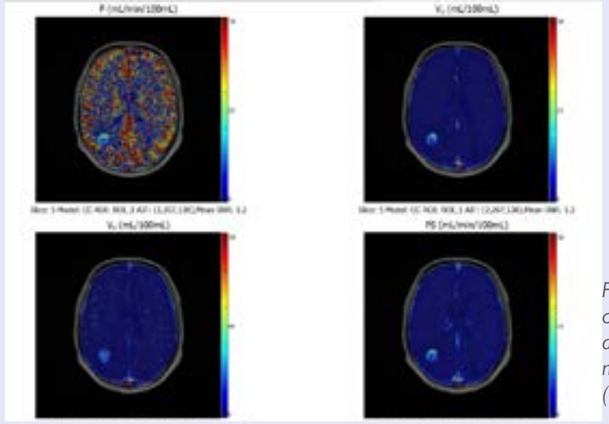
HELPING LOCAL PHARMA ACCELERATE SKIN HEALTH INNOVATION

*SMS Koh Poh Koon (centre) with A*STAR representatives at the opening of Hyphens Pharma. (Credit: Hyphens Pharma)*

As one of Singapore's largest LLEs in the pharmaceutical space, Hyphens Pharma is continuously looking to innovate to build its competitive edge to serve the rising demand for quality healthcare products. The Singapore-headquartered, SGX Catalist-listed ASEAN specialty pharma company signed a Memorandum of Understanding (MOU) with A*STAR's commercialisation arm, A*ccelerate, at the opening ceremony of its corporate headquarters and integrated facility in Singapore. The MOU is a five-year agreement to promote R&D collaboration with a focus on commercialisation to help develop innovative and differentiated skin care products to address unmet market needs for skin disorders. This agreement creates deeper partnership which is building on the close research collaborations between Hyphens and A*STAR since 2014.

Hyphens has also been collaborating with SRIS, a collaboration between A*STAR, the National Skin Centre (NSC) and Nanyang Technological University Singapore (NTU Singapore), to develop skin care products for eczema and acne, and licensed sugar-based surfactant micro-emulsions technology from ICES.

PRECISION ANALYTICS FOR CANCER IMAGING



FITPU's software platform can perform comprehensive imaging of tumour tissues, and quantitatively assess the status of tissue microvascularity of most solid tumours. (Credit: FITPU Healthcare)

FITPU Healthcare, a spin-off from I^{2}R and the National Cancer Centre (NCC), have developed Mitalytic, a software platform for oncology imaging analytics that enables precise diagnosis and prognosis of cancer. The technology has been validated and adopted by over 30 hospitals globally, and is being used by NCC and the Singapore General Hospital (SGH) as a research tool.

A NEW COAT OF INNOVATION

Read More About Nipo's Innovation Journey

Ms Amanda Khoo, Director at Nipo International (left), worked with Dr Li Xu, Senior Scientist at IMRE (right) to produce Nipo's own brand of thermal insulation wall and roof paints. (Credit: RICE Media)

When coatings specialist manufacturer, Nipo International, wanted to diversify and develop innovative new products, it turned to IMRE, ICES and SIMTech. The collaboration resulted in Nipo developing its own brand of thermal insulation coating, enabling it to serve the building and construction sector. It also spun-off an independent company, A&T Inno, which developed a refining solution of waste carbon char and produces a recycled grade of carbon black, which can be reincorporated into the manufacturing of rubber products, reducing the impact of waste tyres on the environment.

"I would like to give credit to the A*ccelerate office. They know our capabilities and they continuously introduce us to new technologies or scientists that are relevant. They are a vital bridge between Nipo and A*STAR."

- Ms Amanda Khoo, Director at Nipo International

Growing and Transforming Singapore's Economy for the Future

As Singapore continues to grow and transform its economy, A*STAR is helping key industry sectors upgrade their capabilities and thrive in the age of digital and technological disruption, and also supporting new areas of growth.

Our FoM initiative was rolled out to help industry capture opportunities in digitalisation and advanced manufacturing, and we have since extended it to the Fast-Moving Consumer Goods (FMCG) sector. We also formed the Pharma Innovation Programme Singapore (PIPS) consortium to improve and transform the local pharmaceutical manufacturing industry.

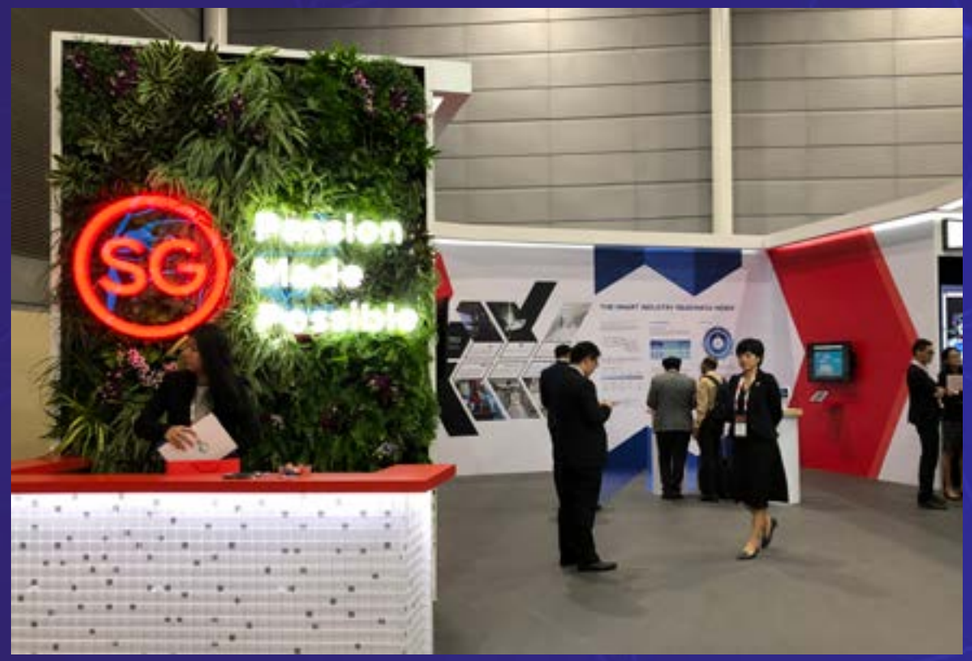
We continue to nurture Singapore's biotech ecosystem, creating a prolific environment for advancements in drug and diagnostics development. Looking ahead, we are harnessing our R&D efforts to seed new growth areas in food and consumer innovation, and grow the biopharmaceutical manufacturing sector.

To position Singapore for the future, A*STAR and fellow public sector organisations are working together to develop innovations that enhance Singapore's public services for our citizens. A*STAR's capabilities are helping to improve urban mobility and keep our neighbourhoods safe, as well as contributing to disease diagnosis, prevention and treatment.

Underlying these efforts is a talent base that is committed to excellent research that advances science, and translates to meaningful outcomes for industry and society. A*STAR contributes to Singapore's strong core of local research talent, complemented by a rich diversity of international talent. This is reflected in our scientific discoveries and technological developments, many of which are featured in prominent publications.

HANNOVER MESSE COMES TO ASIA-PACIFIC

From 16 to 18 October 2018, A*STAR was part of a multi-agency effort in organising the inaugural Industrial Transformation Asia-Pacific (ITAP), the Asian edition of Hannover Messe, the world's largest trade fair for industrial technology.



> **"Singapore's approach towards Industry 4.0 is not simply about technology.**
>
> **At the heart of our Future of Manufacturing Strategy, is a strategy about how we can better organise ourselves, and how our workforce and companies can respond more nimbly to rapidly changing economic and technological trends."**
>
> - Dr Koh Poh Koon
> Senior Minister of State, Ministry of Trade & Industry,
> at the Future of Manufacturing (FoM) Summit 2018

ITAP comprised a showcase of game-changing technologies, as well as the FoM Summit which brought together thought leaders, manufacturers and technology providers, to drive conversations on business opportunities and challenges, and implementation strategies for Industry 4.0 in the Asia Pacific region.

(Credit: SingEx Exhibitions)

Read More

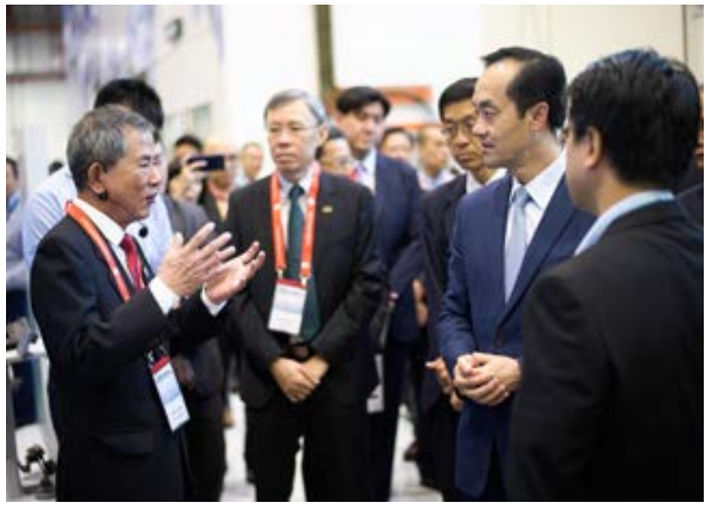
DRIVING THE FUTURE OF MANUFACTURING

*A*STAR's Model Factory Initiative, located at SIMTech and ARTC, was officially launched in August 2018. The initiative provides a Factory of the Future platform for companies to experience the latest manufacturing technologies in a learning environment, and collaborate with stakeholders to jointly develop innovative solutions for their processes.*

With manufacturing accounting for around 20 per cent of Singapore's Gross Domestic Product (GDP), A*STAR is working towards building capabilities in Industry 4.0 to maintain a globally competitive manufacturing sector. A*STAR is staying the course in driving the uptake of advanced manufacturing and digitalisation through public-private platforms (Tech Depot, Tech Access and Model Factory) under the FoM Initiative to sustain Singapore's competitiveness in manufacturing and technology innovation, so that it is a choice location for developing, test-bedding and deploying advanced manufacturing technologies.

Learn more about our FoM Initiatives

A DIGITAL SHOT IN THE ARM TO BOOST PRODUCTIVITY



Mr Tan Ser Hean, Managing Director of Abrasive Engineering (left) speaking to SMS Koh at the launch of the Model Factory Initiative

Abrasive Engineering (AE), a local SME that designs and fabricates blasting and shotpeening machines, wanted to adapt to Industry 4.0 to stay competitive for the future. Since 2017, AE joined the Model Factory Initiative and partnered ARTC to digitalise the shot peening process of its machines, to meet customer needs for an autonomous surface treatment process that would lead to better product quality and service. Since implementing technologies to its machines such as sensors, connectivity, advanced image data analytics, as well as an online quality check system, AE's revenue for services in shot peening preparation and design and manufacturing increased by 40 per cent in 2018.

SMOOTHING THE WORKFLOW WITH SMOM

With the aim of improving productivity in its operations, Banshing Industrial, a custom mould maker and moulder with sub-assembly capabilities for the precision engineering industry, approached SIMTech to implement the Smart Manufacturing Operations Management (SMOM) system in its production line. Banshing initially relied only on an ERP system that created sales and production orders. By adding the SMOM system to its work processes, Banshing could automate the process of creating and tracking sales and production orders, generate performance reports, as well as have real-time visibility into its operations. Banshing now reduces excess movement of production parts by 40 per cent and eliminates the risk of losing production parts, and it is able to generate performance reports on demand. The implementation of the system also brings Banshing a step closer towards Industry 4.0 for greater efficiency and productivity.

SUPPORTING FAST-MOVING CONSUMER GOODS

A*STAR has also extended its FoM strategy to the FMCG sector, embarking on new partnerships with Nestlé and Procter & Gamble (P&G) to co-develop advanced manufacturing solutions to improve their production operations in Singapore and accelerate product delivery for fast-changing consumer needs.

FUTURE PHARMA

The PIPS consortium members at the agreement signing ceremony during the ITAP.

To drive the transformation of the local pharmaceutical manufacturing industry and pre-position it for the future economy, PIPS signed a consortium agreement valued at S$34 million in October 2018. PIPS brings together multiple innovation players, with industry giants GSK, Pfizer and MSD partnering A*STAR and the National University of Singapore (NUS) to improve and transform manufacturing operations. These include more sustainable manufacturing of complex chemicals through the use of bio-catalysis technologies, and a fully automated supply chain that can predict and respond better to patient demands and market trends.

Find out how PIPS is helping the pharma sector innovate

> **"Digitising our factories helps to improve transparency tremendously, as I now have real-time visibility of my production schedules.**
>
> **SIMTech gave us a comprehensive suite of digital technologies to implement in Racer, and A*STAR's Model Factory Initiative gave us the flexibility to mix and match its modular technologies according to our needs and budget."**
>
> **- Mr Willy Koh**
> **CEO of Racer Technology**

WINNING THE RACE WITH ADVANCED MANUFACTURING

Racer has increased the efficiency of its factory floor by up to 70 per cent, and enjoyed cost savings of up to 70 per cent. (Credit: The Straits Times)

Racer Technology, which designs and manufactures high-value medical devices, has worked closely with SIMTech since 2006, adopting advanced manufacturing technologies to optimise its operating efficiencies, and build new capabilities, products, and services to remain competitive. It has also tapped on A*STAR's Model Factory Initiative to digitalise its manufacturing processes, and train its staff using advanced manufacturing technologies. Racer now has a projected revenue of S$40 million for FY2018, and with A*STAR's help, expects to double its revenue to S$80 million within the next five years.

One BioMed founder Park Mi-kyoung explaining her start-up's work to Senior Minister of State for Trade and Industry Koh Poh Koon as he looks through a microscope at the Genome Institute of Singapore. ST PHOTO: GAVIN FOO

Biotech expected to be key driver of future economy

Sector is rich in intellectual property and deep in technology, says Koh Poh Koon

Linette Lai

The biotechnology sector will play a key role in developing Singapore's future economy, Senior Minister of State for Trade and Industry Koh Poh Koon said yesterday.

"The key driver of the new economy is innovation," he said on the sidelines of a visit to the Genome Institute of Singapore (GIS). "Therefore, the biotech sector, which is very rich in intellectual property and deep in technology, will be an important sector to drive the future economy."

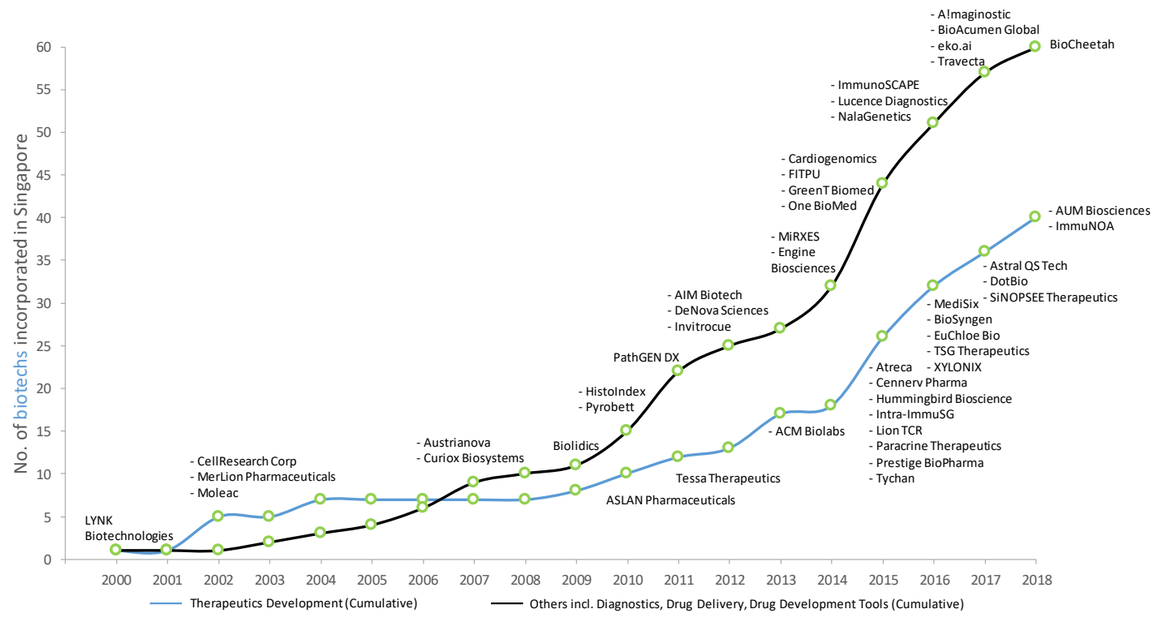
Between 2015 and last year, 32 local biotech start-up firms were set up – double the number incorporated between 2012 and 2014.

Dr Koh added that nearly a quarter of the 79 home-grown biotech firms operating here last year were spin-offs from the Agency for Science, Technology and Research (A*Star).

"This is a good momentum and something that we would like to encourage and support," he said. "But in order to make this a lasting and sustainable approach, we need to look at how we can grow this beyond just the A*Star ecosystem and integrate larger parts of our healthcare and biomedical system."

Dr Koh visited the GIS laboratories with Senior Parliamentary Secretary for Trade and Industry Tan Wu Meng. GIS is one of 18 research institutes under A*Star.

Earlier this year, A*Star said it was changing its funding model to place more emphasis on institutes that collaborate with industry. Those that focus on basic science research will have to work even harder to ensure they survive.



The number of biotechs incorporated in Singapore from 2000 to 2018.

A*STAR has played a key role in fostering the growth of the local biotech ecosystem and tackling Singapore's healthcare challenges, through open innovation and public-private partnerships between research institutions, clinicians and the industry.

As of 2018, there were approximately 100 biotechs that were incorporated in Singapore, 29 per cent of which are A*STAR spin-offs, and about half of which have collaborations, Intellectual Property (IP) licenses, joint labs with A*STAR, or were incubated at A*StartCentral. In 2018, there were over US$350m in deals and investments for Singapore biotechs. The growing traction of local biotechs demonstrates that A*STAR's investment in scientific research has borne fruit as these biotechs are the products and industry receptacles of public R&D.

SPOTLIGHT ON A*STAR SPIN-OFFS

(Credit: Lucence Diagnostics)

PIONEER IN GENOMIC MEDICINE LAUNCHES PRODUCTS FOR CANCER SCREENING

Lucence Diagnostics, an IBN spin-off, which focuses on early cancer detection using non-invasive liquid biopsy blood testing, has to date launched four products using A*STAR intellectual property.

In 2018, the company expanded to the US, Hong Kong and ASEAN to deliver its liquid biopsy tests to patients worldwide.

In January 2019, Lucence announced the opening of its new 10,000 square foot headquarters in Singapore to meet the growing demand for its clinical services.

Read about Lucence Diagnostics' R&D and business journey

(Credit: Advent Access)

MED-TECH SOLUTION FOR HEMODIALYSIS POISED FOR GLOBAL MARKETS

Singapore Biodesign spin-off, Advent Access is working on making kidney dialysis less painful and more effective, through av-Guardian™, a medical implant which eases access to veins.

It has recently acquired the global manufacturing and commercialisation rights to key product assets from Vital Access, a vascular technology company based in the US. This acquisition supports Advent Access' plans to establish a leading portfolio of vascular access solutions to address key gaps in enabling haemodialysis to be delivered in novel or alternative care environment, and opens up the firm to the US market.

(Credit: MiRXES)

BRINGING EARLY-STAGE CANCER-DETECTION TESTS TO MARKET

MiRXES, a joint spin-off from NUS and BTI, has developed four early-stage cancer detection tests, at varying stages of development and clinical validation. It has also raised US$40m in series A investment.

The first product, GASTROClear, is a blood test which detects early-stage stomach cancer before clinical symptoms appear. It was developed and validated in collaboration with the Singapore Gastric Cancer Consortium (SGCC), Diagnostics Development (DxD) Hub, National University Hospital (NUH) and Tan Tock Seng Hospital (TTSH).

CATALYSING PARTNERSHIPS FOR HEALTH AND BIOMEDICAL OUTCOMES

BUILDING A GLOBAL CANCER DATABASE TO UNDERSTAND CANCER PATIENT PHENOTYPES

On 18 December 2018, Indivumed GmbH, a global oncology company and IMCB launched the Cancer Library Initiative, to further accelerate precision diagnostics and personalised treatment for cancer patients. Together, both organisations aim to build an Asian-centric Cancer Database (ACD) which leverages Singapore's clinical network and renowned cancer centers.

Professor Wanjin Hong, Executive Director of IMCB and Professor Harmut Juhl (centre), Founder and CEO of Indivumed at the agreement signing ceremony.

CENTRE OF EXCELLENCE TO ADVANCE INNOVATION IN BIOPROCESSING

In January 2019, ESCO Aster Pte Ltd, a contract development and manufacturing organisation of Esco Group, and BTI announced the official opening of BTI-ESCO ASTER Centre of Excellence in Bioprocessing. The centre will leverage BTI's expertise in bioprocessing science and engineering, and adopt an Industry 4.0 integrated bioprocessing platform, to advance the development of safe and effective cell and gene therapies.

Professor Lam Kong Peng, Executive Director of BTI (left) and Mr Lin Xiangliang, Founder and CEO of ESCO Aster Pte Ltd.

CHUGAI-A*STAR JOINT DEVELOPMENT PROJECT RECEIVES SECOND GRANT TO CREATE ANTI-DENGUE VIRUS ANTIBODY

With the World Health Organization reporting that the incidence of dengue is dramatically growing worldwide, the search is on for a cure.

The Global Health Innovative Technology Fund, which funds scientific R&D for diseases that primarily affect the developing world, has selected a joint research project between Chugai Pharmaceutical Co., Ltd and A*STAR as a grant recipient.

The US$5.3 million grant that will enable both parties to build on Chugai's proprietary antibody engineering technologies and SIgN's expertise in biology of the dengue virus, to create a new antibody drug against the virus.

Cell as medicine

$80m boost to turn manufacture of cells into a big money-spinner

Chang Ai-Lien
Science Editor

Cell therapy, where living cells are harnessed to treat or prevent disease, is hailed as the future of medicine. But the bottleneck is in producing good-quality cells cost-effectively and in large quantities.

Singapore, leveraging on its strong biopharmaceutical manufacturing base and its early lead in stem cell research, has earmarked cell manufacturing as its next big money-spinner.

Dr Benjamin Seet, executive director of the Agency for Science, Technology and Research's (A*Star) Biomedical Research Council, said: "Around the world, there are relatively limited concerted efforts in scaling up cell production and ensuring quality of the final product. We have the opportunity to invest aggressively in this space, with the end-goal of growing our biopharmaceutical manufacturing pie."

Biopharmaceutical manufacturing, which is the production of small molecule drugs and biologics such as proteins, is an important sector for Singapore, contributing about 4 per cent of gross domestic product and employing more than 7,700 highly skilled workers. Last year, it generated $15.7 billion in manufacturing output and $9.4 billion value-add.

To replicate the success in cell manufacturing would call for advanced technologies and techniques, said A*Star.

So $80 million is going into programmes to scale up, deepen understanding of cell attributes relating to safety and efficacy, and developing technology to assess product quality during manufacturing.

Dr Seet said: "These are living cells, not chemical compounds. We have to ensure we keep them alive and functional."

In cell therapy, intact living cells are injected, grafted or implanted into a patient to restore tissue or organ function, or fight diseases such as cancer, for instance.

The handful of local companies doing such research will get a boost from the effort.

Biotech firm CellResearch Corporation, which is worth $700 million and has 44 patents, is among the home-grown firms that are pioneers in cell therapy. It has developed a stem cell treatment that can potentially heal wounds such as diabetic ulcers quickly, doing away with the need for skin grafts. It has received approval from the United States Food and Drug Administration to test its treatment on patients, with clinical trials starting this year.

A CellResearch spokesman said: "We want to take advantage of Singapore's efforts and tap the facilities it is building as a potential source of stem cells." This will contribute to the firm's long-term aim of building a plant here to produce medical grade stem cells, he added.

ailien@sph.com.sg

Thursday, March 28, 2019

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Under RIE2020, funding for cell manufacturing capabilities for cell therapy received a boost, as announced during the Research, Innovation and Enterprise Council press conference in March 2019.

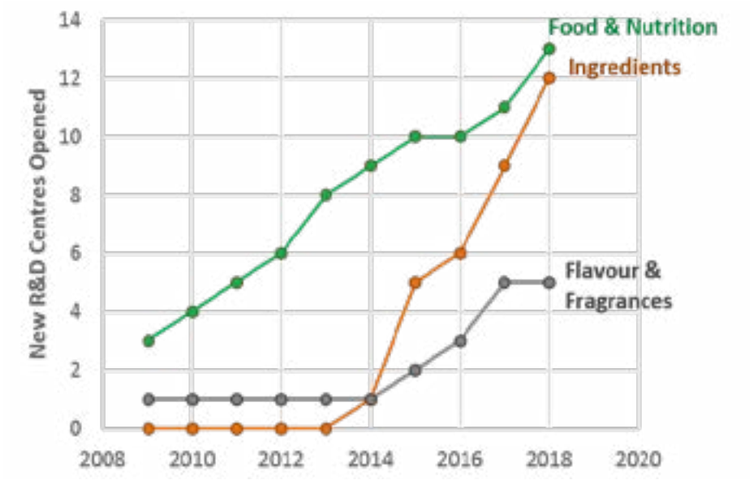
A*STAR's newly launched Cell Therapy Manufacturing R&D Programme supports the government's new efforts to preposition the sector for future growth, and brings together multi-disciplinary teams from A*STAR, Singapore-MIT Alliance Research & Technology, institutes of higher learning, and hospitals.

Manufacturing cell therapies still remains a challenge due to the complex manufacturing process and lack of suitable manufacturing technologies. The programme will develop technologies to support scalable manufacturing from development to commercialisation, identify the critical quality attributes correlating with safety and efficacy, and analytical technologies to assess product quality during manufacturing.

CELL THERAPY: THE FUTURE OF MEDICINE

Cell therapy is a therapy in which intact living cells are injected into a patient to derive a therapeutic effect such as restoring tissue or organ function, or fighting cancer. Cell therapy holds great promise in addressing unmet medical needs. Today, with the majority of treatments for chronic and life-threatening diseases designed to deal with symptoms or delay disease progression, cell therapy has the potential to revolutionise this – to cure or significantly change the course of disease.

Growth of Food and Consumer MNC R&D Centres



The past five years have seen a rapid growth of MNC R&D Centres setting up in Singapore. This started with the initial growth of food and nutrition companies, followed by the other companies in the supply value chain such as the ingredients, and the flavour & fragrances companies.

Over the years, A*STAR's R&D engagements with food and nutrition companies such as Nestlé, Danone, and Kellogg, have contributed to the emergence of a new food and consumer innovation cluster in Singapore. Business expenditure on R&D (BERD) in this sector grew at a compound annual growth rate (CAGR) of 17 per cent from S$100 million in 2007 to S$496 million in 2017.

To help Singapore achieve its vision of becoming the leading food and nutrition hub in Asia with globally competitive food companies, A*STAR is supporting FoodInnovate, a key initiative under the Food Manufacturing Industry Transformation Map (FM ITM). A*STAR is also contributing its R&D expertise in food and nutrition in new programmes such as the Food Structure Engineering for Nutrition and Health (FSENH) Programme, to improve food structures that lead to positive health and commercial outcomes; and the Innovations in Food and Chemical Safety (IFCS) Programme, which aims to develop novel ways of assessing the safety and toxicity of chemicals, towards improving food safety.

Growth of Food and Innovation Cluster @ Biopolis

More recently, we are seeing a third wave of small innovative companies such as venture capitalists, which together builds on Singapore's cluster of food and consumer industries in the ecosystem. Notably, there has been an increasing congregation of food & consumer companies within the Biopolis campus.

PLAYING A ROLE IN SINGAPORE'S FOOD STORY

In a push to ensure sustainability and resilience in Singapore's food production system, the government has set a goal to develop the capability and capacity in Singapore's Agri-Food industry to produce 30 per cent of the nation's nutritional needs locally by 2030.

A*STAR is working with fellow government agencies to develop the Agri-Food industry in areas such as R&D, manpower development and regulations. With the establishment of the Agri-Food Innovation Park (AFIP) in March 2019, a pilot cluster to catalyse innovation in the agri-tech ecosystem, A*STAR is working with EDB, ESG, JTC Corporation, and the Singapore Food Agency (SFA) to foster the co-location of high-tech urban farming and associated R&D activities.

We have also joined hands with SFA to develop the Singapore Food Story R&D programme, and will work with industry to carry out R&D in sustainable urban food production, future foods through advanced biotech-based protein production, and food safety science & innovation.

Dr Nic Lindley is leading the Biotransformation Innovation Platform which houses a pilot-scale fermentation facility for start-ups to test their processes and concepts.

Through A*STAR's Biotransformation Innovation Platform, we are also working with food, fragrances and personal care industries to overcome current challenges in the traditional sourcing of natural ingredients from plants and animal materials through alternative method of production based on biotransformation, by discovering novel sustainable biotechnology for the production of high value-added specialty chemical ingredients. It has successfully partnered with two local enterprises in these areas, working towards translating its innovations into commercialisation outcomes.

Learn about the capabilities of the Biotransformation Innovation Platform

MAKING A MARK IN THE TEA INDUSTRY

Teapasar worked with the Biotransformation Innovation Platform to develop fingerprinting technology to identify organic composition of tea leaves, and machine learning algorithms to predict taste profiles of each tea based on its organic composition. These capabilities developed enabled Teapasar to provide recommendations on its online platform based on matching individual preferences with the taste profiles of the teas, as well as assure its customers of both taste and quality of its products.

UNLOCKING NUTRITIONAL VALUE FROM FOOD GRAINS

Eatobe, which aims to transform whole plant ingredients in such a way that inherent nutrients would be more bio-accessible, worked with the Biotransformation Innovation Platform to engineer a consortia of natural food-grade microbes to ferment a food grain to a ready-to-drink beverage.

KEEPING SINGAPORE SAFE

The Singapore Police Force (SPF) collaborated with I^{2}R to develop a surveillance patrol robot to complement human patrolling, especially after office hours. The robot which is able to function autonomously and independently, is expected to enhance productivity, and enable more frontline officers to be deployed in other areas where help is needed. The robot can also provide better protection for police officers' welfare as it can conduct surveillance operations in dangerous and demanding environments.

I^{2}R spin-offs Xjera Labs and SoundEye are collaborating with Certis Cisco to develop and pilot a multi-signal surveillance platform which combines audio with video analytics that could assist security officers to determine if an alert received was a true security incident. Apart from visual element, they can analyse audio data to detect things such as gunshots and bomb blasts. Changi Airport is one of the sites that may potentially be a test-bed for this project.

FACILITATING SMOOTH TRAFFIC

A smart traffic light control system developed by the Land Transport Authority (LTA) and I^{2}R is helping to ease traffic congestion along busy roads. The system, which was trialled at a few roads near traffic intersections and pedestrian crossings, can pick up the physical presence of vehicles and pedestrians, and optimise traffic light and pedestrian crossing timings.

HARNESSING AI FOR THE IP REGISTRY OF THE FUTURE

To help the Intellectual Property Office of Singapore (IPOS) achieve its vision of driving Singapore's future growth through using its IP expertise and networks, I^{2}R is collaborating with IPOS to develop an Artificial Intelligence (AI)-based system with machine learning and statistical models to improve productivity, and reduce time taken for trademark applications, subsequently reducing the time to market of new products and services.

TRANSLATING GOVERNMENT COMMUNICATIONS

A*STAR is supporting the government's drive towards building a smart nation through the innovative use of digital technology. As a host of the Smart Nation Applied R&D Lab (SNAL), we worked with the Ministry of Communications and Information (MCI), tapping on I^{2}R's capabilities in human language technologies, to develop a machine translation engine that produces faster, more accurate machine translation between English and Chinese. I^{2}R and MCI are currently developing an English-Malay machine translation engine. The translation engines are expected to achieve quality translation with consistency in the rendering of government terms and messages.

Co-working space to bring tech firms, lawyers together to develop solutions

Lawyers and technology companies can come together to develop tech-enabled solutions for the legal sector in a new co-working space when the new State Courts Towers opens its doors next year.

The new space, roughly the size of two courtrooms, or 470 sq m, will be managed by the Singapore Academy of Law (SAL).

It will cater mainly to small law firms with fewer than five lawyers, said Justice See Kee Oon, Presiding Judge of the State Courts.

The space will also be open to tech start-ups, academics and students who can collaborate with the lawyers to develop tech solutions for the legal profession.

The aim is to develop solutions to improve access to justice, he said at the State Courts' annual Workplan Seminar yesterday.

"The combined ecosystem will be conducive for legal professionals and technology start-ups to work together, where they may redesign processes, share information on court-user needs and co-create practical tech-enabled solutions," said Justice See.

The co-working space, on the 21st floor of the State Courts Towers, will also provide more convenient access to pro bono legal services for the man in the street, he added.

With operational costs reduced from the shared amenities and facilities, law firms can focus on improving their legal practice and provide affordable legal service.

While applications will be open to all law firms, preference will be given to lawyers with a strong record in pro bono work, said SAL. In the first phase, Clicks @ State Courts will have space for rent for about 40 lawyers and 20 tech start-ups, academics and students. An information session will be held by the end of the month, it said.

The 35-storey State Courts Towers, next to the current State Courts building in Chinatown, and made up of two interconnected towers, will house 53 courtrooms and 53 hearing chambers.

When it opens next year, it will also boast technological features such as a live transcribing system developed by A*Star, which will increase efficiency of court proceedings and reduce legal costs.

The system, to be piloted in two courtrooms in the existing State Courts building, is able to recognise the Singaporean English accent, common legal terms and jargon, as well as transcribe the speeches of multiple speakers simultaneously.

To stay relevant in the digital age, the State Courts will also ramp up its data analytics capabilities and train its staff in digital literacy.

This is so that the State Courts' workforce remains relevant to "avoid risks of redundancies", said Justice See.

He added that staff will be provided with digital skills and knowledge of digital technology, as well as resources to apply these skills.

Saturday, March 9, 2019

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To replace the labour-intensive process of transcribing in the Courts, the State Courts and I^{2}R have developed a speech transcription system powered by AI. This allows oral evidence and delivery presented in court hearings to be transcribed in real-time and reviewed in court immediately by judges, prosecutors, defence counsel and parties to the case. It will be implemented in the new State Courts Towers in 2020.

TARGETING AND TREATING DISEASES

Dr S. Sendhil Velan from SBIC contributed his expertise in magnetic resonance imaging and spectroscopic approaches to measure metabolic activity of patients.

SBIC, Duke-NUS Medical School and the Singapore Clinical Research Institute (SCRI) have completed a clinical study that showed low dose thyroid hormone supplementation may be beneficial for reducing fatty liver in male diabetic patients with non-alcoholic fatty liver disease (NAFLD). The results of this study bring us closer to finding a cure for NAFLD, a major health problem that affects more than 30 per cent of Singaporeans.

A researcher attending to a GUSTO baby

In 2008, SICS, KK Women's and Children's Hospital, National University Health System (NUHS) and NUS collaborated on Growing Up in Singapore Towards healthy Outcomes (GUSTO), a cohort study on how conditions in pregnancy and early childhood influence the health and development of women and their children. The 10-year study has since yielded results that were translated into healthcare policy and practice.

Recently, the study found preliminary associations between the pre-academic performance of GUSTO children at four years old, and their subsequent real-life school performance in the early years; and showed that beyond socio-economic inequalities, maternal moods, particularly antenatal, can drive pathways that affect a child's subsequent cognitive performance and school readiness. GUSTO aims to translate its findings into initiatives as it embarks on its next phase of its study as GUSTO children move through primary school, and beyond.

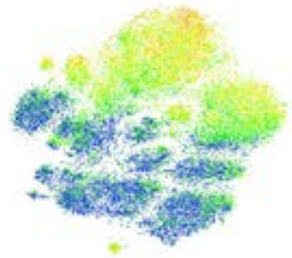
ADVANCING SKIN RESEARCH

Demonstration of a new, non-invasive 3D skin imaging technique called multi-spectral optoacoustic tomography. The technique is a result of collaboration between SBIC, SRIS, NSC and the Technical University of Munich.

SRIS is a partnership between A*STAR, NTU Singapore and NSC to establish Singapore as a hub for skin research in Asia. Established as a virtual institute in 2013, SRIS has grown to become one of the biggest and most concentrated skin research clusters in the world. It has formed multiple partnerships with industry, notably with P&G which established an Innovation Centre in Singapore in 2014. SRIS has brought about successful clinical outcomes, such as the application of imaging technologies to diagnose skin cancers without biopsies and to improve surgical accuracy in removing cancerous lesions.

Today, SRIS sits in the heart of Singapore's new healthcare nexus, at NTU Singapore Clinical Sciences Building, next to NSC and TTSH. It aims to foster even more interdisciplinary collaborations, and has also established flagship research programmes catered towards addressing skin conditions of high clinical burden in Singapore, such as atopic dermatitis, chronic wounds particularly resulting from diabetic conditions, as well as acne.

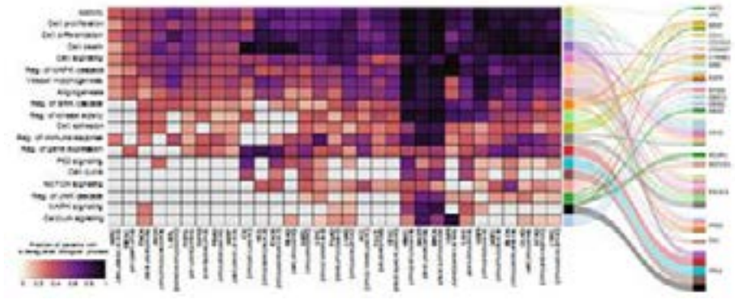
AN UNEXPECTED INFILTRATOR



Green and red tumour-infiltrating lymphocytes expressing CD39 in human lung cancer

SIgN was featured in the May 2018 issue of Nature, for its study on white blood cells known as Tumour-Infiltrating Lymphocytes (TILs), and its findings that the expression of a biomarker CD39, an enzyme typically located on cell surfaces, could be a way to accurately identify tumour-specific immune cells that help to fight cancer tumours. These findings suggest that measurements of CD39 expression in a patient's TILs could potentially be used to determine the patient's response towards immunotherapy treatments, and lead to more effective cancer diagnosis, and treatment strategies.

TOWARDS COMPREHENSIVE CANCER CLASSIFICATION



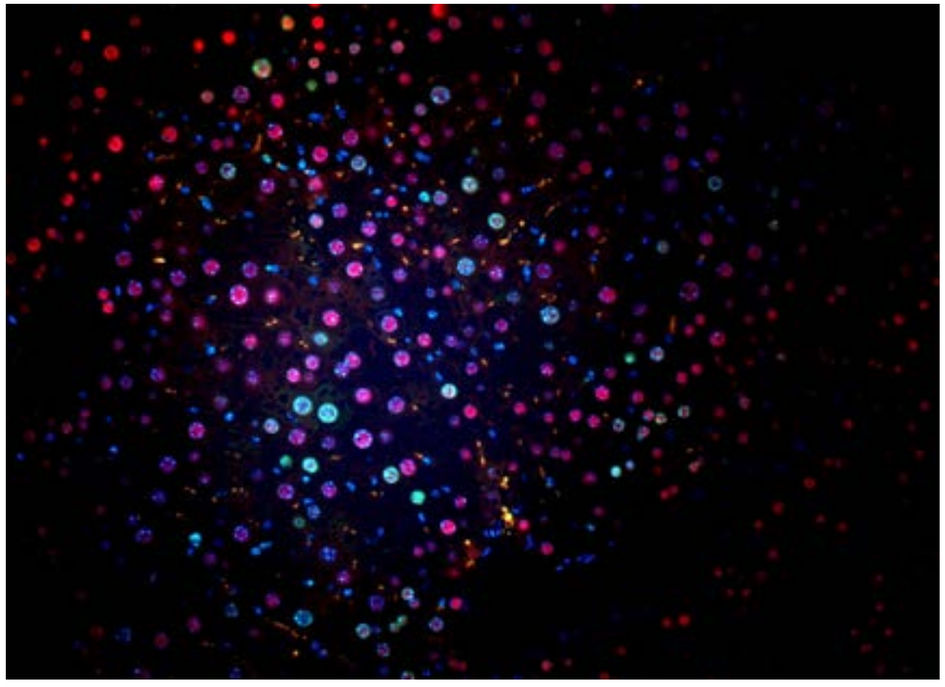
GIS performed integrative analysis of genome mutations and transcriptomic activities, which reveals the relationships among cancer-causing processes, cancer types, and driver genes.

GIS has contributed its expertise in integrating a number of computational analysis tools, which has helped the Pan-Cancer Atlas identify 299 cancer genes. As identifying molecular cancer drivers is critical for precision oncology, this study will serve as an important blueprint for future biological and clinical endeavors. Its work was published in the April 2018 issue of Cell.

UNDERSTANDING HOW LIMBS ARE FORMED

Findings from a study made by IMB and international research collaborators, have countered the current perception that the proteins called RSPO only work with their receptors LGRs for limb development. This discovery has new implications for regenerative medicine, especially for application in amputees. Their work was featured in the May 2018 issue of Nature.

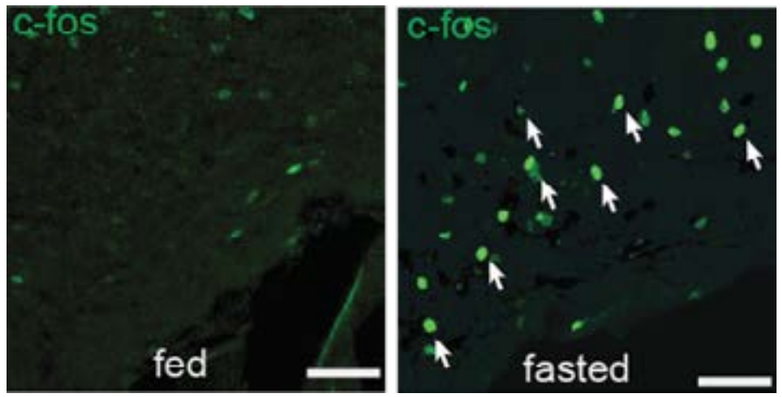
UNDIVIDE AND CONQUER



IMCB's study on mice showed that livers could grow back even after the division of hepatocytes – the main liver cells that are responsible for all basic functions of the organ, was blocked. The results of the study provide hope for new ways for doctors to combat liver disease, such as supplying amino acids to liver disease.

Read more about A*STAR Research

NEW REGION IN BRAIN CONTROLS APPETITE



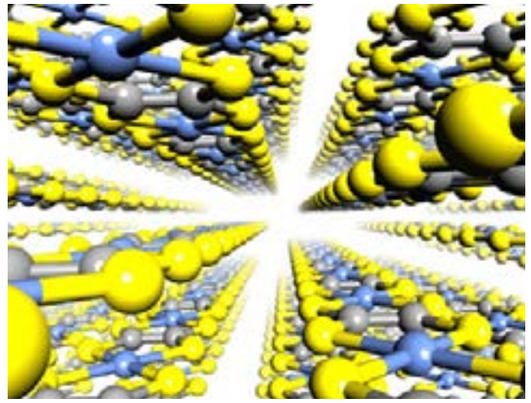
SBIC's research findings indicated that somatostatin neurons in the tuberal nucleus were activated by hunger and likely involved in feeding regulation.

SBIC has discovered a new neural circuitry mechanism involving somatostatin neurons of the tuberal nucleus that plays a central role in controlling appetite. This finding broadens our understanding of the brain's role in regulating metabolism and food intake, and offers a new avenue to combat eating disorders and obesity. Its work was published in the July 2018 of Science.

MANIPULATING LIGHT AT THE NANOSCALE

IMRE and IME demonstrated how dielectric and semiconductor nanoantennas with low dissipative losses at visible and near-infrared wavelengths could efficiently manipulate light at the nanoscale as compared to conventional plasmonics. Their new concept will pave the way for future laser devices that are compact and can be readily integrated in multi-layered photonic devices. Their work was featured in the August 2018 issue of Nature Nanotechnology.

POLYMER POWER POTENTIAL

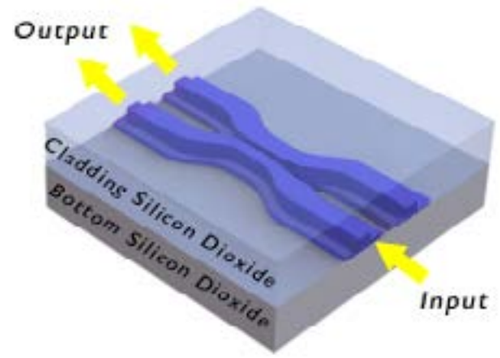


*(Credit: A*STAR Research)*

Researchers from IHPC have identified four organic thermoelectric polymers that could potentially overcome the efficiency limits of thermoelectric materials, in terms of high electrical conductivity, low thermal conductivity, and a high voltage generated per degree of temperature. These materials prove promising for more efficient ways to transform waste heat into reusable energy.

A NEW DESIGN FOR BETTER PERFORMANCE

IME has proposed a novel way to create mid-infrared (MIR) wavelength-flattened directional couplers, based on studying the physics of rib waveguide dispersion. Directional couplers are devices that divide and distribute power, and used in applications that require measurement and power monitoring. IME's design offers a convenient and low cost approach to achieving good broadband performance, and is promising for label-free and damage-free sensing applications such as high sensitivity greenhouse gas detection, exhaled breath monitoring, cancerous tissue identification, and water quality inspection.



SPOTLIGHT ON AI

A*STAR's talent is integral to supporting the nation's push towards becoming a smart nation, in particular building up local capabilities in AI, that could be integrated in our everyday lives, and benefit our society and economy.

Dr Vijay Chandrasekhar
Head, Deep Learning 2.0 Unit, I²R

As Head of I²R's Deep Learning 2.0 Unit, Dr Vijay Chandrasekhar is integral to building A*STAR's world-class research capabilities in deep learning algorithms, next-generation deep learning hardware and a range of untapped enterprise applications. A senior member of the Institute of Electrical and Electronics Engineers (IEEE), Dr Chandrasekhar contributes his expertise in deep learning and machine learning algorithms, computer vision, large-scale image and audio search, augmented reality and deep learning hardware. He has also published over 120 papers in more than 25 top-tier journals and conferences, and has filed seven US patents.

DEEP LEARNING TO BOOST ACCURACY AND PRECISION IN INDUSTRIAL APPLICATIONS

Building on advanced deep learning capabilities such as semi-supervised learning with generative adversarial networks, and anomaly detection, I²R's Deep Learning 2.0 programme has developed deep learning capabilities which allow for high degree of accuracy in the area of measurement and classification, outperforming domain experts. Examples include reducing average error and standard deviation of critical dimension measurements in semiconductor metrology by more than 30 per cent at the nano scale, a 10 times reduction in Design-of-experiments (DoE) time in advanced manufacturing, high accuracy classification with only 25 per cent of labelled data in medical imaging, and a 100 times reduction in false positive defect detection. The research team will be enhancing core deep learning research and adapt it for untapped applications in industries such as cybersecurity, fintech and pharmaceutical.

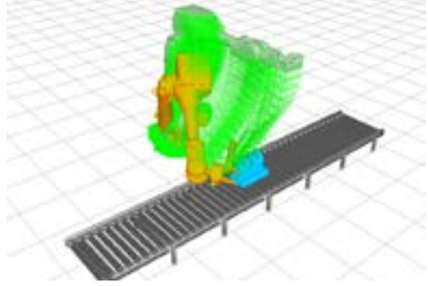
Dr Kenneth Kwok
Programme Manager, A*STAR AI Initiative
Principal Scientist, IHPC

Dr Cheston Tan
Programme Manager, A*STAR AI Initiative
Principal Investigator, Human-Centric AI Programme
Senior Scientist, Visual Intelligence unit, I²R

Dr Kenneth Kwok and Dr Cheston Tan are leading part of A*STAR's Artificial Intelligence Initiative (A*AI), which spearheads the creation, translation and adoption of AI technologies by tapping A*STAR's strengths in vision, speech, robotics and social cognitive computing, and forging strategic partnerships with government agencies and global AI leaders. Locally, A*AI has established a strategic partnership with NTU Singapore and SUTD to collaborate in AI research.

Under this initiative, they formed the Human-Centric AI Programme in 2017, and work with skilled researchers from the universities to develop technologies that enable machines to be more human-like. The objective is to help achieve national goals such as boosting productivity levels, supporting worker training, and addressing the needs of an ageing population.

HUMAN-CENTRIC AI FOR MACHINES



A robot performs 3-dimensional shape inspection on a production line.

Researchers at the A*AI are developing AI techniques that enable machines to understand humans and simplify the way in which machines work with humans in performing complex tasks. Such human-centric AI technologies can be applied in a broad range of industry sectors, such as customer relationship management and advanced manufacturing.

In one study, a robotic system developed can understand the concept of ownership, through integrating norm learning algorithms, inference of ownership relations and prediction of an object's likely owners. In another study, researchers developed a computational approach to represent and recognise human relationships, and to understand social relationships in diverse social contexts.

A*AI researchers also developed an algorithm that allows robots to learn and plan tasks such as performing 3-dimensional shape inspection automatically, without extensive programming or manual teaching. This algorithm, which is based on the concept of reinforcement learning and automatic planning, can be further extended and applied to many other applications with industrial robots.

PRESIDENT'S SCIENCE & TECHNOLOGY AWARDS (PSTA)

2018 marked the 10th anniversary of the President's Science & Technology Awards (PSTA). On this occasion, we honoured research scientists and engineers in Singapore, including two of A*STAR's talents, whose achievements in science and technology have resulted in significant benefits for the country. In addition, through other prestigious awards, many of our scientists are recognised for their scientific excellence and contributions to their fields of research, placing A*STAR on the global map.

"Research, innovation and enterprise remain very important to Singapore's development. And we must continue to attract bright minds to be engaged in science, and to be excited in a future built on science and technology."

- Mr Heng Swee Keat
Minister for Finance
and Chairman of the National Research Foundation, at PSTA 2018

Learn more about the PSTA Awards and the winners

PRESIDENT'S SCIENCE AND TECHNOLOGY MEDAL (PSTM)

Professor Judith L. Swain
Founding Executive Director (Emeritus), SICS
Visiting Professor, Yong Loo Lin School of Medicine, National University of Singapore (NUS)
Chief Medical Officer, Physiowave Inc.

Professor Judith L. Swain was awarded the President's Science and Technology Medal (PSTM) for her outstanding contributions in leading the development of translational and clinical research, nurturing of scientific talent, and facilitating closer interactions between universities, hospital systems, and research institutes, which raised Singapore's international reputation in biomedical research and economic development.

PRESIDENT'S SCIENCE AWARD (PSA)

Professor Ng Huck Hui
Executive Director, GIS

From left to right: Professor Ng Huck Hui, Professor Tan Eng King, Assistant Professor Lim Kah Leong, and Assistant Professor Louis Tan

Professor Ng was part of the winning team from A*STAR, the National Neuroscience Institute (NNI), and NUS, recognised for its outstanding contribution in the field of Parkinson's Disease, galvanising clinical research and transforming patient care through the identification of clinical biomarkers, development of novel models and therapeutics.

YOUNG SCIENTIST AWARDS (YSA)

The YSA recognises young researchers aged 35 and below who have shown great potential to scale greater heights.

Dr Xue Shifeng
Senior Research Fellow, IMCB

Dr Anjan Soumyanarayanan
Scientist, IMRE

A*STAR Graduate Academy
October 26, 2018 ·

Winners of the Young Scientist Award 2018 and #ASTARScholars Dr Xue Shifeng and Dr Anjan Soumyanarayanan give insight into their research journey as a Developmental Biologist and a Physicist. Take a peek into their lives as a scientist as they tell us more about their research projects, motivations and aspirations. Read more:
https://www.a-star.edu.sg/.../lwAR1l6ZSD-PDmgA99NNgE-EvU-QePY...

Dr Xue was recognised for her research on gene regulation in developmental biology, while Dr Anjan was recognised for his research on unveiling and tailoring emergent quantum phenomena towards scalable nanoelectronics.

AMERICAN ASSOCIATION FOR CANCER RESEARCH TEAM SCIENCE AWARD

The ACCR Team Science Award is established by the American Association for Cancer Research (ACCR) and Lilly Oncology to acknowledge and catalyse the growing importance of interdisciplinary teams to the understanding of cancer and/or the translation of research discoveries into clinical cancer applications. Dr Khor Chiea Chuen from GIS was one of the members of first Asian team to receive the award, for its work in delving deep into the interactions between the environment and cancer.

THE CIFAR AZRIELI GLOBAL SCHOLARS PROGRAM

GIS researcher Dr Wan Yue has been selected as one of 12 exceptional early career investigators worldwide under the 2018 CIFAR Azrieli Global Scholar Program. The Program provides funding and support to help these global scholars build their network and develop essential skills to become the next-generation of research leaders.

IES PRESTIGIOUS ENGINEERING ACHIEVEMENT AWARDS 2018

The annual awards recognise engineering achievements that demonstrate outstanding engineering skills which have made a significant contribution to the engineering progress and the quality of life in Singapore.

Mr Heng Chee How, Senior Minister of State for Defence (far left) presented the award to IMRE researchers (Credit: The Institution of Engineers, Singapore)

IMRE researchers Drs Yao Kui, Lai Szu Cheng and Chen Yi Fan received their award for their contributions towards research on ferroelectric bulk photovoltaic effects. Results of the research were used to create a unique wireless ultra-violet (UV) sensing and monitoring technology that does not require a battery.

ENGAGING THE COMMUNITY

To share the far-reaching impact of STEM in our everyday lives, we make science accessible through our outreach activities with community partners. These range from school outreach and the annual one-north Festival to other community events that raise awareness of science, research and enterprise in Singapore.

BEAUTIFUL SCIENCE IMAGE COMPETITION AND EXHIBITION

ONE-NORTH RUN

ONE-NORTH FESTIVAL

AMBIENT SHOWCASE ON RFID TECHNOLOGY

SCHOLARSHIP AWARD CEREMONY

A*STAR TALENT SEARCH

SCHOLARSHIP FAIR

SCIENCE BUSKERS FESTIVAL

X-PERIMENT!

LEADERS IN SCIENCE FORUM

A*STAR SCIENTIFIC CONFERENCE

ANNEX: KEY PERFORMANCE INDICATORS

Key Performance Indicators

	RIE2020 KPIs	FY2018 Achievement Cumulative (% achieved)	RIE2020 Target
1	Industry R&D Projects	4,433 (134%)	3,315
2	Industry R&D Spending (S$ mil)	813 (68%)	1,200
3	Licenses	771 (171%)	450
4	Spin-offs	51 (98%)	52
5	Industry Cash Funding Received (S$ mil) *(as a subset of indicator no. 2)*	308 (98%)	313
6	Licensing Revenue (S$ mil)	20.4 (136%)	15
7	RSEs from RIs Seconded to Industry	187 (68%)	275
8	PhD Postgraduates Trained or Being Trained	426 (73%)	585

In addition to the indicators above, A*STAR's research was also published in 7,096 high-impact publications.

Agency for Science, Technology and Research
SINGAPORE

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