SG GUIDE TO TECHNOLOGY, INNOVATION AND ENTERPRISE

RIE NEWS

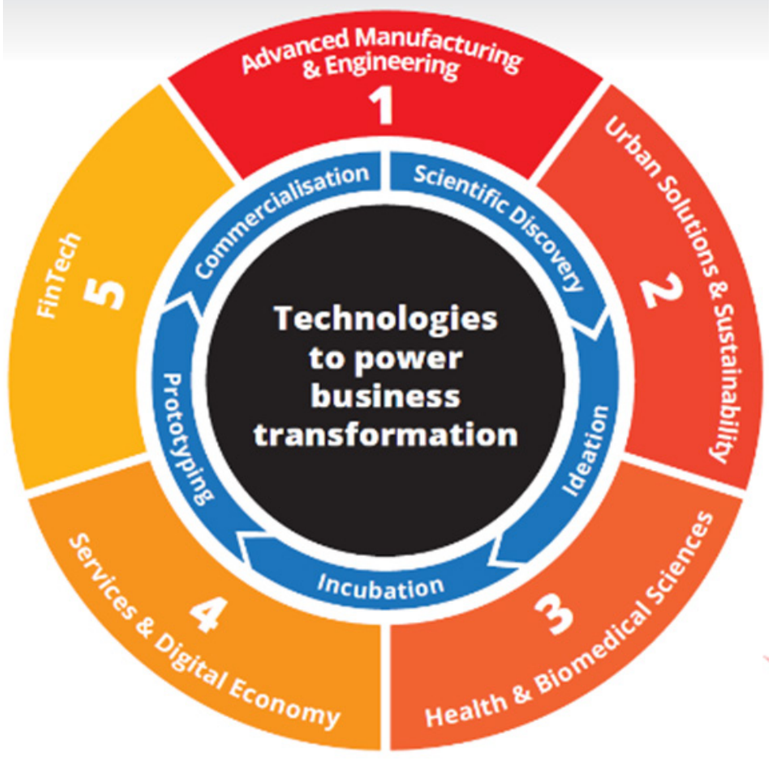
October 2019

COUNTDOWN TO THE BIGGEST TECH EVENT IN 2019

THE SINGAPORE FINTECH FESTIVAL (SFF) AND THE SINGAPORE WEEK OF INNOVATION AND TECHNOLOGY (SWITCH) WILL COME TOGETHER AS SFF X SWITCH THIS YEAR, SO YOU CAN DISCOVER INNOVATIVE CONCEPTS AND BREAKTHROUGH TECHNOLOGIES ALL AT ONE LOCATION!

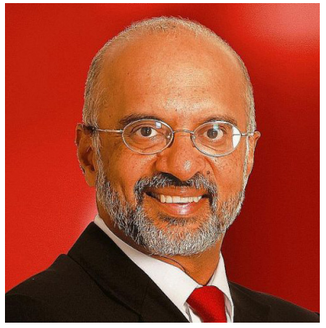
Join us at SFF X SWITCH for a week of activites that bring together entrepreneurs, investors, researchers, innovators and industry professionals across 5 key sectors.

KEY SECTORS



KEY SPEAKERS

Bill Winters, CEO
Standard Chartered Bank



Piyush Gupta, CEO
DBS

Hong Feng, Co-Founder & Senior Vice President
Xiaomi Corporation

Sir Robin Saxby,
Former Founding CEO & Chairman
ARM

Joseph Lubin,
Co-founder
Ethereum

Dado Banatao,
Managing Partner
Tallwood Venture Capital

SFFXSWITCH WILL BE HELD AT EXPO FROM 11 TO 15 NOVEMEBER. REGISTRATION AND MORE DETAILS AT WWW.SFFXSWITCH.COM.

SFF X SWITCH FESTIVAL HIGHLIGHTS

SLINGSHOT

International deep tech startup pitching competition SLINGSHOT returns for its third edition with a new focus on deal-making. Participating startups will have the opportunity to connect with leading investors and partners through a matching system.

SLINGSHOT will also provide the top 100 global startups with the opportunity to pitch their ideas to over 200 judges from organisations comprising unicorns, tech giants, and investors. These startups will also get a chance to meet tech partners for R&D collaboration, tech commercialisation or licensing, and more.

SLINGSHOT will take place from 11 to 13 November.

Alchemy Foodtech was the winner of Slingshot @ SWITCH in 2018. The startup uses its 5ibrePlus additive to lower the Glycaemic Index of food like white rice, white bread and noodles.

TECHINNOVATION

Organised by the Intellectual Property Intermediary, this technology-to-industry matching marketplace will bring together international technology providers and enterprises from different industries. It focuses on matching industry needs with ready-to-market inventions and technologies from global sources.

TechInnovation 2019 will include activities such as sharing by thought leaders and industry experts on emerging tech trends, crowdsourcing sessions where corporations engage innovators for tech solutions, crowdpitching opportunities for innovators to showcase and present their technologies for commercialisation or co-development, and TechExpert sharing and clinic sessions for startups and SMEs looking for product development advice from technical experts.

TechInnovation 2019 will be held from 11 to 13 November.

DEEP TECH SUMMIT

From AI to robotics to genetic engineering, the Deep Tech Summit will explore the dynamics, ethics, and economics of scientific progress.

Presented by SGInnovate, this edition of the Summit will cover themes such as the ethics of AI and improving the human condition through deep tech.

Speakers include Go-Jek group CTO Ajey Gore, Element AI co-founder Nicolas Chapados, and AI Singapore executive chairman Professor Ho Teck Hua.

The Summit will take place on 13 November.

GLOBAL FINTECH HACKCELERATOR

With the aim of creating solutions to meet needs in the FinTech industry, the 12-week programme will see startups from around the world developing market-ready solutions to address problem statements presented by the local financial sector.

This year, the Hackcelerator will expand to include an international programme as well, with startups from five different countries working to solve problems faced by financial organisations back home. This is part of an effort to increase the diversity of the FinTech solutions produced at the Hackcelerator.

Finalist solutions will be exhibited at Demo Day on 11 November.

INNOVATION LAB CRAWL

Participants will get the opportunity to take part in tours and exhibitions at innovation labs across Singapore. The labs will showcase their latest innovations in FinTech and deep tech, offering participants the opportunity to network with startups and key players in the local innovation scene.

Participating labs include the Aquaculture Innovation Lab, the Visa Innovation Centre, and the Deloitte Greenhouse.

The lab crawl will take place from 14 to 15 November.

Exhibitors demonstrating their technology at the festival.

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RESEARCH ROUNDUP

SINGAPORE'S FIRST VIRTUAL POWER PLANT IN THE WORKS

NTU will be developing Singapore's first virtual power plant - a digital platform that can coordinate energy resources across solar and energy storage systems. Using real-time information from a variety of distributed energy resources, the virtual power plant can optimise the power output of these resources located across the island. Energy fluctuations due to solar intermittency at different locations can also be balanced automatically within the virtual power plant.

FRENCH RESEARCH CENTRE EXPANDS PRESENCE IN SINGAPORE

The French National Centre for Scientific Research (CNRS) will set up its first overseas subsidiary at the Campus for Research and Technological Enterprise (CREATE). CNRS@CREATE will work with researchers in our universities and research institutes in fields such as energy and synthetic biology. CNRS aims to implement its first major research project by 2021.

TEA AND BRAIN HEALTH

A new study led by the NUS Yong Loo Lin School of Medicine's Department of Psychological Medicine revealed that regular tea drinkers have better organised brain regions – and this is associated with healthy cognitive function – compared to non-tea drinkers. The research team made this discovery after examining neuroimaging data of 36 older adults. The research team found that individuals who consumed either green tea, oolong tea, or black tea at least four times a week for about 25 years had brain regions that were interconnected in a more efficient way.

A researcher from SMART reviewing a 200 mm silicon III-V wafer. Photo: SMART

CLEVER CHIPS

In most devices today, silicon-based CMOS chips are used for computing, but they are not highly efficient for illumination and communications. To address this, the Singapore-MIT Alliance for Research and Technology (SMART) at CREATE has developed a commercially viable way to integrate III-V into silicon. III-V chips are made from elements in the 3rd and 5th columns of the elemental periodic table. Due to their unique properties, they can boost efficiency in applications such as optoelectronics (LEDs) and communications (5G).

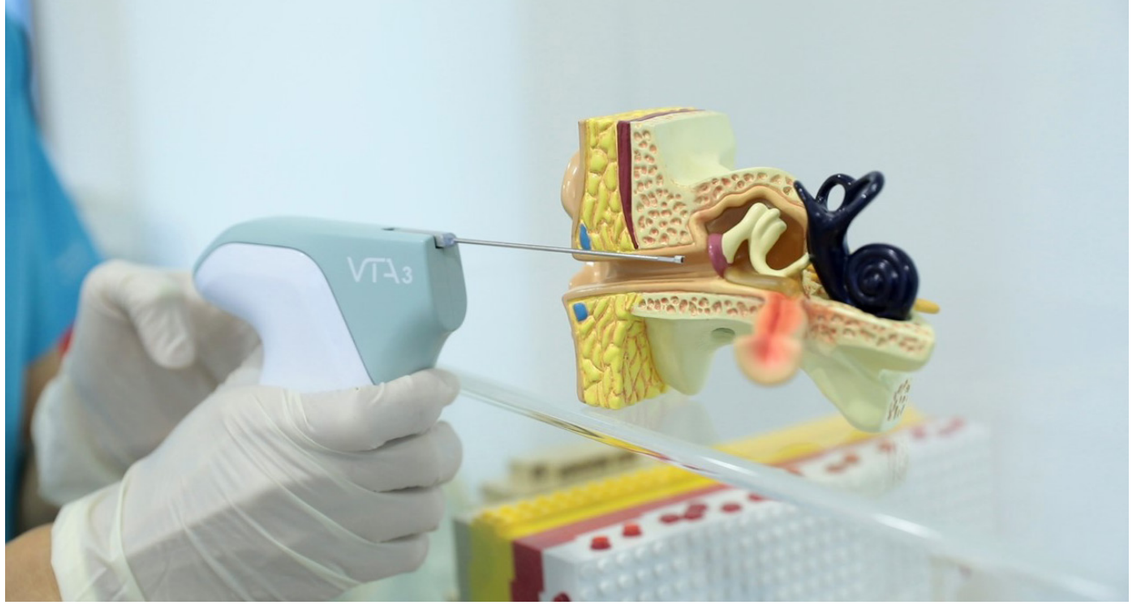
NEXT-GENERATION MEMORY RAMPING UP

Resistive Random-Access Memory, or ReRAM, is a non-volatile memory technology that is an ideal future solution for electronics, due to its potential for larger storage densities, lower power usage and production cost - all of which are important requirements for ultra-low power applications in the Internet of Things (IoT). NTU is entering a new partnership with GLOBALFOUNDRIES to demonstrate ReRAM on 12" wafers. The collaboration could see the advancement of ReRAM as the main embedded memory technology in next-generation computing devices.

SPOTLIGHT ON SGINNOVATE

TREATING CHILDREN WITH GLUE EAR

SGINNOVATE WORKS WITH ENTREPRENEURIAL SCIENTISTS TO BUILD AND SCALE THEIR COMPANIES. IN THIS ISSUE, WE CHAT WITH DR LYNNE LIM, CO-FOUNDER OF CLiKX, AN INNOVATION SUPPORTED BY SGINNOVATE.



Demonstration of how the handheld device, CLiKX, is able to drain fluid from the ear with a single 'click'. Photo: Dr Lynne Lim

While on a humanitarian mission to Cambodia, Dr Lynne Lim realised that some children who suffered from glue ear were unable to get the treatment they needed, despite having trekked for days to meet the medical team to seek help.

Glue ear is a condition that happens when fluid is chronically trapped in the middle ear space behind the ear drum. It can result in complications such as recurrent ear infections, fever, hearing loss, poor speech and learning development, and even brain infection. In the event that medication fails, grommet tube surgery is required.

However, such a surgery requires general anaesthesia, a well-staffed operating theatre, and an expensive and bulky microscope. These necessities could be inaccessible to children in impoverished countries.

"It was very frustrating," Dr Lim says.

But one day, the solution to this challenge came to her in the unlikeliest of circumstances – while watching her daughter get her ears pierced.

It was then that she began dreaming of a device that would safely insert grommet tubes with the click of a finger, in the same manner that ear piercings are done via a piercing gun.

Dr Lim calls it her "aha" moment. "I needed a super-intelligent device that would not need a surgical theatre, general anaesthesia, or a microscope," she realised. "Something I could pop into my bag and do surgery anywhere, for anyone, at any time."

Such a device, she says, could help millions of patients worldwide, and save billions in healthcare costs as well. In fact, grommet tube surgery is the most common surgery done under general anaesthesia for children worldwide, with an estimated 16 million surgeries needed to treat glue ear each year.

With her 25 years' worth of experience as an Ear Nose & Throat (ENT) surgeon, Dr Lim kick started the CLiKX project with NUS Engineering Department's Professor Tan Kok Kiong in 2011. With $500,000 from the A*STAR Bioengineering Programme Proof of Concept Grant, the team – including engineers Mr Gan Chee Wee and Dr Liang Wen Yu – developed the first prototype over the course of eight years.

Cut to today, and the team has come up with a product that is hand-held, and can potentially insert a grommet tube safely and precisely without the need for general anaesthesia and an expensive microscope. CLiKX is poised to enter the world market as a proudly made-in-Singapore product, with the first-in-man trial targeted for the second half of next year.

The team is currently seeking Series A funding for the company, and Dr Lim hopes to see CLiKX in use in Singapore and the US by 2022.

But things were not always rosy. At the beginning, the Medical Technology (MedTech) ecosystem in Singapore was nascent. Their A*STAR grant ended in 2018, and although they already had a working prototype at that point, they needed additional research funding to get the prototype ready for first-in-man clinical trials.

They also had many more things to consider –

The team behind the development of CLiKX (From left: Mr Gan Chee Wee, Dr Liang Wen Yu, Professor Tan Kok Kiong, Dr Lynne Lim, Miss Jasmine Qiu). Photo: Dr Lynne Lim

manufacturing, regulatory approvals, clinical trials and commercialisation – but investors in Singapore preferred later-stage products that had been de-risked, which contrasted with the high-risk invasive nature of MedTech surgical devices like CLiKX. Other investors, says Dr Lim, wanted too much control of the direction CLiKX was going towards, for too little, and too early.

Dr Lim calls this time "the sickening valley of death".

Despite all the challenges, Dr Lim and her team were determined for their project to succeed and help bridge the gap between the public health problem and the medical technology needed. In July 2018, the team finally got their lucky break when SGInnovate came aboard as the host institution, and they received National Research Foundation Gap Funding to continue developing CLiKX.

"We are grateful as we are one of the first MedTech teams to tap this fund, it being set up only in 2018," she says. "Mr Steve Leonard, founding CEO at SGInnovate, has taken a very hands-on approach with CLiKX, and it has made all that difference."

The SGInnovate team is currently helping to get CLiKX clinical trial and investment ready, and has appointed project leads to help the team drive the work, she added. In the meantime, the team is still working on improving the device so that it works even for patients with challenging ear anatomies.

"I hope to see CLiKX help more doctors to help more patients," she says, "and I hope to see it help patients access the care they need easily and safely, and help governments reduce the burden and cost of glue ears."

Dr Lynne Lim on the humanitarian mission to Cambodia in 2008. The trip sparked the research on CLiKX. Photo: Dr Lynne Lim

Dr Lynne Lim says:

"Innovations for the real world have to be the simplest, most cost-effective and sustainable solution to a real problem. It must not be an innovation just to publish a paper, grab glory, or generate business. The best innovations would not just aim for miniscule incremental improvements – a new version every year makes it expensive for the end-user, even though it may make business sense. It takes clear thinking, patience and nerve to deliver an innovation that can really change practice and make a difference.

Just-enough-tech that simplifies and reduces cost; tech that is sensitive to the economic climate and needs of the time and geography; tech that is naturally adopted and sustained – that is how I like it.

It is important to think many steps ahead in a Medtech-type surgical innovation like CLiKX where there is high risk and a seven- to ten-year runway before market. Even when one is still unsure about one's first prototype, one would need to have the heart to start considering practical issues like getting regulatory clearance, legal issues, cost, manufacturing and distribution, first markets, and workable business models. Though that seems impertinent, it allows one to get a better product, and in a shorter time.

You will need not only passion, but also dispassion to take many cold, hard looks at your innovation."

COMMENTARY

THE DIGITISED URBAN FARM

SCIENTISTS AT THE SINGAPORE-MIT ALLIANCE FOR RESEARCH AND TECHNOLOGY AND TEMASEK LIFE SCIENCES LABORATORY ARE BREAKING THE CODE FOR REAL-TIME KNOWLEDGE ON PLANT BEHAVIOURS. **PROFESSOR MICHAEL STRANO** AND **PROFESSOR CHUA NAM-HAI** TELL US HOW.

DiSTAP is co-led by Professor Michael Strano from Massachusetts Institute of Technology and Professor Chua Nam-Hai from Temasek Life Sciences Laboratory. Photos: DiSTAP website

Collectivised Agriculture is a human technological advance associated with the dawn of civilisation itself. Scholars credit it with the growth and flourishing of human cities and the underpinnings of human advancement and achievement. However, through the lens of the modern world, agriculture in the field or on the rooftop remains one of the least digitised industries today.

That was the major conclusion from a recent Urban Farming Symposium that we held on the National University of Singapore (NUS) campus as a part of DiSTAP: the Disruptive and Sustainable Technology for Agricultural Precision group. DiSTAP – a joint effort between Singapore-MIT Alliance for Research and Technology (SMART) and Temasek Life Sciences Laboratory – focuses on next generation agriculture. As one of the most important human enterprises historically, collectivised agriculture is long overdue for the revolutionary changes the digital age has brought to communications, medicine and transportation. To catalyse such digitalisation, fundamentally new tools are needed to connect the biological with the computational.

The Vision of the Singapore Food Agency's "30 by 30"

To feed the world population, and to address the health and nutritional needs of Singapore and beyond, the Singapore Government has undertaken a bold plan of "30 by 30." This goal of generating 30% of Singapore's nutritional needs domestically by 2030 requires a fundamental rethinking of the farm, agriculture and how food is produced. The potential benefits are many.

The integration of agricultural production with urban centers shortens the transportation cost, time and environmental footprint of moving food to where it is needed. Such a simple supply chain affords consumers a higher level of security over what has entered or left their food. Time on the shelf can be minimised, meaning food is fresher, healthier and waste can be minimised. This vision encompasses 'agriculture on demand' where producers can rapidly adjust both supply and variety to meet changing consumer needs and preferences.

The timing and foresight of Singapore is that as the world becomes increasingly calorie secure, the emerging challenge for humanity is to realise nutritional security. The focus on access to foods that enhance and optimise human health and well-being is a shift beyond the 19th century vision of calories as the defining metric of global food production. This in turn requires a fundamental rethinking of how and where food is produced.

Agriculture as Manufacturing

For more than 12,000 years, farming has predominantly occurred in the open field where land is inexpensive or free at the margins, with water and sunlight supplied from Nature, affording minimal input cost. However, through the lens of the modern world, and global challenges such as climate change, open field agriculture has several scaling drawbacks highlighted above.

To turn a living crop into a well-designed, efficiently produced product of human innovation, we must have, as the underpinnings of production,

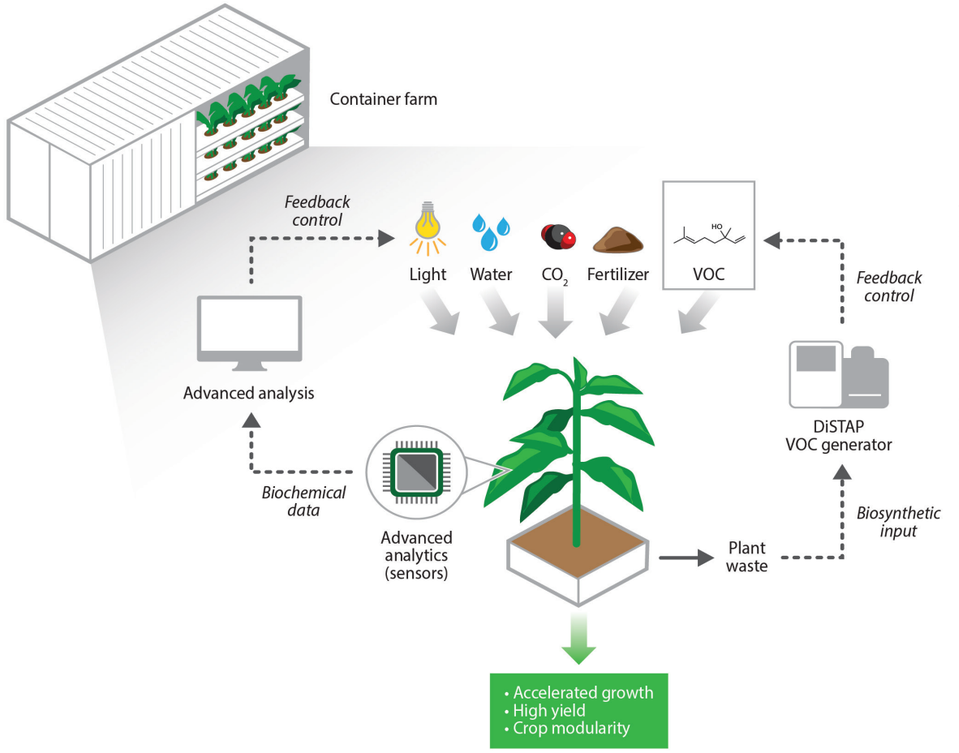


Diagram illustrating the use of novel sensors to measure plant metabolites in real time. The data recorded can digitally control input such as light, water, carbon dioxide, fertiliser, and volatile organic compounds for optimal yield. Image: DiSTAP

the precision and measurements that we apply to microelectronics, machined parts, and even pharmaceuticals.

The technological focus of the DISTAP group is to fundamentally rethink and enhance agricultural production by turning the complexity and biological variability of plant systems into precision engineering inputs and tightly controlled production variables. This is an ambitious goal that requires a new set of agricultural tools. At the top of the list of required tools is the need to measure new critical attributes of plants in real time, and in a way not possible with today's technology.

A Biological Engineer's View of the Plant

The initial problem is that the plant as a natural system is itself a highly complex machine. The fundamental study of its internal workings, hydraulics, chemical signaling and genetic pathways remains an important and emerging scientific enterprise. Even the monocultured crops that we eat routinely have phenotypic diversity and variations in properties that change over time that confound engineering analysis. DiSTAP is developing a set of next generation analytical tools to fundamentally address this problem. Handheld Raman spectrometers that allow a form of laser-induced, biochemical fingerprinting of living plants are giving us access to the internal workings of plants with unprecedented precision. New types of nanotechnology enabled molecular recognition is allowing measurement of plant signaling hormones and stress responses in a way that can 'decode' the inner communication within the plant itself. These tools then open up the possibilities for novel and exciting feedback control schemes that accelerate and optimise plant growth rate, yield, nutrition and culinary properties (e.g. flavor profiles.)

Water, light and fertiliser are all example inputs whose amounts and applied durations can be digitally controlled subject to internal responses within the plant itself. The result can be optimal growth conditions for potentially any plant, as well as the seamless transition from one crop to another in successive growth cycles. This accelerated productivity combined with extreme modularity in farming can be important keys to realising the vision of "30 by 30".

While plants have internal biochemical signaling, they also receive external signals that have yet to be fully tapped as a means of optimising their growth. Volatile organic compounds (VOCs) are molecules produced by plants that signal within a plant and between plants, stimulating the production of new or enhanced flavors, increasing pest and pathogen defence, and promoting growth and development.

Farmers have known, for example, that it is beneficial to grow certain crops together (inter-cropping), such as mint and soy. VOCs produced by one are perceived and utilised by the other in an advantageous manner.

At DiSTAP, we are creating technology that can intercept and utilise this communication channel as an additional set of inputs. Devices that use plant waste itself as precursors for VOC signals into the next crop will contribute to a circular growth economy, minimising inputs needed from the farmer.

Harnessing the tools of biosynthesis itself produces a new set of knobs and levers through which this goal of optimisation and acceleration can be accomplished.

The Emerging Singapore Agricultural Economy and Beyond

By inspiring the current and next generation, Science Fiction has often provided a template for Science Fact. The Star Trek replicator was a futuristic vision of food production whereby the user could generate any product imaginable in real time and on demand. Within the limits of plant biology, urban farming incubators could provide close to the same modularity with many times faster growth over conventional farming.

Space travel is useful conceptually for focusing the mind on how to sustain human life with minimal energy and material inputs. The urban farming modules envisioned by DiSTAP will provide an enabling solution to sustaining such life, wherever we choose to live. As technology, this will provide an integral part of the solutions needed for "30 by 30". However, as a human achievement, it will provide us with the means of producing fresh, nutritional food anywhere on earth or even off of it.

The Disruptive and Sustainable Technologies for Agricultural Precision group, under the Campus for Research Excellence and Technological Enterprise (CREATE), looks into the sustainable production of plant products for enhancing food sustainability in Singapore.

COMMENTARY

THE LONG FIGHT AGAINST DENGUE

PROFESSOR OOI ENG EONG, DEPUTY DIRECTOR OF THE EMERGING INFECTIOUS DISEASES PROGRAMME AT DUKE-NUS MEDICAL SCHOOL, TALKS ABOUT HIS CURRENT FIGHT AGAINST DENGUE THROUGH VACCINE DEVELOPMENT.

Dengue is an *Aedes* mosquito-borne disease that afflicts an estimated 100 million people throughout the world annually. This disease is caused by four different dengue viruses, DENV-1 - 4.

Dengue patients develop an acute febrile illness, with symptoms such as headache, body ache and joint pains that can occasionally be debilitating. In some patients, this disease can progress to severe dengue, which is life-threatening due to low blood pressure or shock from leaky blood vessels, internal bleeding and multi-organ dysfunction.

Treatment for dengue patients is entirely supportive – including maintaining blood pressure levels via judicious fluid replacement or administering blood transfusions to overcome the effects of internal haemorrhage – that would tide patients over the critical phase until convalescence. Despite efforts, an anti-viral drug against dengue has remained elusive.

The large number of dengue cases and the potential for severe disease outcome thus demand effective methods to prevent virus transmission. This will subsequently reduce the burden of dengue on global societies.

HISTORY OF DENGUE PREVENTION

Unfortunately, dengue prevention has had more misses than hits. In fact, Singapore's experience with dengue control underscores its complexity. Dengue overtook malaria as the most common mosquito-borne illness in Singaporean children in the 1960s.

The *Aedes aegypti* mosquito species, likely introduced to Singapore and other parts of South-east Asia during World War II through the movement of war material, is an efficient vector for the transmission of the dengue virus. It is well adapted to thrive in Singapore's urban environment.

Dengue is an Aedes mosquito-borne disease that afflicts an estimated 100 million people throughout the world annually.

In response to the emergence of dengue as a major public health problem, Singapore instituted its vector control programme in 1970.

The programme was founded on data derived from extensive field-based studies on mosquito breeding habitats, dengue case demographics, and the relationship between dengue outbreaks and environmental factors such as temperature and rainfall.

It turned out to be highly successful, having reduced the mosquito population from a premise index of 50 per cent – *Aedes* mosquito breeding found in one out of every two residential or workplace premises – to less than two per cent by 1975. At the same time, the rate of severe dengue cases and the frequency of dengue outbreaks dropped.

Remarkably, from 1975 till the end of the 1980s, Singapore did not witness a single dengue outbreak.

However, the low DENV transmission rate also led to reduced overall population level immunity – children who grew up in the 1970s and 1980s did not acquire DENV infection during childhood and thus as adults, remain susceptible to the virus.

Consequently, both children and adults in Singapore are susceptible to DENV infection, and the average age of dengue cases has elevated from childhood in the 1960s to over 35 today.

With reduced population level immunity, dengue outbreaks re-emerged in the 1990s despite continued investment towards mosquito control.

Professor Ooi Eng Eong and his team hope to contribute to a more systematic approach to developing vaccine candidates for dengue. Photo: Duke-NUS Medical School

The first outbreak since 1975 was in 1992, followed by 1998, 2005, 2007 and 2013; dengue outbreaks in Singapore thus appeared once every five to seven years. The current resurgence in the number of dengue cases is thus consistent with this cycle. Singapore's experience with dengue prevention thus underscores the need for better tools to reduce the burden of this global health scourge, such as vaccination.

DENGUE VACCINE DEVELOPMENT

Dengue vaccine development has a long history that dates back to the 1940s, when its symptoms were discovered in dengue afflicted troops fighting World War II in the Pacific. A globally coordinated effort was launched after the World Health Organisation convened a meeting on dengue vaccine development in 1977, in Singapore.

Based on available data, it was decided that only a live attenuated vaccine was able to generate sufficient levels of immunity to protect against all four DENVs.

This early effort led to several vaccine candidates that yielded mixed results – the process of trial and error mostly derived vaccine candidates that were either inadequately safe in clinical trials or insufficiently potent to generate useful immunity. To overcome this tedious process where the safety and potency of vaccine candidates could not be predicted, dengue vaccine development shifted towards the use of chimeric virus constructs. Chimeric dengue vaccines were generated by splicing the structural genes of DENVs into either the genomic backbone of the attenuated yellow fever virus or an attenuated type of DENV to generate vaccines against all four DENVs. Thus, the Chimeric yellow fever dengue virus tetravalent dengue vaccine that is marketed under the name, Dengvaxia, became the first licensed dengue vaccine in the world. However, this vaccine cannot be used in those who have not had a prior DENV infection, as vaccination paradoxically enhanced the likelihood of hospitalisation, when vaccinated individuals become naturally infected with DENV. Hence, despite more than half a century of effort, the world awaits an effective vaccine that safely and effectively prevents all four DENVs.

The trial and error approach to live attenuated dengue vaccine development was necessitated by the lack of a clear understanding of the biological mechanisms that underpin disease development from DENV infection, or dengue pathogenesis. A major limitation in the field is the lack of animal models that reliably and accurately replicate the clinical features observed in dengue patients.

Consequently, to understand the way dengue is developed, my research at Duke-NUS Medical School interfaces clinical studies with basic virology and applied immunology. In a nutshell, my team's interests lie in defining how the various types of human cells targeted by DENV respond to infections and how such responses lead to disease and dengue.

We also use other viruses that are related to DENV, such as the yellow fever and Zika viruses, to understand how the different responses to infection with these viruses lead to illness. In this context, the live attenuated yellow fever virus vaccine has been especially useful in our quest to fill the gap in knowledge. This vaccine strain causes a weakened infection and about half of the vaccinated individuals develop mild flu-like symptoms that last for about one day.

We have thus been testing this life virus vaccine out on volunteers, with their written informed consent, to define the full repertoire of responses and dissect the responses that lead to symptomatic outcome. At the same time, we are actively exploring the genetic factors encoded in the viral genome that shape our response to infection.

By understanding the molecular underpinnings of dengue pathogenesis, we hope to be able to contribute to a more systematic and precise approach to developing vaccine candidates, removing the trial and error process that is both time and resource consuming.

FEATURE

FOOD PACKAGING GETS SUSTAINABLE

AEGIS PACKAGING AIMS TO "DO RIGHT, DO GOOD, DO WELL" WITH A MORE SUSTAINABLE FOOD PACKAGING SOLUTION

Growing up around their parents' peanut business, brothers Ong Boon Chuan and Andrew Ong gained an intimate understanding of what they call "the marvel of modern packaging technology".

As they watched their parents manage their business, which exports peanut products to over 40 countries, the brothers observed firsthand the importance of packaging materials in preserving the shelf life of food products. But at the same time, they also witnessed the relentless damage that plastic waste inflicts on the environment.

This unease over the excessive production of plastic waste led to the creation of Aegis Packaging. Founded in August 2018, Aegis Packaging produces a recyclable and flexible transparent material, called O_2X, which helps to preserve the freshness of food while minimising carbon footprint. In fact, that was how the company got its name. Like its namesake, the legendary shield Aegis of Greek mythology, the company aims to protect the environment with its innovation.

The key difference is in the simplicity of O_2X's structure. Traditionally, food packaging is derived from materials like PET, EVOH and aluminum, which have a complex coating of multiple layers in order to protect the food products.

"Materials with a composite structure — for example, a Tetrapak box of orange juice — is made from layers of paper, aluminum foil, and plastic glued together, resulting in packaging that is non-reusable and non-recyclable," explains Mr Andrew Ong, who leads the company's business and technical direction.

"The simpler structure of O_2X means it is easier to break down and recycle," he adds, "and the burning of some materials like PET, EVOH and aluminum complicates the process of cleaning gas fumes and managing ash."

O_2X is being used in food packaging. Photo: Aegis Packaging

Ordinarily, fewer layers would leave the food vulnerable to moisture and oxygen, which can result in the oxidation of the product. For example, plastic is commonly used due to its affordability and protection from moisture, but it does not offer protection from oxygen.

To get around this problem, some companies use thick polymer films like EVOH, nylon, and aluminum foil. But these solutions are not perfect. For example, nylon may not provide sufficient resistance to the diffusion of oxygen molecules, and microcracks can form in aluminum packaging, compromising food safety and quality.

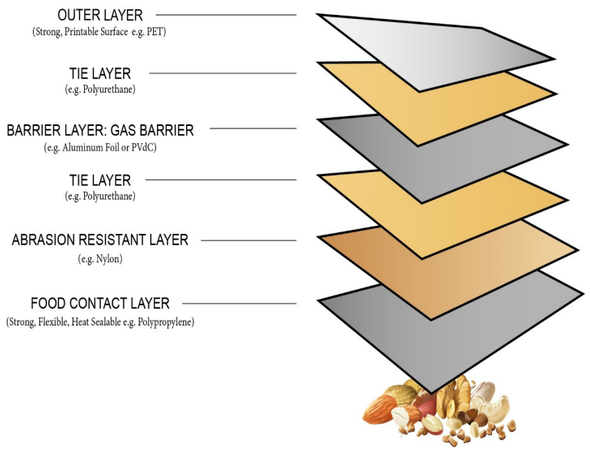
In contrast, O_2X uses highly dispersed food-grade filler particles to form a physical barrier to block oxygen molecules from transmitting.

This technology means that the material is more effective in maintaining the shelf life of food products like fresh meat and processed food, says Mr Andrew Ong.

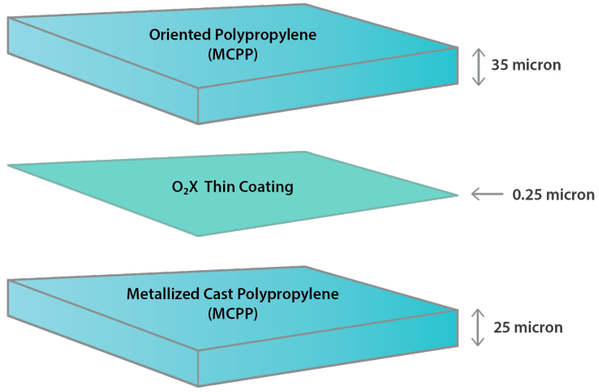
"Furthermore, O_2X is cheaper than EVOH and aluminium laminates in most instances, making it a viable option for commercial use," he says.

Traditional food packaging uses multiple layers of coating of coating to protect the food products. In contrast, the simpler structure of O_2X means it is easier to break down and recycle.

TYPICAL MULTI-LAYER STRUCTURE USED IN FOOD PACKAGING



THREE-LAYER FOOD PACKAGING USING O_2X



Images: Aegis Packaging

Despite its merits, launching the new product was not easy. As O_2X was a new product, the brothers spent many hours doing trial qualifications with various packaging manufacturers. They also struggled to get production lines at manufacturers' factories, and had to put in extra effort to convince manufacturers of their economic model.

Despite this, the brothers still count themselves lucky. "The early validation of the formulation for O_2X was a great plus point. We also had productisation support from A*STAR A*ccelerate," says Mr Andrew Ong.

Working with Dr Li Xu of A*STAR Institute of Materials Research and Engineering, who invented the O_2X formulation, also meant that the product went through intensive testing, allowing Aegis Packaging to enter pilot production with confidence, he adds.

Having confidence in O_2X means that the brothers are not afraid to dream big for the company. They hope the O_2X can be the innovation that revolutionises the flexible packaging industry, by leading others towards packaging that is safer, more effective, and easily reused and recycled.

Currently, Aegis Packaging only uses O_2X for food packaging. But the brothers are looking to expand the use of O_2X for paper packaging, pharmaceuticals and energy storage production. And their sense of purpose remains strong as they continue to innovate on application areas.

"This is an opportunity for us to contribute to address the worldwide plastic waste problem, while also creating a business out of an invention from Singapore," Andrew Ong says.

FEATURE

SCIENTIST USES HEAT TO REVEAL FLAWS

DR ANDREW NGO FROM THE INSTITUTE OF MATERIALS RESEARCH AND ENGINEERING AT A*STAR IS USING INFRARED THERMOGRAPHY TECHNOLOGY TO UNVEIL STRUCTURAL FLAWS

Scientist Andrew Ngo sees himself as a detective armed with skills to discover defects that are hidden deep in everyday structures.

He has developed a technology based on infrared thermography that can be used to detect defects in aircraft parts, rail components and building claddings.

This ability to detect structural flaws is important as it ensures safety and reliability of critical infrastructure in our environment.

“It is important to ‘catch’ flaws as early as possible before they pose a threat to structural integrity,” Ngo says.

Ngo’s infrared thermography technology presents an innovative way to do this. The technology involves non-contact imaging of heat emission from the object being investigated. Depending on how the defect and its surrounding materials emit heat energy, one can identify the defect from thermal irregularity that arises during the inspection.

Equipped with expertise in materials science, Ngo is able to recognise differences in material properties of defects and their surroundings. This enables him to reveal hard-to-detect defects, making inspection easier and more efficient.

Ngo finds this area of materials science fascinating. He particularly enjoys being able to uncover crucial material defects that threaten structural integrity.

The process takes experience. “In real life, there is usually more than one type of defect in the structure and most of the time, Pareto principle applies – 80% of the effects come from 20% of the causes,” he says.

Dr Andrew Ngo (right) and his colleague presenting their advanced thermography solutions to companies at an industry event. Photo: Dr Andrew Ngo

UNDERSTANDING INDUSTRY’S REQUIREMENTS

To invent technologies for structural inspection, Ngo has to understand how building and infrastructure inspectors work.

He said that inspections of buildings and equipment are often conducted during downtime when they are not in service. This means that inspectors are often faced with operation constraints such as short inspection time, unearthly inspection hours in the wee morning hours, and site constraints such as great height, inaccessibility and limited lighting.

This is where Ngo hopes that his technology would be translated into industry solutions to improve inspection processes and the safety of the workforce.

“I would like to think that my technology will contribute to making Singapore a safer place to work in,” Dr Ngo says.

In working with the industry, he is also constantly reminded that not only must the technology lead to better business outcomes, it must also be affordable to implement.

“I remember a company said that implementation would be a ‘no-go’ if the solution that I propose can only be realised with sophisticated laboratory-based R&D equipment. This is because the implementation would be too costly and impractical for on-site usage by inspectors on the ground. In short, it would not make a good business case,” Ngo recalls.

This episode made Ngo more sensitive to the need to

develop affordable solutions for the industry. But he stays true to his purpose of developing solutions to solve industry problems.

“Looking at the increased productivity and reduction in man-hours that my technology brings is very fulfilling. It can also be very addictive at times, such that you want to stretch your technology to value-add even more!” Ngo says.

INSPIRING THE YOUNG

Apart from devoting time to his research on infrared thermography, Ngo is an associate faculty member at the Singapore Institute of Technology where he teaches the topic to full-time and part-time master students.

He believes in applied learning and wants students to be able to make the connection between academic knowledge and skills with real-world applications in industry. He would, therefore, always include demonstrations during his lectures. Students can then better appreciate the practical application of infrared thermography.

“Since I cannot bring the student out to the industry, I bring the workplace into the classroom. For most students, this is perhaps their first time looking at objects from the infrared vision. And I never fail to see the surprised look on their faces,” Ngo says.

INNOVATING CONTINUOUSLY WITH NEW TECHNOLOGIES

Due to the constant requirement for better performing or greener materials, advanced structural materials are always being introduced. As new materials are used, existing inspection techniques might not be relevant or sufficient.

Therefore, Ngo hopes to continually improve infrared thermography technology so that it will always be relevant in material inspection.

Ngo is now seeking to further the capabilities of infrared thermography technology with emerging technology platforms such as artificial intelligence, drone technology, and the Internet of Things.

He has imagined one possible scenario. This involves a drone that is equipped with his advanced thermal imaging capability sending visual and thermal images to the cloud via 5G or 6G network. These images will be used to train machine learning networks, and the validation and retraining will allow for increasingly accurate defect recognition. The results will be provided to a certified thermographer or professional engineer for assessment before generating an inspection report.

And this possibility might just be around the corner – Ngo is already working with an industry partner to translate this imagination into reality.

Soon, this detective will be riding on advanced digital technologies to develop the next generation of infrared thermography inspection systems.

NUS researchers have discovered six species of Corallimorpharia, commonly known as mushroom anemones, on coastal sites in Singapore. Sightings of corallimorpharians have been photographed and reported by non-scientists who visit the seashores almost monthly to document marine life. The researchers used the data that has been amassed by these citizen scientists in the last two decades for this study.

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