Biomedical optics and instrumentations
– case studies on university-enterprise collaboration

Ma Hui

Graduate School at Shenzhen, Tsinghua University
Graduate School at Shenzhen, Tsinghua University, was jointly founded by Tsinghua University and the Shenzhen Municipal Government for cultivating top-level professionals and carrying out scientific and technological innovations.

It is a branch campus of Tsinghua University and follows the principle of 'one university, one brand'. It shares the same culture, style and the same goal of excellence as the main campus in Beijing.
History:

- **Jan. 2000**: Leaders of Tsinghua University and Shenzhen municipal government decided to set up a joint institution for higher education.
- **Oct. 2000**: The two sides signed an agreement for the joint institution.
- **June 6, 2001**: The Graduate School at Shenzhen, Tsinghua University was inaugurated.
- **Oct. 2003**: The School moved to the new campus in the University Town of Shenzhen.
About my School

Statistics of last year

- Over 80 full time faculty members and 150 staffs.
- Over 200 dual-based faculty members from Tsinghua.
- 1100 MSc candidates and 300 PhD candidates.
- 50 million RMB from competitive grants, 67 SCI publications, 43 patents.
ENTER THE DRAGON

Once a poor village, Shenzhen is now one of the wealthiest cities in China. David Cyranoski learns its plans for the future.

Shenzhen is a city of transformations. Until 1979, it was a small fishing town in southern China. Then in 1980, Communist Party chairman Deng Xiaoping designated Shenzhen, located in Guangdong province just a few miles from Hong Kong, as a special economic zone where tax policies encouraged foreign investment and trade. Since then the city has boomed, with its population growing to 12 million and fishing stakes being razed in favour of towering skyscrapers. In what came to be known as the factory of the world, the city’s economy soared to its current gross domestic product (GDP) of $31 billion yuan (US$67 billion), the fourth largest in China. It produced clothing, shoes and toys quickly and cheaply, and assembled simple electronic goods.

A second transformation is now underway. With active support from local and central government, the city is metamorphosing from contract manufacturer to knowledge producer. The turning point came with the formation of a university town in 2005, comprising graduate schools from three of China’s leading academic institutions for the north; Peking University and Tsinghua University, both in Beijing, and Harbin Institute of Technology in Harbin.

Many academics refer to Shenzhen as “special” or an “experiment” Aia Hui, associate dean of the Graduate School at Shenzhen, Tsinghua University, is one. He calls the city both “a window and an open door”: its proximity to Hong Kong (see map opposite) can provide a flow of free-market funding and its high profile can show the West how much and how fast China is changing. Just how good the picture from the window will be, and just how wide the door will open, could well depend on how the city manages a balancing act between free-market economy and top-down planning and between basic and applied research.

To create the human resources and technology needed by a high-tech city, Shenzhen’s policy-makers set about creating a combined science park and university town. Most scientific hubs are based on existing strong research universities, but Shenzhen had no such academic core. So its high-tech industrial park came first, in 1996, led in its early years by Liu Yingyi, who subsequently became executive vice-mayor and a key force behind Shenzhen’s economic development. Then, in 2001, the city persuaded the graduate schools to set up as University Town. Before this, there was just one university, Shenzhen University, which had around 25 graduate students. “That wasn’t enough for a modern city,” says Zhang Rulin, deputy director of University Town. Of the 4,500 students now studying in University Town, 300 are pursuing PhDs.

Coming home

Although Shenzhen’s declared aim of becoming an international research centre is still a work in progress, increasing numbers of Chinese scientists are coming to Shenzhen from overseas. One is Zhang Yuntao, a professor of cellular and molecular biology in the life-sciences division of Tsinghua University’s Shenzhen campus. After earning a medical degree in China, she gained research expertise in oncology and haematology in Canada and the United States before moving to Hong Kong, while keeping an eye on China’s political and intellectual environment. She’s glad she made the move, noting that the Shenzhen students are of the highest quality and as bright as any she’s worked with elsewhere.

To ensure these high standards, two-thirds of the teaching staff at the Tsinghua graduate school come from the home institution in Beijing, either residing in Shenzhen or travelling down periodically to teach courses or lead research. The other third mainly comprises returnees like Zhang Yuntao. The researchers

Striking a balance

Basic science is not neglected, however. In collaboration with the National Orchid Conservation Center in Shenzhen, researchers at the Tsinghua University Shenzhen campus recently discovered and characterized an unknown type of self-pollination used by tree-living orchids in times of drought and lack of wind (Liu, K. W. et al. Nature 441, 945; 2006; a video of the orchid can be seen at natureasia.com/Shenzhen).

Ma thinks that the balance between basic and applied science will change with time. “As we establish ourselves in Shenzhen, we will move more and more upstream towards basic research, always aiming to stay a step ahead of Shenzhen’s rapidly evolving high-tech industry,” he says. Research is already addressing real-world problems as well. For example, the Cooperative Research and Education Center for Environmental Technology at Shenzhen, funded and staffed jointly by Tsinghua University and Kyoto University in Japan, is looking at ways to provide cleaner water in urban areas.

And Shenzhen already has some role models for applied technology and industry. Telecoms companies Huawei Technologies and Zhongxing Telecom (ZTE) were founded in Shenzhen in the 1980s, and in 2006 brought in 66 billion yuan and 24 billion yuan in
Bridging academic excellence and innovation with entrepreneurship

"One university, one brand" is a guiding principle of Tsinghua University's new graduate school in Shenzhen. It reflects the school's intention to maintain the high standards of academic excellence of its home institution, Tsinghua University, far from the north in Beijing. At the same time, the Shenzhen graduate school seeks to create a new culture through interaction with Shenzhen's vibrant economy and industry.

Tsinghua University ranks as one of China's top universities, alongside Peking University. Its neighbour in Beijing, it is quite a coup for the Shenzhen local government to have persuaded both of these prestigious institutions to set up graduate schools in Shenzhen's new university town.

"Our graduate school is focused on developing professionals with leadership skills, international vision, and an enterprising and innovative spirit in a multidisciplinary research environment," explains Guan Zhigang, the school's dean.

Established on a new campus on the outskirts of Shenzhen only 4 years ago, the school has about 2,000 graduate students, with nearly 1,500 of them based full-time in Shenzhen. All students do some course work at the Beijing campus. About 90 full-time faculty and 200 part-time faculty from Beijing are spread across five divisions: Information Science and Technology, Engineering, Life Science, Management, and Science and Liberal Arts.

Two-thirds of the full-time faculty are either from Tsinghua University or have connections to Tsinghua.

"We apply exactly the same procedures for hiring faculty for Shenzhen as the main campus and therefore standards are just as high," explains Guan. Similarly, students face the same rigorous standards for entrance to the graduate school and for completion of degrees as at the main campus.

"I was not sure if I wanted to come to Shenzhen but once I got here I really liked it," says Guan. The campus, next to Lake Xi and the mountains, about 30 minutes drive from the centre of Shenzhen, provides a quiet environment for study. The rapidly expanding high-tech industry of Shenzhen and nearby interactions with industry are actively encouraged.

Tsinghua University, which is particularly strong in engineering, but is also branching out into life science and medicine, generates about 500 patent applications a year. The Shenzhen graduate school has already produced 82 in its short life.

The school aims to be a conduit for the transfer of technology from Tsinghua University to industry. As an example, Guan points to technology for a production line for compact discs that was initially developed at the main campus but has been taken forward at Shenzhen with 14 additional patents. This production line has now been lent to a local company for further development. Until now, such production lines have tended to be imported from overseas.

Professor in the Management Division have also taken part in developing an important new roadmap for an IT strategy for both the local and central government. Others are advising on transport infrastructure and logistics. The first batches of graduate students have completed their degrees, while the majority have gone elsewhere for employment, a significant proportion of them -- particularly law students -- have found jobs in Shenzhen.

The Shenzhen local government is clearly pleased with the graduate school and is giving it RMB 60 million in one-off funds to set up new cluster laboratories. Tsinghua is building laboratories in three areas: "clean production" to help local industry reduce pollution and increase efficiency; "new media technology", including 3D video systems; and "new medicines" where the focus will be on basic research. With funding from Guangdong Province the school has also set up a key laboratory for research in chemical biology.

Guan Zhigang, Dean of the Graduate School at Shenzhen, Tsinghua University.
Laboratory of Optical Imaging and Sensing
Laboratory of Optical Imaging and Sensing

- OCT: technology, applications and commercialization
- SPR
- Polarization imaging
- Polarized photon scattering in turbid media
OCT -- Optical Coherence Tomography
OCT—the principle

图 1 OCT 的原理图
**Merits:**
Flexible, Portable, Cost effective, can be integrated into almost all medical imaging devices
OCT---imaging the eye
OCT---imaging the retina
Commercialize the OCT

光学平台上构建的OCT系统

第一套脱离光学平台的OCT系统，稳定工作。
第二套OCT系统
小型化第一步

由标准的工业机箱向自主设计的
个性化机箱转变
Potable system
位移调节

扫描振镜

通用型探头，可用于科研、工业、皮肤等
Potable system
Ophthalmic system
Ophthalmic system

- 二维扫描振镜
- 眼底78D镜
- 二项色镜
- 屈光度调节杆
- 注视光点
- 光程补偿
- 准直镜
- 成像CCD
- 照明光源

CCD成像系统
Ophthalmic system

仪器化产品样机
Ophthalmic system
Commercialize the OCT

Key to success:

- Respect to your partner.
- Modular design.
- Reliable technology
- Commercially available parts.
- Your own IP.
- Right time to phase out.
Commercialize the OCT
OCT: Modular design

耦合器模块
探测器模块
参考臂模块

眼科样品臂模块
珠宝检测样品臂模块

软件模块
OCT: Modular design
OCT – for pearl inspection
Pearl inspection

海水贝壳插核珍珠
淡水有核珍珠
淡水无核珍珠
贝壳伪珠
玻璃伪珠
Pearl inspection
Pearl inspection
Polarization sensitive OCT

– the next generation
PS OCT imaging – collagen
PS OCT imaging – pearl
Polarization imaging
Polarization imaging

Polarization reflectometry

\[ DOP = \frac{I_{co} - I_{cr}}{I_{co} + I_{cr}} \]
DOP imaging

S. Jacques

Intensity

DOP
S. Jacques: Malignant basal cell carcinoma
S. Jacques: Sclerosing basal cell carcinoma

The patient had to return again for a second surgery because the doctor's eye underestimated the extent of the skin cancer.
New experimental setup

“线偏振光成像方法及装置”，蒋啸宇, 马辉等，发明专利，200610063723.1

International patent
\[ PD(\theta_i, \theta_s) = \sqrt{A \cos(4\theta_s - \varphi_1) + B \cos(2\theta_i - \varphi_2(\theta_s)) + C \cos(2\theta_s - \varphi_3)} \]
Thank you!