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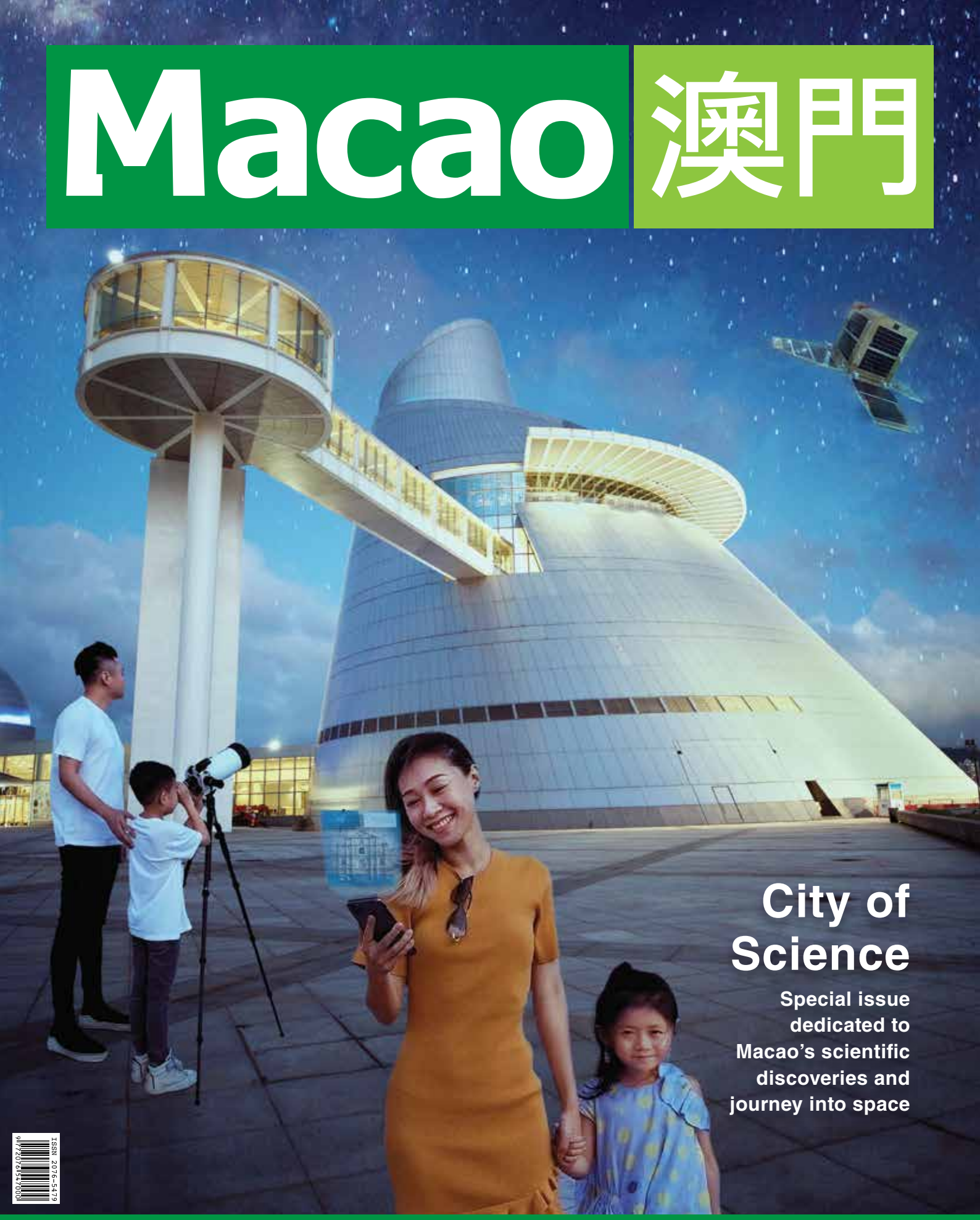

City of Science

Special issue dedicated to Macao's scientific discoveries and journey into space

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Science and Space Special

For more than 400 years, Macao has been a hotbed of scientific research and innovation. We take a look at the important scientific discoveries that have been made in the city over the past two decades, as well as the Macao Science Center's new methods of educating young people. Finally, enjoy our special feature on the SAR's first ever satellite which is set to boldly go into space in the near future. **p.22**

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On page 77 of our last issue, we incorrectly published an image of Chinese politician Li Hongzhang in a section that was devoted to senior Chinese official Zheng Guanying. We apologise for any inconvenience caused.

Publisher Government Information Bureau (GCS) of the Macao SAR
15th Floor, China Plaza Building, Avenida da Praia Grande, 762 – 804, Macao
T. +853 2833 2886 F. +853 2835 5426
info@gcs.gov.mo

Director Victor Chan Chi Ping

Executive Editor Amelia Leong Man Ieng

Editor Eva Lei Sao Iok

Meet our team

Producer and Distributor Macaolink News and Information Services, Ltd.
Av. do Dr Rodrigo Rodrigues 576, Edf. Centro Comercial First Nacional 2406, Macao
T. + 853 2835 5315 F. +853 2835 5466
contact@macaulink.com.mo

Editor-in-Chief Gonçalo César de Sá
cesardesa@macaulink.com.mo

Acting Editor Matt Fleming
mattfleming@macaulink.com.mo

Business Development Manager Mariana César de Sá
marianasa@macaulink.com.mo

Designer Sandra Norte
sandra@macaulink.com.mo

Contributing Writers Rafelle Marie Allego, Cláudia Aranda, Neil Ford, Lucian Hoi, Christian Ritter, Sheyla Zandonai

Translator Kary Lam

Photographers Mércia Gonçalves, António Sanmarful, Cheong Kam Ka

Proofreader Anna O'Connor

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Cover image The Macao Science Center at dusk by António Sanmarful. Thank you to (from left to right) Luciano, Lúcio, Shelby and Leila Gonçalves for posing for our cover image.

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Here's to the future

We're almost halfway into 2020 and, since the turn of the year, so much has changed for every person across the world. The COVID-19 pandemic has changed the way we live, work and look at the globe in just a few months. Science necessitates change more than any other field of study and only with it can science evolve, adapt and reach new levels of understanding and invention. As the frantic search for a COVID-19 vaccine continues, scientific endeavour has never been as crucial as it is right now and that's why we've chosen to dedicate our main features in this issue to science – in particular, to Macao's scientific contributions.

Enjoy our piece on our city's first satellite, Macao Science 1, which will soon be launched into space, marking a milestone for the local development of aerospace technology. Join us as we investigate the major scientific discoveries that have been made in Macao over the past two decades, including breakthroughs in AI and robotics and cancer treatments. Finally, toast the Macao Science Center and its team, which successfully shifted all its educational content online during COVID-19.

Macao discharged its last COVID-19 patient from hospital on 19 May in a moment which was met with much relief across the city. But many other countries, such as the UK, have so far not been as fortunate. We talk to a Macao resident living in London – Dr Jessica Mok, a frontline volunteer working at the capital city's Nightingale Hospital – about what it's like over there now. While in London, we also catch up with astronomer Tania de Sales Marques – a shining representative of Macao at the Royal Observatory of Greenwich.

Change is in the air and in Macao we can see it at every turn – literally. Across the city, dozens of roads are being renewed and major infrastructure projects are underway – either in the planning phase or already being built. Read about these projects in our in-depth article and dig into the Macao government's 2020 Policy Address, made on 20 April, in this issue too. With clear guidelines established in the address by Chief Executive Ho Iat Seng – which set out a raft of policies to stabilise and stimulate the economy – positive changes are on the way for us.

Gonçalo César de Sá
Editor-in-Chief

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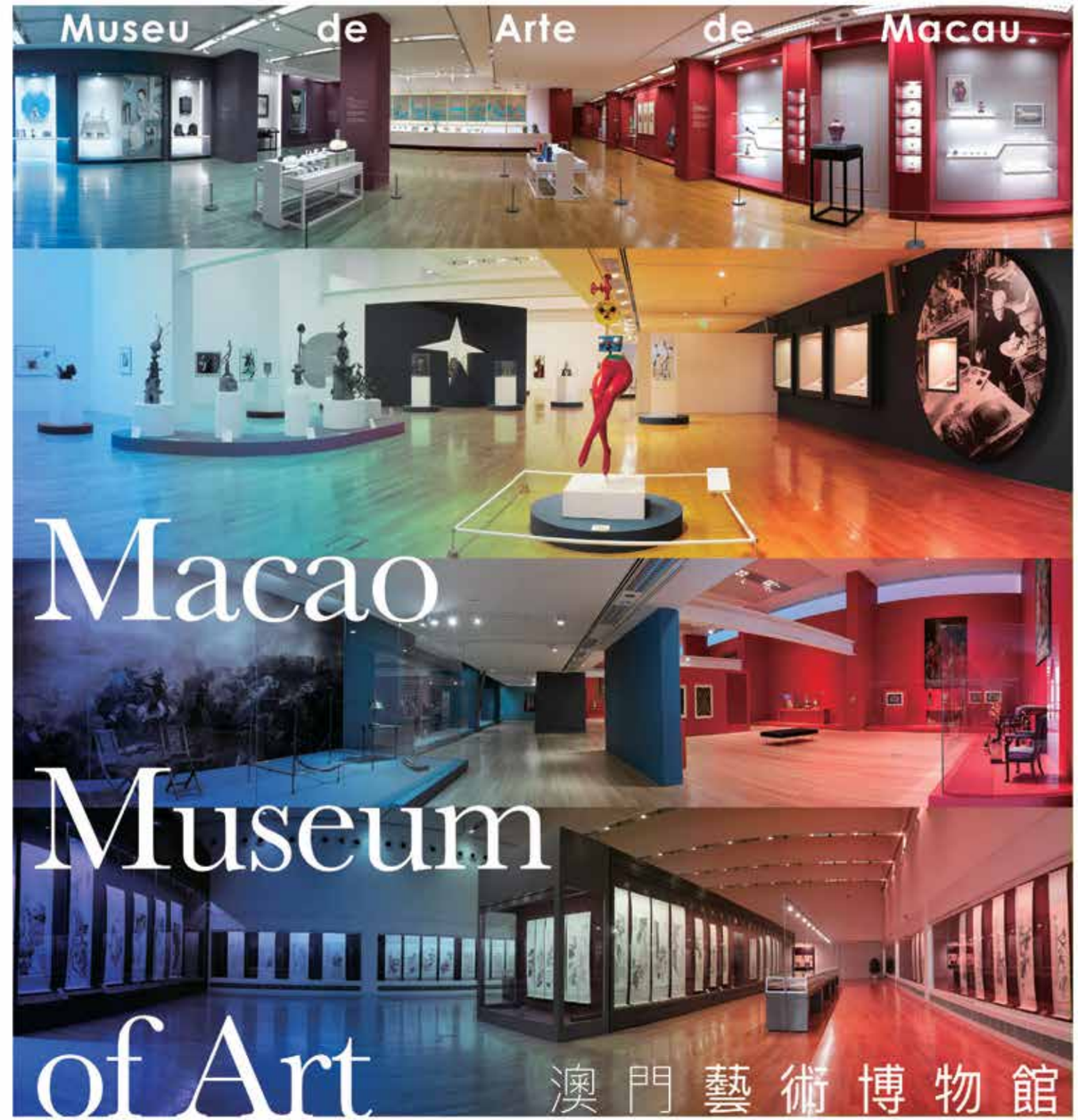

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Politics

Macao's golden years

Text **Christian Ritter** and **Gonçalo César de Sá** Photos **Courtesy of Government Information Bureau**

Chief Executive Ho Iat Seng announced a raft of policies to stabilise and stimulate the economy and to fast-track infrastructure projects and institutional reform at his 2020 policy address last month. He also said Macao is heading for its 'golden years'.

The legislature; (left) Chief Executive Ho Iat Seng delivers his 2020 Policy Address

On 20 April, Macao's Chief Executive Ho Iat Seng delivered his first policy address at the Legislative Assembly, exactly four months after taking office on 20 December. It was an address that carried great importance as the city waited to see what he would say about the government's plans to get Macao back on its feet in the wake of the COVID-19 pandemic and the effect the virus has had on the territory.

COVID-19 was at the heart of Ho's policy address. He said that the outbreak had brought severe challenges to the local government and to Macao's society, but he also said that the government had nevertheless given top priority to the safety and health of Macao's residents and had implemented a raft of measures to prevent and control the spread of the disease. As a result, he said that his government is putting forward a series of additional measures, such as reducing taxes and fees, implementing public and infrastructure programmes and supporting small and medium-sized enterprises (SMEs), to ensure sufficient supply for people's livelihoods and employment, as well as the stabilisation of the economy.

Also at the address, Ho called on his government and all sectors to have more confidence and to stay focused to cope with the existing difficulties and challenges. The Chief Executive vowed to firmly implement the policy of 'One Country, Two Systems' and 'Macao people governing Macao' with a high degree of autonomy and to safeguard the authority of the country's Constitution and the Macao Basic Law, as well as the central government's overall jurisdiction over the SAR. Ho stressed that there is no home without a state and there is no Macao Special Administrative Region without the People's Republic of China. "We need to pay attention to national security at all times," he said. "It is a long-term job."

A second Macao

According to the Chief Executive, the neighbouring Hengqin island in Zhuhai will become an important platform for Macao so it can play a more active part in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA), turning the island into a 'second Macao'. The policy address, which was titled 'Forging Ahead Towards New Horizons', had a whole section of it dedicated to Macao's efforts on integrating into national development and the fostering of local economic diversification.

What the secretaries said...

ADMINISTRATION AND JUSTICE

At the legislature's hemicycle, which took place between late last month and earlier this month, five government secretaries announced policy guidelines for their respective portfolios. Secretary for Administration and Justice André Cheong Weng Chon said that the government will hold a public consultation this year on its plans to reform the civil service as many long-existing problems have been identified. Cheong, who previously headed the Commission Against Corruption, acknowledged that the civil service is 'beset with overlapping functions' and an 'inadequate deployment of civil servants', as well as 'the difficult co-ordination and sluggish implementation of interdepartmental tasks'. He also singled out a 'lack of clear objectives in civil service training programmes'.

What the secretaries said...

ECONOMY AND FINANCE

Secretary for Economy and Finance Lei Wai Nong last month reaffirmed that the government aims to launch a public consultation by the end of this year on the granting of future gaming concessions in the run-up to the expiration of the city's three gaming concessions and three sub-concessions. "This time, the government will have more space on choosing and deciding how the gaming industry should run in the future," he said. The city's current gaming concessionaires are SJM, Wynn and Galaxy and its sub-concessionaires are The Venetian, MGM and Melco. Lei was quick to add that the government's 'ultimate aim' is to ensure that the process will be completed by June 2022 and that there is a need to 'redefine non-gaming elements'.

Lei also said that the government is aiming to launch a public consultation on the drafting of the city's first-ever trade union bill in the third quarter of this year. He pledged that the government will draft a bill which will be 'suitable for Macao's continued development and its future needs' after collecting residents' opinions during the upcoming consultation. The legislature rejected a trade union bill for the 11th time in March last year. Macao is the only jurisdiction in China that does not have a trade union law.

Lei also urged civil society not to be prejudiced against the government's policy of deepening co-operation between Macao and Hengqin. He said that Hengqin would provide Macao with sufficient land for the latter's continued development, particularly by helping Macao diversify its industries and tackle the housing problem. He also noted that the local government has always stressed Macao's need to integrate itself into the Guangdong-Hong Kong-Macao Greater Bay Area. He underlined that Macao's insufficient land resources have limited its continued development for a long time.

While Macao's land area amounts to just 32.9 square kilometres, Hengqin is around three times bigger, covering 106 square kilometres. Ho used the University of Macau (UM), which is already located on Hengqin Island, as an example because Macao leased a one-square-kilometre plot of land on the island from the Mainland city of Zhuhai for the UM campus. He said he wished that one day Hengqin could help Macao's development.

Ho pointed out that Macao needs space for development, especially because of its aim of diversifying its economy in a short period of time. On the other hand, Ho also said there was a drawback to developing Hengqin because, he said, currently a manufacturing industry can't be developed there – previously it has been decided that the island won't be used for industries like this. He underlined that the government is working with the Hengqin government, hoping that the latter would provide some space for high-tech related manufacturing industries in order to promote further co-operation between Macao and Hengqin. "Macao will spare no effort in its co-operation with the Guangdong government and the Zhuhai government regarding collaboration in relation to Hengqin," he said.

The co-operation zone in Hengqin would be positioned to develop as a free economic zone, according to the Chief Executive. It would have international standards with regards to market operations, investment and trade rules and financing systems. The effort would aim to create a business environment that would be comparable to Macao and the Macao and Guangdong authorities would work closely to create an innovative customs-clearance model and remove institutional barriers so as to promote a freer and more orderly flow of relevant resources.

While at the Legislative Assembly, Ho detailed several functions and roles envisioned for the intensive co-operation zone in Hengqin. He said the government would explore the feasibility of both developing high-tech industries and seizing the opportunities arising from the Guangzhou-Shenzhen-Hong Kong-Macao innovation and technology corridor – an initiative mentioned in the outline development plan for the Guangdong-Hong Kong-Macao Greater Bay Area – to build a high-tech hub in the Hengqin intensive co-operation zone.

Ho also said that the state key laboratories set up in Macao would play a more active role in terms of leading technological development and talent development, giving full play to Macao's role as a platform for co-operation between China and Portuguese-speaking countries (PSCs). "With Macao's advantages on ship registration," he said, "Macao and Hengqin could jointly promote marine co-operation between China and Portuguese-speaking countries."

On the topic of the PSCs, Ho said that 'Macao and Guangdong would explore the possibilities for establishing in the intensive co-operation zone within Hengqin e-commerce and cross-boundary trade sectors serving China and Portuguese-speaking countries'. "Macao and Guangdong," he said, "would also look at the feasibility of building an international trade centre serving China and Portuguese-speaking countries to further their economic and trade ties." Expediting the establishment of a multicultural exchange and co-operation base with an emphasis on Chinese culture is also part of the government's future policies. "Hengqin would encourage its film and television industries, and other cultural and creative industries, to explore Macao's profound history and culture," added Ho, "particularly its Chinese and Western characteristics."

The possibility of exploring potential co-operation with Hengqin in the development of a leisure sports sector by serving as a platform for exchange and co-operation between China and Portuguese-speaking countries was also discussed. "Industries with relatively high added value and less energy consumption and pollution – such as traditional Chinese medicine, food and dietary supplements – would be a priority," said Ho. Establishing a financial

> ***"The government will reduce unnecessary spending and impose strict control measures on public administration budgets.***

What the secretaries said...

SECURITY

Secretary for Security Wong Sio Chak said that the novel coronavirus epidemic 'has resulted in many impacts' on the city's public security. He said: "The development trend of cybercrime, the significant changes in the operations of criminal organisations, the increased risk of cross-border crimes, the complexity of maritime and coastal security, and the instability brought about by gaming-related illegal activities are posing challenges to the police's law enforcement."

"Moreover," continued Wong, "the negative impact of the novel coronavirus epidemic on Macao's economy and the life of its population, as well as various kinds of social conflicts, have resulted in many impacts on the stability of Macao's public security and its safety landscape." Wong said that this year, 'Macao's general security landscape continues to face many threats and challenges', particularly 'the ensuing negative impact brought about by the novel coronavirus epidemic, the increasingly serious situation concerning the surrounding security and the risk of natural disasters that have occurred in recent years'. He said these instances 'highlight the importance and urgency of defending national security' and Macao's 'public order'. He also said they highlight the importance of 'pushing ahead with the reform' of the city's 'civil protection'. And he underlined that the Macao Special Administrative Region 'definitely' has the constitutional, legal and national responsibility for safeguarding national security, adding that the nation's sovereignty, security and development interests are 'prerequisites' for maintaining Macao's safety, stability and prosperity.

In 2015, the government entered its first phase in a four-phase police surveillance project to install 1,620 CCTV cameras across the city. Wong said last month that the installation of the fourth phase, which was initially slated for the previous quarter, had been delayed due to the COVID-19 epidemic, adding that the government now expects this phase, which includes the installation of 800 CCTV cameras, to take place in July. He also reaffirmed that the facial recognition technology to be added to the citywide CCTV camera system will facilitate the police forces' criminal investigations. He underlined that no cameras installed across the city will be equipped with facial recognition devices and the technology will only be installed in the back office equipment of the citywide CCTV camera system, which he said was fully in line with the law regulating the system.

What the secretaries said...

SOCIAL AFFAIRS AND CULTURE

Secretary for Social Affairs and Culture Elsie Ao Ieong U said that the government will study the suitability of turning the Old Courthouse in Nam Van into the city's new Central Library and converting the old Hotel Estoril and its adjacent swimming pool into a youth recreation and activities centre, as well as building several schools on the former greyhound racetrack in Fai Chi Kei. The government will study whether the three locations are suitable for the three projects after the publication of the government's urban master plan in the near future.

Ao Ieong pledged that the local government will continue to closely monitor the changes in the COVID-19 epidemic in Macao and elsewhere, and 'take necessary epidemic prevention and control measures in a timely and effective manner'. She also said that the government will increase its funding to local schools for the purchase of hygiene items and facilities, as well as strengthening its financial support to the schools that are planning large-scale or urgent renovation projects. She said that the Cultural Affairs Bureau will exempt for one year local arts and cultural groups from paying fees for using the Macao Cultural Centre. She also pointed out that the Higher Education Bureau will be merged with the Education and Youth Affairs Bureau with the aim of 'promoting the co-ordinated development' of education in the city. The government's Cultural Industry Fund will be merged with the Cultural Affairs Bureau for a 'more effective planning' of the development of the city's cultural sector. She said that the local government will help Macao residents who hold a Mainland residence permit to join the Mainland's basic medical insurance scheme.

Ao Ieong said that the local government will establish a patriotic education base in Macao with the 'unwavering' aim of promoting the city's 'loving the country and loving Macao' education, adding that the phased opening of the education base was expected to start by the end of this year. The local government's patriotic education 'is not just a slogan', she said, adding that the government wants young people to 'experience the country and Macao through their eyes and ears' to develop 'their passion for the country and Macao through their personal experience'. She also said that in addition to the raising of the national flag and the singing of the national anthem in local schools, the local government was also encouraging young people to participate in internships, exchanges and fact-finding trips in the Mainland so that they could gain a better understanding of the nation's latest developments and its current governance. She said that young local people have the ability to 'think independently'.

During the plenary session, Ao Ieong said that the local government plans to organise an international sports event every month after the COVID-19 epidemic is over. She mentioned some possible events including golf tournaments and volleyball and table tennis competitions. She also said that football matches involving teams from the Mainland, Portuguese-speaking countries and Europe could also take place in Macao.

services platform between China and Portuguese-speaking countries is also part of the main objectives of the government policies.

The Chief Executive said that 'the intensive co-operation zone within Hengqin would have facilities to promote innovative financial services and technology'. "Macao would strive to lower the threshold for Macao banks, insurance providers and other financial institutions to establish business in Hengqin in order to realise free flow of capital between Macao and Hengqin," said Ho. "The Hengqin intensive co-operation zone would be positioned as a cross-boundary renminbi [RMB] clearing centre and Macao and Guangdong would study the feasibility of a securities market denominated and cleared in renminbi in order to promote development in modern financial services."

The Chief Executive said Hengqin was a path to new opportunities regarding Macao's pursuit of further development. Ho also shared his belief that Hengqin could become an open and innovative city with high-quality municipal services and sound environmental conditions. On residential and social welfare in Hengqin, he said that 'while advancing connectivity of infrastructure between Macao and Hengqin, the government would gradually extend to Macao residents residing in Hengqin coverage regarding medical services and social security protection'. The government would also accelerate development of a residential project in Hengqin specifically for Macao people, enabling them to have access to, for instance, 'care services for the elderly, housing, education and general healthcare services'. "The residential project would create more convenient conditions for Macao people to use Hengqin as a base either for study, employment, starting a business, retirement or residence," he said.

Gaming matters

In a press conference held at the government headquarters after the policy address, Ho said that 'for the time being, we [the government] do not have any plans to reduce tax', referring to the gaming tax rate which is currently at 35 per cent. He underlined that the government would hold an international open tender for the granting of future gaming concessions in the run-up to the expiration of the city's three gaming concessions and three sub-concessions in 2022. Ho also reaffirmed that none of the current concessions and sub-concessions will be automatically renewed in 2022. While SJM, Wynn and Galaxy are concessionaires, the Venetian Macao, MGM and Melco are sub-concessionaires.

The Chief Executive also pointed out that in the future the government would reduce 'unnecessary' spending and impose 'strict' control measures on public administration budgets. But he also said that the government will increase expenditure on large-scale activities such as the Macau Grand Prix, with the hope of attracting more tourists to Macao and further promoting the local economy. He said he hoped that the current number of 38,000 public servants had reached its 'peak' but he also pointed out that each year the government would still recruit 'proportional numbers' of new public servants. He did not elaborate any further on this point but he did underline that the current overall number of public servants would not decline, adding that the government could use secondments as a measure to fill the government departments that need more staff. Ho pointed out that the government is drafting a law on the setting up of a system of secondments.

From prioritising infrastructure projects and focusing on the structural changes taking place at the government level to encouraging Macao businesses and people to make full use of neighbouring Hengqin, the Chief Executive's policy address covered much ground and highlighted how many immense changes Macao will see as we enter a new decade. Echoing Ho Iat Seng's words, the next few years are set to be Macao's 'golden years'. And this will begin with the new measures being made by the government in relation to helping society get back on its feet following the COVID-19 pandemic. Read an overview by the government on exactly what these measures entail by scanning the QR code below... •

What the secretaries said...

TRANSPORT AND PUBLIC WORKS

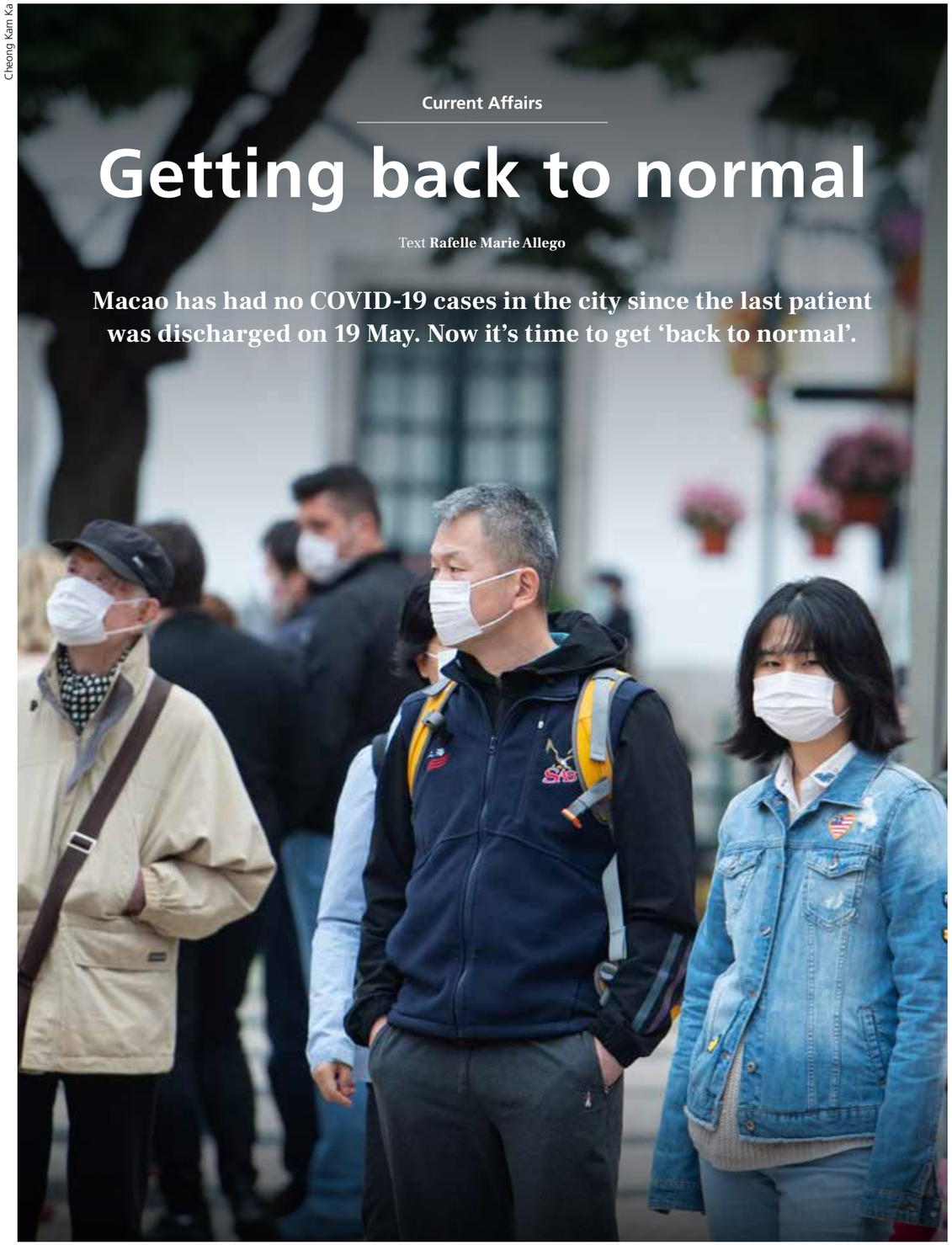
The local government aims for a Light Rail Transit (LRT) section connecting Macao's Cotai and Zhuhai's Hengqin Island to get off the ground this year. Secretary for Transport and Public Works Raimundo do Rosário said that as the LRT Cotai-Hengqin section is a cross-border project, it will be constructed by a Mainland construction company. Rosário pledged that the government will invite bids this year for the construction of the LRT Seac Pai Van section, which will connect the still under-construction Cotai hospital complex – officially known as the Cotai Healthcare Complex – and the sprawling Seac Pai Van public housing estate in Coloane.

The policy secretary said that although the Seac Pai Van section will only have two stations, it will still be a large-scale project as it will be 1.6-kilometres long.

Macao's first LRT – the Taipa section – came into service in December. The section cost between MOP 10.1 billion and MOP 10.2 billion (US$1.26–1.28 billion). The 9.3-kilometre-long Taipa section, which also covers Cotai, has 11 stations. Rosário said that the government's work in his portfolio has 'inevitably' been affected by the COVID-19 epidemic but stressed that all the entities under his portfolio have never stopped any of their tasks. "We continue to plan, adjust and implement our measures and projects as needed," he said.

Scan this QR code to learn all about the 2020 Policy Address

Cheong Kam Ka



Current Affairs

Getting back to normal

Text **Rafelle Marie Allego**

Macao has had no COVID-19 cases in the city since the last patient was discharged on 19 May. Now it's time to get 'back to normal'.

Tuesday 19 May was a landmark day for Macao. This was the day that the last COVID-19 patient in the city was discharged from hospital. It was the last day that Macao could say there were any coronavirus cases in the territory. The public breathed a sigh of relief, celebrated the good news and then looked to the future with one purpose in mind: it was time for life in the SAR to 'get back to normal'.

Around four months ago, COVID-19 entered Macao. The city reported its first case on 22 January and braced itself for a crisis. But, thanks to the strict government measures that were enacted over the following weeks, there were only 45 cases reported between the start of the outbreak in the city and that final case. On top of that, no-one up until we went to print had died from the coronavirus in the city.

The last patient to be discharged was a 15-year-old female Macao resident who had been studying in the UK. She arrived in the city on 24 March and tested positive for COVID-19 the following day. After 56 days in hospital, she began a 14-day recovery period in isolation at the Public Health Clinical Centre in Coloane on 19 May. As of 21 May, there were still 315 people – 197 of them Macao residents – under medical observation at a hotel in the city but none of these were confirmed as COVID-19 cases.

The battle lines were drawn from day one and Macao quickly prepared for a long and arduous battle as the pandemic gripped the world – but considering the city's proximity to the Mainland, where the outbreak began, Macao and its people have done remarkably well in the face of adversity. The measures enacted by the government in response to the outbreak have been far reaching – and have, on the whole, been supported by Macao's society. One day before the first case in January, for example, the Novel Coronavirus Prevention and Co-ordination Centre was created and this became – and still is – the centre of all things COVID-19, particularly as the government has broadcast a press conference at the centre daily since day one to keep residents in the loop.

> ***During COVID-19, the workload for Macao's hospitals was very heavy. We did not make any mistakes, though.***

Each of the government's 12 facemask distribution rounds at designated pharmacies over the past four months – at MOP 8 for a pack of 10, available to both residents and non-residents – has lasted for 10 days at a time. Each purchase has been registered and the price fixed, thus avoiding unfair hikes. The government's support has not wavered in providing this basic personal protective equipment (PPE), even going so far as to provide children's masks as well as the adult-sized ones. The facemask is now a requirement to enter most establishments.

Macao experienced two COVID-19 'waves' – and hopefully, it will experience no more. The first wave, brought over from Mainland China, in January and February, saw 10 cases in the city and then it appeared to be clearing, with government measures relaxed as a result. But the second wave began on 15 March, with all 35 cases coming from abroad, most of them returning students. At the height of the second wave, 12 government-designated hotels were being used for quarantine purposes.

The clinical director of Macao's Conde de São Januário Hospital, Dr Lei Wai Seng, has been heavily involved with the COVID-19 cases in the SAR since the outbreak. He says that testing for the virus was done at the 12 hotels – a 'difficult' situation for his staff as they had to check all the patient details and confirm hotel

Health Bureau

Healthcare professionals at Conde de São Januário Hospital; (left) facemasks are worn by everyone on the streets of Macao

room numbers before even setting foot in the hotels. "The workload was very heavy," he says. "We didn't make any mistakes and we had to work with high efficiency." Despite the challenges, Dr Lei is proud of his staff's dedication and pleased with the results as working fast meant earlier detection, earlier isolation and earlier treatment for anyone with the virus.

Back to school

During the past four months, the government has had to make tough decisions, like ordering civil servants home unless they belong to essential departments, closing public facilities and entertainment complexes and encouraging people to stay at home. The government even closed all of Macao's gaming venues – which collectively account for about 85 per cent of the SAR's income – for 15 days, which had not been done since the city's gambling monopoly ended in 2002. Additionally, all the city's schools were closed on 30 January and children and young adults took lessons at home from then on. That's until 1 April, when tertiary institutions – such as universities and higher education colleges – became the first to resume classes for many students. They were followed around a month later by senior high and middle school students on 4 May and junior high school students on 11 May, following thousands of tests for the virus being carried out on both teachers and pupils, who were exempt from paying for the tests.

Primary schools were expected to be the next to resume classes at the end of this month and the beginning of June. Class resumption details for special needs education and kindergartens were yet to be announced but the head of the Education and Youth Affairs Bureau's (DSEJ) Education Department, Wong Ka Ki, did say the bureau 'does not rule out the possibility that kindergarten and special needs education pupils will not go back to school during the current school year'. Another clinical director of Conde de São Januário Hospital, Dr Alvis Lo Iek Long, also said during one of the city's daily press conferences on 12 May that 'considering that small children have a weaker immunity than older ones', the Social Welfare Bureau (IAS), for the time being, had no plan to re-open day nurseries.

There has been no noticeable lack of food supplies in the city since January and over the past few weeks, the traffic across Macao has also returned to normal, with bus schedules and routes being resumed. Most small businesses and restaurants have opened up again, benefitting from government tax waivers. And the government-issued smartcards which have been given to all Macao residents have also been welcomed. These cards are intended to 'promote consumption, boost the economy and stabilise employment'. Released in two phases, the first amount of MOP 3,000 (US$375) per card was usable from 1 May to 31 July, while the second injection of MOP 5,000 (US$627) per card will be made between August and December. In the first 10 days since 1 May, a total of MOP 568 million (US$71.1 million) had been spent. The daily threshold for the cards is MOP 300 (US$37.50) and they can be used by residents in restaurants, retail outlets and department stores. Altogether, the government expects to spend MOP 5.8 billion (US$727 million) for both phases combined.

School pupils wear facemasks and take each other's temperature following the resumption of classes earlier this month

No case in point

There have been no new COVID-19 cases recorded in Macao since 8 April, thanks to both the government's measures and the swift, effective action of the health services in the city. It's been such a good result that on 12 May, it was announced that a local medical team would leave the city and go to Algeria in support of the African country's fight against the virus, where the death rate was at nine per cent of all cases. The five-person team from the China International Emergency Medical Team Macao branch, which is recognised by the World Health Organisation, joined a group from Chongqing and took supplies alongside their expertise to Algeria.

That may be international news but on a more local level, as we went to print, travelling to and from Hong Kong was still a lengthy operation. As it stood, a 'double quarantine' method was still in force at all the checkpoints between the two SARs – with the exception of those working in essential logistic services – and that means anyone going to Hong Kong must spend 14 days in quarantine on that side before spending another 14 days in quarantine in Macao on their return. However, the Guangdong, Hong Kong and Macao authorities have been in recent talks over a plan that would allow residents to move more easily between the three places.

At one point during the outbreak in Macao, a directive was given for everyone to present health declarations at border checkpoints and upon entering public premises in the city. But that was recently replaced by a simple three-colour health code that residents can show to prove what state of health they are in with regards to COVID-19. They answer some questions online and then they are given one of three colours to describe their risk – red shows high risk, yellow is medium risk and green shows little to no risk. Non-residents who get a red code can be denied entry to the SAR, while Macao residents who show red will immediately be transferred to hospital for tests.

A big thank you

Macao's Chief Executive Ho Iat Seng thanked essential workers on Labour Day – 1 May – for maintaining the everyday services required by society throughout the pandemic, adding that 'their efforts helped to ensure Macao's stability'. Ho also previously said that once it is confirmed that the pandemic has been controlled, the authorities will ask the central government to restart the Individual Visit Scheme (IVS), which was introduced in 2003 and allows Mainland Chinese people living in eligible areas of China to apply for a travel permit to visit Macao or Hong Kong individually instead of the need to be part of a tour group. "We will strengthen our local support so the gaming and tourism sectors can overcome the difficulties caused by the pandemic," said the Chief Executive last month, "[so the city can] once again receive tourists and restore the vitality and dynamism of the market."

Health Bureau director Lei Chin Ion said on 19 May, following the announcement of the city's last discharged case, that the risk of COVID-19 infection in Macao is now 'extremely low' – but the public should nevertheless remain cautious and continue with the current prevention measures as the pandemic is still 'very serious' in other countries. Secretary for Social Affairs and Culture, Ao Ieong U, also said that Macao should 'prepare for welcoming visitors again in the future' as the Macao Government Tourism Office (MGTO) has started planning for the tourism industry's revival, which will be implemented in three stages.

All in all – and despite the economic challenges it still has to face – Macao has seemingly swiftly overcome COVID-19. It isn't a time to rest on our laurels, though. As Dr Alvis Lo Iek Long said at a daily press conference on 14 May, the local government will continue its fight against the threat of the virus 'as a matter of routine'. He added that dealing with the government's anti-COVID-19 work will be a 'protracted war' – but he also encouraged residents not to be 'pessimistic' about this as a vaccine or treatment may be successfully developed in the future.

Even with challenges ahead, Macao has clearly been successful in battling the COVID-19 outbreak. Last month, the Chief Executive said that if the Macao community continues to stay united, he is confident of the city's prospects after COVID-19. And with the support measures already in place, no new reported cases and border movements slowly recovering, many residents in this resilient city would wholeheartedly agree with Ho Iat Seng's words. ●

All photos on this spread by Government Information Bureau

Dr Lei Wai Seng

Dr Alvis Lo Iek Long

Brian Aldrich

Dr Jessica Mok in London during a break between shifts at the Nightingale Hospital

Virus Q+A

Life at the front

Text **Matt Fleming**

Dr Jessica Mok moved from Macao to the UK when she was just 14 and since then she's trained to be a doctor. And when the UK needed medical professionals to join the frontline in the battle against COVID-19, she was one of the first to volunteer. She speaks to us about her selfless act and what it's like to be labelled a 'hero'.

Every single nurse and doctor in every country and city across the globe who is right now battling COVID-19 on the frontline is a hero. But it takes an extra special hero to volunteer for that frontline if you aren't already doing so. You have to dig down deep and put yourself in danger in the hope that your actions will save lives. One of these extra special heroes is a woman who grew up in Macao but now lives in the UK. Dr Jessica Mok has joined the fight on the frontline in London. Her selfless act is already helping to save lives.

Dr Mok was born and raised in Macao but she has been working as a doctor in the UK for the past 11 years. The 34-year-old, who is training to be a surgeon at London's Royal College of Surgeons of England, last month stepped up to the UK government's call for fresh volunteers to help in the country's fight against the virus. She answered the call along with 750,000 other people with medical experience and was chosen for London's newly erected Nightingale Hospital, which is a temporary facility set up to treat up to 4,000 people with COVID-19 that was built in just nine days and received its first patients on 7 April. It actually closed to new patients on 15 May after a fall in cases in the London area but it was reported that the UK's government had said it was 'on standby' as we went to print.

> *The UK and the world are really coming together to tackle COVID-19. It is a real privilege to be part of this fight.*

Following her early years in Macao, which included attending Santa Rosa de Lima English Secondary College, Dr Mok, who lives near London Bridge, moved to the UK to improve her English skills at the age of 14. She later went to medical school in Nottingham and trained to be a doctor. The medical professional, whose mother, the owner of natural skincare and beauty shop Bare Nutrition in Taipa Village, is from Macao and father, a retiring pharmaceuticals trader, is from Hong Kong, gained experience over three months working at the Chris Hani Baragwanath Hospital in Johannesburg, South Africa, which included dealing with gunshot wounds and victims of violence on a daily basis. She also worked in the Peruvian Amazon jungle as an expedition medic. But now she is on the frontline and 'sees it as a moral obligation' to 'care for the public'. She tells us more…

Why did you answer the call to join the team at the Nightingale?
When COVID-19 became a global pandemic, I was desperate to do something to help. I was in a research role and all that research suddenly stopped, so then I wasn't doing much

and was frustrated. When I heard the Nightingale was opening, I offered to help immediately. I have trained all my life to look after sick patients so when I saw how many people were getting sick with the virus, my instinct – like all doctors and nurses – was to go out and do what I could to help in the battle against the virus. Also, on a personal level, I love challenging situations. I like working under pressure and doing things that are difficult. That's one of the reasons why I'm a surgeon. There has never been a time when a hospital like the Nightingale has been needed so I saw this as an incredible opportunity to learn new skills.

What has it been like in the new centre?
When you first walk into the centre, you are struck by the enormity of the operation. The hospital is massive. Walking from one end to the other takes ages so you're on your feet all the time. In my first few days, I was worried because I'm a surgeon and caring for patients who are critically ill with breathing problems is not my specialty. I was out of my comfort zone. However, I quickly met so many incredible people who are in the same situation as me, like eye doctors and other surgeons. It's been a really humbling experience knowing so many people, like me, volunteered for this. I met a dentist at the Nightingale who has been a dentist for 20 years but is now in a nursing role. The UK and the world are really coming together to tackle the situation. It is a real privilege to be part of this fight.

How do you feel about being on the frontline?
I have been apprehensive but I am not actually worried about getting sick myself – my parents in Macao have been concerned, though. I am worried about whether I can do the job to the best of my ability. If I get sick, my colleagues will be one team member down. I know Macao Magazine is calling me a hero but I do get embarrassed when that word is used. I certainly don't feel like one. I'm just doing my job. The real heros of this pandemic are the nurses. They are inspirational, compassionate and caring. Relatives are not allowed to visit the patients in the Nightingale so we pass on messages, even though the patients are ventilated and sedated. Some of these messages are emotional and hard to deliver. The nurses tell the patients it will all be okay. They wipe their eyes, brush their teeth and moisturise their skin. If there is one good thing that comes out of this pandemic, I hope it's that nurses are appropriately recognised for their professionalism and skills in the future.

Do you see volunteering for the frontline as a moral obligation?
Yes. Doctors have an obligation to care for the sick. In a pandemic we are needed more than ever, so we don't really have a choice. We train all our lives for this and most of us are eager to help, providing we are given the appropriate personal protective equipment (PPE).

What message do you have for people who don't understand the dangers of COVID-19?
Unfortunately, we have seen people die at the Nightingale. Many hospitals have seen this. And this is all the more heartbreaking when the dying person's family can't be with them. I have never had to tell someone that their family member is dying over the phone before. I've never had to hold that dying patient's hand in lieu of a family member before. My message to people is that, yes, this virus affects older people and people with pre-existing medical conditions but we also see young people with no pre-existing conditions die at the Nightingale. Take this virus seriously. If people don't, it will affect all of our lives for much, much longer.

What would you like to say to your family and friends in Macao?
When I first told my parents I will be working at the Nightingale, they were speechless. Later, my father called me emotional and asked me not to do it. It was a really difficult conversation with him as I had no idea how scared they would be about my welfare. But now I understand. I have a partner in London, Haris, who is also a doctor. When he has to go and perform an emergency operation, I now become worried sick that he may get COVID-19. But what he tells me is what I want to tell my family and friends: I try my best to be safe. I am a doctor and I have trained all my life to do this so I can't sit idly by and do nothing. Knowing that people in Macao support me and are proud of what I do makes a huge difference to me, especially at those times when it's so hard and I'm exhausted. Messages of thanks help a lot. I feel this is the first time in history that people have openly valued the world's healthcare professionals.

Vudi Xhymshiti

The Nightingale Hospital in London has not been accepting new patients since 15 May

When do you foresee you will have the chance for a break and a brief return to Macao?
I would love to know the answer to this! Hopefully as soon as the UK lockdown eases off and I have a bit of time off. I haven't been back for more than a year. When I go back, I usually end up seeing family, friends and relatives. I always have some pasteis de nata and an espresso while walking along old Coloane. I also go on the walking trails with my friends and visit the pandas!

Courtesy of the Royal College of Surgeons of England

A computer-aided design image of what the Royal College of Surgeons of England will look like next year after current works are completed

What do you think about the way Macao's government and people have handled COVID-19?
I often use the example of Macao when my colleagues in the UK ask me about the situation in the East. I think the Macao government has done an excellent job containing the virus. The information seems to be transparent and clear. I am particularly proud of the measures and financial relief the government has given the people. I think it shows real leadership. I'm so proud to be from Macao. I think the tough border measures are necessary and have worked out well for Macao. I hope that the government will use this opportunity to review and improve the medical system and hospitals as I think Macao is in an extremely good position to provide an excellent national health service like the one in the UK.

How do you think the coming weeks and months will play out, worldwide?
It is really difficult to say. On the one hand we are encouraged in the UK, at least, because the cases seem to be stabilising thanks to the social distancing and lockdown measures. However, we are all concerned about relaxing the measures at this time. I am hopeful about the development of technologies that might help detect illness earlier, as well as the development of a vaccine which will be the key to controlling this pandemic.

What does the future hold for Dr Jessica Mok?
My career has been forever changed and I feel I am becoming a much better doctor due to this pandemic and the opportunities I have been given while working with such amazing people. I am completing my PhD qualification in obesity research, where I'm trying to understand how gut hormones contribute to obesity and how they can be targeted for both surgical and medicinal treatment, and I will return to my final three years of surgical training before fully qualifying as a surgeon. After that, who knows? I would love to be able to return to Macao and work in its health system. I will also definitely do some work with various international humanitarian medical non-governmental organisations like Médecins Sans Frontières or the Red Cross. That is my dream. But for now, we all just hope that the world can get through this pandemic and it will learn from it and it will become a better, stronger, fairer place in the future. That's also my dream. ●

SCIENCE IN MACAO

Three special features that champion the city's scientific discoveries, its new methods of science education and the city's forthcoming epic journey into space.

Macao may not be the first city you think of when science is mentioned in conversation but it's done – and is still doing – a lot of work in this field. Read on to find out why we call Macao a 'city of science'…

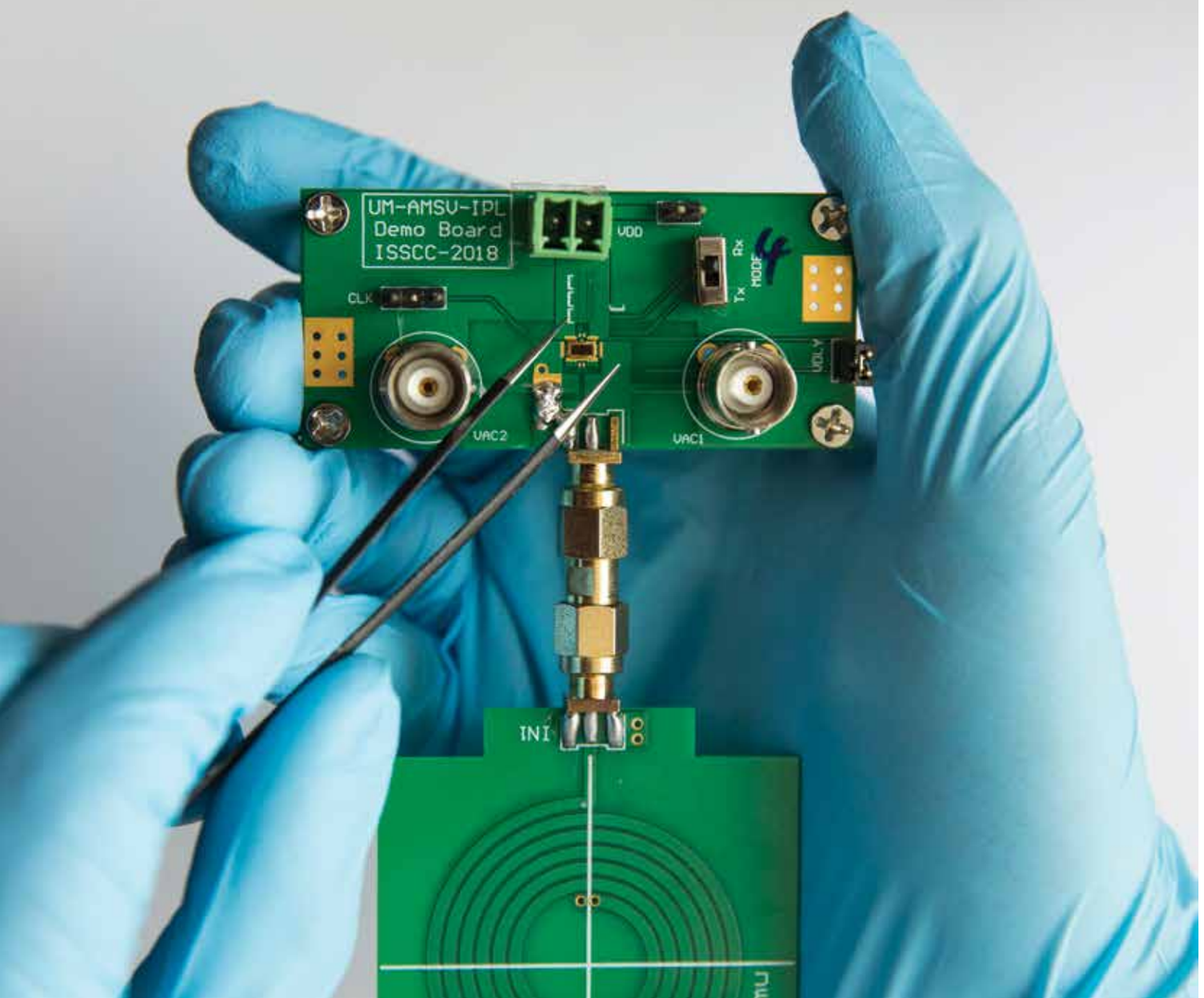
António Sanmarful

Science feature

City of discovery

Text **Lucian Hoi**

Macao's contribution to the world of scientific research is often overlooked. Here are eight major scientific discoveries that this small, ambitious city has made over the past 20 years.



Almond cookies, pork chop buns and egg tarts. Glamorous entertainment resorts. Throngs of tourists taking selfies outside an ancient church which was almost totally lost to fire. These are the images that are most likely conjured up when people think about Macao. What these people probably won't muse on, however, is the Chinese city's contributions to the world of science and research. It may have a more than 400-year-old history but Macao has a population of less than 700,000 people and a land area of just 32.9 square kilometres. So it can't have made much of a contribution to science, can it?

It can. Despite its small size and population, Macao has actually contributed much to mankind's ever-growing pool of scientific knowledge and understanding. And it's set to contribute much more in the future, thanks to the central government designating Macao as part of the 'scientific and technological innovation corridor', alongside Guangzhou, Shenzhen and Hong Kong, in the blueprint of the Guangdong-Hong Kong-Macao Greater Bay Area. But what has Macao discovered over the years and how do these discoveries help the world's scientific understanding? We have chosen eight major discoveries in the city that have been made over the past 20 years, since the 1999 transfer of administration, so you can discover Macao's recent scientific prowess for yourself.

The portable nuclear magnetic resonance platform

With the steadfast support of both the central and Macao's governments, the city has taken a giant leap forward in its scientific research work since its transfer of administration to China in 1999. As a result, there have been a number of cutting-edge discoveries that have been made in the territory which have been celebrated on a global level. And microchips feature a good few times in this list over the years. There have been many studies involving this tiny unit that's used in an integrated circuit.

> ***We have been training Chinese researchers to develop independent innovation rather than using reverse engineering to replicate imported chips.***


António Sanmarful

SKL-AMSV's Professor Elvis Pui-in Mak; (left) a microchip being designed at the University of Macau

One such discovery that uses microchips was made just this year – and it's led to an invention that's already garnered much international praise. The portable nuclear magnetic resonance (NMR) platform came about as a result of a years-long collaboration between the University of Macau (UM) and Harvard University in Massachusetts in the US. The NMR spectroscopy technique is a powerful analytical tool used to determine the presence of bacterial contaminants in complex biological samples, so this new platform is designed to improve the efficiency and effectiveness of all NMR tests. This may not sound like a major scientific discovery but it certainly is because it can also be applied in biological diagnostic tests. Conducting blood and protein tests, for instance, with the new platform will be much cheaper and faster than using any traditional NMR testing method.

Advanced integrated circuits technology, alongside semiconductor chips and portable magnets, have made this new platform possible. "The current [NMR] diagnostic tests usually require the use of large devices and a lot of time and skilled professionals," says Dr Lei Ka-Meng, the UM researcher behind the project, "but with this proposed NMR technique, we no longer need to use large devices for diagnostic tests and the cost can be brought down from between MOP 500,000 and MOP 600,000 [US$62,000 – $75,000] to between MOP 30,000 and MOP 40,000 [US$3,700 – $5,000]. This technique allows diagnostic tests to be conducted outside the centralised laboratory. Even clinics in remote regions can afford it."

The new platform has the potential to seriously change the way that important NMR tests are done on a global scale. But it's not the only discovery made by the UM over the years that could have a great

impact upon the world of scientific research. In 2017, the UM's State Key Laboratory of Analogue and Mixed-Signal VLSI (SKL-AMSV) – which was officially inaugurated in 2011 under the approval of the Ministry of Science and Technology – was behind a new fast and convenient point-of-care pathogen detection method which utilises a digital microfluidic (DMF) chip, an emerging chip technology. According to the UM, the lab, which is one of four state key laboratories in the city and more than 200 similar units across China, is ranked second in the world in terms of the number of academic papers in chip design that it has published.

"Our dimensions, in terms of human and space resources, are still of a small scale," says SKL-AMSV's associate director of research, Professor Elvis Pui-in Mak, "but the work [that is] developed [at the lab] is of extremely high quality, with world-class results, and we have the ambition to contribute further, with great determination and hard work, for the development of state-of-the-art electronics in Macao and [Mainland] China. We have been training Chinese researchers to develop independent innovation rather than using reverse engineering to replicate imported chips."

Prof Mak says that, starting from 2012, 'a wide variety of biomedical and chemistry-related circuits, systems and industrialisation-ready prototypes with high sensitivity and rich functionalities have been developed' at the lab. For instance, the prototype of a portable automation device and platform for DNA detection called Virus Hunter has been developed in accordance with the lab's patented DMF technology. Digifluidic Biotech Ltd, which was founded in nearby Hengqin in 2018, is described by the professor as 'the first spin-off company of the University of Macau'. The company is now working on the development – as fast as it can, given the current pandemic – of a test kit for the rapid detection of COVID-19 using the Virus Hunter. "The research team has been in touch with relevant medical units," says the professor, "and the system will be available to frontline medical personnel upon verification." As we went to print, the test kit was not yet ready for use.

The active power filter

Macao isn't just world class when it comes to microchips. It's also world class when it comes to energy research – and it excels in its work on active power filters. An active power filter (APF) is a device that is dedicated to improving the quality of electrical energy and the efficiency of its use. APFs can provide crucial support for the development of smart grid technologies, which are self-sufficient systems that can find solutions to problems quickly in an available system that reduce the workforce and target sustainable, safe and reliable electricity to consumers. These technologies are considered by many governments – including China and the US – to be an effective way to reduce energy consumption and to mitigate the contribution to global warming. In short, APFs are vital devices in creating the electrical energy systems of the future.

Components in an NMR platform at the University of Macau

Image courtesy of the University of Macau

The University of Macau has played a key role in APF research over the past few years. And – in the same vein as its NMR work – it has discovered a way of using APFs that can reduce costs and improve efficiency for all. Since 2005, the UM's power electronics team has been focusing its energy on the development of hybrid power filters, which are a combination of APFs and passive power filters (PPF). As opposed to APFs, PPFs do not require an external power source to run but together with APFs they can reduce the cost of power filters and operating losses.

In 2015, Prof Wong Man Chung, head of the university's Department of Electrical and Computer Engineering, revealed that the power electronics team had successfully installed the first capacitive grid-connected hybrid power quality compensator at the Macao Water Supply Company a year earlier. He added at the time that the compensator had been 'operating smoothly' with an operating efficiency reaching 98.8 per cent when fully loaded. He said that had brought 'substantial economic benefits' to the water company. The professor said the compensator is characterised by its 'medium price range and high efficiency' and it was also revealed that the design had been patented in both China and the US.

The power electronics research team has, over the past few years, participated in a number of energy conservation projects at the university. Between 2012 and 2017, the UM ranked among the top three institutions in the world in terms of publishing the most papers in the area in three respected power electronics academic journals: 'IEEE Transaction on Industrial Electronics', 'IEEE Transaction on Power Electronics' and 'IET Power Electronics'.

Image courtesy of the University of Macau

Active power filter equipment at Macao Water Supply Company

The new species of insect

Toxorhynchites macaensis, Chlorophorus macaumensis and Crematogaster macaoensis. Sounds like a tongue twister but these are actually the names of the only three species of insect – a mosquito, a beetle and an ant – that paid homage to Macao in their scientific names prior to 2017. Then a young researcher from Macao, Danny Chi-man Leong, arrived on the scene. On his own, he discovered a whole new species of ant in the city – Leptanilla macauensis.

Since 2017, Leong, who was then a Master's student but is now studying for his PhD at the University of Hong Kong as well as working as an adjunct instructor at the University of Macau, has been known locally as Macao's 'Ant Man'. He discovered Leptanilla macauensis in Ilha Verde, a small hill situated in the northern part of the Macao peninsula. It was a whole new species of ant and was also the first new insect species that had been discovered in the territory since two biting midge species, Dasyhelea gongylophoda and Dasyhelea linlingae, were found back in 2005.

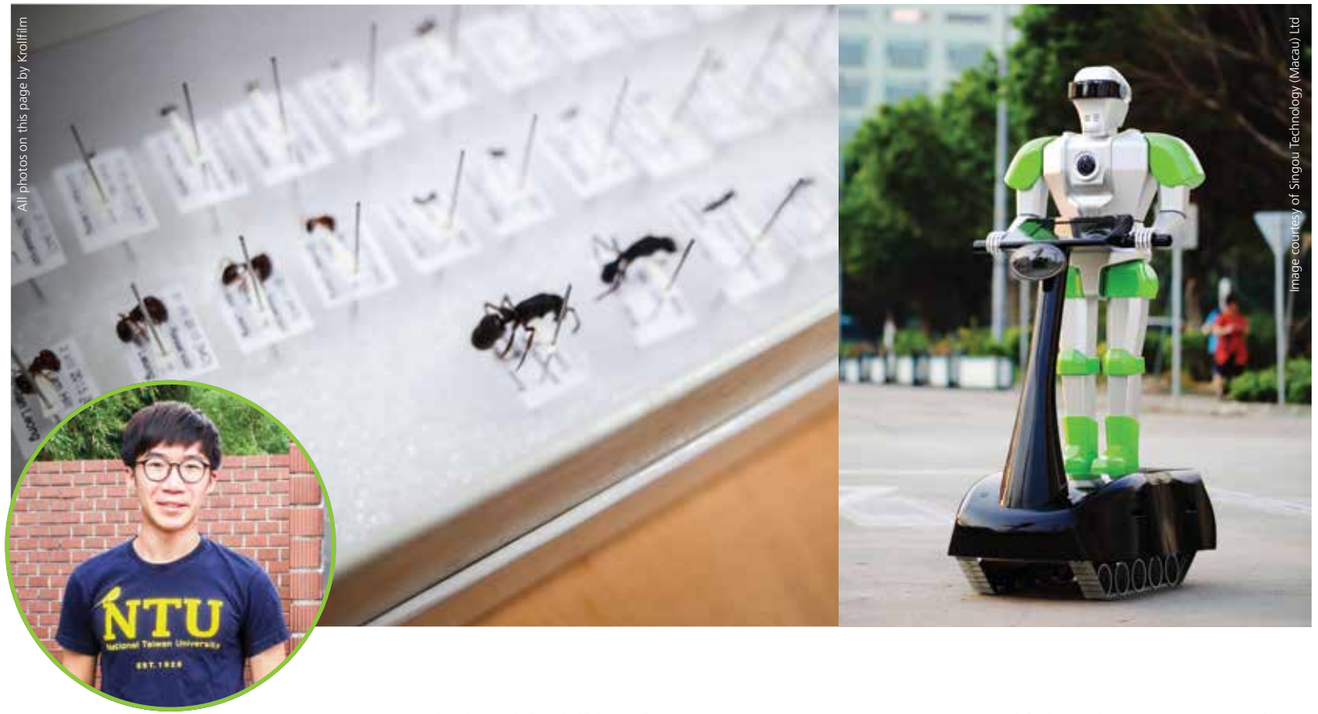
Leptanilla macauensis is tiny at under one millimetre long, with short antennae due to their subterranean nature. The naming of the species was recognised in 2018 by the International Commission on Zoological Nomenclature, a global organisation for disseminating information on the correct use of the scientific names of animals. It made history because it meant Leong had become the first person from Macao who had named a new species from his own city – and it wasn't Leong's final discovery in the city. Also in 2018, he found two new orbatid mite species on that same small hill – Meristolohmannia macaoensis and Dimiodiogalumna ilhaverdeensis.

The service robot

It's a truth almost universally accepted – robots are the future. The scientific study of robotics and artificial intelligence (AI) is seen by many as a crucial process in the development of the human race and the tools it has at its disposal. Robots can, in theory, serve almost limitless purposes for humans, from freeing up manpower and taking backbreaking work away from the poor to running mechanical operations more efficiently and effectively. Research into robotics is being done across the globe and in some robotic fields, Macao is at the forefront.

One of the companies breaking new ground is Singou Technology (Macau) Ltd, a local AI and robotics firm backed by the Macau University of Science and Technology (MUST). The team at Singou has created different types of service robots over the past few years. Its first invention was in 2017 – the 'Singou Guard 1', which incorporated the functions of facial and speech recognition with barcode scanning and video surveillance to create a robot that could be deployed for tasks like patrolling services, handling simple hotel customer enquiries and check-ins or marking attendances at meetings and exhibitions.

A year later, Singou improved its design and unveiled the 'Singou Butler 1', which came in a smaller size, boasting similar functions to its predecessor. However, this robot could be used in households and elderly care homes because it is additionally designed to perform cleaning tasks, measure blood pressures and call for the emergency services after detecting, for instance, a fall. A spokesman for Singou says: "Last year, the Singou team received commercial contracts to develop in-car social robots for several automotive companies in Mainland China. The in-car robot enhances the experience of interaction during driving."



All photos on this page by Krollfilm

Image courtesy of Singou Technology (Macau) Ltd

'Ant Man' Danny Chi-man Leong; (above left) some of Leong's collected ant species; (above right) a 'Singou Guard 1' robot out on the streets

The revolutionary cancer treatment

A scientific discovery doesn't necessarily mean an invention or the development of a piece of hardware. It can be the discovery of a new way of thinking or a new methodology. And it's a particularly revolutionary discovery if it's something that could significantly help millions of people to beat cancer in the coming years. Welcome to the work of Professor Chen Xin and Dr Joost J Oppenheim, two men dedicated to important cancer research.

Cancer is one of the leading causes of fatality worldwide, leading to about 9.6 million deaths a year or one in every six deaths globally, according to estimates by the World Health Organisation. In Macao, the proportion is even higher. Cancer is the most common cause of death in the city and accounts for about 35 per cent of its deaths. It's no wonder, then, that scientists and medical experts in the SAR are searching for a cure. University of Macau scholar Prof Chen, however, may be moving us closer to one.

In 2018, Prof Chen, a professor at both the State Key Laboratory of Quality Research in Chinese Medicine (SKL-QRCM) and UM's Institute of Chinese Medical Sciences, conducted an important study with Dr Oppenheim from the National Cancer Institute in the US. The study – which was featured in 'The Scientist', a globally influential professional magazine – focused on the role of 'tumour necrosis factor receptor type II' (TNFR2), which was long believed by the medical and scientific community to downregulate – a process of suppression – regulatory T lymphocytes (Treg cells or Tregs), meaning that TNFR2 was thought to decrease the function of Treg cells. That would be a good thing for any cancer patient, since the elimination of Treg cells is essential to cancer treatment as these cells could facilitate the growth and metastasis of a tumour.

But Prof Chen and Dr Oppenheim's study – the first time that a scientific research study made in Macao has ever appeared in the pages of 'The Scientist' – challenged the traditional viewpoint of TNFR2. Together, they discovered that TNFR2 does not downregulate Treg cells but instead activates, expands and stabilises them. Basically, the doctors' research had discovered that instead of promoting TNFR2, medical professionals should instead target it as that could help kill cancer cells. It was an important discovery that created a new theoretical framework in the treatment of cancer and has already led to the global pharmaceutical and medical community developing safer and more effective therapeutics against tumours.

"The significance of research like [ours]," says Prof Chen, "depends on whether it can have an impact upon the research and development initiatives of international pharmaceutical companies and whether it can be applied to the clinical treatment of patients. It's not easy to do so but our discovery has gotten the attention of pharmaceutical companies worldwide." Prof Chen, who joined the UM in 2014, adds that globally prominent laboratories like Harvard Medical School have already followed up on the research and he says that Swedish pharmaceutical firm Bioinvent revealed last year that it has been developing cancer treatments based on the anti-TNFR2 approach, saying it believes 'targeting TNFR2 for cancer therapy holds great promise'. "We first found out about the role of TNFR2 in 2007," says Prof Chen. "The result [we found] was completely the opposite to what academia believed at the time. There has been considerable success over the past 13 years in convincing most of the scientific community that TNFR2 should be targeted."

The new TCM polysaccharides method

Boasting thousands of years of history, traditional Chinese medicine (TCM) has gained recognition and popularity beyond Chinese soil for its medical value in recent years. The World Health Organisation last year

Courtesy of Chen Xin

Professor Chen Xin

> *It's not easy to do so but our cancer research discovery has gotten the attention of pharmaceutical companies worldwide.*

approved the inclusion of TCM for the first time in the 11th revision of the International Classification of Diseases (ICD), an influential document that lists out thousands of diseases and medical diagnoses. As TCM is one of the emerging industries that Macao aims to nurture, the city has made significant progress in discoveries in the field to advance the development and internationalisation of the TCM industry.

A research team led by Professor Li Shaoping, deputy director of the SKL-QRCM at the UM, introduced in 2017 a new qualitative and quantitative method to determine the specificity of polysaccharides – carbohydrates whose molecules consist of a number of sugar molecules bonded together that are widely used in the development of commercial dietary supplements – after a decade of study. Due to the complexity of polysaccharides, it was previously difficult to assess their health benefits but the research by Prof Li's team offers a simple way to do so. In short, polysaccharides are believed to have a number of benefits, including improving the function of the liver and adjusting the rhythm of the heart. Li's study provides a usable method to assess the quality of polysaccharides in dietary supplements, thus helping to improve the development of these supplements. As a result, the team's new methods have received multiple invention patents in Mainland China and have been applied to the quality evaluation of lingzhi mushroom dietary supplements in the US.

Prof Li and his team are not the only important TCM 'discoverers' in Macao. Another UM research team, led by Prof Lee Ming-Yuen, is also worthy of note. This team took nine years to extract a bioactive ingredient of the 'PD-001 Molecule' from Alpinia oxyphylla, a flowering plant in the ginger family that is a popular TCM ingredient. This extract from the plant could, it is hoped, significantly reduce the cellular damage in dopaminergic neurons in the brain that is believed to cause Parkinson's disease, a condition that is famous for problems like shaking and stiffness that get worse over time. The discovery was made in 2018; however, Prof Lee's work was less about discovering the extract and more about isolating it so that it can enter the food and nutrition supplement market.

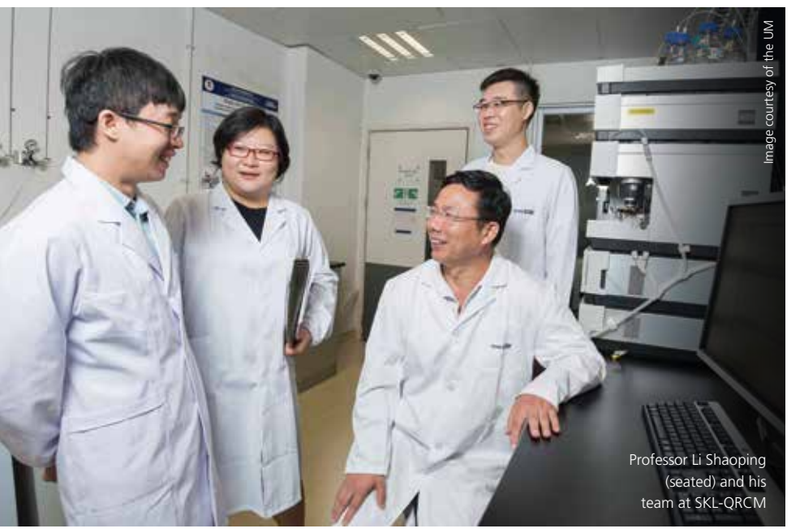


Image courtesy of the UM

Professor Li Shaoping (seated) and his team at SKL-QRCM

The Ebola virus drug

With the current COVID-19 pandemic taking all the headlines, it's easy to forgive anyone who forgets about Ebola. This severe, often fatal disease is still out there. In fact, just three days before the second largest Ebola outbreak, which started in 2018, was expected to be declared over, a new case was identified on 10 April when a 26-year-old died of the disease. Over the following days, five other people were identified as having Ebola, all in the Beni region of the Democratic Republic of the Congo.

Ebola, which has claimed more than 10,000 lives in West Africa since 2014, is a virus that is transmitted to humans from wild animals and spreads through populations thanks to human-to-human transmission. The fatality rate is around 50 per cent of all cases. It's been mostly prevalent in sub-Saharan Africa over the past few years but the threat of a pandemic is always there. However, researchers across the globe have been working overtime for years to find a vaccine or treatment. And one of these researchers is Faraz Mohammadali Shaikh, a doctoral student at the University of Macau's Faculty of Science and Technology.

In August, Shaikh discovered two Ebola virus drug candidates. He screened a TCM-derived library of almost 2.5 million compounds on a computer against the Ebola glycoprotein and from that he identified eight candidates with potential inhibitory effects on Ebola's infectious activities. Following that, two of the compounds were validated by collaborators from Oxford University in the UK – where Shaikh previously did a six-month internship – showing strong activity against viral entry. The discovery was then published in the 'Journal of Medicinal Chemistry'.

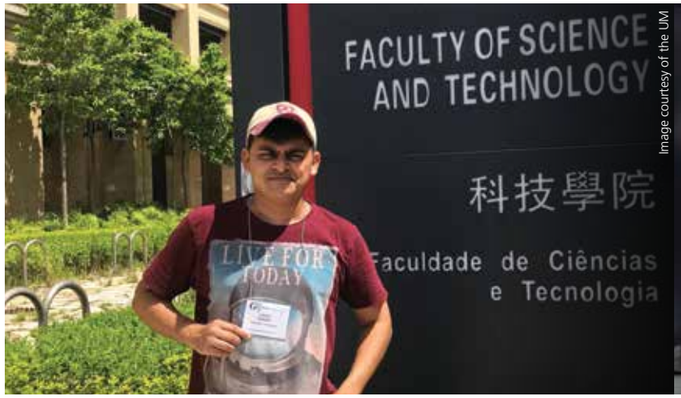
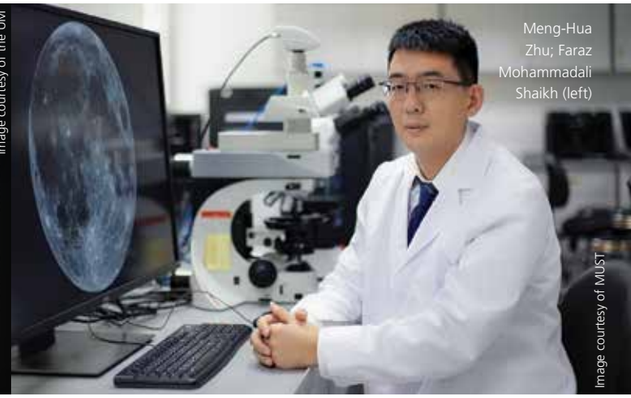


Image courtesy of the UM



Meng-Hua Zhu; Faraz Mohammadali Shaikh (left)

Image courtesy of MUST

For his work, Shaikh was awarded the Carl Storm International Diversity Fellowship, which sponsored him to attend the 2019 Computer-Aided Drug Design Gordon Research Seminar and Conference, in the US to present his findings. He was the only PhD student from an Asian university invited to speak at the seminar. There is currently no licensed treatment or vaccine for Ebola, so it is hoped that Shaikh's discovery may pave the way for more research in the global mission to find one.

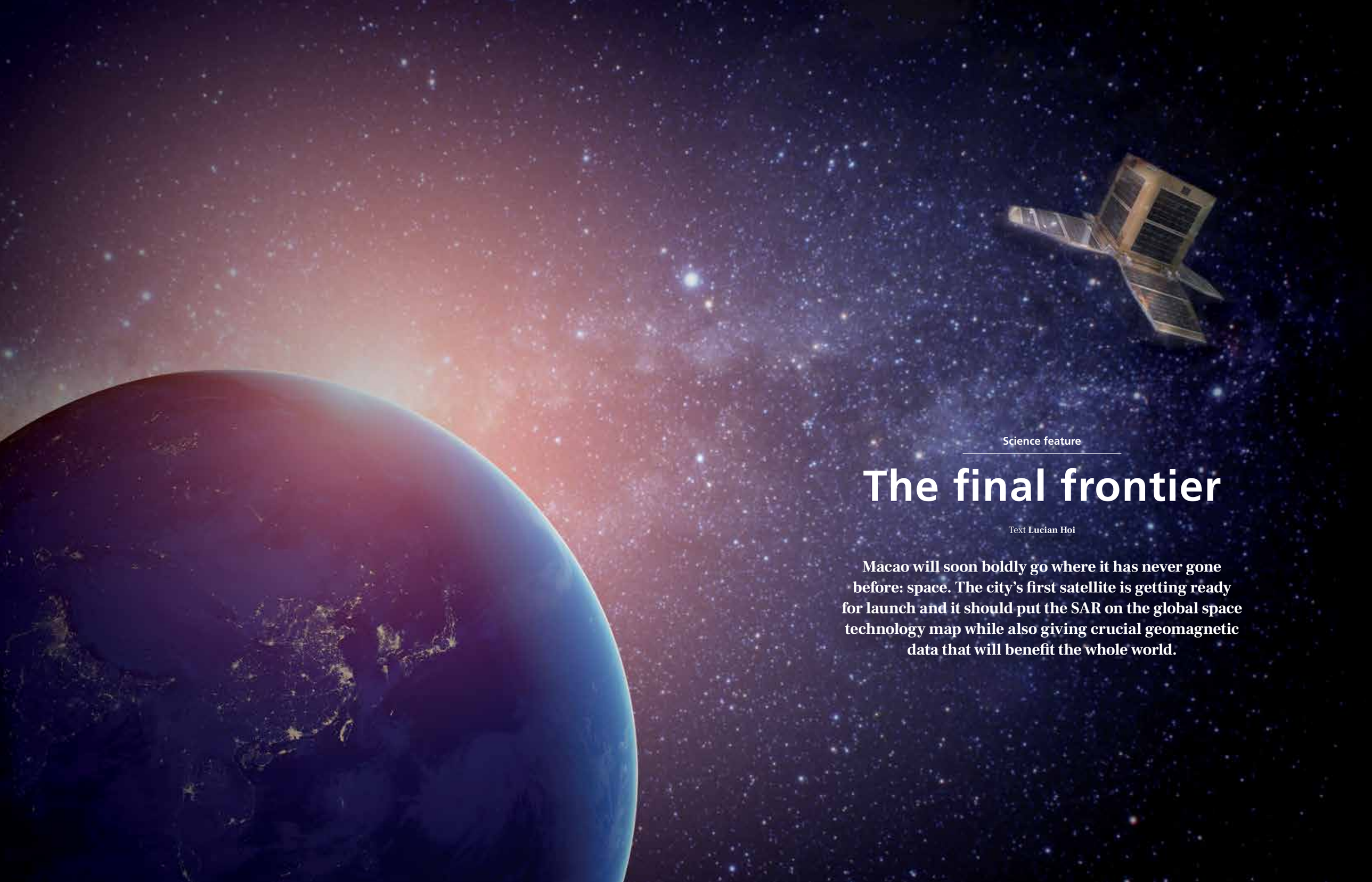
The revolutionary Moon theory

Macao may not seem like a hotbed of scientific activity when it comes to studies of the Moon. But it is – or at least it was last year when a group of scientists from MUST discovered something quite revolutionary about the evolution of Earth's only natural satellite. In a paper published last May in the 'Journal of Geophysical Research – Planets', the team, led by Meng-Hua Zhu, suggested that our Moon, following its birth in a huge collision between the early Earth and a Mars-sized object, was hit by a second massive planetoid shortly after its formation. This would explain, claimed the team, why the Moon's near side and far side are so different in terms of topology, composition and the thickness of their crusts.

The discovery made international headlines last summer, not least because the paper was published only a few months after China's Chang'e 4 spacecraft became the first to land on the far side of the Moon. Of course, we never see the far side from the Earth because the Moon is tidally locked to our planet but thanks to NASA's GRAIL mission to map lunar gravity, we now know the crust on the far side is up to 20 kilometres thicker than the crust on the near side. And the work by Zhu, an assistant professor at the State Key Laboratory in Lunar and Planetary Sciences at MUST, and his team has helped to explain the thicker crust on the far side, as well as helping scientists understand why the composition of the Moon is similar to Earth in some ways and in some ways not.

The team argued in the paper that the stark differences between the near and far sides could be the result of a 'giant impactor' slamming into the Moon and leaving a massive crater across the entire nearside. The researchers modelled 360 different collisions before suggesting that an object the size of the large asteroid Ceres, which is between 800 and 900 kilometres across, could have made the collision. The impact, claimed the scientists, could have left a crater stretching 5,600 kilometres across the moon's surface, which would essentially cover the entire near side.

The effects of this discovery could be far-reaching and could displace other theories, including the idea that the Earth originally had two smaller moons which collided to form the Moon we see today. Describing Prof Zhu's discovery – which was made in collaboration with colleagues in the US, France and Germany – as making 'major breakthroughs in the field of lunar evolution history', a spokesman from MUST following the release of the paper said this discovery could help provide more theoretical and scientific support for future missions to the Moon. For a small city in a small area, Macao is frequently astronomically effective when it comes to scientific research and discoveries. ●



Science feature

The final frontier

Text **Lucian Hoi**

Macao will soon boldly go where it has never gone before: space. The city's first satellite is getting ready for launch and it should put the SAR on the global space technology map while also giving crucial geomagnetic data that will benefit the whole world.

António Sanmarful

A half-sized model of Macao Science 1, which is on show to the public at the MUST campus

Before 1957, the night sky had barely been touched by humankind. But on 4 October that year, the Soviet Union successfully launched the world's first artificial satellite into space and history was forever changed. Sputnik 1 was about the size of a beach ball and took around 98 minutes to orbit the Earth on its elliptical path. It carried no scientific instruments, however it did send radio signals back to the ground for a short period, meaning there was nevertheless much to learn from the first man-made object to orbit the planet.

Since that iconic day, thousands of artificial satellites have been launched into space and it is believed that there are now more than 2,000 of them orbiting the Earth that are fully operational. And, like Sputnik, they all perform one or many functions that help us down on the ground to learn about the planet, the solar system and the universe as a whole. Some experts predict many thousands more will be launched over the coming years as private companies send satellites up into the sky like technology entrepreneur and SpaceX boss Elon Musk did in March as he sent a sixth load of 60 Starlink satellites into orbit. However, not only has the number of satellites in orbit surged over the past few decades but also the number of countries and regions behind this space odyssey. And this elite list of backers will soon welcome a new name: Macao.

With support from the local and central governments, the State Key Laboratory of Lunar and Planetary Science (SKLplanets) at the Macau University of Science and Technology (MUST) has been developing the city's first satellite – named Macao Science 1 – since 2018. The world's first and only scientific exploration satellite to be placed in a near-equatorial orbit to monitor the geomagnetic field and space environment of the near-equator South Atlantic Anomaly (SAA), the project marks a milestone for the local development of aerospace technology.

Despite the ongoing COVID-19 pandemic, Professor Zhang Keke, who is the chair professor and director of SKLplanets, finds time to speak to us about the project on MUST's campus, which is almost deserted as we meet during lockdown. And although he wears a facemask throughout our interview – only taking it off for a photo shoot – it's clear he is hugely excited about Macao Science 1. "There has possibly never been a scientific research project in Macao that will have such an enormous impact nationally and globally," he tells us.

> ***"There has possibly never been a scientific research project in Macao that will have such an enormous impact nationally and globally.***

Prof Zhang has more than three decades' worth of experience in planetary physics and astronomy, so his words carry great weight. He has worked at a range of universities and research institutions during his life and he has also headed up multiple research projects in the US, UK and China over his acclaimed career, including a stint as director of the Centre for Geophysical and Astrophysical Fluid Dynamics College at the UK's University of Exeter. The professor, who received a Royal Astronomical Society Group Achievement Award for his work in magnetohydrodynamics as part of a team in 2013, was appointed director of SKLplanets in July 2018. He is now the chief scientist on the satellite initiative. "This project," he says, "is of paramount importance: Macao needs it and so does Mainland China and the rest of the world."

Protective umbrella

To get a clear grasp of the significance of Macao Science 1, the geomagnetic field – the magnetic field of the Earth – first needs to be understood. In the words of Prof Zhang, this field serves as 'an umbrella' to protect us and all life on the Earth from solar wind, a continuous stream of charged particles released from the Sun. "The geomagnetic field is key to the survival of mankind," says the renowned astrophysicist. "You can't see it but it is everywhere. It is also crucial in our daily life nowadays when it comes to national defence, mining, space weather forecasting, navigation and so on."

Although our ancestors acknowledged the existence of the Earth's magnetic field more than 1,000 years ago, satellites were only first deployed for monitoring and studying it about two decades ago. "Satellites could cover every corner of the Earth," says Prof Zhang, "giving us more detailed information about the geomagnetic field from its structure and its origin to its changes [over time]." The latest example of sending up satellites to do just that was the Swarm mission – which was made up of a constellation of three satellites – that was launched by the European Space Agency in 2013. The satellites are still up in space studying the planet's magnetic field. Macao Science 1, as Prof Zhang puts it, could 'fill the blanks' in the global study as it specifically focuses on the southern parts of the Atlantic Ocean, between South America and the southern tip of Africa, that make up the SAA.

Photos courtesy of MUST

Liu Liang, president of MUST, speaks at the opening ceremony of a MUST aerospace exhibition at the turn of the year; (left) Zhang Kejian, CNSA director, speaks at the same event

The Earth's magnetic field doesn't just give us our north and south poles – it also protects us from solar winds and cosmic radiation. But scientists have found it is rapidly weakening and some believe it could soon flip, thus reversing the magnetic poles. This has happened before, with evidence it last happened almost 800,000 years ago. The region that gives scientists most concern is the SAA, which boasts a field so weak that it's dangerous for satellites to enter it as the additional radiation it lets through could disrupt their electronics. Prof Zhang describes it as 'a hole in the umbrella' – hence the SKLplanets team's great interest in this region. According to a spokesman for SKLplanets, Macao Science 1 could provide the team on the ground with highly accurate high-resolution and long-time vector magnetic data on the SAA, as well as information about the high-energy particles in the region. This data can then be applied to all sorts of diverse areas of scientific interest.

> ***The China National Space Administration attaches great importance to Macao's development in the field of space science and technology.***

Macao Science 1 is made up of two major parts, each containing hi-tech equipment. Part A is the main section which consists of a 3.7-metre non-magnetic boom and an optical platform that sports graphics in the shape of a lotus to symbolise Macao. The total length of the satellite is more than eight metres and it weighs about 500 kilograms. It's made up of an array of components, materials and parts like, says the team behind it, 'the making of a vehicle'.

Multinational ties

Macao is a city with a land area of just over 30 square kilometres. It is known for its world-class services industry, its tourism and its unique culture. It is not known for its interest in space – but this project could change all that. And the city has had plenty of helping hands while it prepares to embark on its cosmic journey. The development of the satellite relies on the backing of – and collaboration with – Mainland China, which has ascended to become one of the world's major aerospace powers. Executed by SKLplanets, the Macao project is co-organised by the China National Space Administration (CNSA), the Macao government and the Liaison Office of the Central People's Government in Macao – and it has also received the support of the Macao Foundation and China Space Foundation. The CNSA and Macao's government consolidated their partnership by inking an agreement in December which will expedite the project.

In a ceremony marking the signing of the partnership agreement in December, Zhang Kejian, director of the CNSA, noted in his remarks that the satellite project 'opened a new chapter' of co-operation between Macao and the Mainland when it comes to astronomical technology. "The China National Space Administration," he said, "attaches great importance to Macao's development in the field of space science and technology, and encourages the science and technology community in Hong Kong and Macao to participate in national space projects."

Besides the Macao Science 1 project and the 2018 establishment of SKLplanets – the first and only State Key Laboratory in the nation in the field of astronomy and planetary sciences under the approval and governing of the Ministry of Science and Technology – MUST has a relatively long history of engaging in national space projects. For instance, its scholars and researchers have been part of the Chinese Lunar Exploration Programme, an ongoing series of robotic Moon missions initiated by the CNSA, since 2005. Liu Liang, president of MUST, noted in the December ceremony that Macao could play to its strengths and become 'a global gateway' for the Chinese astronomy and aerospace sector and 'a bridge' for exchanges between the Mainland and the international community.

Sharing a similar perspective, Prof Zhang says the satellite project has attracted the participation of renowned institutions and experts from across the world. "Without the 'One Country, Two Systems' [principle in Macao], there would not be Macao Science 1," he says, adding that during the development of the project SKLplanets has joined forces with, for instance, Harvard University in the US, the Danish National Space Centre, the

Professor Zhang Keke, director of SKLplanets

António Sanmarful

Children marvel at an exhibit at the aerospace event at MUST

Photo courtesy of MUST

Xu Yi, assistant professor at SKLplanets

António Sanmarful

University of Leeds and the University of Exeter in the UK and the Swiss Federal Institute of Technology in Zurich, Switzerland (ETH Zurich), as well as other international institutions.

Star trek

The development of satellites and space technology in Macao is beneficial, in general, to the city's goal of diversifying its economy away from such heavy reliance on its glittering integrated gaming resorts. "Both the local administration and the central government have worked on steering Macao towards economic diversification," says Prof Zhang, "but given its limited geographical size, the city could not just be another Shenzhen, with factories to manufacture goods. High technology is the way for the city to move forward and developing the area of astronomy does not require the need to have a lot of space, people and money."

There are now nearly 100 scholars, researchers and postgraduate students in the SKLplanets team. The MUST team itself, which is made up of around 10 people, is headed by Prof Zhang and, along with leading figures from external institutions, it is in charge of the satellite project. Gathering experts from around the world, the team has great ambitions – launching Macao Science 1 is only the start of what the team envisages to turn the city into a global centre when it comes to geomagnetic field studies. "After the launch of the first satellite," says Prof Zhang, "we plan to send three to four satellites in total to form a constellation which will monitor the geomagnetic field from different orbits, generating a huge amount of astronomical data." To receive and process such data, the team plans to build a ground station and an astronomical data centre in the university. "Macao could dominate this area globally," says Prof Zhang, "and we hope, in the future, any parties requiring relevant data will come to us."

Xu Yi, assistant professor at SKLplanets, is part of the satellite team. Her recent work focuses on the application aspects of satellites as the team wants the project to participate in an entrepreneurship contest in nearby Hengqin for more funding. "We will receive a lot of data from the satellites," she explains, "which could be processed and handled by AI [artificial intelligence] to develop different types of data products for the purposes of navigation and other [applications]."

Launch date

When it comes to Macao Science 1, one big question remains: when will it take to the skies? The launch date, however, is yet to be finalised. In 2018, the proposal was made and the naming process was undertaken last year, with more than 1,100 people from the city submitting more than 1,500 possible names for the satellite over the period of a month. Finally, the name Macao Science 1 was chosen. The city's first satellite was originally slated for launching from the Mainland some time next year. However, the ongoing COVID-19 pandemic has already hit the global economy hard so delays to the project might be expected.

"Concerning the progress of the satellite, we are now in the stage of design and signing relevant contracts," says Prof Zhang. "I was 100 per cent sure it would be launched by the end of next year but that's difficult to say now with the COVID-19 outbreak." However, the works for the satellite, data centre, ground station and upgrade of the SKLplanets facilities will continue on regardless, according to the professor. "There have been different types of challenges for the project due to its complexity," he says, "and this has required technical and administrative co-operation between all the involved parties. But, so far, I've not encountered any challenges that we can't overcome. This project is highly regarded by the management of MUST, as well as fully supported by the SAR's government."

It's safe to say that Prof Zhang is extremely upbeat about the prospect of developing satellites in Macao. "I hope," he concludes, "when you come again to interview me in four or five years' time, your phone will be using the data from our satellites." With the unswerving support of the local and central governments, as well as the total commitment from experts in the field locally, nationally and globally, not to mention SKLplanets itself, Prof Zhang's vision may soon become a reality. But he does bring us back down to Earth at the end of our interview, saying simply: "There is still a long way to go." ●

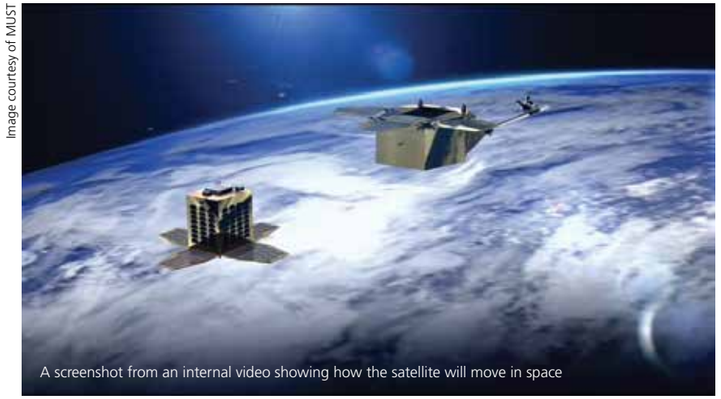


Image courtesy of MUST

A screenshot from an internal video showing how the satellite will move in space

OTHERWORLDLY EXPERIENCES

SKLplanets doesn't just focus its energy on the Earth

SKLplanets at MUST has only been going for less than two years. But over this time, it has nevertheless been involved in much more than just the satellite project. "Our laboratory is still growing," says Prof Zhang, "and we hope it will become a more efficient research institution." According to the SKLplanets director, the laboratory has already been involved in the research and development of the nation's first robotic mission to Mars, which is expected to send an orbiter, lander and rover to the Red Planet later this year. "The data collected and compiled during this mission will also be sent to our laboratory for analysis," he says, "so that we can understand more about the structure, atmospheric conditions and other [aspects] of Mars."

Mars is not the only planet in the solar system the CNSA has its eyes on. The administration also plans to launch a Jupiter explorer in the future – and that's a mission that will see SKLplanets assisting in the research and development process, according to Prof Zhang. Since 2005, MUST has been involved in the Chinese Lunar Exploration Programme, which is an ongoing series of robotic Moon missions. Prof Zhang notes that his team will further help in the programme by studying some of the soil samples that are collected by Chang'e 5, a robotic lunar exploration which is scheduled for launch later this year. "We will carry out analysis on the soil samples from the Moon with our advanced equipment," he says, "to shed more light on the Moon from its origin to its evolution."

SKLplanets boasts five labs and centres in the areas of astrophysics and astrochemistry, small body physics, planetary environment simulation, high performance computing and science communications. Prof Zhang notes that his team is also working on setting up a new astrobiology lab which will see more studies done on one of the planet's greatest unsolved mysteries: the origin of life.

António Sanmarful

Science

Changing with the times

Text **Rafelle Marie Allego**

The COVID-19 pandemic has rapidly changed the way people – in particular, children and young adults – have been learning. The Macao Science Center has quickly adapted by moving its educational materials online, making science accessible to all, even if you're stuck at home.

Members of Macao Science Center's team filming one of their videos for their online platform

Just over a decade ago, one of Macao's most important buildings that's connected to the world of science opened its doors to the public. In December 2009, the Macao Science Center began life and it's been fascinating both locals and tourists ever since. Conceived in 2001 by then Chief Executive Edmund Ho Hau Wah, the centre, with its distinctive conical shape perched at the water's edge off Avenida Dr Sun Yat Sen, was designed on invitation by Pei Partnership Architects and Chinese-American architect IM Pei in 2002 before building works began four years after that. It now boasts a planetarium with 3D projection facilities, as well as an array of galleries, interactive exhibits and a large atrium, all geared toward science education.

People from all over the world have walked through the centre's doors over the past 10 years. But all that stopped in January once the COVID-19 pandemic swept through Macao. On 25 January, the centre was closed along with all the other museums across the city as Macao entered a period of lockdown. And between 30 January and 1 April, children and young people were confined to homeschooling. Since 1 April, up until we went to print, primary, special needs education and kindergarten pupils had still not gone back to school. But when it comes to the education of these young people, the centre has come up with a new way to pass on its wealth of scientific knowledge.

A lot has 'gone digital' in Macao over the past few months, such as school lessons, where children and teenagers can virtually learn from home without the need to be in the classroom. The Macao Science Center often teaches school groups at its base throughout the year but now it too has 'gone digital'. To encourage continued learning despite the schools being closed, the centre has introduced a new programme called the 'Macao Science Center Online Education Resource Platform'. This programme, which began on 15 April, sees the centre being as progressive as the science world itself by moving its operations online.

One of the centre's staff doing an experiment outdoors

Macao Science Center

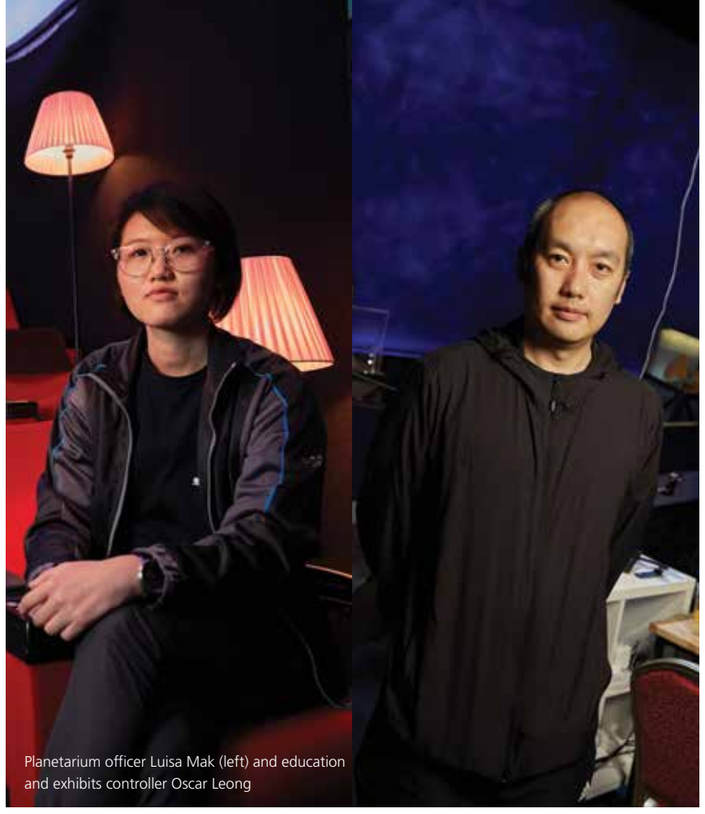
> *The 'Macao Science Center Online Education Resource Platform' is exciting, new and we get to learn by doing.*

There is still a great need for digital homeschooling in Macao so the centre's online multimedia science learning platform has been seen as a godsend for many parents and youngsters across the city. The head of the centre's publicity department, Bonnie Fung, says that the team at the centre set out 'to boost students' interest in science and help them learn through enjoyable and visually entertaining videos' – although it's all just done in Cantonese at the moment.

Going digital

In general, topics that can be heavy or complicated for children to consume can be made easier if they are presented in a more visually appealing manner. For instance, using puppets or animated characters to explain difficult concepts can help younger children to understand and learn. This is one method the centre's team has adopted in the 'Macao Science Center Online Education Resource Platform' – puppets and cartoon characters are used in a series of online lessons for primary and secondary pupils.

All of the lessons on the platform have been produced in-house by the centre's team – some of them creating this type of content for the first time. Education and exhibits controller Oscar Leong, for instance, initiated one of the many segments on the platform called the 'Science News of



António Sanmarful

Planetarium officer Luisa Mak (left) and education and exhibits controller Oscar Leong

the Week' as soon as the content was beginning to be created. By simply explaining the COVID-19 pandemic and how it spreads, as well as going through simple prevention methods like washing your hands, Leong was able to create a video all on his own, learning from scratch how to record, video edit and add a voiceover.

Now holding a key role in this new programme, Leong also plans and schedules the video lessons with his team of 30 people through an inter-departmental effort. "It's exciting, new and we get to learn by doing," he shares, adding that the team is trying different methods to attract the public's attention by including slightly unconventional approaches to learning. One video includes footage of science-related toys being unboxed, with the most recent video as we went to print showing a drone being unwrapped. There are also online storytelling sessions.

The centre's planetarium is also involved in the platform. Planetarium officer Luisa Mak says that at set times young people have been able to tune in and hear astronomers speaking live on an array of subjects. The children can then ask questions via the comments section and have the interplanetary experts answer them in real time. Most recently, young people enjoyed a session with Kenneith Hui, an astronomy officer at Hong Kong's Ho Koon Nature Education cum Astronomical Centre (HKNEAC). "We're like reporters ourselves," says Mak, explaining that the planetarium staff act as facilitators between their young viewers and the guest speakers.

The team at the centre has also ventured into using Lego creations to explain topics, such as using pieces alongside electricity to create simple motors so the team can demonstrate how they function. In a recent video, the team spent a week building different Lego motor models but eventually they managed to make one which worked. "If you have a box of Lego," says Leong, "you don't need to be limited to the guide that the pieces come with. You can think outside the box and make something completely different from those pieces instead." Leong and his team hope to 'spark creative thinking' in their young viewers with these Lego videos.

Connecting with children

The centre is devoted to furthering local science education, highlighted by its collaborations with the government's Education and Youth Affairs Bureau (DSEJ) on various science-related teaching materials for teachers, students and parents. In relation to the content the team has made so far this year, Leong shares that both Macao's Pui Ching Middle School and Chan Sui Ki Perpetual Help College have already reached out to the team and asked it to conduct science classes via online video conferencing platform Zoom. So far, claims Leong, the team has conducted 20 separate classes with about 30 students on each call. He says these sessions can be quite hard to manage with so many students on one call but admits that he and the young people have got a lot out of them.

There may be far more mileage to the 'Macao Science Center Online Education Resource Platform' yet. For example, the centre has just started to create an online library geared towards both children and adults – and this is expected to be filled with science e-books so that people can read them online. As we went to print, it was not yet ready for the public but it is expected to be opened in phases over the coming days. Due to licence ownership, only six copies of each book on the platform will be available online to 'borrow' as part of the centre's drive to create a web-based multimedia science learning experience.

It is also hoped that the platform will allow anyone who conducts and films scientific experiments at home or in a safe environment to share their videos and inspire others to learn and do the same. The team welcomes any submitted videos from the public and it will endeavour to include as many as it can on its online platforms. The videos on the platform so far have only been made by the centre's team in Cantonese, however there are hopes that versions will be made in Mandarin, English and Portuguese soon. As Leong shares, however, translating and subtitling a video and keeping it the same length as the original is a tough, complicated task. But as with this new platform as a whole, it is a work-in-progress. Leong also notes that creating Mandarin content on the platform would help the centre's reach on the Mainland, thus accessing a wider audience.

Over the past few months, following the launch of the platform, the centre's team has seen an audience growth of around 50 per cent on both its YouTube channel and Facebook page. And soon, the team intends to develop its Instagram and WeChat presence as well, once it has created enough content. Granted, when life finally gets 'back to normal', the team might not have as much time to create as many videos as they have so far been able to do since January. However, Leong believes that the materials the team has been able to make during this time will supplement the lessons they can give in schools when they 'guest lecture' in the future. "It's still a win-win," he concludes. ●

Macao Science Center

Centre staff dress up for one of their online video presentations

LEARN ONLINE WITH MACAO SCIENCE CENTER

The centre's educational videos are available on its YouTube channel and its daily lesson schedule can be also found on its website. Visit youtube.com/user/mscmacao or msc.org.mo/education. Here are QR codes you can also use to access the videos...

Scan QR code for Macao Science Center website

Scan QR code for YouTube channel

Tania de Sales Marques inside a library at the Royal Observatory in Greenwich

Brian Aldrich

Macao **ABROAD**

Written in the stars

Text **Matt Fleming**

Since she was a young child, Tania de Sales Marques has always been fascinated with space – and now the scientist from Macao has carved out a cosmic career at one of the most famous places for astronomy in the world.

We all wonder about the delicious mysteries of the night sky. However, a small number of people across the world don't just wonder. They dedicate their entire lives to the pursuit of knowledge about the planets, the stars, the black holes and all the space in between. Tania de Sales Marques, who was raised in Macao, is one of these intrepid astronomers – and she is representing the city at one of the most famous places that's connected with the night sky in the world: the Royal Observatory in Greenwich, London.

Sales Marques first began dreaming about the mysteries of space when she was just five years old in Macao. In her school years, she trained hard to get the qualifications needed to be an astronomer and, save a few gaps to explore other careers, in her adult life she has consistently pursued her cosmic passion. "I love astronomy," says the 37-year-old, who is married and has a two-year-old son. "The night sky is a beautiful, mysterious place and I always want to learn more about what's out there. I'm lucky to work at the Royal Observatory – but I also never forget my roots in Macao, the city where I first found my passion for the stars."

Despite not technically hailing from Macao – she was born in Portugal but moved to the Chinese city when she was only eight months old – Sales Marques considers herself a Macao girl with a local family history that spans many centuries. She grew up in the territory and was educated in her early years at both English and Portuguese-speaking schools.

> ***I was inspired to become an astronomer by the night skies over Macao – night skies that, as a child, I would dream about.***

Later, she moved to the USA to study astronomy and maths at the University of Massachusetts Amherst, where she graduated with a degree in 2004. She moved to the UK for 12 months and then lived in Portugal for a couple of years before heading back to Macao in 2007, where she landed a job at the planetarium within the then new Macao Science Center, which was being built along the waterfront. Sales Marques says the centre's team were looking for someone from Macao with an astronomy degree who could speak Portuguese, Chinese and English – and she says she was 'probably one of the only people in Macao with such credentials'.

For a couple of years, Sales Marques worked as a planetarium officer, however the facility was not yet finished – the whole Science Center project was completed in 2009 – so her main tasks involved preparing the shows in advance of the planetarium's opening. She did learn plenty of skills in the process, though – skills she would later need when working at the Royal Observatory. In early 2009, she left the Science Center after deciding she wanted 'a more formal education', so she studied a master's degree in education at Macao's University of St Joseph (USJ). She says: "I wanted to acquire a formal degree in education but I also taught at USJ for five years. During my time there, I taught maths and physics and did some research into gender and science, technology, engineering and mathematics (STEM) studies."

In 2007, Sales Marques met her future husband, a musician and music journalist who also represented Macao artists on a global scale, and the couple were married in 2014 in Iceland, however Sales Marques decided not to change her maiden name. Together, the couple fancied a new challenge so they moved to the UK, where Sales Marques undertook a postgraduate degree in astrophysics while also volunteering at museums. Soon, she saw an opportunity at the famous Royal Observatory at Greenwich, London.

"I always wanted to work at the Royal Observatory," she says, "because it's an iconic place for science communication and it has such a long history too." The observatory was founded in 1675 and gives its name to the prime meridian: Greenwich Mean Time. "It has always been one of my favourite places in the world to visit," she continues, "and one day in 2016, I found that there was a job going as an astronomy presenter at the Royal Observatory's Peter Harrison Planetarium. I was so pleased when I got it."

Sales Marques, who lives near the observatory, fell in love with the job and, in September 2018, she was promoted to the role of planetarium astronomer, working at the only planetarium in the capital city. The 132-seat facility, which opened in 2007 and is part of the National Maritime Museum, uses the latest digital laser technology to create incredibly detailed representations of the night sky for public and private shows. Sales Marques and her team present shows almost every day, including weekends. There are workshops for students, general shows for the public and all sorts of private sessions where young and old alike can learn about the night sky.

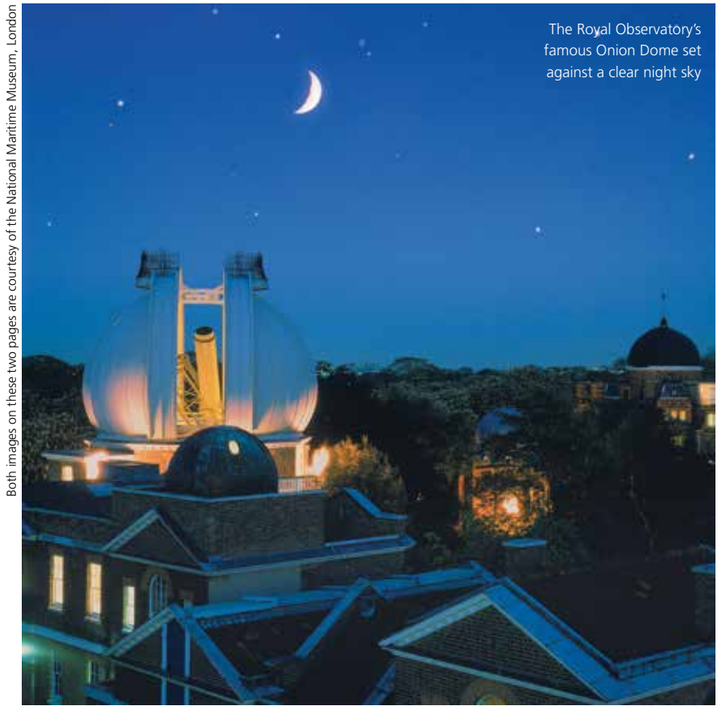
"My team's role," says Sales Marques, "is to help maintain the planetarium and to create the content. We also – along with other teams – deliver the shows and workshops to schools and to the public and we collaborate with other teams on a range of competitions, such as the Insight Investment Astronomy Photographer of the Year competition. Among many other things, we also answer questions to the media – such as 'when is the next full moon?' It's a busy job but I love doing it."

"I work in an iconic place," continues Sales Marques, "so we get a constant stream of visitors – locals and tourists alike. We aim to give them the best experience possible using the most up to date scientific information. All of us are really passionate about astronomy. Our shows are always dynamic. I love talking to visitors about difficult scientific concepts – in fact, that's one of our main aims as science communicators: to use the planetarium and our presentations to make difficult concepts easier for everyone to understand." Sales Marques cites the different phases of the moon as an example, saying that children can find the concept difficult until they see a simulation of the moon orbiting the Earth from space while a separate video displays the changing phases of the moon from our perspective on Earth.

It's been a long journey for Sales Marques, one that started all those years ago in Macao. "When I was five years old," she says, "I knew I wanted to be an astronomer. In the 1980s, Coloane was really dark – not like today. You could see the stars so clearly. On Sundays, my family would drive there and I became fascinated with the stars and I would dream about what mysteries lay out there in space. Ever since then, I wanted to be an astronomer and when I was maybe 14 or 15, I decided I would pursue a career in astronomy. It's why I switched from a Portuguese-speaking to an English school in my teenage years because I realised I needed to go to the USA to study astronomy. But I was originally inspired by the night skies over Macao."

Inside the Peter Harrison Planetarium

Both images on these two pages are courtesy of the National Maritime Museum, London



The Royal Observatory's famous Onion Dome set against a clear night sky

Sales Marques – whose father, José Luís de Sales Marques, is the president of the board of directors at the Institute of European Studies of Macau (IEEM) – says that, since those early days, her thirst for knowledge as a scientist has motivated her. "Scientists are always pursuing a deeper understanding of their subjects," she says. "I too am never satisfied. I'm always curious and I always want to acquire more knowledge. My role now gives me an opportunity to constantly learn more about space, about the planets and stars, about physics and about what's out there. I want to share my passion for astronomy with as many people as possible."

Despite living in the UK, Sales Marques has a strong affinity for her homeland. In fact, she visits Macao every Christmas and stages a planetarium show in English at the Macao Science Center during the holiday, with a show already scheduled for Boxing Day this year. She's been doing this for the past few years and says she 'enjoys presenting a show in Macao' especially as her 'friends and family in Macao get to see my work'.

"Macao is not just a gaming industry city," concludes Sales Marques. "It's a city that's home to a really interesting mix of people who have great potential. It may only be a small place but the people of Macao are special. I don't know if I will ever move back as I love being in London but I am really proud to be a Macanese person who, with the support of her parents, was able to follow her dreams. As a five-year-old, I dreamed of the stars and now I'm proud to work among them." •

FIVE FUN FACTS

Royal Observatory facts that are out of this world

1. King Charles II founded the Royal Observatory in the 1670s. He commissioned famous architect Sir Christopher Wren to design its first building. Handily, Wren was also a professor of astronomy.

2. Since 1884, Greenwich has been where zero degrees longitude is marked. You can actually stand on the 'prime meridian' at the Royal Observatory, putting one foot in the Eastern Hemisphere and one in the West at the same time.

3. Bizarrely, the famous Onion Dome, built to house the enormous Great Equatorial Telescope, was initially made out of papier mâché. It was damaged by bombs during the Second World War.

4. The Royal Observatory houses the 'H4' sea watch, which can be seen by the public. This crucial invention by British clockmaker John Harrison in the 1760s solved the problem of how to measure longitude.

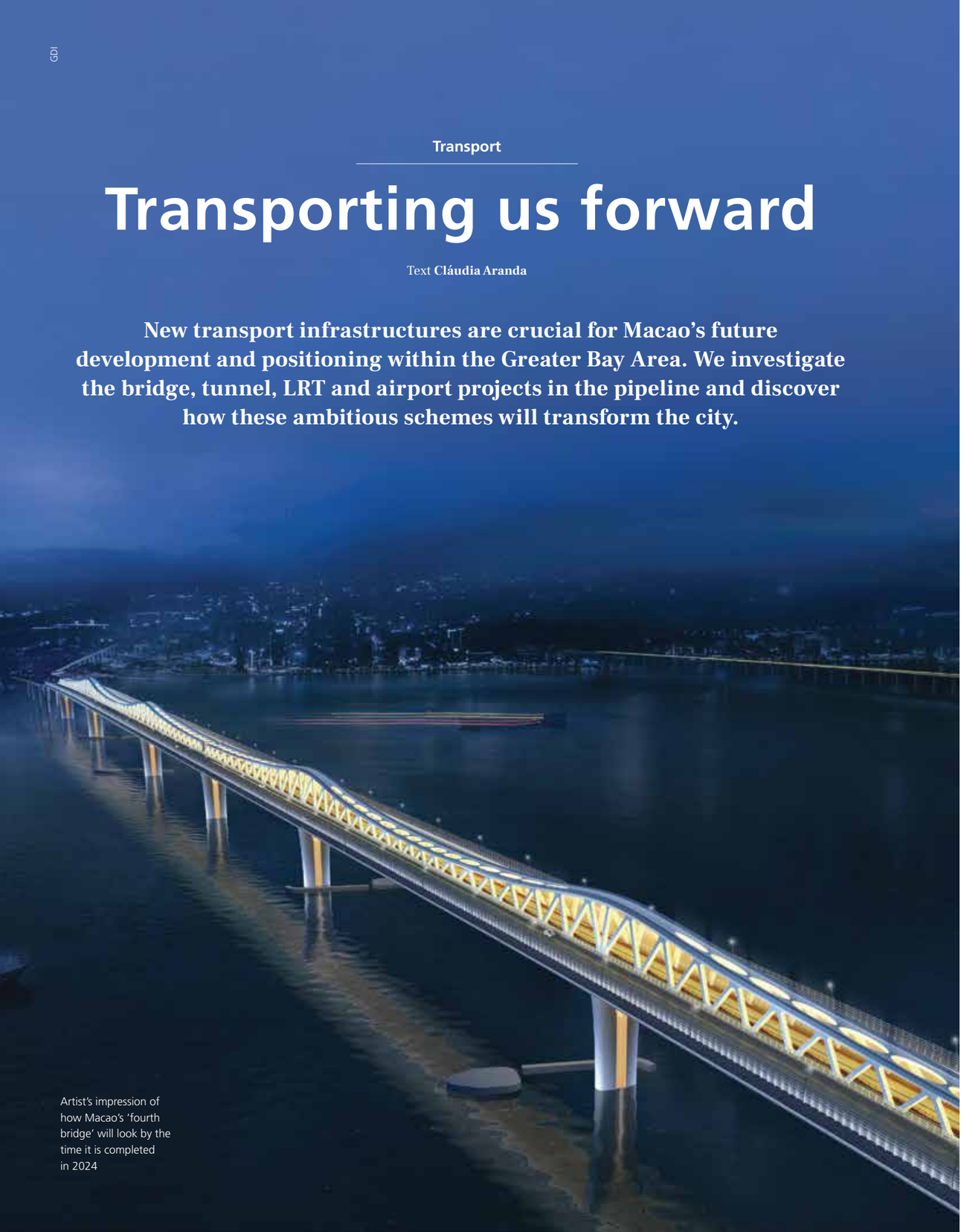
5. The observatory's Peter Harrison Planetarium opened on 25 May 2007. It uses laser projectors to create its mesmerising views of the night sky.

Transport

Transporting us forward

Text **Cláudia Aranda**

New transport infrastructures are crucial for Macao's future development and positioning within the Greater Bay Area. We investigate the bridge, tunnel, LRT and airport projects in the pipeline and discover how these ambitious schemes will transform the city.



Artist's impression of how Macao's 'fourth bridge' will look by the time it is completed in 2024

In October 2018, one of the biggest transport infrastructure projects in Macao's history was completed to great fanfare. The 55-kilometre Hong Kong-Zhuhai-Macao Bridge (HZMB) – the world's largest sea crossing – was opened and the city entered a new dawn of easier travel to its sister SAR and to China's Mainland. A year later, the Macao Light Rapid Transit (LRT) system – the first rapid transit system in the territory – opened and, despite being far from complete just yet, this new mode of travel around the city was also welcomed by locals. But even these milestone projects are just the tip of the iceberg.

There are many more improvements to Macao's transport infrastructure that are due to happen over the coming years. These projects will further boost the freedom of movement around the city and they will certainly help Macao to further integrate with the Greater Bay Area (GBA) and beyond. Experts agree that these plans are crucial for Macao's future development, growth and positioning within the GBA.

Macao has several transport infrastructure projects underway or in their beginning stages that are expected to change the territory's scenery. That includes a fourth bridge and an underwater tunnel between Macao and Taipa, as well as the extension of the LRT, a new tunnel linking Cotai to Ka Ho in Coloane and the expansion of the Macao International Airport (MIA) at the eastern end of Taipa Island. With the underwater tunnel, Macao will have five connections between the peninsula and Taipa Island – there are also flyovers, expressways and other tunnels in the pipeline across the city. These are projects that are expected to serve an increasing number of locals and visitors and will link the peninsula to new residential areas on new reclaimed land zones, as well as reducing traffic congestion across the city.

The aim is also to better connect the territory with the GBA, a megalopolis which consists of nine cities on the Mainland as well as the Macao and Hong Kong SARs and is expected to have a combined population of around 100 million in the near future. The GBA project aims to foster growth by further developing technology and innovation, boosting infrastructure and increasing financial links between the cities. And, for Macao, these transport infrastructure improvements will go a long way to helping the SAR better connect with the GBA.

On 20 April, Macao Chief Executive Ho Iat Seng gave his 2020 policy address before the Legislative Assembly, also discussing the measures that the city is taking to revitalise the economy following the hit it took during the coronavirus pandemic. Shortly afterwards, the government announced that it intends to take a raft of measures in order to promote this revitalisation, including increasing its public investment in infrastructure, particularly in relation to urban transport projects, as well as schemes surrounding public housing and government facilities. The need to expedite public construction projects to create job opportunities was highlighted as part of these measures, as was the need to both commence construction of the fourth Macao-Taipa cross-harbour bridge and to expedite the construction of the LRT system.

Challenges and opportunities

"The connection of Macao to the Mainland and especially to the Greater Bay Area," says Joe Eddie Wu Chou Kit, legislator and chairman of The Macau Institution of Engineers, "will lead to mutual benefits in the future development of these regions." Time is of great importance to Wu and he expects many transport infrastructure schemes will be completed in Macao over the coming decade. "The infrastructure projects," he says, "especially the LRT, the bridges and even the highways, expressways and the expansion of the international airport, are all projects that Macao must complete in the next five to 10 years."

Over the coming years, Macao is expanding to new reclaimed areas of land in the city in a move that was given approval by the central government in December 2009. These strips, known as the Macao New Urban Zone and making up a total area of 3.5 square kilometres – or 350 hectares – of land reclaimed from the sea, are divided into five sections. As they are being created,

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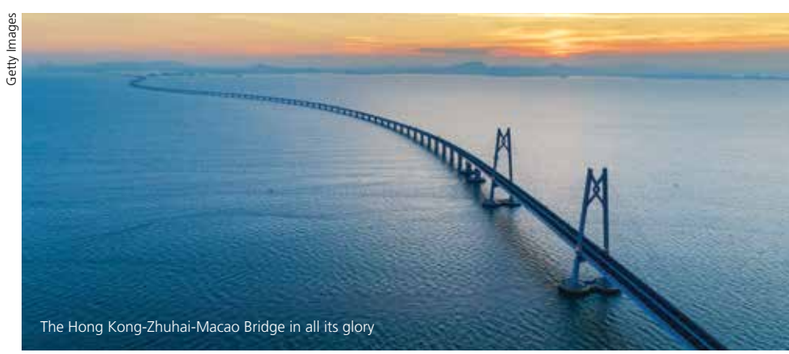


The Hong Kong-Zhuhai-Macao Bridge in all its glory

Source: GDI (Infrastructure Development Office) and Land, Public Works and Transport Bureau (DSSOPT)

there is a real need to implement the connections between them and the existing Macao peninsula.

Zone A, a 1.38-square kilometre area near the Outer Harbour Ferry Terminal and the HZMB checkpoint, is expected to hold some 32,000 housing units, with 28,000 of them to be used for public housing. Zone B, with its 0.47 square kilometres in the south of peninsula that's split into two lots separated by the Governor Nobre de Carvalho Bridge, is designed for public facilities and green areas. Zones C and D, which are 0.33 and 0.59 square kilometres, respectively, will focus on housing and commercial areas in the northern part of Taipa Island, while the 0.73-square kilometre Zone E, also split into two lots next to the airport and the Pac On ferry terminal, will be for public infrastructure, with a focus on transportation, housing, commercial and industrial areas.

"These infrastructures," says engineer Tiago Pereira, an advisor to the Civil Engineering Laboratory of Macau (LECM) and a territory representative within the relatively new Association for Co-operation and Development Portugal – Greater Bay Area, "will introduce profound changes in Macao's transportation network." He says that the new reclaimed areas make up 'an urban development plan that aims to solve the problem of presently overpopulated areas, namely in the north of Macao, allowing the construction of public housing and the expansion of commercial, green and administrative areas'. Pereira adds that this plan will 'significantly alter the distribution of the population' throughout the territory and, as a result, it will also alter 'mobility patterns'.

Reinforcing connectivity

Pereira predicts that 'the fourth and fifth connections between Macao and Taipa will further reinforce connectivity and transport network redundancy by offering additional alternatives between Macao and Taipa, Cotai and Coloane'. Also, he says the Macao Light Rail Transit system 'will play an important role in the internal mobility of the city by offering an attractive public transportation alternative'.

These projects 'by their very nature represent a huge financial investment and are technically complex', according to Pereira. He says that the fourth and fifth connections between Macao and Taipa are 'most notably' expensive and complex. The six-lane, 2.4-kilometre-long tunnel built in soft soil 'introduces new challenges as it is the first of this size in Macao', explains the advisor to the LECM. He also explains that the role of the laboratory is 'to fully support the Macao government in every way possible' so that there will be a 'successful completion of these projects'. The LECM has been in charge of quality control for projects like the LRT, the Ka Ho Tunnel and the new land reclamation areas – plus, it is currently involved in the fourth bridge project. "The LECM's participation is as a quality control consultant," says Pereira, "with the purpose of guaranteeing that the construction follows the quality requirements established by the design and by Macao law and international standards."

Joe Eddie Wu Chou Kit

Tiago Pereira

Rui Leão

Macao architect Rui Leão, who is a partner and director of LBA Architecture and Planning, stresses that 'these infrastructures, mainly those linked to increasing accessibility and solving traffic flows, are fundamental and urgent'. Leão, who is the president of Docomomo Macau, a non-profit organisation that promotes modern architecture to the public in the city, explains that 'Macao has had a very rapid development since 2004' with the construction of its newer entertainment resorts. At the time of the transfer of administration from Portugal to China in 1999, says Leão – who has a PhD from the School of Architecture and Urban Design at Australia's Royal Melbourne Institute of Technology University – the territory may not have been prepared enough 'to respond to the challenges presented by such demanding and fast development'. This rapid development, he claims, was not preceded by 'urban planning or a strategic vision for the implications of a rapid growth' when it comes to, for example, traffic volume or accessibility.

Now, however, Leão says: "Macao is finally gaining momentum and keeping up with the challenges that the city has been facing since 2005. In the first few years following the transfer of administration from Portugal to China, these challenges were not really talked about – challenges that included the astronomical amount of tourists visiting such a small territory and using the existing infrastructure, thus affecting the daily life of the population." Today, the city 'has more muscle, more capacity and more know-how to respond to the different challenges', he says, adding that this includes how it deals with subjects like 'mass transport, how to improve accessibility and how to access a greater supply of affordable housing'. Planning and executing all these projects is, however, says the architect, a 'complex exercise, particularly the LRT system, because it requires co-ordination with other public infrastructure projects'.

> ***These transport infrastructures will introduce profound changes in Macao's transportation network.***

Improving the transport system

The 9.3-kilometre Macao LRT Taipa Line began life last December and now serves 11 stations. With the construction and inauguration of this Taipa section, traffic is expected to be eased in the Taipa-Cotai areas, where many entertainment resorts are located, attracting plenty of tourists. Macao's government has already remarked that the line, which currently connects passengers to Macao's airport, the Taipa ferry terminal and the Lotus Flower checkpoint, will also connect to Seac Pai Van in Coloane and to Barra on the Macao Peninsula.

Following the Chief Executive's policy address on 20 April, the government announced that it will conduct a public consultation and will publicly release the environmental impact assessment of the LRT East Line project. With a length of 7.8 kilometres, the East Line will pass through Zones A and E in the Macau New Urban Zone and will connect to Zhuhai's Gongbei border – or Portas do Cerco – checkpoint. According to a document containing the 'lines of government action for 2020', the conception and execution of the work on the LRT line connecting to another checkpoint at Hengqin 'will begin as soon as possible'. As for the


An air traffic controller at Macao's International Airport

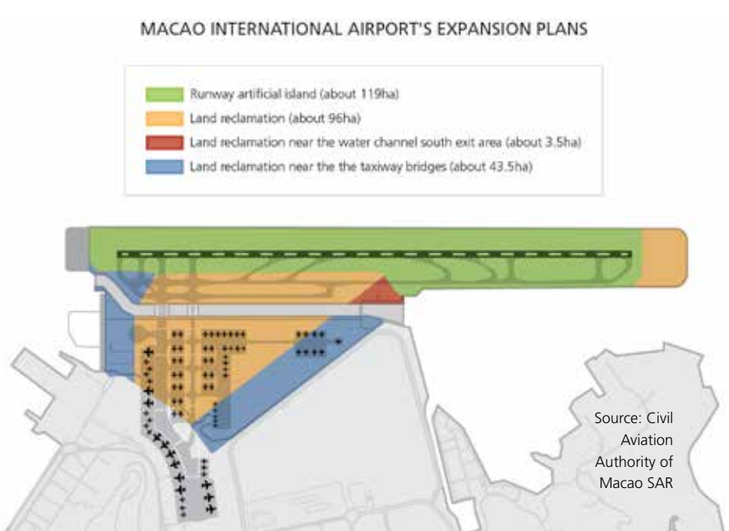
Xinhua News Agency

Seac Pai Van Line, the tender for the construction of the main structures 'will be launched as quickly as possible'. Work on the Barra Station structure is already underway.

While the construction works in Barra Station have been accelerated and the Modal Transport Centre of Barra (or Barra Public Transport Interchange) – which sees different modes of transport coming together at one centre – is in the final stages of construction, works on the Sai Van Bridge to connect the LRT Taipa Line to the Macao peninsula are expected to begin later this year. The Barra Public Transport Interchange – a 35,957-square metre underground station and parking facility for coaches and private cars in Barra district – has been designed by local firm LBA Architecture and Planning. According to the 'lines of government action for 2020', the LRT connection to Barra should be concluded by 2023. The LRT Seac Pai Van Line will have a total length of 1.6 kilometres, covering the Islands District Medical Complex, which is under construction, and the Seac Pai Van public housing area. Some preliminary works have already started. The tender for the main structure's construction works will open soon; however, the whole project is not expected to be completed until 2024.

On 20 April, the Chief Executive also announced that Macao will be linked, in the future, to the high-speed rail network in China following the construction of an underwater tunnel to the checkpoint on Hengqin Island, as part of the LRT's development. The LRT system in Macao is expected to be connected to the Guangzhou-Zhuhai Intercity Mass Rapid Transit and from here to the Guangzhou-Zhuhai-Intercity Railway through Hengqin Station, which is set to become one of southern China's major transport hubs. The Guangzhou-Zhuhai Intercity Railway will, over the next few years, be further extended from Hengqin Station to Zhuhai Airport, allowing for a faster connection from this China's Mainland airport to Macao in the future, according to media reports. Hengqin is currently connected to Cotai via Lotus Bridge.

The future underground LRT extension line connecting the Cotai checkpoint, which is also known as the Lotus Flower checkpoint, to Hengqin Island in Zhuhai will have a total length of 2.2 kilometres, covering two stations – one in Macao and the other on Hengqin Island. The preliminary design of this task will be completed this year and the construction will be undertaken by a company or organisation from the Mainland, according to the 'lines of government action for 2020'. The Lotus Flower checkpoint is also expected to be relocated from Cotai to the new Hengqin checkpoint, which has been partially under the jurisdiction of the SAR since 18 March. The relocation will allow the flow between the Mainland and the city to be reduced to a single border control and it will also help LRT passengers to connect to the high-speed rail network in Guangdong province.



Source: Civil Aviation Authority of Macao SAR

On the subject of Hengqin Island, Ho Iat Seng, during his policy address, said it 'would be a prominent platform for Macao to play an active part in the Guangdong-Hong Kong-Macao Greater Bay Area'. During the Legislative Assembly session, Ho noted Hengqin was a location that is convenient and appropriate in terms of Macao's economic diversification efforts. The 106-square kilometre island is administratively part of Zhuhai but parts of it have been allocated to Macao to support the SAR's development plans.

Other infrastructure plans set out by the government shortly after the Chief Executive's policy address included the move 'to implement construction of public housing in New Urban Zone Area A' and to begin construction of 3,011 housing units. There was also a pledge to 'commence reconstruction of certain facilities of the Taipa Ferry Terminal, which is to be integrated with the second passenger terminal at the city's airport' and 'to conduct a public consultation before year-end on Macao's urban development master plan'.


Cheong Chi Fong

Macao's LRT system in full swing

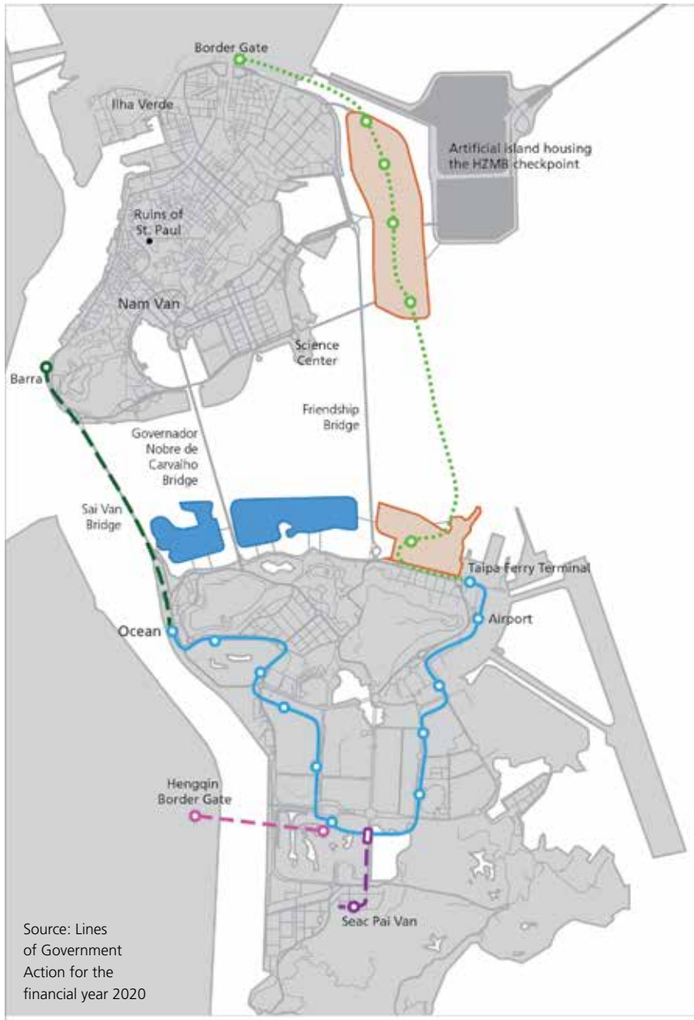
An important direction

The light rail extension to the Mainland, namely 'through the entry of Zhuhai-Hengqin' is 'an important direction for the future development of Macao', says Joe Eddie Wu. He also underlines that a 'complete transportation system is inevitable to position Macao as a World Centre of Tourism and Leisure'. Pereira agrees, saying: "From the perspective of connectivity at the Greater Bay Area level, the LRT connection to Hengqin is especially relevant." He adds that the LRT connections with Zone A and the HZMB artificial island that houses the boundary crossing facilities are equally important.

"With the extension of the Zhuhai Intercity Railway line to Hengqin," says Pereira, "the connection with the Macao LRT will be significant in linking Macao to a GBA-level transportation network." The Zhuhai transportation infrastructure development, which includes "a planned expansion of the Zhuhai Jinwan Airport" and an "increase in its capacity", as well as "the Macao LRT connection with Zhuhai Intercity Railway in Hengqin", will eventually impact Macao's international airport (MIA), he says. Therefore, he adds, 'the MIA will thus be subject to the compounded effects of these future railway and LRT links at Hengqin and Qingmao, the connection at Gongbei and the articulation of the Macao transportation network with the Hong Kong-Zhuhai-Macao Bridge'.

Pereira stresses that 'complementarity is the way forward in this regard as far the MIA is concerned' and he says that is 'perfectly in line with the principles of co-operation laid out in the GBA Framework Agreement', citing the framework: 'achieve a win-win situation through complementary co-operation'. He stresses: "The Greater Bay Area has five international airports in close proximity. Co-operation is the only way forward." Pereira also highlights that these road and railway systems shall be further complemented by 'effective intermodal platforms guaranteeing smooth transitions between road, rail and air travel'. "This offers," he says, "adequate linkage to the GBA transportation network at large, which is of the utmost importance for Macao to take advantage of due to the GBA's possibilities."

The Civil Aviation Authority of Macau (CAAM) is in charge of the 'Macau International Airport Master Plan', which began being drafted in 2010 and was approved in 2016 by Macao's government. The plan anticipates that the future 'closer co-operation among the cities' in the GBA and the increased movement of people and the transport of



Source: Lines of Government Action for the financial year 2020

MAP OF PROPOSED FUTURE EXTENSIONS TO MACAO'S LRT SYSTEM

COMPLETED	UNDERWAY PROJECTS	UNDER CONSIDERATION
Taipa Line (inaugurated in 2019)	Hengqin Island Extension Line	Inner Harbour Line
	Taipa and Macau Line Connection	Macau Peninsula Line
	Seac Pai Van Line	Coloane Line
	East Line	North Cotai Extension Line

cargo in the GBA 'will bring about a higher demand for air transport'. Also, according to the plan, the operations of the MIA 'have reached the maximum capacity' and it is 'therefore with an urgent need' that the airport 'must undergo expansion'. The document forecasts an increase in future air traffic and sets two development phases for the MIA to expand its capacity up to 11 million passengers a year between 2024 and 2026, going up to 15 million passengers a year between 2031 and 2037.

In August, the master plan and the MIA's land reclamation application, which was adjusted to 1.49 square kilometres, was officially approved by China's State Council, with instructions to proceed to the next stage of the airport expansion. The Environmental Protection Bureau, the Civil Aviation Authority and the airport concessionaire, Macau International Airport Co Ltd (CAM), are now working on a design plan of land reclamation at the site, as well as an environmental impact study and other necessary information that is required for the application for land reclamation, which should be ready in the second half of this year. It will then be submitted to the central government for approval. Meanwhile, the project to transform some of the facilities at the Taipa Ferry Terminal and to integrate the ferry terminal with the airport's second passenger terminal should begin over the coming months.

Bridging the gap

Other transport infrastructure works are either being carried out in the city right now or are in the pipeline. As it stands, three bridges connect the peninsula of Macao with the island of Taipa. The first, the Governor Nobre de Carvalho Bridge, opened in 1974 and the second, known as Friendship Bridge, opened

Aerial view of Barra Public Transport Interchange – a 35,957-square metre underground station and parking facility for coaches and private cars in Barra district –designed by local firm LBA Architecture and Planning

Arka Biswas

exactly 20 years later. In 2004, the grand Sai Van Bridge took its first vehicles but, within the next few years, it will no longer be the most recent. The fourth one will be built to the east of Friendship Bridge, linking the eastern part of the Zone A land reclamation area with the artificial island under the HZMB before passing over the outer port and the access channel to the inner port and ending in the Zone E1 land reclamation area next to Pac On in Taipa. A flyover will link the bridge with another future project, the Big Taipa Hill tunnel. According to the government, and as far as current plans are concerned, this tunnel would link the sea accesses, such as Friendship Bridge, to Cotai, allowing a faster access from the Macao peninsula and alleviating heavy traffic flows in the MIA and Taipa urban areas.

The fourth bridge will be about 3.6 kilometres long, with the section above the sea measuring about 2.9 kilometres in length. There will be four lanes in each direction – eight in total, with two of them for motorcycles only. Speed limits are expected to be 80 kilometres an hour along the highway and 40 kilometres an hour along the access ramps. Wind protection barriers will be installed to reduce the wind speed across the bridge – and that will help keep wind speeds down during typhoons which could prevent future accidents.

The first phase of the public tender to construct the bridge was launched in December 2018 and the evaluation process was completed in May last year. According to the government's Infrastructure Development Office (GDI), seven bids were accepted in August and, following that, an MOP 5.2 billion (US$651 million) contract, with a completion date of 1,098 workdays, was awarded in December to a consortium composed of the China Civil Engineering Construction Corporation, the China Railway Construction Bridge Engineering Group Co Ltd and Omas Construction and Engineering Company Ltd for the bridge's design and construction. Ove Arup and Partners Hong Kong Ltd is in charge of the project management and the LECM is responsible for quality control along with Macao's Institute for the Development and Quality. The project is now pending the conclusion of a judicial process before construction can begin but works are expected to start later this year, according to the 'lines of government action for 2020. The main works,

including the bridge structure and flyovers, are expected to be concluded by 2024.

Going underground

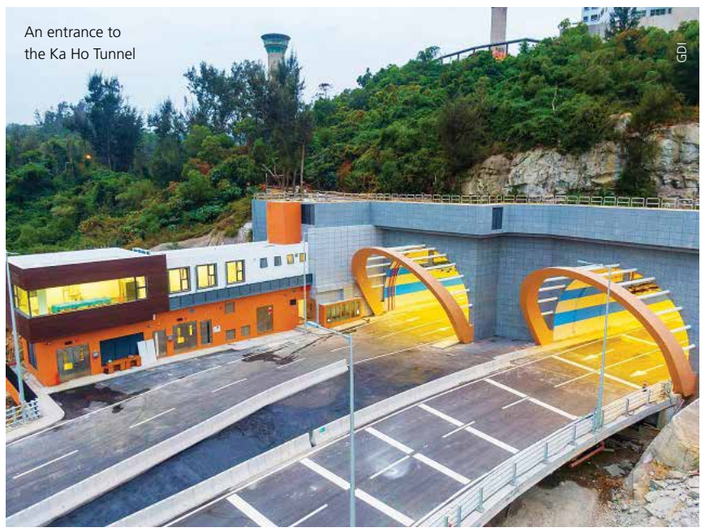
The construction of Ka Ho Tunnel – a project that will link the east of Cotai to the northeastern tip of Coloane – is already well underway. It has so far been built by a consortium, made up of China Gezhouba Group No 2 Engineering Co Ltd and Zhu Kuan – Fomento Imobiliário Limitada, who were awarded the MOP 254.1 million (US$31.8 million) contract by the government. Two sections of the tunnel have already been completed – the main section was finished in November, according to the government's Infrastructure Development Office (GDI), and the southern exterior section, which involved road widening and additional sewage and peripheral containment works, was completed in 2015. The final project for the tunnel – the northern section – is being constructed by Companhia de Construção Cheong Kong Ltd under a contract worth MOP 175.1 million (US$21.9 million). It is expected to be finished by the end of next year.

The main tunnel section is 500 metres long and lanes run in both directions, each one 20 metres wide and 10 metres high. Its northern entrance starts near the Rua de Central Termica de Coloane in eastern Cotai and connects to the area near Ka Ho Port, the northeastern tip of Coloane where the Macau Oil Terminal and the Macau Cement Manufacturing Co Ltd lie. According to the GDI, the project will facilitate access by residents from Ka Ho village and vehicles driving towards the Ka Ho Port Container Terminal and will allow for a significant reduction in both driving time – up to 15 minutes – and traffic load.

Beneath the waves

The government has also been doing studies on a fifth link between Macao and Taipa. Chinese state-owned company CCCC Highway Consultants received in 2018 an MOP 99.2 million (US$12.4 million) contract for the preliminary design, geotechnical survey and study of an underwater tunnel near the existing Governor Nobre de Carvalho Bridge, with an 800-day deadline granted for the project to be finished. Once complete, this project will lay the foundation for a future underwater tunnel connection that will be approximately 2.4 kilometres long, have three lanes in each direction and a speed limit of 60 kilometres an hour.

An environmental assessment report was carried out by the Shanghai Architectural Research, Design and Research Institute Co Ltd under a contract signed with CCCC Highway Consultants' Macao branch – and that assessment, completed in three phases, has been successively made available for the public to view. According to the Land, Public Works and Transport Bureau (DSSOPT) the environmental impact that could be caused by the construction of the underwater tunnel on the surrounding area will be 'temporary and reversible' and could be reduced if appropriate measures are implemented. Studies regarding preliminary works are now underway and, after these are completed, preliminary designs are expected to be drawn up.


An entrance to the Ka Ho Tunnel

GDI

The road to sustainable development

All of these projects will undoubtedly ease traffic and create opportunities in Macao. But at a regional level, Joe Eddie Wu highlights the relevance of the development of the GBA for the future of Macao. He stresses that, despite the city's rapid economic growth, 'the scale of development is limited' in Macao. "Therefore," he says, "the government always encourages young people to seek opportunities outside. This is not only a slogan but also the future direction of sustainable development in Macao. However, Macao itself must have the corresponding infrastructure to accelerate the integration of the city into the Greater Bay Area."


Aerial view of the Zone A reclaimed land area with its transport links already branching off in all directions

Cheong Chi Fong

A mindset change is needed in Macao, according to Leão, when it comes to the GBA and the new transport projects. "It is important," he says, "to understand that we are not isolated here in this small territory but we have an action area that comprises nine plus two cities. All these cities offer a wealth of possibilities, cutting edge industries, investment areas and know-how. There are so many interactions that we can have as part of a megalopolis of 100 million people who think as agents and actors of that megapolis." The architect stresses the importance of 'gradually stopping a village way of thinking where we are competing with each other within Macao'. The idea, he explains, is to understand 'who our peers and our partners are – not only here in Macao but across the Pearl River Delta'. He adds: "As more relationships between the various cities develop, this need for accessibility and fast transport will naturally emerge."

> ***"As more relationships between the various cities of the GBA develop, the need for accessibility and fast transport will naturally emerge.***

Along with the projects that link Macao's transport system to the neighbouring cities, the local urban transport system is 'equally important' when it comes to the development of Macao's internal infrastructure, underlines Wu. "Macao is a small place with high traffic density," he says, "and a new thinking is deemed necessary in road planning." Pereira says that the new transport infrastructure projects 'will have an impact at a general level, which will bring about important changes in traffic patterns'. He says that mobility can be further improved as the new reclamation zones, as well as Hengqin, are developed. Ultimately, he recommends, "infrastructure development should be defined 'vis-à-vis' with government policies concerning urbanism, transportation, the environment and tourism".

Wu also emphasises that the development of 'Macao's future infrastructure should not only focus on transportation'. It should, in addition to achieving the positioning of Macao as a 'World Tourism and Leisure Centre', he says, also be designed 'to improve the overall quality of life for residents' and this includes, among other things, the expansion of urban living spaces, priority given to a range of industries as well as the gaming businesses and the reservation of land for green areas, public facilities and public housing.

There will undoubtedly be a new raft of transport infrastructure projects implemented in Macao over the coming years as the city connects further with the GBA. However, these bridge, tunnel, LRT and airport schemes that are happening right now – or are set to begin shortly – will surely improve the flow of traffic and people and ensure that the territory is in the best place possible to function effectively within the GBA in both the near and distant futures. ●

Social affairs

The foreign legion

Text **Sheyla Zandonai**

Macao is home to thousands of people from across the world who have moved to the city to work in unique and fascinating jobs. Meet eight men and women from foreign countries who help make the city what it is today.

Almost 100 countries and territories across the world celebrate Labour Day on 1 May – and that includes Macao. The public holiday, often called International Workers' Day, commemorates the working class and organised labour worldwide and dates back to 19th century Chicago in the US, when trade unions battled for workers' rights and an eight-hour workday. In Macao, workers get the day off and many celebrate all professionals across the world in their own way.

To mark the special day, Macao Magazine has chosen eight professionals who we can also celebrate in our own way. Each one of these workers hails from a different foreign country and adds to Macao's diverse and colourful society by performing a job that is both unique and fascinating. They each came to the city – some as recently as four months ago and some as long as 18 years ago – with the aim of contributing to Macao's society and they each have done extremely well in their chosen field. And above all, they all share an intense passion for what they do as a profession.

In these times of uncertainty and isolation due to the worldwide COVID-19 pandemic, it is worth remembering just how important cultural diversity and social inclusion have always been to our world – and, in particular, for Macao. For more than 400 years, people from across the globe have moved to the city and helped shape it into the thriving metropolis it is today. They've brought with them knowledge, skills and traditions, and helped shape the city's identity as a unique melting pot of culture which is of utmost importance. And some professionals who come to Macao to work for a short period quickly become seduced by the SAR and soon call it home – like our eight professionals who once travelled to us from far-off lands.

The South African farrier

"If you can shoe a horse in Macao," says Tyrone Sapire, "you can shoe a horse anywhere in the world." The new master farrier at Macau Jockey Club is referring to the challenge of working with racehorses in the SAR, which sometimes run up to three times as much as their counterparts do in other countries every month. He notes how hard it can be in Macao to do such a job – but he is nevertheless extremely good at it and loves the challenge.

> ***I'm just happy to be in Macao. I want to be here for a while and, hopefully, maybe even retire here.***

Sapire, a 37-year-old South African with extensive farriery training, arrived in Macao only four months ago. Immediately, he began to lead a team of 24 farriers at Macau Jockey Club, working alongside three vets who all keep around 380 horses in tip-top shape. Shoeing or farriering a horse is essential to equine hoof care. It includes trimming hooves and 'balancing' them so they land flat on the ground. It's a physical and highly specialised profession which combines the skills of a blacksmith and a vet.

Despite his father encouraging him to become a horseracing jockey when he was young, a growth spurt in his teens meant that Sapire was not able to fulfil that ambition. Horses, however, were in his blood – his father was a racehorse trainer and his older brother was a farrier in South Africa – so he followed in his brother's footsteps in his later teenage years. After attending high school in South Africa, the young farrier continued practicing the craft and furthering his training, which included an apprenticeship with a two-year residency in the US under Chris Gregory, one of the most celebrated names in farriery and hoof-care education in the world.

Sapire is an American Farriers Association (AFA) Certified Farrier. He also gained eight years of experience in the trade in Dubai, as well as three years in Singapore, prior to his move to Macao earlier this year, which he made because he says he was seeking a new challenge. And a challenge it is. "It is very tough to keep horses running in Macao," he says. "They race a lot more often. But I have been able to help a few horses so far and it is extremely rewarding. I've got a great team of farriers behind me. They are all enthusiastic. I'm just happy to be here more than anything else. I want to be here for a while and, hopefully, maybe even retire here. I'd like to see the Macau Jockey Club grow back to its former glory. If I'm able to play a small part in that, it would be a defining achievement in my career as a farrier."

Antonio Sanmartul

Tyrone Sapire has brought his expertise as a farrier over to Macao

Mohammad Reza Rashidnia (right) demonstrates the art of karate with young learners of the discipline

Antônio Sanmarful

The Iranian martial artist

Most people have heard of karate. But many may not be familiar with karate-do. This is a martial arts discipline which refers to a way of practicing karate that focuses on its virtues as a lifelong path of self-improvement. And Mohammad Reza Rashidnia is an expert in the discipline. He was initiated in karate-do 48 years ago in Iran when he was just 13 years old and he practiced it for many years before heading to Macao.

Rashidnia's relationship with Macao began when he met the previous head of the Macau Karate-do Federation, José Martins Achiam, at a sports event in Singapore in 1999, when he was the coach of Iran's national karate team. His experience in the discipline impressed the head of the federation so in 2001, when they met again at another event in Malaysia, he was invited to move to Macao and prepare local karate competitors for the 2002 Asian Games in Busan, South Korea. He accepted and under his training and guidance, the team brought home three medals – a men's silver and two women's bronzes. Since then, he and his team have participated in dozens of championships and tournaments across the continent, including five Asian Games and two East Asian Games. Under his leadership, the competitors have collected more than 200 medals.

He may be a coach these days but at 62 years old, Rashidnia packs plenty of competitive experience under his black belt. As an athlete in his younger years, he scooped silver and bronze medals at the Iran National Karate Championships, as well as gold medals at military competitions in the country. However, sadly he was never able to compete on an international level because he was at his peak during torrid times for the Middle Eastern country, including the 1979 Iranian Revolution and the Iran-Iraq War between 1980 and 1988. These conflicts made training for and attending international competitions far too problematic.

As he aged, however, the champion converted his passion for the sport into a coaching career, first training military karate teams from all over Iran in Tehran, the capital and his hometown. In 1996, aged 39, he became Iran's national karate team coach in a country where the Japanese sport was becoming a widespread phenomenon.

Rashidnia has been the head of Macao's team for the past 18 years and he says he is grateful for the trust that has been placed in him over such a long period. "The teamwork is very important," he explains. "They have allowed me to run the team any way I want here in Macao." Coupling the science of sport with technical and tactical preparations, he stresses that karate-do is more than just the fighting – the suffix 'do' means 'the way of', implying it is both a fighting system and path to self-knowledge. "It involves physical and mental training," says Rashidnia. "You learn how to control yourself and your emotions. I love my job. This is my life."

The German scuba diver

A professional diver with nearly 20 years of experience behind her, Ute Friedrich signed up for an instructor course at the age of 40 years old. In the beginning – she only started diving when she was 35 – exploring the underwater world allowed the German to recover from the stressful situations she encountered as a social worker involved with children from problematic families. Soon, though, diving became her full-time occupation. She acquired a professional licence in Egypt – she went to the African country as she had friends there and it is also seen as one of the best places in the world for diving – and landed her first instructor job working for boat tour operators in Egypt, where she lived for a total of seven years.

Friedrich left Egypt and headed to Macao in 2010 with her husband, and two years later, joined the aquatic department at The House of Dancing Water, which is based at the City of Dreams entertainment complex in Cotai. The House of Dancing Water is a show that combines circus and acrobatics performances, creating a powerful visual theatre that's staged on water. The show's swimming pool is Friedrich's workstation. Much of the show's water wizardry depends on the expertise the 59-year-old and nearly 30 other show divers and technicians provide behind-the-scenes.

In her daily routine, Friedrich services the scuba diving gear, carrying out underwater inspections and moving subaquatic scenic elements for checks and repairs. She is also licensed by the company as a technician. She oversees all the scuba diving training at The House of Dancing Water, which became a Professional Association of Diving Instructors (PADI) Dive Centre in 2011. Since joining the production, the Berliner has taught around 200 people. "For me," she says, "the teaching part makes this job exciting. It is very rewarding."

Diving into a pool packed with props and gear, however, requires expert knowledge and the need to stick to extremely high safety measures. "I always compare this job with wreck diving or cave diving," explains the instructor, who adds that she enjoys working for the company and that she loves life in Macao, whether it's viewed from the inside or outside of a pool. "I wouldn't have stayed here if I didn't like it," she concludes.

Photos by Janusz Ciechowski of J.Cphotographyvideography

Ute Friedrich in her diving gear at The House of Dancing Water

The Mosotho researcher

Computer science research may not be for everybody. But it is an exciting and rewarding career for Mamello Thinyane. The 39-year-old Mosotho – the name given to someone from Lesotho, an enclaved country within South Africa – has notched up many years of training in computer science and he is now a respected researcher at the United Nations University Institute (UNUI) in Macao.

Thinyane received his PhD in computer science in 2009 from Rhodes University in South Africa where he studied and worked for 17 years before he moved to Macao and joined the institute in July 2016. Over his career, the researcher has steadily become more interested in issues related to technology and sustainable development, in particular Information and Communication Technologies for Development (ICT4D). This is an initiative aimed at bridging the 'digital divides' – the disparities between technological 'have' and 'have not' geographical locations or demographic groups – and aiding sustainable development by ensuring an equitable use of information and communications technologies.

> ***How do we prepare Macao's society to function in the face of adverse events?***

This focus on technology and sustainable development is actively promoted by the United Nations – so it was this focus which brought Thinyane to Macao. Here, he co-ordinates small scale-yet-meaningful projects at UNUI, including his work with Macao's branch of Catholic relief and social service not-for-profit organisation Caritas. He was working with the organisation to develop a system to manage their homeless services when Typhoon Hato struck in August 2017. "When Hato happened, they lost a lot of their data," says the researcher. "This is an organisation that is mission-driven. When they get affected by an adverse event like that, everything is disrupted."

This previous experience with Caritas became 'part of the motivation' for a new project called 'Smart City-zen Cyber Resilience', which was launched earlier this year. Backed by Macao's Science and Technology Development Fund (FDCT), it seeks to expand the scope of 'operational stability' concerns such as the one that affected Caritas, including adverse effects caused by nature and people, such as cyber attacks – which can trigger data loss and breach online privacy. "My concern with this project," he says, "is that citizens and non-governmental organisations (NGOs) are sometimes not aware, not prepared or not engaging with these issues. How do we prepare Macao's society to function in the face of these adverse events?"

For the next year and half, 'enhancing the cyber resilience of Macao citizens' will occupy the researcher's time. It's a rising concern in Macao. "We'll definitely be looking into expanding," says Thinyane, who is also the chairman of the board of the African Footprints of Hope Organisation, an NGO that empowers young people in southern Africa with skills so they can improve their livelihoods. "There is so much [going on] around [the issues of] cyber security and cyber resilience. A lot needs to be done. We are the only UN agency in Macao and with that connection there are specific insights and advantages that we can bring and hopefully contribute as well."

Mamello Thinyane is a respected researcher at Macao's United Nations University Institute

António Sanmarful

The French florist

A six-year course at l'École des Fleuristes de Paris – Floral Design School of Paris in English – followed by specialist management and floristry business training at the Paris Chamber of Commerce gradually transformed Carole Delavelle's once-amateur passion into a budding profession. Backed by extensive formal training and diverse work experience, the 46-year-old Parisienne arrived in Macao nearly 11 years ago, making herself at home in a city she believes has never lost its glow. "It is the place to be," she says, "to develop new flower concepts with other strong and motivated people."

Delavelle made her base in Asia in November 2009 after landing a contract to design an artificial foliage decoration for The House of Dancing Water. She founded her company, Oulala Flower, in Macao six months later. The business provides floral design services that cater for events ranging from wedding celebrations to grand openings. She has clients across the region and she tells us the word 'oulala' is an idiosyncratic French expression of surprise. The Frenchwoman says she chose it because she used the expression for so long that her friends told her the word had started to 'define' her. So she thought it could define her business too.

As a creator, Delavelle draws inspiration from a variety of sources, including 17th and 18th century French design aesthetics. "I also love French gardens," she says, highlighting the works of Gallic landscape architect André Le Nôtre, who designed the park at the Palace of Versailles near Paris in the mid-17th century. She says she admires several other French royal gardens such as 'Chantilly, Fontainebleau and Tuileries'. Plus, she has a soft spot for Impressionist painters – all influences on her work as a floral artist. And over the past 10 years, she has also been sharing her knowledge on French floral art and design in a series of creative studies courses at the School of Continuing Education at Macao's Institute for Tourism Studies (IFT).

On a practical basis, Delavelle's work is made possible by the arrival of flowers by boat from a Hong Kong supplier every two days. They come from all over the world, including Italy, Japan, France, New Zealand, Australia and the Netherlands. As long as the flowers continue sailing to her, she believes her business will keep on blooming just like her love for Macao has been growing. "I really believe that I am useful here," she says, "and that I have brought a French and modernist touch to the city's flower business. The students I have trained here have acquired the necessary skills to develop their own projects in Macao and become even more creative. Today, I am very proud of them." She adds that she 'loves the way people think in Macao'. "They are curious," she says. "They want to learn and they are quite open to other cultures. They are also worldly wise."

Carole Delavelle says Macao is the 'place to be' to develop new floristry concepts

Carole Delavelle

Classical music is in Veronika Csajági's blood

The Cultural Affairs Bureau

The Hungarian flautist

At the tender age of eight years old, Veronika Csajági was introduced to the flute. She was 'left free' to practice the instrument as much as she wanted outside school and extracurricular music classes in her hometown of Budapest, Hungary. As a result, she cultivated a strong affection for classical music. At just 12 years old, Csajági decided that she wanted to join a secondary school that was solely for budding musicians and she enrolled in that school when she turned 14 years old. Her path was set and she would go on to become a talented, passionate flautist – one who would eventually bring her skills to Macao.

In 2014, Csajági joined the Macao Orchestra, which was formed in 1983 and consists of around 60 musicians from across the world. The 35-year-old Hungarian, who has been part of the orchestra ever since, is the second flautist and also the ensemble's only player of the piccolo, a small flute that sounds an octave higher than the regular instrument. "It is tiny but it is loud," she says, warning us not to be fooled by appearances. Classical musicians are trained to learn a set of instruments and learning the piccolo is part of a flautist's education. During her formative years, first at the Liszt Academy in Budapest, where she obtained her Bachelor's and Master's degrees in music, then as a member of the Györ Philharmonic Orchestra, also in Hungary, Csajági claims she built up her profile to be a piccolo player.

Csajági says that she had 'not planned' to come to Macao prior to joining the city's orchestra. "A door opened and I did not slap it shut," she says, adding that she's 'always loved' Asia, particularly the continent's movies, music, paintings and places. "So, next to the main motivation that I wanted to work in a symphonic orchestra, it was an adventure to move to Macao." Csajági applied for the position, passed a preliminary DVD audition and got an invitation to undertake a three-month trial period. She excelled and was able to join the orchestra. "I was honoured to work with highly qualified musicians," she says.

Over the years, Csajági has participated in many concerts and has had many influences but she admits that she finds it difficult to name a favourite composer, highlighting instead the experience of 'immersion' in a variety of compositions and pieces. "I have enjoyed many beautiful experiences and memories with many [classical music] pieces," she says. "I need stimuli and challenges. My musical experience is a never-ending journey of curiosity."

Over the past six years in Macao, Csajági, who has previously worked with the Danubia Philharmonic Orchestra and the Hungarian Radio Philharmonic Orchestra as a guest musician, has devoted four years to also teaching music at the Macao Conservatory as a part-time instructor. "Classical music can be a kind of knowledge that you wouldn't use directly," she says. "But it can train both your personality and your creativity. This European heritage is recognised in Asia as an important part of a person's skills. In Macao, I have had students who have put a lot of effort into studying music next to their school or job. They want to evolve and I have been happy to contribute to this."

The Peruvian chef

Many chefs in Macao have moved to the city from faraway lands. This could be because there are plenty of opportunities in the SAR for talented culinary maestros – but it may also be because Macao's own cuisine is so unique and its locals and visitors expect an excellent gastronomic experience at the city's many restaurants, markets, takeaways and entertainment resorts. One such talented chef who came to Macao all the way from Peru in South America is Edwin Guzmán.

Guzmán was born and raised in Peru's capital city, Lima. He began working in the culinary industry at 19 years old, starting in the kitchens at restaurants in the city before acquiring formal training at St Ignatius of Loyola University in Lima. He says his mother was an early inspiration. "When I was young," he says, "seeing my mother getting up early to prepare for her restaurant, going with her to the market and experiencing many aromas and flavours from her cooking – it's imprinted in my DNA." The young chef arrived in Macao in July 2017. He had been handpicked to join the team as chef de cuisine at the new Aji fine dining restaurant, which opened at the MGM Cotai entertainment complex in February 2018. Over seven months, he helped the team to prepare for the opening and he has been working at the eatery, which specialises in Nikkei cuisine, ever since.

Nikkei cuisine is actually a Peruvian cuisine which sees famous ingredients from the South American nation like tropical fish, quinoa and aji amarillo peppers moulded by Japanese culinary techniques. The word 'nikkei' refers to Japanese people who have permanently relocated overseas and Peru is home to South America's second largest Japanese population after Brazil. Aji is Macao's first Nikkei restaurant and it is headed by one of the world's best-known Nikkei chefs, Mitsuharu Tsumura, who owns Lima's Maido restaurant, which was ranked 10th in the 2019 World's 50 Best Restaurants list. Guzmán trained here before he moved to Macao and the chef says that Tsumura has become his mentor over the years. "Every day in Macao," says Guzmán, "I am becoming a more accomplished chef."

Guzmán says that Nikkei is a cuisine in which fresh fish marries citrus-based sauces and in which the humble potato, a quintessential Peruvian ingredient – more than 4,000 varieties reportedly exist in the country – takes the spotlight. He says that he has introduced seven types of Peruvian potatoes to Aji's tasting menu. "Nikkei cuisine combines Peru's popular culinary culture with Japan's subtlety," says the 30-year-old. "I believe, as Peruvians, we have achieved a very interesting balance in this type of cuisine." Aji's name itself is proof of this happy marriage, meaning both 'flavour' in Japanese and 'chilli pepper' in Spanish – an ingredient that Guzmán, who has been developing his own Peruvian chilli-based XO sauce lately, calls 'the most important in Peruvian cuisine'. "I feel honoured," concludes the talented chef, "to have had such an amazing opportunity to come to Macao to represent my country with our unique culture and cuisine, adding a special taste to the local culinary landscape."

Edwin Guzmán is passionate about Nikkei cuisine

MGM Cotai

The Filipina marine biologist

Karen Araño Tagulao was born in 1972 in the municipality of Cabagan in the Philippines. The eldest daughter in an academically inclined family – her parents are retired professors and several of her five siblings have pursued academic careers – she found her vocation in biology. After pursuing Bachelor's and Master's degrees at the University of the Philippines, she became a PhD fellow in marine biology in an integrated scheme involving the Netherlands' Radboud University and the UNESCO-International Institute for Infrastructural, Hydraulic and Environmental Engineering, now known as the IHE Delft Institute for Water Education. Her ongoing doctoral research consists of applying molecular techniques to study the evolution and relationships of seagrass populations in the Indo-Pacific region.

In January 2003, shortly after she was married in the Philippines, Tagulao arrived in Macao. She moved to the city because her husband was already there – he'd been working in the territory since 1992. "I was uncertain about the future," she admits, "but I was optimistic that I could continue my scientific work in Macao because the city is surrounded by water." The marine biologist soon settled in and became a mother. She spent the following few years raising her two children, however, in 2008, she landed a position at the University of Saint Joseph (USJ), where she is now a senior lecturer at the Institute of Science and Environment and the co-ordinator of USJ's Pre-University Programme, which helps prepare students for university in Macao or overseas. In 2010, she also became the principal investigator of the institute's project on mangrove forests – a position she still holds as she and her team investigate these unique habitats that are characterised by vegetation growing in tidal coastal swamps.

"In a city like Macao," says Tagulao, "which is vulnerable to the impact of storm surges, mangroves can help protect the coastline by acting as natural barriers." She adds that mangroves are 'equally important in the protection of the city's coastal waters from pollution due to their ability to act as filters'. Whether she is engaged in science promotion projects or supporting international bodies like global health organisation Clean the World Foundation, Tagulao highlights the importance of 'translating science into action'. The environment has found an ally in the marine biologist and Macao has, yet again, brought a professional in from a foreign country who is benefitting the city and its society as a whole every single day. •

Antonio Sanmartul

Karen Araño Tagulao knows a thing or two about mangroves

The Athlete Training and Development Centre is a shining new facility that is set to become one of Macao's most valuable sporting assets

António Sanmarful

Promotional Feature

Fit for purpose

Text **Rafelle Marie Allego** and **Kary Lam**

Macao's new Athlete Training and Development Centre in Cotai is already garnering praise for improving the city's chances of future sporting success. We put on our joggers and take an energetic look inside this forward-thinking sports facility.

A milestone for Macao's sporting world'. That's what the president of the city's Sports Bureau, Pun Weng Kun, called the new Athlete Training and Development Centre in 2016, long before the facility was constructed in Cotai. And it's true – just five months after it opened its doors to sportsmen and women from across the city on 5 December, it's already proving to be a valuable athletic asset.

The grand new centre, which was built between February 2017 and 30 September last year, lies next to the Macao East Asian Games Dome, about a kilometre away from Cotai's Rotunda do Istmo. The facility, which was the brainchild of the Macao Sports Bureau, is already full of state-of-the-art sports equipment and spaces and adds to the bureau's extensive list of sports training venues which are dotted across the territory.

The actual building, which is located near Rua de Tenis, just north of the dome, occupies just over 12,000 square metres in space on a patch of land which measures more than 59,000 square metres in area. The centre, which has a parking area, has so far cost MOP 1.63 billion (US$203.2 million) to build, including implementations that save both energy and water.

> *With its ideal environment, the centre will help improve the competitive level of our sports teams in a space that's solely dedicated to training.*

Prior to the opening, Pun Weng Kun said that, in the past, athletes in Macao had to leave the city if they wanted to train together but he believed that the centre 'will not only provide local athletes with training conditions in Macao but it can also attract high-level foreign teams to train in Macao' and he added that this allowed 'local players to train together' with those foreign teams, thus allowing 'Macao athletes to raise their level'.

Director of the Athlete Training and Development Centre, Debby Fu, says: "It is an incredible building with a sizeable green space next to it. It also fulfils its obligation to the environment by having implementations that save energy and water and it provides a favourable atmosphere that is designed to provide the perfect training conditions for Macao's athletes, coaches and technical support teams."

Sporting environment

The facility's environmentally friendly features include photovoltaic solar panels on the roof that are used to preheat the water before it is used in the showers. There is also a rainwater recovery system that irrigates the terrace garden, with the added feature of shutting off automatically if no rainwater is detected. With its double-glazed windows, the searing outside heat

is blocked, which also reduces any reliance on air-conditioning. Natural light also comes in through the centre's northern and southern glass facades and LED light bulbs cut the facility's energy consumption.

The centre has been designed to have three main functions – there are training spaces, sports medicine services and a dormitory that has more than 300 bedrooms. It also includes two multi-function gymnasiums and a weight-training centre. There is a dormitory for sportsmen and women which is spread out over nine storeys, an indoor 25-metre pool and a restaurant, which are all expected to be put into service in the near future.

Athletes from across the world will be able to use the centre. It is primarily designed for Macao's own sports teams, though. At the moment, there are five official Macao teams stationed at the facility – the Macau Judo Association, the Macau Karate-do Association, the Macau Taekwondo Association, the Wushu General Association of Macau and the Macau Dance Sport Federation. "With its ideal environment," says Fu, "the centre will help improve the competitive level of our sports teams in a space that's solely dedicated to training. The coaches and athletes of the five sports teams have already all found the centre to be a great benefit to them." These teams have previously trained at other government-run facilities in the city. The Macau Taekwondo Association, for instance, used to train in one of the small industrial buildings in the Iao Hon area of the city.

Just one of the many users of the new training centre is 35-year-old judo coach Aquino da Silva, who tells us the facility is a huge improvement for his team. And 30-year-old wushu coach Iao Chon In, who has been coaching the martial art sport since 2015, agrees. He says the centre is actually fairly similar to the sorts of venues the team is used to competing at throughout the year. And that can only be beneficial to the team's development. "This helps the athletes adapt to the actual competition environment," he says.

With a massive gym and a wide range of bodybuilding equipment available, all of the sportsmen and women who now use the centre have a fighting chance of improving their performance when they come to competitions. Even the changing rooms are receiving praise. "We used to train in a small, crowded place," says 16-year-old taekwondo athlete Alba Merilda de Assunção. "But now we have better air and better changing rooms."

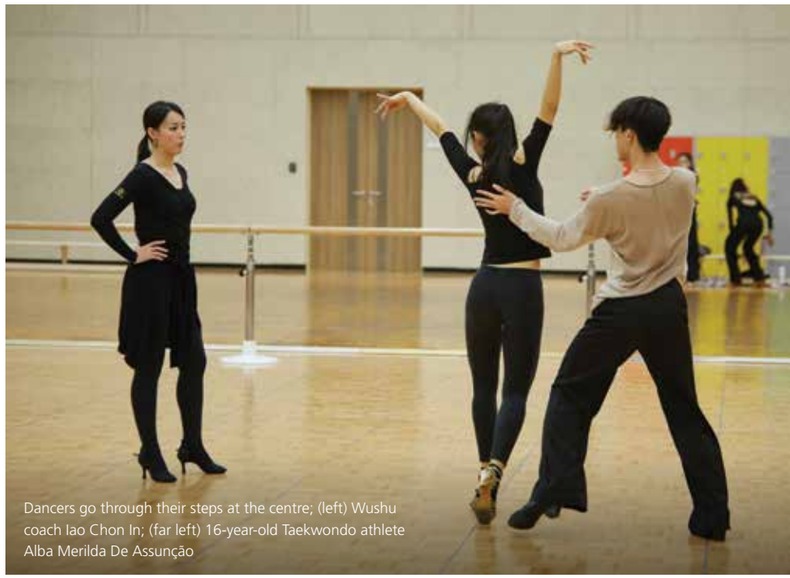
De Assunção's coach from the Macau Taekwondo Association, Chao Iat Keong, says that compared to where the team used to train, there is now more ceiling height for the acrobatic jumps that are necessary in the sport. The 42-year-old coach also says that the team doesn't need to move equipment around during every training session any more. Being provided with readily available medical support is also a big advantage, shares 28-year-old gold medallist Huang Jun Hua. Huang scooped gold in wushu at the 2018 Asian Games.

All photos on this spread by António Sanmarful

28-year-old Wushu athlete Huang Jun Hua who took gold home at the 2018 Asian Games

Taekwondo coach Chao Iat Keong correcting a student's stance

Karate-do athlete Kuok Kin Hang



Dancers go through their steps at the centre; (left) Wushu coach Iao Chon In; (far left) 16-year-old Taekwondo athlete Alba Merilda De Assunção

António Sanmartul

The centre's 25-metre indoor pool is one of its much-praised features

In the case of dancesport – which is a form of competitive ballroom dancing – coach U Mei Kok of the Macau Dance Sport Federation stresses the importance of the flooring quality. In the new centre, the bureau has provided teams with excellent flooring so that the athletes can practice their disciplines to the highest standard. As dancesport athletes Tam Ka Pan, 25, and Vong Weng Lam, 23, – who have been dance partners since 2009 – say, with more floor space in this new centre, they can adjust their 'bigger movements' according to how it would actually be during competitions, without the limitations they had experienced in their previous facilities.

Homegrown athletes

This new centre – which is for the sports teams and not for the general public – is an encouraging move by the government for Macao's sports growth as the facilities have the potential to attract the interest of future homegrown athletes. Most of the sportsmen and women who already use the centre agree that drumming up interest for their disciplines is hugely important for the future of their teams. "The completion of the new centre is a milestone for the development of wushu in Macao," says Iao. "There are still many open quotas for people to become a full-time wushu athlete in Macao and carry this traditional Chinese discipline forward into the future."

With COVID-19 still affecting Macao and the rest of the world, many of the athletes who use the centre have been using the break as a time to improve themselves for future competitions. Iranian coach Mohammad Reza Rashidnia of the Macau Karate-do Association hopes this training will 'bring more wins for Macao'. Treating his students like his own children, Rashidnia shares how warm and friendly the Macao sports environment has been over the past couple of decades. "There is much support from the bureau," he says.

Karate athlete Kuok Kin Hang credits the bureau for helping the Macau Karate-do Association to reach a high level of success over past years. The 27-year-old athlete says: "I need to give a big thank you to the SAR government and the Sports Bureau for the new centre as I believe it will help us as we strive for better performances in our careers." Iao agrees, saying that the effort that the bureau has invested in the city's sports has yielded great improvements. He adds that the sports team now have 'higher hopes of doing even better' in future competitions.

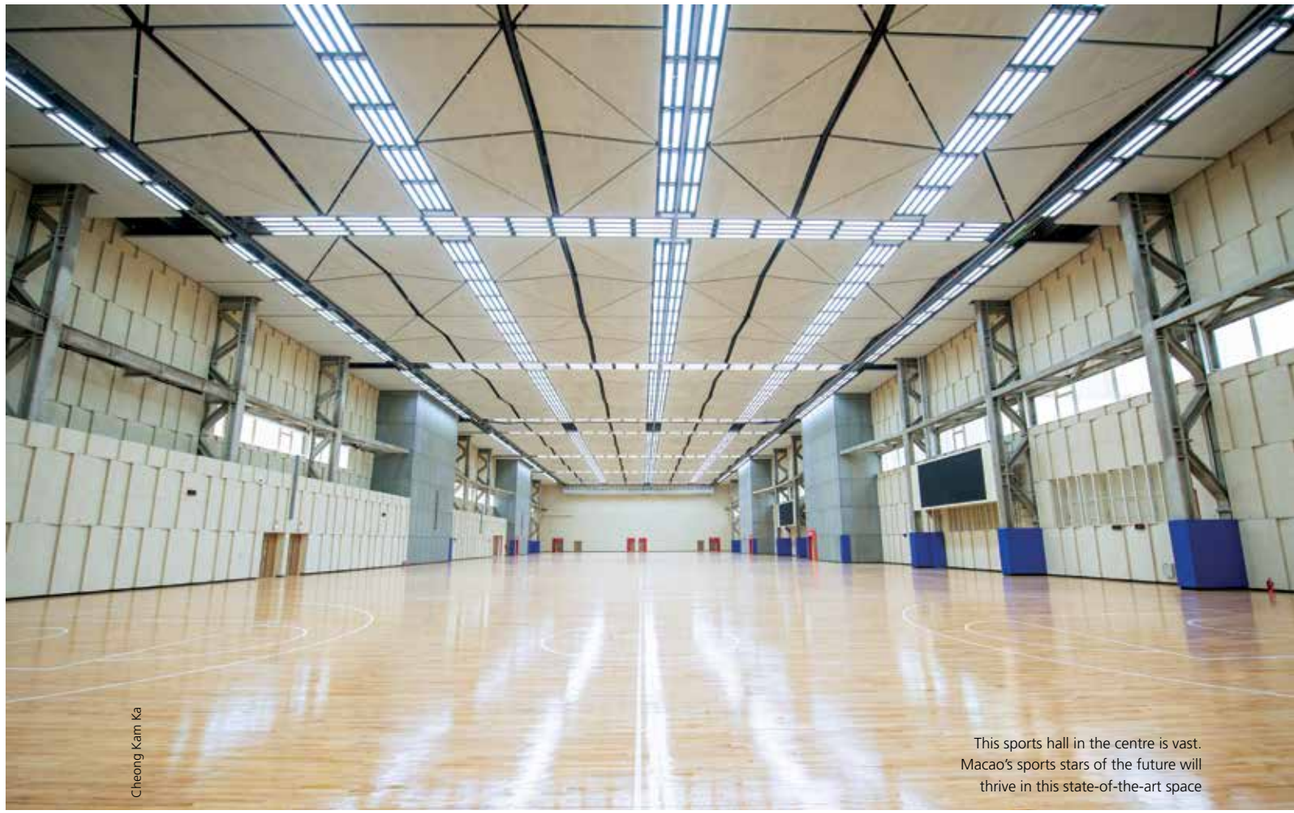
"This centre will give hope to the city's sports teams," says Fu, "and it should motivate the city's athletes into continuing to pursue their dreams in the sport of their choice. With the centre's ample space for training, all of the athletes in Macao are looking at a bright future." •

Presented by the **Sports Bureau**

THE FAST FACTS

The Athlete Training and Development Centre in Cotai is a major new crown in Macao's sports development. Here is a quick overview of the facts:

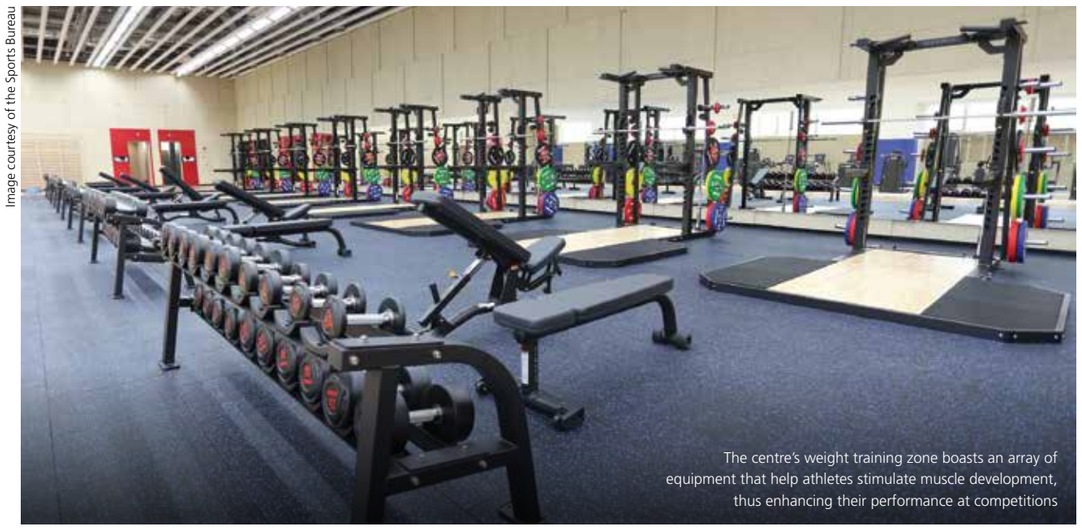
- The centre has cost MOP 1.63 billion (US$203.2 million) so far to create.
- It occupies a building floor area of about 12,000 square metres.
- The total gross floor area of the whole site is 59,000 square metres.
- It boasts a couple of two-storey multifunctional gymnasiums at 5,000 square metres each as well as a five-storey training centre covering a gross floor area of over 20,000 square metres.
- There is a 200-square-metre atrium garden next to the centre.
- A 2,000-square-metre outdoor terrace garden on the mezzanine floor provides natural insulation to the whole centre.



Cheong Kam Ka

This sports hall in the centre is vast. Macao's sports stars of the future will thrive in this state-of-the-art space

Image courtesy of the Sports Bureau



The centre's weight training zone boasts an array of equipment that help athletes stimulate muscle development, thus enhancing their performance at competitions

Portuguese-speaking countries

Land of sunshine

Text **Neil Ford**

Solar energy is on the rise in Brazil and Chinese companies in the industry have quickly identified the South American giant as a key market for overseas expansion.

It's the fifth largest country in the world in terms of land mass. Brazil, the biggest country in South America, occupies a land area of more than 8.5 million square kilometres – and that's a huge amount of space for the sun to relentlessly shine on during the nation's hot summers and at other times of the year. With this space and sunshine comes the potential for countless solar energy plants – and Chinese companies in the renewable energy sphere have begun to clearly identify Brazil as a key market for overseas expansion.

Chinese companies operating at all levels of the solar photovoltaic (PV) sector have been pinpointing Brazil for a range of projects. JinkoSolar, the world's largest solar panel manufacturer based in Shanghai, and BYD (Build Your Dreams), the Shenzhen-based world's largest maker of electric vehicles which also manufactures solar panels, are rapidly increasing their solar module manufacturing capacity in the colourful South American country. On top of this, BYD has joined China General Nuclear Power Group – or CGN – as solar farm operators in the Portuguese-speaking nation. On the Brazilian side, an array of state organisations and regulators have swung their support behind the renewable energy boom that could revolutionise power production in the country.

China's JinkoSolar Holding Company, which has operated in Brazil since 2012, announced in January that it could sell one gigawatt – or GW – of solar panels in Brazil in 2020, ramping up sales quickly over the course of the year, with just 100 megawatts – or MW – in the first quarter. Its 400W units are being distributed in Brazil by Aldo Solar. This compares with JinkoSolar's expected global sales of 20 GW, up from 16 GW last year. A total of 1.3 GW of solar distributed generation (DG) was added to the Brazilian grid last year, with JinkoSolar taking a 12 per cent share but its 1 GW target should give it a much bigger slice of the market, even if – as expected – the overall market grows rapidly.

JinkoSolar's general manager for Latin America, Alberto Cuter, says that the Brazilian DG market – the market for distributed generation, the electrical generation and storage performed by small, grid-connected devices – is 'actually growing impressively' and represents 'the first key market for Jinko in Latin America'. "We are delighted," he says, "that Aldo Solar, one of the most professional and experienced distributors in Brazil, decided to put their trust in the superior quality of JinkoSolar modules for this huge distribution agreement."

The distributed generation

Traditional power sectors rely on large power plants generating electricity that is then transported via the grid to commercial and residential consumers, with a proportion of that electricity lost in transmission. DG projects are still connected to the grid but involve much smaller generation projects with a far higher proportion of electricity sold locally because of the much higher number – and wider distribution – of power plants. Transmission losses are therefore much lower. DG is usually not a commercial option for traditional thermal power plants – fired by coal, gas or oil – but is now becoming much more popular because of the renewable energy boom.

It works particularly well with PV projects, on which costs have fallen rapidly because mass production has reduced manufacturing costs at the same time as solar cells have become more efficient – that is, they are able to turn a higher proportion of the sunlight that falls upon them into electricity. There is little sign of these efficiency gains coming to an end, so it seems unlikely that any new gas or coal-fired power plants will be able to compete with solar and wind power in a decade's time.

According to figures from the Brazilian Association for Solar Photovoltaic Energy (ABSOLAR), national solar DG capacity reached 2 GW in January, from 171,000 connected arrays. By the end of April, ABSOLAR announced that the total installed solar capacity in Brazil had reached 5 GW and that is was now employing 130,000 people. Solar PV accounts for 99.8 per cent of all Brazilian DG generating capacity, with 72.6 per cent owned by residential consumers and 17.99 per cent by commercial operators. Minas Gerais

has more DG connections than any other state. Brazilian solar power production was 16 per cent higher at the start of this year than at the beginning of 2019.

At the end of April, it was announced that China-based solar module manufacturer Amerisolar is planning to open a solar module factory at Belo Horizonte International Airport in Minas Gerais state. Solar panel production was expected to begin as we went to print.

Governments usually want to retain a proportion of thermal generating capacity in their generation mixes because solar and wind power production is intermittent, whereas coal and gas plants offer baseload – or generally constant – power production. However, battery storage is becoming cheaper and more effective, with 'solar plus battery' projects now being developed, including in the USA, so even this advantage for thermal plants is likely to disappear over the next few years. While the environmental advantages of renewables, in terms of much lower carbon emissions and air pollution, are well known, the commercial benefits are now being taken on board even by governments with more interest in economics than the environment.

A taxing time

In January, President Bolsonaro announced on social media that the Brazilian government is against possible taxation of solar generation by power sector regulator Agência Nacional de Energia Elétrica – also known as Aneel – and that followed his November veto of a bill that allowed tax exemptions for solar equipment imports. The emerging commercial benefits of solar power could explain the President's attitude to Aneel's plans to tax solar power production. He has been a strong opponent of environmental regulation, including restrictions on the oil and gas sector, but his tweet on 6 January said that he opposes the taxation plans and that the government would legislate to block it. Support has also come from the House of Representatives' Finance and Taxation Committee, which has approved the introduction of incentives for renewable power investment by farmers.

In December, the Brazilian Chamber of Foreign Trade (Camex) agreed to exempt imported solar cells – used in solar panel manufacture – from import tariffs, although President Bolsonaro is concerned about the impact on his government's finances. More establishment support came at the start of January, when Brazil's development bank, BNDES, agreed to lend US$322.9 million (MOP 2.58 billion) to Spain's Iberdrola, providing 80 per cent of total construction costs on 370.8 MW of wind farms in Paraiba state that are due to come on stream in 2022. The European Investment Bank is providing another EUR 250 million (MOP 2.16 billion) to support 520 MW of new Iberdrola wind power capacity in Brazil.

JinkoSolar is not the only Chinese firm to identify opportunities in the Brazilian solar power sector. BYD, which is also known for its battery manufacture, was due to double production at its factory's solar panel output in Campinas, in the state of São Paulo, in February. The firm's marketing and sustainability director for Brazil, Adalberto Maluf, said that falling component costs and the attractiveness of the Brazilian market had prompted the decision. BYD, which is believed to have its eye on the manufacture of thousands of electric buses in Brazil over the coming years, as well as the possible acquisition of Ford's old São Bernardo do Campo factory which closed in October, opened its first factory in Brazil in 2015 and hopes to increase its market share from 20 per cent last year to 35 per cent this year.


JinkoSolar

> *We are delighted that Aldo Solar, one of the most professional and experienced distributors in Brazil, decided to put their trust in the superior quality of JinkoSolar modules for this huge distribution agreement.*

As well as selling its solar panels, BYD is developing its own generation projects, including the Araçatuba solar plant, also in São Paulo state, to supply commercial customers. Until 2018, it only sold its solar modules to big projects but that year began working with Aldo Solar to market its products to the DG market. It now works with a variety of distributors in the country, including Alsol. Together, the two companies market an integrated 400 kW solar unit with a 1.36 MWh battery which allows electricity produced during the day to be stored for use in the evening, which is during peak residential demand.


Workers at a BYD factory in Brazil
BYD

Battery powered

BYD is to build a new lithium battery factory in Brazil to supply electric vehicles, including bus fleets in São Paulo, Brasilia and other cities. It delivered its first pure electric buses to São Paulo at the end of 2018, with electricity supplied by BYD's own solar project. BYD's lithium batteries enable the vehicles, each with the capacity to carry 80 passengers, to cover 250 kilometres on a single charge. More than 45,000 BYD buses now operate around the world.

The firm says that it is the world's biggest manufacturer of lithium batteries and pure electric vehicles. The company's vice president of sales for Brazil, Wilson Pereira, says: "Our recent deliveries, not only in the Brazilian market but also in Chile, have made BYD the leader in the electric bus sector in South America." São Paulo's maximum air pollution and carbon emission levels, it has been reported, are being decreased every year by the city council, encouraging the uptake of electric buses.

Last June, China's CGN Energy International Holdings announced that it had bought 540 MW of Brazilian renewable energy generating capacity from Italy's Enel for BRL 2.9 billion (US$567.8 million or MOP 4.57 billion), compromising the 292 MW Nova Olinda and 158 MW Lapa solar projects, plus the 90 MW Cristalandia wind farm. CGN will take over the three 20-year power purchase agreements – or PPAs – with a price of about US$0.08/kWh (MOP 0.64/kWh) that run until 2035, with Enel continuing to provide operation and maintenance support on the three projects. The Italian company intends to use the proceeds to develop new renewable energy projects in Brazil and the firm is already building the 475 MW São Gonçalo solar park, which is expected to come on stream this year.

Other news related to China, Brazil and energy includes the announcement in March that Brazilian energy management company Grupo IBS Energy had secured a contract from PowerChina to provide engineering, procurement and construction services for an 80 MW biomass project – where plant or animal material is used for energy production – in the city of Lençóis Paulista in São Paulo state. The project is expected to break ground in July. And last month, Canadian Solar closed a US$30 million (MOP 238 million) funding round from the China-Portuguese Speaking Countries Co-operation and Development Fund, which was established by the China Development Bank and the Macau Industrial and Commercial Development Fund. It will use the capital to develop and build photovoltaic projects in Brazil.

Booming times

Projects defined as providing renewable energy by Aneel accounted for more than three quarters of the new generating

capacity added to the Brazilian grid last year: adding up to 4,839 MW out of the 7,246 MW installed. However, large hydro schemes accounted for part of that and large hydro is not regarded as a renewable energy technology by many organisations because of the impact of construction on flora and fauna, as well as displacing those living in the affected area. Nevertheless, wind farms accounted for 971 MW of new capacity and solar for 551 MW. Wind and solar now contribute nine per cent and 1.5 per cent, respectively, of the country's total generating capacity of 170 GW.

Although wind power is still the leading renewable energy technology in Brazil, there are signs that solar power is catching up. Aneel has launched a licensing round for renewable energy projects to be awarded 20-year PPAs, plus 30-year PPAs for hydro projects, commencing in 2024. The range of bidders has already been revealed, with 51,438 MW included in the bids, of which 20,825 MW comes from 659 wind schemes, plus an incredible 28,667 MW from a total of 794 solar projects.

Aneel's last licensing round, which concluded on 14 January, sanctioned 1,162 MW of new capacity. Wind was the big winner, with 39 wind farms due to provide 878 MW. Similarly, the wind sector took 1,040 MW out of the 2,245 MW licensed in October. Global offshore wind development remains concentrated in the UK and other parts of the North Sea but is beginning to take off offshore the United States and now Brazil's Neoenergia hopes to oversee the development of three big projects off the shores of the Brazilian states of Rio de Janeiro, Rio Grande do Sul and Ceará. The sun could soon certainly shine on Chinese companies who identify the Brazilian wind power industry as the next big energy opportunity in the country. All that may yet slow down, however, as it's being predicted with solar energy. As we went to print it was reported that increasing import costs, a fall in electricity consumption and indefinitely proposed auctions are likely to impact the momentum of Brazil's solar PV sector. Globaldata predicted that the country's annual installed capacity is expected to decline to 0.7 GW this year from 1.3 GW last year due to the economic effects of COVID-19. But nevertheless, the solar energy sector has been rapidly growing and there is expected to be plenty of future opportunities in this market for ambitious Chinese companies. •

Nova Olinda, Brazil

Total Eren

Lapa located in Bom Jesus da Lapa, in the north-eastern state of Bahia, Brazil

Zoom

Images from the sky

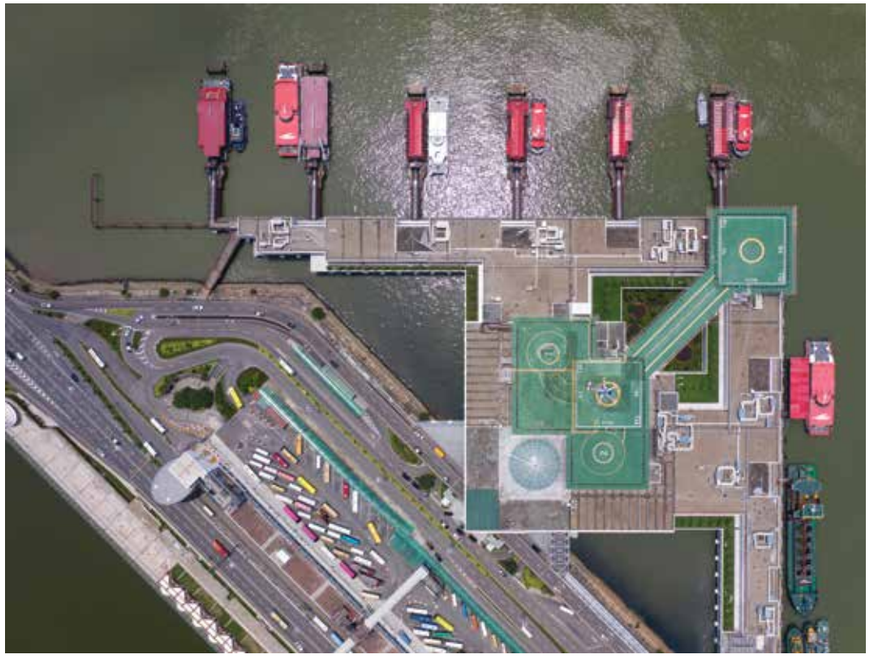
Text **Rafelle Marie Allego** Photos **Cheong Chi Fong**

Cities are often viewed from the ground, not from high up in the air. However, local photographer Cheong Chi Fong regularly gets his drone out to give a unique perspective of Macao from the skies. He has shared a series of aerial shots with us for this issue's Zoom, highlighting some well-known landmarks in the city as well as a few hidden gems. Take a fresh look with us at Macao's inimitable beauty from the heavens.

Part of the Historic Centre of Macau, which is on the UNESCO World Heritage list, Guia Fortress was built between 1622 and 1638. The lighthouse inside the fort was built in 1865 and is considered the first modern lighthouse on the Chinese coast.

Macao peninsula's Nam Van Lake and Macau Tower slowly come alive at nightfall.

A mass expanse of urbanisation stretches out beyond the border between Zhuhai and Macao on the Ilha Verde side.



A unique aerial view of the Macau Outer Harbour Ferry Terminal. An array of ferries are in the dock, waiting to head off to Hong Kong and other locations.

The Tap Siac Craft Market is held at Tap Siac Square twice a year, bringing locals together in celebration of creative talents from the city and overseas.

Galaxy Macau's 75,000-square metre Grand Resort Deck boasts the longest skytop aquatic adventure river ride in the world. It runs for 575 metres.

This aerial shot of a water walkway surrounded by lotus plants is in Lou Lim Ieoc Garden, a garden built by merchant Lou Kau in 1906.

Standing tall at 258 metres, the Grand Lisboa entertainment resort was completed in 2008. It dominates the skies, whether photographed from above or below.

Macao's 5.2-square kilometre Cotai Strip, the home of many iconic entertainment complexes, occupies reclaimed land between Taipa and Coloane.

The Parisian Macao, located on the Cotai Strip, opened on 13 September 2016. The Eiffel Tower replica is exactly half the size of the real landmark.

Part of the Historic Centre of Macao, Senado Square boasts a beautiful Portuguese wave-patterned mosaic that covers the whole 3,700-square metre pavement.

To finish off our display, here's an aerial view of the entire Macao peninsula. A fascinating Asian city, wherever you view it from.