Visitors order from a 'restaurant of the future' at a conference in Hangzhou, China. The country has set aside around US$332.6 billion for innovative start-ups.

HUANG ZONGZHI/XINHUA/ALAMY LIVE NEWS

THE INNOVATION HUBS THAT DRIVE CHINA

China is transforming itself from a low-cost manufacturing base to a global industrial leader through the spread of commercial centres.

BY FLYNN MURPHY

A new 'innovation hub' seems to launch in China each week. Whether it's an office of one of the 'BAT' companies — Baidu, Alibaba and Tencent, China's most prominent tech giants — or a regional town's overnight conversion into a nerve centre for a particular hardware type or research field, few can deny the dizzying velocity of change and development. As of 2016, the nation had more than 1,600 business incubators.

"You're basically going from an agrarian society to a digital society without the bricks and mortar in the middle," says Hong Kong-based Warwick Pearmund, who works with Chinese tech companies as part of his role at the international recruitment firm Pure Search (see 'Q&A: Warwick Pearmund'). "That makes this region incredibly interesting." Pearmund advises that foreign researchers looking for work in China should think laterally about what the country needs next. For example, eyeing the nation's vast e-commerce system, now the world's largest, for opportunities in data science.

China's government is investing more money into its domestic start-ups than any other country in the world. In 2015, the total amount under management in government-backed venture funds was more than 2.2 trillion yuan (US$332.6 billion), according to data from Beijing's Zero2IPO Group. The money was held in around 780 so-called government guidance funds financed by tax revenue and state-backed loans.

In addition to making such huge investments, China has altered government regulations to help get projects moving, such as by relaxing visa requirements for staff and giving tax breaks to companies.

WHERE ARE THE COMPANIES?

Although innovation hubs are a dime a dozen in China, three cities are leading the pack in terms of commercially driven science and innovation: Beijing, Shanghai and Shenzhen. This is partly

historical. Beijing has housed China's leadership almost continuously for six centuries and is home to its most prestigious universities, Peking and Tsinghua, which draw the most academically gifted students from across the nation each year. And it's the headquarters of leading Internet and search company Baidu, which is at the cutting edge of China's forays into artificial intelligence and machine learning. It is also a hub for Chinese returnees.

China's financial capital and most populous city, Shanghai, has the means and expertise to roll-out ambitious projects. A recent report by global consultancy firm KPMG on the world's top ten innovation hubs outside Silicon Valley and San Francisco ranked Shanghai as the number one to watch for the next four years, according to a survey of more than 800 technology company executives around the world. The authors credited the high-tech parks there and also noted that the city's "more pleasurable lifestyle and favourable climate" were attractive draws for outside talent. Although Shanghai's summers can reach temperatures of 40 °C, its air pollution is not as severe as Beijing's, which tied with Tokyo as the third city to watch, just after New York.

"Shanghai has been getting a lot of attention recently because the city's government is trying to make it the financial services hub of Asia," says Egidio Zarrella, a partner at KPMG China who focuses on innovation. He said the city would thirst for mathematicians and data scientists as it grows into this role.

China's third commercial centre is Shenzhen, which grew from a fishing village of around 30,000 people in the 1970s to become one of the world's biggest manufacturing hubs, with a population of more than 10 million. Shenzhen was China's first Special Economic Zone (launched in 1980 under the guidance of China's paramount leader Deng Xiaoping), growing from humble beginnings through government planning and foreign capital to become the world's factory. Now maturing beyond that status, diversifying into a centre for advanced manufacturing, robotics, genomics and more (see 'Q&A: Yongwei Zhang').

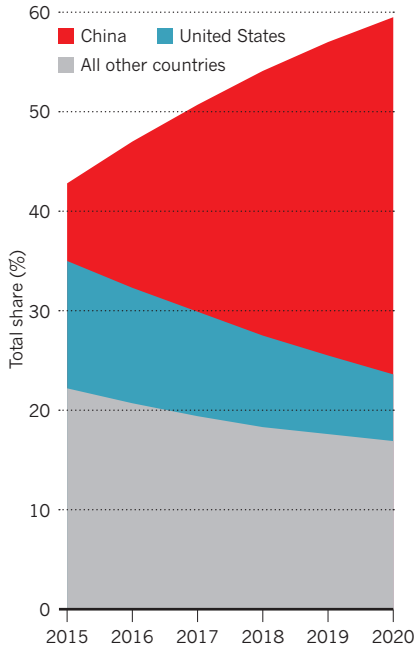
"Shenzhen is a very important hub for commercial applications," says Roy Green, outgoing dean of the Business School at the University of Technology in Sydney, Australia. "Every major corporate that wants to do very competent and relatively low cost prototyping comes to Shenzhen."

Mike Reed, an Australian mechatronics engineer who works at the high-profile start-up incubator HAX in Shenzhen, made the city his home almost three years ago. Reed says the efficiency of commercialization there is mind-blowing compared with its sluggish pace in his homeland.

"Living in Australia and making things don't really mix too well together," he says.

SALES SHARE

China's dominance of the world's e-commerce market is due to increase further over the next three years.



The 24-year-old finds Chinese life affordable and convenient. He estimates that taxis cost one-quarter of the price in his native Brisbane. His monthly rent, nearly 4,000 yuan, is "pretty reasonable", and he uses apps on his phone to do everything from food shopping to paying his phone bill.

Reed is excited by the commercialization projects he sees every day. He cites a Canadian team of academics who are working on a highly efficient equipment-manufacturing tool called Pin Press, as well as graduates from the University of Pennsylvania in Philadelphia who are developing a high-pressure water jet, Wazer, that can cut through steel.

FROM INTENT TO INNOVATION

China's large financial investments in science and technology research and development (R&D), alongside ambitious targets for innovation, have begun to challenge the hegemony of the world's most technologically advanced nations. One-fifth of all money spent on all R&D comes from China, and the country plans to become a global leader in artificial intelligence by 2030 (see page S10).

Yet government targets are not always enough to kickstart innovation, says Green, citing Hangzhou, the home of Alibaba and the flourishing start-up ecosystem that sprang up around it. Now the world's largest e-commerce platform (see 'Sales share') and a shining example of Chinese innovation, Alibaba was launched from the apartment of former English teacher Jack Ma. "Ma picked up what was happening in Silicon Valley and developed this new operation from nothing. That has brought lots and lots of other start-ups," says Green.

Other cities hope to emulate Hangzhou's success, and the country's most powerful innovation hubs face stiff competition. In Shenzhen, Reed says that he has noticed the prices rising steadily in recent years, and David Zweig, a social scientist at the Hong Kong University of Science and Technology, says that "the cost of living is driving people out". Neighbouring, less-developed cities have been quick to seize an opportunity to attract talent. The nearby electronics manufacturing hub of Dongguan is working hard to increase its ability to ▶

Q&A: YONGWEI ZHANG

Executive director of BGI Research in Shenzhen, a non-profit human genome research organization, and chief operating officer of Complete Genomics in San Jose, California, a gene sequencing company owned by BGI Research.

What are the benefits of working in Shenzhen and at BGI?
People, money, infrastructure, ample flexibility, and a good salary package. 'Shenzhen speed' is much faster than in the United States and enables us to develop innovative products much faster.

And the drawbacks?
Chinese companies and employees work very hard, often at the cost of work–life balance. Also, the travel. At BGI, all employees, including senior executives, proudly travel in economy class.

How does Shenzhen compare to Silicon Valley?
Both Shenzhen and Silicon Valley are communities of immigrants and share the common goal of looking for better lives for themselves. This makes the cultures largely the same. But only recently has Shenzhen started to attract talent from other parts of the world. FM

This interview has been edited for length and clarity.

accommodate researchers, says Zweig.

China's central government also seeds the growth of potential commercial hubs. Xiongan New Area, a collection of towns and fields 100 kilometres southwest of Beijing, was last April designated as a new economic area. There has been talk of universities moving or expanding to Xiongan as it grows into an industrial centre: local media have reported early interest from Peking University. He Lifeng of the National Development and Reform Commission, which is overseeing the Xiongan project, said that science and tech innovation would be promoted in the city, and it has been touted as a commercialization hub that will complement the existing R&D infrastructure in nearby Beijing. Chinese state media have trumpeted its future significance with comparisons to the successful Special Economic Zones of Shenzhen and Pudong New Area in Shanghai.

Guiyang, and the surrounding area into China's 'Big Data Valley'. Tax incentives and government support have drawn Microsoft, Huawei, Hyundai Motor, Tencent, Qualcomm and Alibaba to set up offices in Guian New Area, a newly created urban and industrial zone an hour's drive from Guiyang, purpose-built to attract high-tech companies. The local government predicts that investment in the area will grow to $3.34 billion this year and add 30,000 jobs. Learning outsourcing company NIIT, based in Gurugram, India, announced in January that it would conduct training at the site, aiming to recruit and train 2,000 candidates per year. The courses will cover areas such as big data, cloud computing and cyber security, and will place candidates inside companies and government departments.

"If you have missed the investment opportunity in Guangdong or Zhejiang 30 years ago, by no means should you miss that of Guizhou

"THE WORLD DOESN'T REALLY KNOW JUST HOW ADVANCED CHINESE TECHNOLOGY IS."

Although the focus of China's development has long been the east and southeast coastal regions, the Belt and Road trade-route initiative, which will link China with Central Asia and Europe, promises to open up China's west, where cleaner air and a lower cost of living could entice businesses. Chengdu, the capital of the central Sichuan province, has been courting high-tech manufacturing: 300 Fortune 500 companies already operate there. And the impoverished southwestern province of Guizhou has launched efforts to turn its capital, today," Jack Ma was quoted as saying by the newspaper *China Daily*.

It's a pattern seen again and again in the world's most populous nation. There will be many more Guiyangs and Shenzhens as China continues its long-term transition to innovation-driven development, pouring capital and resources into history's largest and most ambitious industrial modernization project. ■

Flynn Murphy *is a freelance health and science reporter based in Beijing.*

Q&A: WARWICK PEARMUND

Hong Kong-based associate director at Pure Search, an international recruitment firm.

What skills are Chinese companies looking for in outside talent?
It all comes down to data scientists. Whether mathematicians, statisticians or computer scientists. The rest of the world doesn't really know just how advanced Chinese technology is and how fast they can build businesses.

What gives potential recruits an edge?
Native Mandarin speakers who have either studied or worked overseas, particularly in Europe, the United States and Australia. In the last five years, it's noticeably changed — firms will say "bring us a native Mandarin speaker".

What do people dislike about working in China?
I have a client who's finding it frustrating working for a Chinese firm having worked overseas. You don't have the same freedom to make a difference. There's a lot more structure and it's more rigid. FM

This interview has been edited for length and clarity.

CAIA IMAGE/ALAMY

BREAKTHROUGH

SCIENTISTS REGENERATE LENS IN HUMAN EYE

Procedure removes damaged tissue to let stem cells grow.

BY JAMIE FULLERTON

In March 2016, it was revealed that a stem-cell therapy had given 12 Chinese infants suffering from cataracts the ability to see clearly (H. Lin *et al. Nature* **531,** 323–328; 2016). Lead scientist Kang Zhang, visiting professor at Sun Yat-sen University in Guangzhou and Sichuan University, said the regeneration of healthy lenses in children up to two years of age could be a paradigm shift in cataract surgery.

For five years, Chinese scientists worked in collaboration with researchers at the Shiley Eye Institute at the University of California in San Diego, where Zhang is a professor of ophthalmology, to develop a non-invasive surgical technique that can restore sight in just three months. During the procedure, surgeons remove the damaged lens from the patient but leave the lens epithelial stem cells intact. These grow and form a new lens to replace the old one.

Zhang says that conducting the clinical trials and tests on primates in China, rather than the United States, helped to keep costs low. He adds that attitudes towards animal testing in China, where animal rights protests are far rarer than in the United States, helped to move the research along quickly.

"If we were just doing it by ourselves in the United States it would have taken five to ten years," he says. "We were able to accomplish it in two to three years."

Praise came from around the world. Dusko Ilic, a stem-cell scientist at King's College London, called the research "one of the finest achievements in the field of regenerative medicine", and "science at its best".

Zhang says that further research using his team's techniques could further "harness a patient's own ability to regrow organs" in other areas of the body, such as the liver and brain. ■