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Science, Technology and Education Section
科技与教育处

Science, Technology, Education and Health News from China

Number 154 – April 2017

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Introduction

The story of the month covers China's new medical reform. China Swiss researchers have developed a system that enables smartphones to remotely manage and treat diabetes in mice. China aims to learn from Finland and Switzerland for research and innovation. China will be spending 59.4 billion US dollars on robotics and related services by 2020. China's first cargo spacecraft, Tianzhou 1, has completed the first of three fuel resupply tests. China to conduct several manned space flights around 2020. Peking University is to start enrollment for Oxford campus. China is aiming to increase the scale of its cloud computing industry by more than 2.5 times by 2019. Chinese university promotes language studies to support one belt one road initiative. Shenzhen's innovation development.

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Story of the Month

Reforms are a shot in the arm for capital's healthcare system

(China Daily, 07-4-2017)

End of medicine price markups puts focus on provision of better services

Beijing put a new medical care reform plan into effect on 8th April, which will bring an end to medicine price markups, according to local officials.

More than 3,600 medical institutions are involved in the reform and all of them will abolish the medicine price markups, according to Fang Laiying, head of the Beijing Municipal Commission of Health and Family Planning.

It is estimated that the cost of treatment per outpatient will be reduced by about 5 percent on average thanks to cuts in medicine prices, while there will be an average cost increase of 2.5 percent for inpatient treatment due to the growth of certain service charges, according to Fang.

Community hospitals and medical institutions will be given the same access to the medicines usually prescribed in higher-level hospitals, so that patients will have more choices, Fang said.

Marking up medicine prices is a practice that has been adopted by most public hospitals in China since the 1950s. It allows hospitals to sell drugs with markups usually at a rate of 15 percent above the drugs' tag prices.

Its purpose was to make up for the shortage in healthcare funding from the government, and it became part of doctors' salaries, creating incentive for doctors to over-prescribe.

In 2015, incomes from checkups, tests and medical treatment materials accounted for about 66 percent of the city's medical services revenue, while the incomes from the intelligence and labor of medical personnel, such as diagnosis, surgery, treatment and nursing, which are closely related to the quality of medical services, only accounted for 34 percent, according to Fang.

"The core of this new reform is to separate the functions of medical services and drug sales so as to shut down the markup mechanism in public medical institutions in Beijing," Fang said.

"The separation will cut off the channel for making money through over-prescription and help medical practitioners provide better treatments and other services," Fang said.

"The reform will effectively motivate the medical staff to pay more attention to the medical service they are providing, and further improve the doctor-patient relationship," said Li Ruifeng, a medical reform expert from Beijing University of Chinese Medicine.

Medical service fee

Another major change brought about by the reform plan is the cancellation of the registration fee and consulting fee, which will be replaced by a single medical service fee instead.

It embodies the intelligence and labor value of doctors, nurses and other medical personnel, creating a boost to the provision of better medical services, said Fang.

Third-level hospitals—the highest-level public hospitals in China—for example, will charge a medical service fee for outpatient services offered by its general practitioners of 50 yuan ($7.26) per instance, for associate chief physicians 60 yuan, for chief physicians 80 yuan, for renowned experts 100 yuan. The registration and consulting fees combined were less than 20 yuan.

For those patients who need emergency treatment, they should pay 70 yuan per instance, and the medical service fee for an inpatient will be 100 yuan per bed per day.

"Most of the doctors in our hospital are optimistic about the medical reform, we are expecting higher income in the following days," said a doctor from Beijing's Chaoyang Hospital, who asked to remain anonymous. The hospital is one of the third-level public hospitals in Beijing.

To ease the burden of the public for the medical service fee, the Beijing Human Resources and Social Security Bureau renewed its medical insurance policies, making the medical service fee reimbursable in the basic medical insurance systems for urban employees as well as urban and rural residents.

Price changes

Besides the medical service fee that is correlated with doctors' incomes, the prices for general healthcare services, ranging from beds and nursing, medical imaging examinations such as CT and MRI scans, to traditional Chinese medicine, surgery and other treatments, will also have major changes, according to the Beijing Municipal Commission of Health and Family Planning.

The general reform principle for those items is to increase the prices for beds, nursing, surgery and traditional Chinese medicine treatment, while reducing the prices for physical examinations using medical equipment.

For example, the price of common-level nursing for patients confined to a bed will be increased from 7 yuan to 26 yuan, appendectomy surgery from 234 yuan to 560 yuan, and acupuncture from 4 yuan to 26 yuan per session.

CT scans will drop from 180 yuan to 135 yuan, an MRI scan from 850 yuan to no more than 600 yuan, and a PET/CT scan from 10,000 yuan to 7,000 yuan.

Fang said the price reform of healthcare services involves 435 items. Medical imaging examinations account for 42.5 percent of the total number, general healthcare services 28.7 percent, traditional Chinese medicine services 22.1 percent, surgery and other physical treatments 6.7 percent.

He said that part of the costs of most of the 435 items will now be reimbursable, making the costs more affordable for patients.

Fang said community medical institutions will also be equipped with more drugs for chronic diseases, such as hypertension, diabetes and cardio-cerebrovascular diseases, offering more convenience for residents.

Similar medical care reforms will be promoted to all public medical institutions in China by the end of this year, according to the National Health and Family Planning Commission, China's top health authority.

(http://www.chinadaily.com.cn/china/2017-04/07/content_28826422.htm)

News

1. Chinese, Swiss researchers use smartphone-controlled cells to manage diabetes

(Global Times, 27-4-2017)

Chinese and Swiss researchers said on 26th April they have developed a system that, for the first time, enables smartphones to remotely manage and treat diabetes in mice.

In a study published in the US journal Science Translational Medicine, the researchers said they developed a smartphone app and used it to command engineered cells to produce insulin that helps diabetic mice achieve and maintain stable blood sugar levels within two hours.

"We believe that the ... concept could pave the way for a new era of personalized, digitalized, and globalized precision medicine," Haifeng Ye, professor of the East China Normal University in Shanghai, China, who led the study, told Xinhua.

For the study, the researchers first created cells that produced insulin when illuminated by far-red light, the same wavelengths emitted by therapy bulbs and infrared saunas.

Then, they added the cells to a soft bio-compatible sheath that also contained wirelessly-powered red LED lights to create HydrogeLEDs that could be turned on and off by an external command.

Finally, the HydrogeLEDs was implanted into the skin of diabetic mice to allow users to administer insulin doses remotely through a smart phone application.

In a small pilot experiment, the system also involved a control box called SmartController that communicates with the smart phone via the global GSM network and executes commands to turn on the HydrogeLEDs.

The scientists also paired the system with a Bluetooth-enabled glucometer, which allowed remote transmission of glycemic values to the smart phone for analysis.

When the measurements exceeded a pre-set threshold, the smartphone will signal the SmartController to turn on the HydrogeLEDs to enable insulin production.

"This work combines the unique capacity of electronic devices in reading and generating digital signals with the maximal theranostic precision of biological cells, and represents the first mobile healthcare system that unites the global markets of point-of-care technologies, mobile phone technology and cellular medicines," Ye said.

Ye expressed the hope that future versions of the system could have a glucometer, which would also be implanted in the body, to monitor the patients' blood sugar levels 24 hours a day in order to automatically trigger the therapeutic response.

Currently, more than 415 million people worldwide are living with diabetes, and frequently need to inject themselves with insulin to manage their blood sugars.

In a commentary accompanying the paper, Mark Gomelsky of the University of Wyoming said Ye's study takes us one step further toward "smart" cell-based therapies.

"How soon should we expect to see people on the street wearing fashionable LED wristbands that irradiate implanted cells engineered to produce genetically encoded drugs under the control of a smart phone?" asked Gomelsky. "Not just yet, but (this work) provides us with an exciting glimpse into the future of smart cell-based therapeutics."

(http://www.globaltimes.cn/content/1044355.shtml)

2. Finland, Switzerland apt models for research, innovation

(China Daily, 05-4-2017)

In three months, President Xi Jinping has traveled to Europe twice. Following his trip to Davos to attend the World Economic Forum and a state visit to Switzerland in January, Xi reached Finland on 4th April before flying to the United States for his first meeting with US President Donald Trump.

Xi has used his overseas trips to deliver messages on how China views the world and the global economy at a time when populism and protectionism seem to be gathering strength. Xi used his Switzerland visit, and will now use his Finland trip to express China's views that all global players, including the European Union and the US, should fulfill their due responsibilities to build a prosperous and peaceful world, instead of telling China what its global duties are. Besides, Switzerland and Finland can also help China strengthen its domestic program for innovation.

Last year, China announced a three-step plan to encourage and improve innovation. First, by 2020, China aims to increase its spending on research and development to 2.5 percent of GDP and ensure its knowledge-intensive service industry accounts for 20 percent of the economy.

Second, by 2030, China aims to raise the budget for research and development to 2.8 percent of the national economy and lift Chinese businesses to the medium-and high-end global supply chain, as well as make the country a global leader in innovation.

And third, by 2050, China aims to become a world leader in science and technology, with its economy mainly driven by innovation. By that time, China aims to make its universities and research institutions world leaders, with science and research becoming the backbone of national strategic resources.

Such innovation goals go hand in hand with China's other economic restructuring efforts such as poverty reduction, tackling the aging population and improving people's livelihoods. Though it has made rapid progress in innovation in recent years, the gap between China and its competitors remains wide. Based on the World Intellectual Property Organization's annual report, China ranked 25th in 2016, moving up nine spots from 2012.

In Switzerland and Finland, China has perfect economic partners; Switzerland occupied the top spot in the World Intellectual Property Organization rankings, with Finland taking the fifth slot. And the two countries are willing to share knowledge and technology with China.

Such openness offers great opportunities for Switzerland and Finland. Even though the two countries' population is less than 10 million each, they can get access to China's market of more than 1.3 billion consumers.

And since innovation has become an integral part of the national policy, even Southwest China's Guizhou province, a relatively poor region, has made Switzerland an example of its efforts to reduce poverty.

Guizhou and Switzerland are both mountainous and landlocked areas, although their economies differ radically. But learning from Switzerland, China is injecting resources in environmental protection, infrastructure construction, tourism and education to remodel Guizhou into the Switzerland of the East. China has a lot to learn from Finland, too, especially in terms of innovation, and scientific and technological research.

(http://www.chinadaily.com.cn/opinion/2017-04/05/content_28793769.htm)

3. China spending on robotics to hit 59.4 bln USD in 2020: IDC

(Global Times, 06-4-2017)

International Data Corp. (IDC) reports that China will be spending 59.4 billion US dollars on robotics and related services by 2020.

As the largest and the fastest growing robotics market in the world, China will account for over 30 percent of all robotics spending in 2020, according to a press release published on IDC's website.

Manufacturing continues to dominate China spending on robotics, it said.

"China continues to lead the adoption of robotics globally, primarily driven by strong spending growth in process manufacturing and cross-industry applications," Zhang Jingbing, research director with IDC Worldwide Robotics and Asia Pacific Manufacturing Insights, said in the press release.

"In China, we are also seeing accelerated growth in commercial service robots especially for automated material handling in factories, warehouses and logistics facilities," Zhang added.

By 2020, China's spending on robotic systems including industrial, service and consumer robots will grow to 29 billion US dollars, while services-related spending involving application management, education and training, hardware deployment is expected to surpass 15.8 billion US dollars.

(http://www.globaltimes.cn/content/1041158.shtml)

4. Successful fuel test takes China closer to manned space station dream

(China Daily, 28-4-2017)

China's first cargo spacecraft, Tianzhou 1, has completed the first of three fuel resupply tests with the Tiangong II space laboratory, Zhang Youxia, commander-in-chief of China's manned space program announced on 27 April.

He described the mission as a success.

China Manned Space Agency said in a news release that the successful test means China has become the third nation to master in-orbit refueling technology, following Russia and the United States.

The technology is crucial to China's plan to establish a manned space station by about 2022.

Two more refueling tests will be conducted between Tianzhou 1 and the space lab during the cargo spacecraft's five-month mission which began on April 20 when it blasted off from the Wenchang Space Launch Center in Hainan province.

(http://www.chinadaily.com.cn/china/2017-04/27/content_29116828.htm)

5. China to conduct several manned space flights around 2020

(China Daily, 28-4-2017)

China plans to conduct several manned space flights from 2019 to 2022, during which a 60-tonne space station will be assembled and built, said Wang Zhaoyao, director of China's manned space program office, on 28th April.

"Tianzhou-1, China's first cargo spacecraft, was the last flight mission of the country's manned space program before the construction of a permanent space station," Wang said at a press conference.

The spacecraft and Tiangong-2 space lab completed their first in-orbit refueling on 7th April, marking the completion of the country's space lab mission.

"The successful conclusion of the mission shows that China's manned space program has entered the space station era," Wang said.

"The space station program has been progressing steadily with its key technologies and plans already completed and its relevant flight products being tested," he said. "Chinese astronauts are preparing for the space station era. They are expected to stay in space for three to six months or even longer during future missions."

Two astronauts, Jing Haipeng and Chen Dong, completed their 33-day journey, the longest mission in the country's manned space program to date, onboard the Shenzhou-11 spacecraft on Nov 18 last year.

Wang said the astronauts would be engaged in more extra-vehicular activities during the construction of the space station, which could pose challenges.

(http://www.chinadaily.com.cn/china/2017-04/28/content_29133887.htm)

6. Peking University to start enrollment for Oxford campus

(China Daily, 09-4-2017)

China's prestigious Peking University will start staff recruitment and student enrollment for its British campus in the city of Oxford in June, according to the dean of HSBC Business School of Peking University on 9th April.

Peking University signed with the Open University in February to purchase the 15-acre campus in Oxford for 8.8 million pounds ($10 million). This was the first time that a Chinese university has used its own finance to set up and manage a school in a foreign country, according to Hai Wen, dean of HSBC Business School.

He said the school would enroll 100 international students when it opens in August 2018.

It will coincide with the 120th founding anniversary of the the elite Beijing university.

"The timing is monumental. In 1818, China's first foreign-founded school, Ying Wa College, was set up by a British missionary. Now 200 years later, a Chinese university will set up its own school in Britain," he said. Hai said that in recent years, many foreign universities had opened schools in China. Peking University, as one of China's top universities, should play a leading role for Chinese universities to go global.

He said HSBC Business School's finance, management and economics courses will feature Chinese business cases to help students become better acquainted with the Chinese economy and reforms. Students will take the first year course in the Oxford campus and the second year at the school's campus in the city of Shenzhen, southern China.

Students on the school's Shenzhen campus will be allowed to select elective courses on the Oxford campus.

(http://www.chinadaily.com.cn/china/2017-04/09/content_28848717.htm)

7. China sets ambitious goal in cloud computing

(Xinhua, 11-4-2017)

China is aiming to increase the scale of its cloud computing industry by more than 2.5 times by 2019, from 2015 levels, according to a new government plan.

The scale of the cloud computing industry will be expanded to 430 billion yuan (about 62.29 billion U.S. dollars) by 2019, up from 150 billion yuan in 2015, according to an action plan for 2017-2019 issued by the Ministry of Industry and Information Technology.

Other targets include making breakthroughs in core technologies, increasing cloud computing in manufacturing and government affairs, and strengthening the global influence of Chinese cloud computing companies.

The ministry expects that two to three Chinese cloud computing companies will lead the global market within three years.

Cloud computing should be a strong support for China's manufacturing and Internet industries and help make other social and economic sectors informationized, the ministry said.

The ministry pledged to enhance cloud computing network security and improve security regulation and relevant laws, as many users from key industries are still hesitating due to safety concerns, reliability and movability.

In the next three years, the government will help boost cloud computing technologies and encourage local governments to work with leading cloud computing companies to build public service platforms.

Support will go to cloud computing-related innovation and entrepreneurship to provide services for small and medium-sized enterprises, the ministry said.

The plan promised better financial services and personnel training, as well as efforts in the branding of current enterprises and products.

Leading cloud computing enterprises should also seek overseas expansion and boost international cooperation in alignment with the Belt and Road Initiative, it said.

(http://news.xinhuanet.com/english/2017-04/11/c_136199971.htm)

8. University promotes language studies

(State Council, 06-3-2017)

China vowed to provide more quality public services for senior citizens, as a way to deal with an aging society, according to the five-year plan (2016-2020) on elderly care issued by the State Council on March 6.

Pension and healthcare systems will be improved. According to the plan, by 2020, 80 percent of urban and rural residents should enjoy basic pension insurance, and 95 percent of citizens should be covered by basic health insurance.

A nationwide information network for basic health insurance will be built to facilitate settlement of healthcare costs for retired people across regions, said the plan.

Local governments will be encouraged to include basic rehabilitation devices in the reimbursement catalog for families living in hardship.

According to the plan, minimum living allowance and other social assistance should be available for all registered poor senior citizens.

As an integral part of elderly care, families and communities are asked to take their share of responsibilities. Community elderly care centerswill receive more government funding.

Private capital and nongovernment organizations will have more access to the elderly care market, so that senior citizens can have more options in diverse services. By 2020, elderly care beds provided by governments should account for no more than 50 percent of the total.

Hospitals and elderly care institutions were asked to enhance cooperation and services, and more efforts should be made to build rehabilitation hospitals, nursing homes and palliative care institutions.

Hospitals should do more in rehabilitation and the fight against old-age diseases, the plan said. By 2020, over 35 percent of hospitals above second-class will have geriatric care departments.

More physical exercise facilities will be built and open for old people free of charge. Sports organization for senior citizens will be encouraged.

Education and culture for the elderly population will also be developed. The plan said that by 2020, every city above county level should have at least one university for senior citizens.

In addition, senior citizens will also be encouraged to get more involved in public activities, especially volunteer work. The plan hoped that by 2020, over 12 percent of elderly people will be registered as volunteers.

According to the document, by 2020, the elderly population over 60 year old will reach approximately 255 million, accounting for 17.8 percent of the total. The number of older people living alone will reach 118 million.

(http://english.gov.cn/policies/latest_releases/2017/03/06/content_281475586946296.htm)

9. Shenzhen is a hothouse of innovation

(The Economist, 08-4-2017)

On a recent weekend several hundred academics and lawyers gathered in a hotel ballroom in Shenzhen for a discussion on “Innovation, inclusion and order”, an event jointly organised by the law schools at Peking, Oxford and Stanford universities. Legal conferences can be soporific, especially in China, and a scholar from Beijing duly set the tone by asserting that “order is important in the market.” But one of the local speakers livened things up by delivering a surprisingly stout defence of disruptive innovation. Xu Youjun, vice-chairman of the Shenzhen division of the Chinese People’s Political Consultative Conference, a government advisory body, said Shenzhen owed its success

not to the government or the Communist Party but to its policy of allowing people to go “beyond the planned economy”.

The city imposes few limits on freedom of movement (though only a minority of its population has an official hukou, or household-registration certificate), is relaxed about employment contracts and does not discriminate against outsiders. “People are the greatest source of our growth,” Mr Xu concluded. The contrasting views of the boffin from Beijing and the local apparatchik help explain how disruptive entrepreneurs turned Shenzhen into one of the world’s most innovative cities.

Between 1980 and 2016 Shenzhen’s GDP in real terms grew at an average annual rate of 22% and today stands at 2trn yuan. The city’s Nanshan district, home to about 125 listed firms with a combined market value of nearly $400bn, has a higher income per person than Hong Kong. Unlike Beijing, which has many top-flight universities, Shenzhen has only a handful of lacklustre institutions of higher learning; but so many graduates from all over China flock to the city that they make up a greater share of its population than do graduates in Beijing.

Shenzhen spends over 4% of its GDP on research and development (R&D), double the mainland average; in Nanshan the share is over 6%. Most of the money comes from private firms. Companies in Shenzhen file more international patents (which are mostly high quality, unlike many of the domestic Chinese ones) than those in France or Britain (see chart).

The official story attributes Shenzhen’s success to brave party leaders and far-sighted policies. Deng Xiaoping is lauded for liberalising the region’s economy. Later political leaders receive praise for investments in infrastructure that enabled rapid growth. That is an incomplete version of history.

An incisive new book, “Learning from Shenzhen”, edited by Mary Ann O’Donnell, Winnie Wong and Jonathan Bach, reveals that many of the advances seen since the city was opened up in 1980 came disruptively from below. For example, early reformers pushed ahead with unauthorised investment deals with non-mainland companies and retroactively developed the legal framework needed to protect foreign firms. Time and again, grassroots innovators hit on better ways of doing things, even though strictly speaking they were not permitted. When their risk-taking proved successful, communist leaders typically took the credit. So the best way to study innovation in Shenzhen is to examine it through the eyes of its entrepreneurial firms.

The common perception that China is incapable of innovation needs re-examining. According to a widely quoted study published earlier this decade, the value added on the mainland to Apple’s iPods (nearly all of which are assembled there) represents less than 5% of the total, reinforcing the stereotype of Chinese factories as low-end sweatshops. However, a more recent study by Britain’s University of Sussex and others for the European Commission concludes that the iPod example “is far from representative”. These researchers calculate that the average value China adds to its exports is 76% (the EU’s is 87%). The World Bank reaches similar conclusions.

The PRD’s companies, which account for a huge chunk of China’s innovation, have been moving up the value chain. Local firms that used to rely entirely on imported know-how and parts have started to work on their own inventions and methods. Foreign firms that used to come to the delta to harness its brawn are now tapping into its brains as well. Today, Shenzhen is attracting many entrepreneurs keen to develop new ways of making things. The innovators are transforming the entire delta into an advanced manufacturing cluster. Many multinationals have a listening post in the city to stay close to the latest trends.

Making it, better

Foxconn, a Taiwanese contract manufacturer which employs over 1m workers on the mainland, is sometimes represented as a low-tech sweatshop; in fact, it holds international patents in areas ranging from electrical machinery to computing to audio-video technology. It is expanding its Shenzhen facility to support rapid prototyping by Apple’s new R&D centre in the city. Its joint venture with Japan’s Sharp is investing $8.8bn in Guangzhou to make advanced liquid-crystal displays. It is also developing industrial robotics in Shenzhen.

BGI, formerly known as the Beijing Genomics Institute, moved to Shenzhen to get away from northern bureaucrats. Seven years ago it was declared a “DNA superpower” by Nature, a science journal, after it bought so many genome-sequencing machines that it ended up owning more than half the world’s total. It is due to go public shortly.

Mindray, a devices firm with $1bn in global sales, is developing new technologies for ventilators, digital operating rooms and surgical robots. The firm's experience of managing both American and Chinese researchers is revealing. Its researchers in Silicon Valley are not just tutoring their counterparts in Shenzhen, it turns out, but also learning from them. Cheng Minghe, the firm's president, observes that Westerners produce high-quality research but take a long time over it, whereas the locals are better at speedy development of new kit.

Huawei spends more on R&D than Apple does. The privately held Shenzhen firm made its name as a telecoms-equipment vendor, but is now a big force in smartphones and cloud computing too. Its revenues for 2016 are estimated at 520bn yuan, a 32% increase on a year earlier. It devotes an impressive 15% of its revenues and 82,000 of its 180,000 employees to R&D.

Huawei is innovating as it is globalising. Dieter Ernst of the East-West Centre, an American think-tank, praises the company for creating a "global innovation network" of the sort that only Western multinational companies used to have, with more than two dozen R&D centres the world over and a number of collaborative hubs run with leading multinationals and universities.

This has paid dividends. Huawei is one of the world's most prolific generators of high-quality international patents. Along with Sweden's Ericsson it is at the forefront of 5G, which will replace the current 4G networks for mobile telephony. Its narrow-band internet-of-things protocol, a cheap and low-energy way to connect machines to the cloud, was recently approved as a global standard.

Another way Shenzhen is rewriting the rules is by embracing open innovation. In the West, corporate innovation has generally been a secretive, top-down affair. Many factories in the city started by making clever imitations of Western goods, which led foreigners to dismiss the locals as mere copycats. That was a mistake. David Li of Shenzhen's Open Innovation Lab argues that the copycats have since morphed into a powerful ecosystem of collaborative, fast-learning suppliers and factories. "Anybody can come to Shenzhen with an idea and get it prototyped, tested, made and put on the market at a decent price," he says. Silicon Valley is obsessed with rich-world problems, he thinks, but China's open innovators work on affordable solutions for the masses on everything from health care to pollution to banking.

Mr Li says the already frenetic pace of Chinese innovation is speeding up further. Dealmaking used to involve long banquets and vast quantities of baijiu, a local firewater. Now introductions are made at the flick of a finger on WeChat, a remarkable messaging and payments app with more than 800m users. As soon as a WeChat group is formed, there is little need for phone calls or meetings. Tencent, the internet and online-gaming giant that invented WeChat, is also based in Shenzhen. Worth some $250bn, it is one of Asia's most valuable firms. Its snazzy and green new headquarters in Nanshan towers over a modern neighbourhood of startups, incubators and funky coffee shops.

One of Shenzhen's most daring startups, Royole, is expanding its output of an extraordinary product: the world's thinnest foldable full-colour touchscreen display. Liu Zihong, a mainlander, earned his doctorate in electrical engineering at Stanford University, where he dreamt of radical new ways for machines and humans to interact. When he started Royole, he says, he knew it had to be based in Shenzhen. Getting from early-stage research to manufactured product would require a massive amount of what he calls integrated innovation: "Materials, process, device design, circuit design—all needed to be innovated…if you changed one material, you had to change the process." His team had to develop entirely new materials and factory tools, including custom-built robots, to make his screens, accumulating over 600 patents along the way. He insists this could not have been done even in Silicon Valley, because California cannot match Shenzhen's ecosystem of "makers".

With $280m in venture-capital investment, Royole is valued at $3bn. It is investing $1.8bn to build a heavily automated factory and integrated R&D complex which should propel sales past $3bn. But Mr Liu has even grander ambitions. He thinks his screens could be deployed more widely, in places such as cups, clothes, desks, even walls. "Last year the display industry was worth $150bn," he says, "but flexible displays will double that."

Hacking the future

Shenzhen has become the world capital for hardware entrepreneurs. Navi Cohen is the co-founder of Revols, a Canadian startup developing affordable, custom-fitted headphones. His firm raised a fortune on Kickstarter, a

crowdfunding site. When it tried to develop its product in Montreal, it found things slow and expensive, so it moved to Shenzhen, where supplies were cheap and factories made prototypes quickly. It is now in production.

Another promising startup that moved to Shenzhen is Wazer, an American firm. A conventional metal-cutting machine on a factory floor costs $100,000 or more. Shenzhen's know-how helped Wazer perfect a way to cut any material precisely with pressurised water. Its desktop cutter costs about $5,000 and will disrupt the industry when it comes to market later this year.

Revols and Wazer are among dozens of startups that have gone through a manufacturing boot camp run by Hax, a hardware "accelerator" based in Shenzhen's Huaqiangbei, the world's largest electronics-supplies market. Benjamin Joffe, a partner at Hax, reckons that Silicon Valley's experience of hardware is "six to seven years out of date". Big firms ranging from Johnson & Johnson, an American health-care firm, to Michelin, a French tyremaker, have entered into partnerships with Hax to get closer to these bright sparks.

The most successful of Shenzhen's recent startups is Da-Jiang Innovations (DJI), reportedly worth over $8bn, which makes affordable commercial drones. Frank Wang, the founder, and his 1,500-strong R&D team had to invent vital bits of the technology needed for its flying robotic cameras. The privately held firm commands over half of the global market for small civilian drones, and is purportedly planning to go public soon. It is now diversifying its offerings. Paul Xu, the head of DJI Enterprise Solutions, says it is aiming for business clients in fields ranging from agriculture and energy to public security. It is also considering a services-business model where users can rent airtime.

Shenzhen has done more than any place on the mainland to debunk the outdated myth of "copycat China", becoming the global hub of innovation in hardware and manufacturing. Its entrepreneurs are coming up with entirely new industries. It has been the driving force behind the upgrading that should help the PRD withstand competition. But what does its rise mean for Hong Kong, which has been the catalyst of investment and growth in the delta for decades?

(http://www.economist.com/news/special-report/21720076-copycats-are-out-innovators-are-shenzhen-hothouse-innovation)