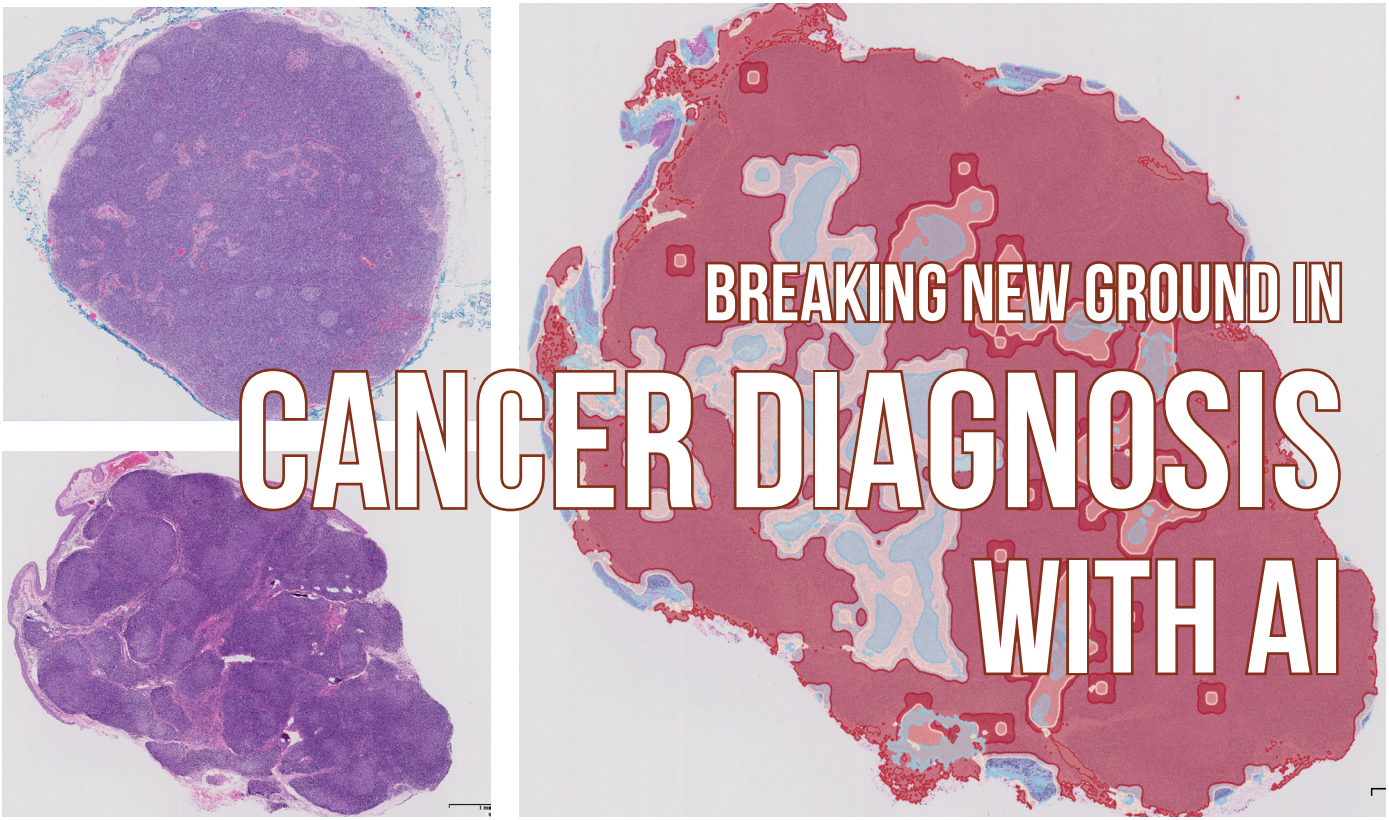
SG GUIDE TO TECHNOLOGY, INNOVATION AND ENTERPRISE

RIE NEWS

April 2020



BREAKING NEW GROUND IN CANCER DIAGNOSIS WITH AI

Using AI to differentiate reactive and lymphoma cases
Photo: Qritive

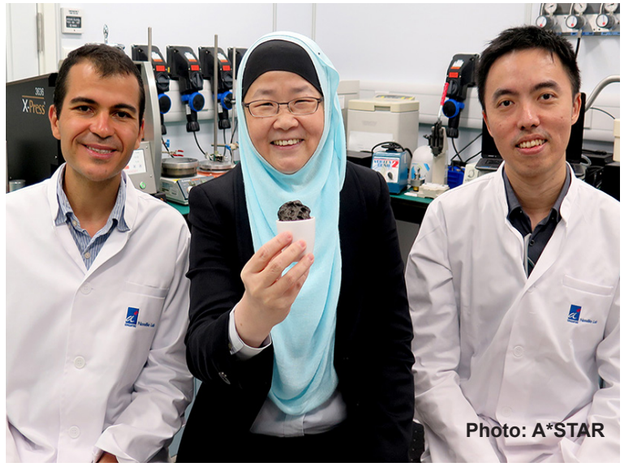
WHAT'S HAPPENING

SINGAPORE SCIENTIST RETURNS HOME TO LEAD CLIMATE CHANGE RESEARCH

Climate change scientist Professor Koh Lian Pin will return home to helm the new NUS Centre for Nature-based Climate Solutions, advancing Singapore's efforts in tackling the effects of climate change. His research will focus on ways to balance human needs with environment protection, and will be set in the context of the developing tropics - a region where population growth is the most rapid, and where biodiversity is the richest, yet most threatened globally.

NEW TECHNOLOGY MAKES LITHIUM BATTERIES SAFER

The use of lithium batteries poses safety issues as such batteries rely on highly-flammable liquid organic electrolytes that leak easily. They also use thermally and mechanically unstable electrode separators. While solid-state electrolytes can improve safety, they perform poorly. To address this, researchers from A*STAR's NanoBio Lab have designed a semi-solid electrolyte for lithium batteries that improves their safety without compromising their performance. The team is working towards commercialising the technology, which would take one to two years.



RESEACHERS TO LOOK INTO HOW DIGITAL TECHNOLOGIES CAN TRANSFORM LEGAL PROFESSION

SMU will examine how digital technology such as Artificial Intelligence can be used in the legal profession to transform the work of paralegals, lawyers and litigators. Under the five-year Research Programme in Computational Law, the university will design a programming language that allows for laws, rules and agreements to be expressed in code. This could lead to 'smart' contracts and statutes executable by computers.

LOCAL FARMERS TO SPEED UP FOOD PRODUCTION

COVID-19 brings new awareness to the need to strengthen Singapore's food security by diversifying our food sources. A new $30m grant has been launched to speed up local production of eggs, leafy vegetables and fish. It can be used by farmers to implement productivity-enhancing technology systems. The open grant call will be launched in mid-April 2020 for local agri-food players to apply.

THRIVING IN THE 'NEW COVID-19 NORMAL'

Have an idea on how to thrive in a world that is reeling from the effects of COVID-19? NRF is calling for innovation ideas or tech solutions from our research community to help Singapore and our people adapt and thrive in the "new COVID-19 normal". There are no specific areas identified for this call, and ideas could draw on any science and engineering areas. For details, click here.

CALL FOR IDEAS

Have an idea of how to thrive in the new COVID-19 normal?
Tell us.

INTERVIEW

DIAGNOSING CANCER THE AI WAY

SGINNOVATE WORKS WITH ENTREPRENEURIAL SCIENTISTS TO BUILD AND SCALE THEIR COMPANIES. IN THIS ISSUE, WE CHAT WITH ANEESH SATHE, CEO AND CO-FOUNDER OF QRITIVE, A STARTUP MAKING ITS MARK IN USING AI TO DIAGNOSE CANCER.

Qritive wants to improve cancer diagnosis by using AI to analyse microscopy images. How does Qritive compare to other similar technology in the market?

Pathology labs have remained unchanged for almost a century. Today, most pathologists rely on their microscopes and visual analysis to arrive at a diagnosis. There are no solutions like ours in the market today. The few automated analysis solutions that do exist are very limited in their applications and require the pathologist to use special equipment and software.

Qritive is among the few companies worldwide that are addressing this problem and is the most advanced in Asia. Today, our solutions are able to address 40% of the cases in pathology labs, and by 2023 we intend to cover 95% of all pathology cases. Some of our differentiators are:

Our first differentiator is our patient-centric approach. Patients are always at the centre of what we develop. We always think about patient safety, ethical factors, and other risks such as privacy before even designing the product and mitigating such risks are of paramount importance to us. Building the technology is only the first step in improvement of healthcare workflows. A significant amount of effort needs to be put in to address safety and effectiveness of the technology, as well as regulatory approvals. We are the first to address all these factors in AI-assisted pathology in Asia and among the few globally.

Secondly, Qritive is easy to use and adopt. We provide a single-window operation with an integrated patient management system that can entirely be accessed remotely in case of emergencies. The technology is also hardware agnostic, and we are able to analyse whole slide images from any microscope. We are also built with Asian data for Asian populations. Our

CEO and Co-founder of Qritive Aneesh Sathe (right) with his fellow Co-founder and CTO Kaveh Taghipour want to enable quality healthcare for everyone through AI.

collaborations with top hospitals enable us to use data that captures the uniqueness of the population. Most of our competitors are in the US, and others use public datasets that are also US-centric. This means that the solutions they build are limited to this population set. Our data captures high variability and allows us to build robust, high-performance AI models.

Lastly, we can deliver strong products for clinical use in record time. This is because our team is our biggest advantage. Today, we have a team that is strong across the board, covering AI, software, pathology, regulations, and sales. We have picked from only the best applicants with <5% making it to interview and <1% being hired.

A strong team combined with a proprietary technology and streamlined processes allows us to deliver solutions fast. We are therefore able to develop high performance AI models for new cancer indicators in just a matter of weeks. Our close collaboration with SGH and NUH that are pioneers in the adoption of new technology has enabled us to conduct clinical trials in short periods of time. We are the first to bring AI-powered technology into clinical setups in Asia.

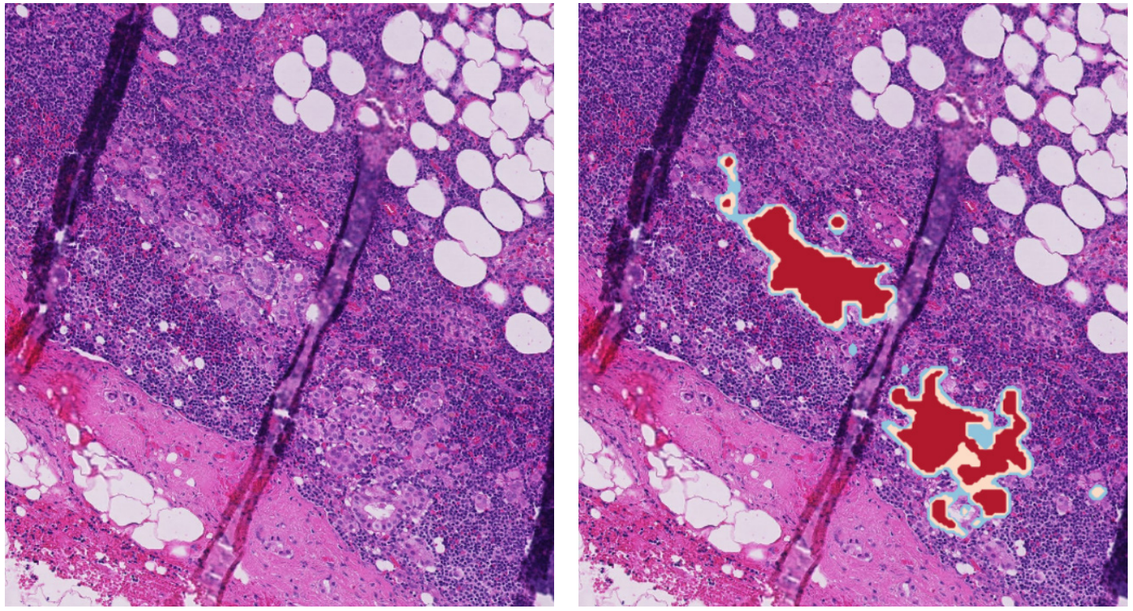
There are ongoing debates on using AI to diagnose cancer, particularly on the kind of data used to train AI systems, which could result in inaccurate diagnosis. How does Qritive obtain quality biopsy data to overcome this, especially for early-stage cancer?

We are able to access anonymised, high resolution whole slide images of histopathology slides through our Research Collaboration Agreements (RCAs) with NUH and SGH. However, having just the images is not sufficient. We need high quality annotations to train our machine learning algorithms. Our collaborators help us to not just annotate the data but also to explain the clinical intricacies of their analysis.

With this holistic approach of understanding the problem, collecting data and annotations, and training our algorithm, we are able to deliver high performance systems that have been clinically validated. Conducting large clinical validations to account for edge cases and gray areas is a key factor in our studies.

What is the most challenging aspect of developing the Qritive AI technology?

The most challenging aspect is understanding the exact problem that is faced by the doctors and



Finding 50 abnormal cells in millions is a near impossible task for a pathologist. However, if found early, patients have much better outcomes. Shown on the right are outputs of Qritive's AI system highlighting in red the handful of abnormal cells that have metastasised from a cancer in one part of the body to another.

building the right AI tools for maximum impact.

What has been your most surprising finding in using AI for cancer diagnosis?

We have made a few discoveries that are unique to cancer analysis with AI – such as our novel diagnostic approach to lymphoma. Medical doctors require several years of training before they are proficient as pathologists and even then, it is not an easy task. During their training, doctors learn to identify patterns that can be understood by the human mind. Our systems are learning patterns to arrive at correct answers in ways not recorded in pathology textbooks. These discoveries open doors to new biomarkers and will provide the medical community with a set of tools to improve patient care.

What, in your opinion, is the future of using AI in cancer diagnosis and prognosis?

AI appears to be the only technology that is capable of bringing in significant improvements to cancer diagnosis and prognosis, and reducing healthcare cost at the same time. It is now a well-accepted opinion in the medical community that AI-assisted diagnosis and prognosis in contrast to fully-automated AI approach is the way forward. AI analysis takes away the menial tasks and allows doctors to take advantage of the huge amount of data available in every case sample. Financial and business operations were revolutionised by the spreadsheet. Qritive's solutions will revolutionise pathology and empower the clinician to see the bigger picture.

Is Qritive currently being adopted for use by doctors?

Yes, Qritive is being adopted by leaders in pathology. After being clinically validated, Qritive's solutions are now being trialled by leading hospitals and labs in Asia. The most important factor is the ability to treat more patients with the same infrastructure. This helps to reduce healthcare costs and enable more patients to receive care, bringing about a positive impact on society. One of the major advantages of starting in Singapore is that we had ready access not just to strong talent but also to a healthcare setup that is pro-technology and adopts with an eye on the future.

What is the end goal for Qritive, and when do you to achieve it?

Qritive's vision is to enable quality healthcare for all. Today, healthcare systems of the world fall short due to a dearth of doctors and overburdened infrastructure. There is room to improve efficiency in healthcare by introducing smart tools in key areas. With an extra layer of analytics, processes will be improved and the same infrastructure can now serve a larger population.

What valuable lesson has your entrepreneurial journey taught you?

Clear communication on all fronts is paramount for a healthy company. Communication between founders ensures that everybody is on the same page and allows for better planning to accommodate needs. Communication with customers and early collaborators allows you to stay in touch with changing trends and course-correct when needed. Investors also need to understand that their investment is in good hands and every decision is deliberate. Most importantly however, success depends on your team. The most effective teams understand the company's vision, make it their own and invent the future.

Do you have advice for fellow innovators out there who are currently conceptualising their ideas, building their prototype or even in the user trials before their product launches?

When building a product or exploring an idea, customer focus is of prime importance. Understanding the exact problem the customer wants to solve and creating a solution requires extreme focus and an ability to prioritise. Often innovators, and this is quite common in scientists, build a solution first and then search for a problem. This creates a double-edged sword – it's difficult to find customers and you go through emotional turmoil when your great idea seems to fall flat. In our experience, we learnt the most when we left the confines of our lab and offices and sought a deep understanding of the world that we want to change.

INTERVIEW

RESEARCHER PARTNERS COMPANY TO SCALE UP MICROSCOPY TECHNOLOGY

SINGAPORE-BASED STARTUP PHAOS TECHNOLOGY LAUNCHED OPTONANO200 – AN ADVANCED MICROSCOPY TECHNOLOGY THAT ALLOWS MICROSCOPES TO SEE SMALLER SAMPLES IN A COST-EFFECTIVE WAY. PROFESSOR HONG MINGHUI, CO-FOUNDER AND DIRECTOR OF PHAOS TECHNOLOGY, TELLS US MORE ABOUT THIS LATEST TECHONOLOGY.

It was in the 17th century that the wish of seeing our micro-world clearly was granted by the invention of the optical microscope. Since the gift of light, research fields including biomedical sciences, chemistry, materials science, and electronics have seen tremendous progress.

But with progress comes the demand to see the tiniest specimen, leading to a technical bottleneck caused by the optical diffraction limit imposed by the illumination wavelength. Ways to circumvent this include applying electron beams or near-field optical probe as mapping tools to sketch the surface textures of tiny samples. In 2014, the Nobel Prize in Chemistry was awarded to a team of scientists for developing fluorescence microscopy, which uses fluoresence tags to image nanostructures at very high resolution.

However, according to Professor Hong, these methods could result in inevitable modifications or even damage to these samples. His microsphere-assisted technology aims to address this shortfall.

Your latest microscopy technology uses microsphere to upgrade the magnification of microscopes by up to four times. Could you explain to us – in simple terms – what is microsphere-assisted microscopy technology?

Our technology uses microspheres – or miniature glass spheres – to turn existing microscopes into nanoscopes, upgrading the magnification of microscopes by up to four times. Using our patented technology, microscopes can be easily turned into nanoscopes by inserting these microspheres. This significantly increases the magnification of the objects that the microscopes are looking at, at an affordable price. OptoNano200 is able to see objects up to 200 nanometres.

Professor Hong Minghui (left), with Mr Yosuke Kondo, President and CEO of SIGMAKOKI Co., at the Photonics West 2020 event, where OptoNano200 was launched in February.

What are some of the market applications of the OptoNano technology?

Optical microsphere nanoscope can be used widely in situations where micro or nano-structures need to be imaged. Some use cases include disease analyses, fast screening of defects in semiconductor structures, and vivid, real-time demonstration of activities in micro or nano systems. The market share in nanoscopy could reach tens of billions (in USD).

> "Our technology uses microspheres – or miniature glass spheres – to turn existing microscopes into nanoscopes, upgrading the magnification of microscopes by up to four times.
>
> - Professor Hong Minghui on OptoNano's capability

One of the advantages of OptoNano200 is that it allows non-contact observation of nanoscale objects, without the need for specimen treatment. How big of an impact do you think this would be for the health and biomedical sciences field?

For life science and biomedical observations, it is critical to keep specimens uncontaminated and intact to ensure reliable results. With the ongoing coronavirus outbreak, it becomes even more critical to be able to identify and study viruses without contaminating the samples. We hope that in future, our OptoNano product line can enable the rapid discovery of new viruses and aid in the creation of advanced treatments for these viruses.

Tell us more about your experience working with SIGMAKOKI Co Ltd. How does the partnership with SIGMAKOKI contribute to the development of OptoNano200?

We see synergy in partnering SIGMAKOKI. The company has over 40 years of experience in manufacturing optical and opto-mechanical parts for scientific research as well as the photonics sector. Combining SIGMAKOKI's high standards in manufacturing with our advanced technology in optical microscopy produces a world-class product for the optical microscopy industry.

What has been your most surprising finding in developing OptoNano200?

While the usual time taken for research to be translated into an actual product is about five to ten years, we were able to develop OptoNano200 in three years from the completion of the research under the NRF's Competitive Research Programme. I attribute this to the strong research and enterprise ecosystem in Singapore which provided us with the right resources and networks to commericialise the product.

What is your end objectives for Phaos Technology, and how would you get there?

Our dream is to establish a flourishing optical industry in Singapore and then expand our market share worldwide. I believe this is possible as our technology can be used in many products. To realise our ambition, we will build manufacturing lines to make advanced optics systems that are centered around cutting-edge technologies. Optical technology is a deep technology that relies not on natural resources, but human intelligence and innovation. Singapore's deep scientific capabilities make the field of science a logical area for Singapore to compete and achieve excellence in.

What valuable lessons did your research in this area teach you?

I had the opportunity to meet many outstanding partners. These include my team members, government and industry partners, and investors. I learnt that the key to the success of any venture is the the ability to inspire and motivate talented people to come together to achieve a common goal.

Professor Hong and his team received the NRF's Competitive Research Programme grant in 2012 to conduct research in microsphere technology. His research spin-off Phaos Technology was started in 2017.

FEATURE

NTU DEVELOPING SINGAPORE'S FIRST VIRTUAL POWER PLANT

WE FIND OUT FROM DR KOH LIANG MONG FROM THE ENERGY RESEARCH INSTITUTE AT NTU WHAT IT TAKE TO DEVELOP SINGAPORE'S FIRST VIRTUAL POWER PLANT AND WHY IT IS IMPORTANT FOR SINGAPORE.

Picture Singapore as a grid.

In a city that is a hundred per cent urbanised, there would be power lines running through every square metre of the city. From street lamps and traffic lights to HDB flats and shopping centres – everything requires electricity.

Now think of where that power comes from. A small amount comes from solar, but the overwhelming majority comes from natural gas, a fossil fuel. But the Republic hopes to cut emissions drastically, and even achieve net-zero carbon emissions as soon as possible, which means fossil fuels need to be phased out. That leaves only solar as the remaining viable energy source in Singapore – and even that is not entirely reliable, owning to environmental factors such as intermittent cloud cover.

With this in mind, there is a pressing need to aggregate whatever power we have and distribute it as efficiently as possible, so as to ensure maximally reliable power supply to consumers while avoiding the use of fossil fuels as far as possible. With a population of over five million people, allocating energy in such a deliberate manner sounds like a daunting task – and that is where technology comes into play.

A virtual power plant (VPP) is an intelligent software system that pulls together power from different sources, and then aggregates it for distribution to consumers. Basically, it's like a physical power plant, but rather than distributing the energy from a centralised source, it does so with multiple sources at different localities, through decisions made by artificial intelligence.

This way, the most efficient and economical sources could be utilised first and directed to the appropriate consumers. For instance, excess PV output during sunny days could be stored and tapped when the

output is low – for instance, during rainy days. Companies that have their own photovoltaic (PV) systems can also sell excess energy generated to consumers, as matched by the VPP.

The Energy Research Institute at NTU (ERI@N) is currently working on developing such a system. Dr Koh Liang Mong, who heads the project, said that over the years, ERI@N has developed and deployed key technologies such as artificial intelligence, microgrid systems, and energy management solutions. As such, when Sembcorp – the country's leader in renewable energy, with over 1,500 solar energy sites in its portfolio – suggested developing a VPP, the institute immediately agreed.

The project has been underway since last October and aims to be ready for deployment by mid-2021, says Dr Koh. Although the research team is making good progress, there are still a few kinks to work out – for one, recruiting researchers in data science and software engineering has proven a challenge, as there is a need to compete for other initiatives such as fintech, which is also experiencing high demand.

On the infrastructure side, there are a number of distributed generation and storage assets to be installed at various sites, all of which have to be completed within the first year. Securing the sites for the installation of assets such as an offshore floating PV system and a battery energy storage system also requires approvals from multiple agencies, says Dr Koh.

"On this front, we're fortunate to have Sembcorp as our project collaborator and sponsor," he says. "Our counterparts in Sembcorp have put in substantial amount of effort in helping to secure the sites and engage agencies for pre-consultation."

Dr Koh Liang Mong at NTU's Energy Research Institute (ERI@N) is currently working on Singapore's first virtual power plant.

The ultimate goal of this partnership is a practical one for Singapore: to improve the efficiency and reliability of Singapore's power system. In addition to a more efficient allocation of resources, which could lead to cost savings for consumers, a VPP would also mitigate the problem of intermittent energy resources generated from sources such solar power. This would help provide better financial returns and hence encourage more solar PV installations, leading to a more sustainable energy supply in Singapore.

"Through this, the VPP could to some extent address the global energy sector's trilemma, on how to provide energy that is affordable, reliable, and sustainable," concludes Dr Koh.

FEATURE

FIXING TOOTHACHES WITH TECH

A*CCELERATE IS THE RESEARCH COMMERCIALISATION ARM OF THE AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH (A*STAR). A NEW 3D-PRINING TECHNOLOGY BY A*CCELERATE JOINT VENTURE STAR3D AIMS TO MAKE VISITS TO THE DENTIST A LESS PAINFUL EXPERIENCE.

If you've been to the dentist lately to get a dental crown done, odds are you've had to wait weeks and endure multiple visits for the procedure to be complete. But a new 3D-printing technology by joint venture Star3D seeks to change things.

A dental crown is a prosthetic 'cap' that is placed over a damaged tooth to restore it to its original shape and size. Although a relatively common procedure, it often comes with long waiting times: crowns have to be custom-made in a dental laboratory, and as such, patients usually have to wait two to three weeks for their permanent crown. In the meantime, the dentist will install a temporary crown to protect the tooth from damage. However, these are more delicate than permanent ones and may break or fall off, requiring multiple visits.

3D-printing seems like an easy solution to this problem. But most existing 3D-printing technologies are unable to generate end-products with material properties that are comparable to that of conventional production methods. In fact, material properties have been a limiting factor for the whole 3D printing industry, as the nature of the process means the materials that can be used for 3D printing are very limited. And since dental crowns are subject to large amounts of wear and tear, there is a need to ensure that the product is highly durable.

To meet this need, local dental-tech startup Singapore Dental Star developed a material technology for Stereolithography-based 3D printing. Unlike previous technologies, the end-product exhibits enhanced properties of strength and rigidity, making it suitable for dental applications such as temporary and permanent crowns. It is also able to print in multiple colours using a patented colour gradient printing technology, allowing users to print crowns that closely match the patient's original tooth colour — a feat

A temporary crown printed using Star3D's 3D printing technology. The material has high hardness and flextrural strength. Picture: Star3D's website

which the firm says no other printer on the market is able to do.

With this new technology, Singapore Dental Star was able to develop a 3D-printing method that can fabricate dental crowns in as little as 20 minutes, cutting down the need for weeks of waiting time and multiple visits. Although the focus has so far been on dental crowns, the firm plans on extending this to include all dental applications that can be produced by 3D-printing, including dentures and mouth devices for sleep apnea. And ultimately, the firm hopes to entirely replace conventional production methods and reduce clinics' reliance on dental laboratories.

"The inspiration behind this project is to enable dentists to provide a better quality of life to their patients through innovative, better-quality, and value-added products," says Mr Vincent Yuen, managing director of Star3D. He explains that while there is a technology available on the market which has attempted to meet this need — the computer-aided design and manufacture (CAD-CAM) system — it is still not widely used.

On the other hand, 3D-printing could be a more accessible option as it is faster and cheaper. It also results in less material wastage as it uses an additive manufacturing method, unlike CAD-CAM's subtractive technology. This could also help clinicians to further cut costs, he adds.

In an effort to bring its product to market, Singapore Dental Star partnered with A*STAR's Institute of Materials and Engineering (IMRE) in January last year to launch the technology under the name Star3D. This partnership allows the startup to focus on commercialising the technology, while A*STAR continues to engage in R&D efforts to keep the product at the cutting edge of innovation, explains Mr Yuen.

And their efforts have borne fruit. Last September, Star3D launched its first product line — including a mini 3D printer, dental model material, and surgical guide material — in China. It hopes to launch its temporary and permanent crown materials this year. This launch will include Singapore as well — although, Mr Yuen says, this might be delayed in light of the COVID-19 virus.

Nevertheless, the firm is confident that their innovation will help revolutionise the current dental workflow. "By working with A*STAR, we hope that we will always be on the forefront of product innovation, transforming new technologies into real world solutions," says Mr Yuen, who adds that through the collaboration, the firm hopes to create more state-of-the-art products and enhance its image as a Singapore-based company in the world.

FEATURE

RESEARCH SHOWS FANS CAN PROVIDE BETTER THERMAL COMFORT AT LOWER COST

HOW TO KEEP COOL WHILE REDUCING OUR USE OF AIR-CONS? PROFESSOR STEFANO SCHIAVON FROM NRF'S CREATE PROGRAMME THINKS THE EVERYDAY FAN COULD BE THE ANSWER.

Many office dwellers in Singapore are used to chilly conditions in their work environment. To stave off the cold, some choose to don jackets or brew a cup of hot coffee to keep themselves warm, as they type away on their keyboards.

This common phenomenon in our air-conditioned nation has led UC Berkeley Professor Stefano Schiavon to investigate the issue of overcooled commercial buildings, which makes people uncomfortable and also wastes energy in Singapore. The research is supported by the NRF through the Singapore-Berkeley Research Initiative for Sustainable Energy programme (SinBerBEST) under CREATE.

In his research, he sets out to unveil a new approach for cooling buildings using less energy. This is critical – as the demand for global space cooling is projected to soar – with populations living in the tropics rising from about 40% in 2019 to 60% in 2060.

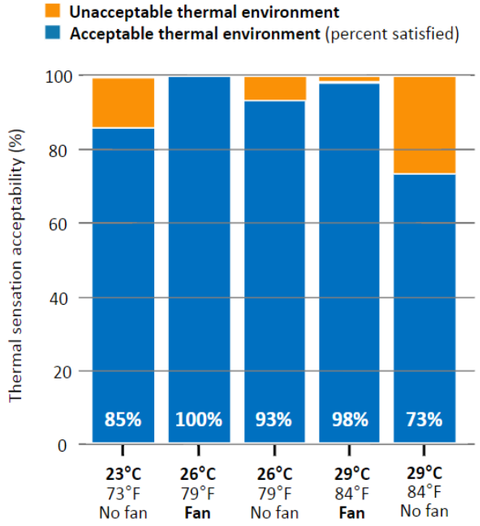
Comfort Cooling through Personal Fans

In his study, Professor Schiavon and his team wanted to test if the simple act of using a personal fan could provide thermal comfort to office workers, while reducing energy consumption.

The team provided personal fans to 56 tropically acclimatised workers in common Singaporean office attire, and tested what air-conditioning temperature would provide optimal thermal comfort and increased productivity.

At the end of the study, the team found that thermal comfort, perceived air quality, and sick building syndrome are equal or better at 26°C and 29°C than at 23°C, if a personally controlled fan is available for use.

The best cognitive performance was also obtained at



In a lab study conducted by Professor Stefano Schiavon, occupants reported higher thermal comfort when the air-con temperature is set higher, and they are provided with a personal fan. Photo: Professor Stefano Schiavon

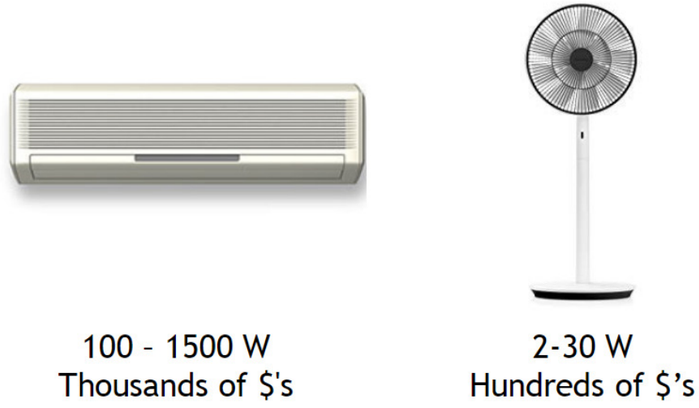
26°C. The typical Singaporean indoor air temperate of 23°C produced the lowest cognitive performance.

The results show that increasing the indoor temperature to around 26-29°C, and simultaneously providing occupants with personally controlled fans could be a cost-effective, sustainable and energy-efficient option for providing thermal comfort in buildings in the tropics. This shows that elevated air movement generated by a personally controlled fan is able to compensate for the negative effects caused by increased temperatures setpoints.

In a separate study, Professor Schiavon also found that increasing the air-conditioner's temperature from 23°C to 26°C, while adding in the use of ceiling fans resulted in a significant increase in thermal comfort (from 59% to 91%), and a substantial energy saving.

Using Fans for Indoor Cooling

While using fans for indoor cooling leads to personal comfort and cost savings, Professor Schiavon said that it is challenging to implement this solution widely. Firstly, there are technical limitations related to floor to ceiling height and designers familiarity with the technology. Secondly, the prevailing existing building regulations on the use of air-conditioning do not support higher air-conditioning temperatures. Lastly, there is still prevailing cultural preference for air-conditioning over fans.



Fans are energy saving and inexpensive, said Professor Stefano Schiavon

However, there are notable shifts in deploying fans for cooling large spaces in Singapore. Professor Schiavon cites the example of the National University of Singapore's SDE4 building. Touted as Singapore's first new-build net-zero energy building, it was designed to consume only as much energy as it produces, such as through solar energy. SDE4 adopts the concept of elevated air movement generated by ceiling fans and higher indoor temperatures.

Future Efforts

This energy efficient and comfortable solution should be applied to office environments. SinBerBEST worked with the Building Construction Authority to renovate the first floor of the three-story BCA Zero Energy Building. Among other technologies, the space was equipped with ceiling and desk fans and it is operated at higher temperature setpoints. Professor Schiavon will test which are the best conditions to provide a comfortable and healthy environment that minimise the use of resources. Given that we spend more than 90% of our time within a built environment, we need to create spaces that promote health, well-being, social connections and productivity.

COMMENTARY

SWISS-SINGAPORE COLLABORATION BRINGS HEALTHCARE CLOSER TO PATIENTS

WITH CHANGING GLOBAL DEMOGRAPHICS, HEALTHCARE SYSTEMS AROUND THE WORLD MAY BE IN DIRE NEED OF AN OVERHAUL, SAYS PROFESSOR NICOLE WENDEROTH FROM THE SINGAPORE-ETH CENTRE'S FUTURE HEALTH TECHNOLOGIES PROGRAMME.

The COVID-19 pandemic has put the spotlight on healthcare systems in every corner of the world. While most may have served their respective populations well in better times, the global health crisis is continuing to strain even the most advanced and efficient systems as it unfolds. But even before the most serious health event in recent history, changing global demographics have already begun to pose challenges to existing systems.

The rapidly ageing population has become a global phenomenon that is sometimes known as the 'Silver Tsunami'. By 2050, the proportion of the population aged 60 years and above is estimated at 34 per cent in Switzerland and 40 per cent in Singapore. The associated increase in chronic diseases could exacerbate the shortage of affordable healthcare services and inevitably lead to increasing costs. This means that existing healthcare models may no longer be viable in the coming decades.

To meet the challenges of the future, we need more sustainable modes of healthcare service delivery to ease the load of hospitals and other medical facilities. In short, we need to move the delivery of healthcare services out of the hospitals, towards the patients and the community.

Towards a Patient-Centric Healthcare Model

Globally, Singapore is among the first to initiate future-oriented initiatives in support of a patient-centric healthcare transformation. This is encapsulated in its vision of "beyond hospital to community, beyond quality to value, and beyond healthcare to health".

With its high technical readiness, innovativeness, and proactive strategy, Singapore is well-positioned to transform its healthcare system. This is an effort that is supported by its Ministry of Health Office for Healthcare Transformation as well as various national

Professor Nicole Wenderoth, Programme Director of Future Health Technologies at the Singapore-ETH Centre, wants to leverage digital technologies to tackle prevalent health challenges in Singapore, such as dabetes and obesity.

initiatives and programmes. The recently launched Future Health Technologies (FHT) programme under the Singapore-ETH Centre will be contributing to this transformation effort, with support from the National Research Foundation's Campus for Research Excellence and Technological Enterprise (CREATE).

Mobile digital technologies developed at ETH Zurich offer many possibilities in supporting both healthcare providers and patients in the continuum of care, ranging from prevention to management and rehabilitation.

What if mobile robots could facilitate rehabilitation after a stroke at home? What if an interactive chatbot, which could help us reduce the risk of diabetes or depression, could be carried in our pocket? What if you could predict the risk of one falling and suffering a fracture?

The FHT programme will leverage such digital technologies to tackle prevalent health challenges in Singapore, including diabetes, obesity, depression, stroke, and fractures. Based on the research outcomes, customised preventive and curative measures will be defined and implemented. In addition, health technology assessments will be routinely performed to estimate and monitor the overall value and costs of such interventions.

The Challenge of a Data-Rich Healthcare System

In the future, effective and efficient healthcare delivery will increasingly depend on the collection and analysis of huge amounts of data, made possible with sensors and other mobile devices. As such, the future of healthcare, much like the future of smart cities and smart factories, will be driven by data.

This brings us to a question: how can we gain public trust and acceptance of these technologies? At the core of this question is the topic of health data governance.

The FHT team will define a 'trustworthy data governance' concept that is applicable to the legal and regulatory framework in Singapore. It covers areas such as privacy protection, data ownership, and accountability. At the same time, the concept allows researchers to analyse health data and build more accurate models to forecast patients' health, predict patients' response to treatment, and to better estimate overall value and cost.

Working with established partners in Singapore, FHT will take a holistic and evidence-based approach to providing relevant solutions. We don't just want to know if, say, a particular sensor is functioning properly. We also want to define a process that highlights what is necessary for new technologies to truly improve health and well-being in a clinical environment. This process should also identify which barriers stand in the way of an application and how these can be overcome. In examining these issues, we will flesh out ethical standards and take regulatory concerns into account – two aspects that are essential to gaining public acceptance and trust.

Collaboration Knows no Borders

With health and technology coming together, interdisciplinary borders only get in the way of a solution-oriented approach. The research programme not only brings together leading Singapore- and Swiss-based researchers and clinician scientists, but also disciplines including health engineering, medicine, computer science and artificial intelligence, economics, bioethics, social sciences, neuroscience, and rehabilitation science.

The FHT programme is established by ETH Zurich (Swiss Federal Institute of Technology Zurich), in partnership with Duke-NUS Medical School, Nanyang Technological University, National University of Singapore, National Health Group, National University Health System, and SingHealth.

In the next five years, researchers will work closely with local agencies, clinical partners, industry and other rel¬evant stakeholders, to develop digital tools that are relevant to the healthcare needs of Singapore's population and that can be integrated into its healthcare delivery workflow.

EXPLAINER

THE ONGOING CORONAVIRUS PANDEMIC HAS SENT SCIENTISTS AND RESEARCHERS INTO A GLOBAL RACE FOR A VACCINE – BUT EXACTLY WHAT DOES THIS ENTAIL? PROFESSOR OOI ENG EONG FROM THE DUKE-NUS MEDICAL SCHOOL'S PROGRAMME IN EMERGING INFECTIOUS DISEASE EXPLAINS.

What are vaccines, and how do they work?

Vaccines work by mimicking the features of a live virus in order to "educate" an immune system to recognise and develop a memory against these viruses. Upon an encounter with the respective wild-type viruses after vaccination, the memory immune cells can be rapidly activated to react against these viruses and prevent infection.

Vaccines have been developed to prevent influenza and adenovirus. They have also been shown to be especially useful in preventing viruses that infect us via the respiratory tract, such as measles, mumps, rubella and chicken pox.

What is the process of developing a vaccine like?

There is no cookie cutter approach to vaccine and drug discovery. Vaccine and drug development needs to be guided by scientific evidence.

However, there are challenges that are universal in vaccine development. Firstly, vaccines must be safe and not cause intolerable side effects. Secondly, vaccines must elicit the right types of antibodies and cells and to sufficient levels so that the immune response would protect against infection for a long time. Thirdly, they will need to be in forms that can be developed and manufactured without costly modifications to existing methods, so that the price of the vaccines would not be prohibitively expensive. These requirements make vaccine development challenging but not impossible.

Could a vaccine be developed against COVID-19? Would it help to curb the pandemic?

Vaccine development typically takes approximaely 10 years or more. However, we are now facing a pandemic and this process will need to be sped up considerably. We (Duke-NUS and SingHealth) have been working on using molecular tools to evaluate the safety and potency of vaccine candidates so that we can make better decisions on which ones to invest in for further clinical development. We hope to be able to use these tools to support the global effort in vaccine development to help overcome COVID-19.

However, I think we will eventually need both vaccines and drugs to fight COVID-19, as there is unlikely to be a silver bullet solution to this disease. As such, in parallel with vaccine development, efforts are also underway to find antiviral treatments to prevent severe disease in COVID-19 patients.

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