

Fifty years on

Investment in science and innovation flourishes in Singapore as the country celebrates its golden jubilee.

On 9 August 1965, Singapore's Prime Minister, Lee Kuan Yew, proclaimed in an emotional TV announcement to the nation that Singapore had become an independent state, having been expelled from Malaysia after long-lasting racial and economic tensions between the local and federal governments. He did not live to witness the grand celebrations that took place in August to mark the 50 years of independence, having died earlier this year aged 91. If he had, he would have seen over 26,000 people dressed in the national colours gathered to celebrate this important milestone with fireworks, parades and cultural events.

Since 1965, Singapore has experienced rapid economic growth, leveraging its strategic position in the Malacca Strait as a commercial port and establishing itself as a large-scale oil refinery site. At the same time, Singapore has heavily invested in the service industry, realizing that — as a small state with minimal land and natural resources — its people are its strength. In this context, a good education system and knowledge of the English language were pursued, which the government continues to support today.

In recent years, Singapore has established itself as a hub for higher education and scientific research and development. The National University of Singapore ranked first among Asian universities in 2015, according to the Quacquarelli Symonds (QS) World University Rankings (<http://go.nature.com/zVEczT>), and 25th worldwide according to the Times Higher Education World University Rankings 2014–2015 (<http://go.nature.com/LnhrGC>). The other major university in the country, Nanyang Technological University, is ranked 61st worldwide (<http://go.nature.com/LnhrGC>). Each of these universities hosts more than 30,000 students from more than 100 countries, and they are increasingly attracting faculty from abroad by providing competitive packages and good access to resources.

Singapore's commitment to innovation and its drive to bridge academic research and industry is championed by the Agency for Science, Technology and Research (A*STAR), which funds about 20 public research institutes in the life sciences,



JOY/ISTOCK/THINKSTOCK

physical sciences and engineering. In 2006, the National Research Foundation was set up to provide a global framework for research and innovation in the country. In 2010, Prime Minister Lee Hsien Loong announced that the government would fund research grants worth S\$16.1 billion over a four-year period ending in 2015 (<http://go.nature.com/X49yo3>). Importance has also been given to activities aimed at fostering innovation and academic entrepreneurship.

In a national survey of research and development (R&D) in Singapore for 2012 (<http://go.nature.com/RhCBZx>), A*STAR reported that the gross expenditure on R&D was 2.1% of the gross domestic product (GDP) — in comparison, the same figure was 2.79% in the US and 1.72% in the UK (<http://go.nature.com/LfcQNX>) — and that “R&D spending by local companies increased by \$180 million to \$1.3 billion in 2012” (<http://go.nature.com/RhCBZx>). This underlines that local businesses as well as the government are focused on innovation. The total manpower in R&D is steadily growing, and reached 45,001 people in 2012, according to the report by A*STAR.

Nanotechnology in Singapore is taken seriously. In 2010, the National University of Singapore provided S\$40 million to set up the Graphene Research Centre,

which boasts state-of-the-art fabrication facilities and is home to a faculty featuring several world-renowned experts in both experimental and theoretical techniques. In 2014, the centre expanded to become the Centre for Advanced 2D Materials, thanks to a S\$50 million grant from the National Research Foundation (<http://go.nature.com/ykV7fZ>). This move strengthened the technical capabilities and human resources of the centre and reflected the current trends in research now embracing all types of layered materials beyond graphene, such as transition metal dichalcogenides and black phosphorus.

Despite the relative geographical isolation from larger academic hubs — which might be detrimental to Singaporean research — and Singapore's tiny size, the substantial investment in scientific training and research has managed to put Singapore on the map. The scientific output of the country on 2D materials, for example, is on the rise. According to Web of Science, in just 5 years, from 2009 to 2014, the number of papers published by Singaporean institutions on graphene and its cousins increased by almost a factor of 7, reaching over 400 contributions in 2014. Looking ahead to the next 50 years, it is hard not to imagine that Singapore will continue to raise its profile in academic and industrial research. □