Introduction: a headlong assault on the inexpressible?

'Headlong assaults upon the inexpressible are not guaranteed to succeed', a wise mentor once warned me. Innovation and entrepreneurship are indeed indefinable. They cannot be defined in the sense of 'put limits to'. They break out, again and again. Innovation is a language and like languages in general can generate endless new combinations. In these pages I shall try to show how.

There are many reasons to be sceptical about the practicalities of teaching innovation. If such lessons are 'innovative' in themselves, then students who absorb this are being compliant, not original. Would not genuinely innovative students find fault with their lessons and rebel? Why would innovative teachers bother to instruct others, when by taking their own advice they could be enterprising, rich and famous? If we define innovation as making new combinations of existing knowledge, then is not the role of the university to impart that existing knowledge? How else are new combinations to be formed? An innovative physicist needs to know his physics. Teaching innovation to young people could be an invitation to cut corners and avoid accumulating facts.

There are also major difficulties about how innovative work is to be graded and assessed. How do you grade someone who has surprised, even confounded you? How is the merit of innovators to be gauged when the very definition of 'merit' has been changed by their contributions? Students who seek to enlighten their teachers might not get the recognition they deserve. It is a rare teacher who invites his authority to be undermined.

It is said that 90 per cent of all attempted innovations fail commercially. If the teacher applauds the innovative student the risk of serious commercial loss is high. If s/he warns the innovator,

who none-the-less succeeds, then the teacher and the university become mere foils to brilliance. Clearly teaching innovation is a thankless task! You get the blame but not the riches.

Then, of course, there is the serious question of whether innovation is a rational form of discourse, befitting scholars. Innovative discoveries can be verified by rational means, by what the philosopher Abraham Kaplan called Reconstructed Logic,[1] but is actual discovery rational? Actual innovation abounds with accident and happenstance, the milkmaids that never got smallpox because cowpox made them immune, Archimedes happening to take a bath when vexed with the problem of estimating the volume of the king's crown.[2] This vital insight, occasioned when the water in his tub rose, belongs to the world of metaphor and analogy. His body became a metaphor for the crown. Two quite separate realms of being suddenly combined.

This is not reason as we know it. No less an authority than Professor William J. J. Gordon of Harvard University, the author of *Synectics*,[3] conceded that innovation was an irrational process, eliding mathematical calculation with bathroom ablutions and similar incongruous associations. We have to ask what kind of university would seek to promote irrational discourse, or want this in its midst?

It might seem that top universities do not even want to read of it. When James Dewey Watson offered his manuscript of *The Double Helix* to Harvard University Press,[4] the university president, Nathan Pusey, intervened to prevent publication. The book was too irreverent, describing some chaotic and quarrelsome scenes at Cambridge University during the discovery of the DNA molecule. He claimed the book was 'controversial'. It seems we are affronted by genuine innovation, even when it occurred more than a decade earlier on another continent. Innovation is too 'messy', too full of raw emotion.

Because innovation startles us, is unprecedented and unique, we begin to doubt that there is anything about it that can be generalized and passed on. Surely each case is *sui generis*, any lawfulness only emerging after the discovery is made? How can you teach that

innovation has a recognizable structure, when suspending the existing structure and re-building this is what innovators do?

As for entrepreneurs, these are, to put it mildly, curious people. Historically they have been drawn from the marginal groups in society, the barely tolerated minorities. Hence Nonconformists, about 7 per cent of Britain's population, produced 50 per cent of its entrepreneurs in Ashton's *History of the Industrial Revolution*.[5] British Quakers contributed to industry forty times as much as their numbers would lead one to expect: Barclay, Lloyd, Cadbury, Fry and Rowntree were among the many Quakers.[6] A survey conducted in the year 2000 found that one-third of Silicon Valley's total wealth, some $58 billion, had been created by Indians and Chinese migrating to the USA after 1970.[7] In numerous cases immigrants have outperformed citizens in the countries they left, witness Europeans in America, and Jews, Chinese and Indians living abroad. French Huguenots were so famed for their enterprise that they were at one time forbidden to migrate from France. The numbers of top scholars, scions of noble families, fashionable insiders and products of our finest universities who become entrepreneurs are very few. For the most part entrepreneurs are a motley crew of diverse newcomers, obviously smart, but often strangers in a strange land, who surprise everyone, even themselves, with their success. They more nearly resemble the products of serendipity than of good order.

All this makes it problematic that entrepreneurship and innovation might be taught to people deliberately. How are we to simulate marginality and disorder? While it is true that entrepreneurs are typically immigrants, outsiders and minorities, these are also over-represented in prisons and in urban slums. Can we produce one without the other? The very challenges that entrepreneurs surmount to succeed may drive others into penury and despair.

There is a final telling argument. Were it possible to teach people to be innovative would not every nation and every culture strive to do this? There can hardly be an issue more urgent than creating innovative products. Standard products gravitate quickly to low-cost suppliers

in China, India and elsewhere. Only ceaseless innovation can give high-wage, affluent economies the temporary monopolies that new products confer. If everyone wants innovation and there is no stampede towards educational breakthroughs, then it would seem that such feats have yet to be performed, or, if performed, they have yet to be validated. Validating such a performance is what this book is about.

The arguments against teaching innovation have all taken a similar form.

(a) If an instructor is innovative, then would not students simply comply?
(b) If instructors can do it themselves, why teach others?
(c) If innovation is a combination of disciplined subjects, should not the university be teaching the latter?
(d) If innovators re-define merit, how are they to be graded and assessed?
(e) If most innovations fail commercially, and they do, should universities be encouraging students to try?
(f) If the logic of verification is different from the logic of discovery, should universities teach the latter?
(g) If creativity is not a rational process, should universities dabble in irrational discourse?
(h) If innovation is controversial, might it not be better to impart to students what has been agreed?
(i) If entrepreneurs are typically migrants, minorities and outsiders, what becomes of the university's mission to civilize elite professionals?
(j) If entrepreneurship is characterized by disorder and disruption, how can this contribute to social order and good governance?
(k) Finally, if the ideal of innovation could only be realized, would not the rush to join this movement be in evidence? Where is it?

What all these objections have in common is the presence of two contrasting and often clashing values in seeming opposition. In short, these are dilemmas. This brings us directly to the definition of innovation and entrepreneurship to be used in this book.

It is a key characteristic of innovation that it resolves existing dilemmas facing people, and it is a characteristic of entrepreneurship

that these resolutions are offered to customers for purchase. The combination of contrasting values is more precious and useful than their separation.

Let us consider the objections-cum-dilemmas one by one to see how these might be resolved.

(a) Innovation is not wholly within the instructors, nor within the students, but occurs in the *interaction* between the two, by leading out (*e-duco*) the potential within both.
(b) Teaching innovation is in itself a new project or service and is an enterprise in its own right. Teachers launch new ventures.
(c) Innovation is so potentially thrilling that denying students this experience is to deprive them of great potential fulfilments.
(d) There is no reason why students should not define their own goals and be graded on the standards which are self-chosen.
(e) 'Failure' is neither traumatic nor costly if it is merely simulated. Innovative education allows for many trials, many errors until learners get it right.
(f) The logic of verification is there to check up on the logic of discovery. The two must work together.
(g) Innovation is not rational in the sense of linear or technical reasoning. It is a form of encompassing or circular reasoning, as I shall show.
(h) Innovation is indeed full of controversy, but from this new disciplines emerge. The controversy is both exciting and temporary.
(i) It is part of the university's mission to extract from minorities, migrants, etc. the diverse abilities these possess, so as to qualify the current consensus.
(j) The disorder and disruption occasioned by entrepreneurship is the midwife of a new, more enlightened order in the process of emerging. Obviously those with a lesser stake in the status quo are more ready to change things.
(k) The ideal of innovative education is only now being realized. If we can establish this fact then the eagerness of many to benefit should follow.

Yet innovation is plagued by fakery and false starts. The history of 'progressive' education hardly inspires. The joust between traditional and progressive teaching is by now more than a century long and utterly sterile in its mutual opposition.[8] So long as each side of the dispute defines itself by opposition to the other side, nothing new can be generated. Breaking up this ideological spat and revealing its foolishness and barrenness is an important part of our work. Genuine innovation marries the old to new combinations, by joining discovery and verification, disorder with new order and making ideals real. It is this process of dilemma resolution that this book expounds.

1 Singapore's challenge

> No longer can we be just a production site for multinational corporations. We will have to be able to generate new knowledge and innovation of our own and commercialise them effectively.
>
> Teo Ming Kian, 'Empowering Technopreneurs'[1]

It is no coincidence that Singapore has been the first to take up this challenge. It has world-class strengths but one major weakness, which we shall examine presently. Colonized by the British, it had the good fortune to be acquired by a benign founder. Sir Stamford Raffles was very much a Renaissance Man, linguist, botanist and gentleman scholar. Raffles is everywhere in Singapore, in streets, squares, quays, drives, avenues, clubs and centres. He carved the whole city into ethnic enclaves and built a free market. He was at heart multi-cultural and defied the Foreign Office by announcing his annexation of Singapore on behalf of the Crown before he had received permission from his superiors.

Business Class on Singapore Airlines is called Raffles Class and a Singapore Sling at the Long Bar in Raffles Hotel is a destination for many tourists. I sought advice from the Permanent Secretary to the Prime Minister's Office located in the Raffles Tower. Rarely has a single name been put to so many uses. Singaporeans are comfortable with authority and have benefited historically from its good judgement.

Singapore was cast out of the Malaysian Federation in 1965, which had earlier gained its independence from Britain in 1957. Singapore was not expected to survive, politically or economically. Its leader Lee Kuan Yew, a lawyer with a Double First degree from Cambridge University, was visibly distressed. How could one crowded city, without adequate material resources, or even enough water, survive in any form? The Japanese had overrun it in 48 hours in 1942. Its largely Chinese

population was suspected of Communist sympathies. The nation's prospects looked bleak.

And yet Singapore prospered. Its per capita income grew from US$600 in 1965 to $35,650 in 2007, ten times higher than China, with a purchasing power per head $5,000 more than Great Britain ($38,340 compared to $43,430).[2] It was more affluent than its ex-colonial master. But its achievement is much broader than this. For many years it has headed *The Economist*'s league table for sustainable economic development. Its urban landscape is immaculately groomed and beautifully maintained, proof, if this was needed, that a fast-growing economy can develop in ecological balance with its environment.

Among Singapore's competitive advantages, besides logistics and the world's biggest port for shipping, is that English is its working language among three others. This makes it extremely attractive to multinational corporations as an Asian HQ. In addition to this, its port facilities lie athwart the world's major trading routes, and are super-efficient logistically with a turn-around time which is the envy of rival facilities.

Because more companies wish to locate in Singapore than it could possibly accommodate, the government can strike bargains with those admitted which are highly beneficial to the state. Singapore's conviction is that wealth creation is learned and those who want office space and production facilities in this valuable location must carry out 'high end', knowledge-intensive work within the country, raising the skills of its work force, employing research graduates and thereby increasing the 'value-added per person' for the Singapore economy. There are incentives to join a 'cluster', a close-knit community of companies in the same industry supplying and buying from each other. There is now a financial cluster, a biomedical cluster (Biopolis), a water resources cluster, a digital media cluster (Fusionopolis) and an energy cluster among several others.[3] Those who wish to do simpler work, like adding water to syrup for Coke or Pepsi, are tactfully steered to Indonesia, Vietnam or Malaysia. Singapore actually penalizes companies for paying low wages by requiring a development levy on low-skilled work. Singapore's vision of world order is that nations find their appropriate rung on the

knowledge ladder, buying what is simple from those below them and selling their own growing complexity to all comers.

One of the architects of the Knowledge Intensive policy is Teo Ming Kian, Permanent Secretary to the Ministry of Finance and head of the National Research Council.[4] He coined the word 'technopreneurship', meaning the fusion of entrepreneurship with high tech, or knowledge-intense innovation. It was he who in his days at the Economic Development Board of Singapore sponsored the Technopreneurship and Innovation Programme at Nanyang Technological University, which is the subject of this book.

Yet the Singapore government is very much more than a booster for economic development. Attracting as it does some of the top scholars in the nation into a Civil Service meritocracy it includes persons of considerable critical acumen. The emphasis on innovation came about, not because Singapore excelled in this respect, but because it was seriously lacking. In the GEM studies of entrepreneurial activity across the globe, Singapore ranked only nineteenth, behind other overseas Chinese communities. Something was obviously wrong and the plan to emphasize Technopreneurship was intended as a remedy. Teo Ming Kian put it well:

> In a way we are probably the victim of our own economic success. Singapore has had full employment for many years and our people led relatively comfortable lives in secure jobs. The rewards for venturing were not seen as commensurate with the risks of doing so. The environment was not supportive of such ventures.[5]

As the programme was about to be launched, Professor Tan Teng-Kee, its designer and founder, along with this author, wrote an article in the *Nanyang Business Review* which addressed the 'Six Dilemmas of Entrepreneurship' confronting Singapore at that time. The article is a clue to our thinking and helps explain the rationale on which the programme was based.[6]

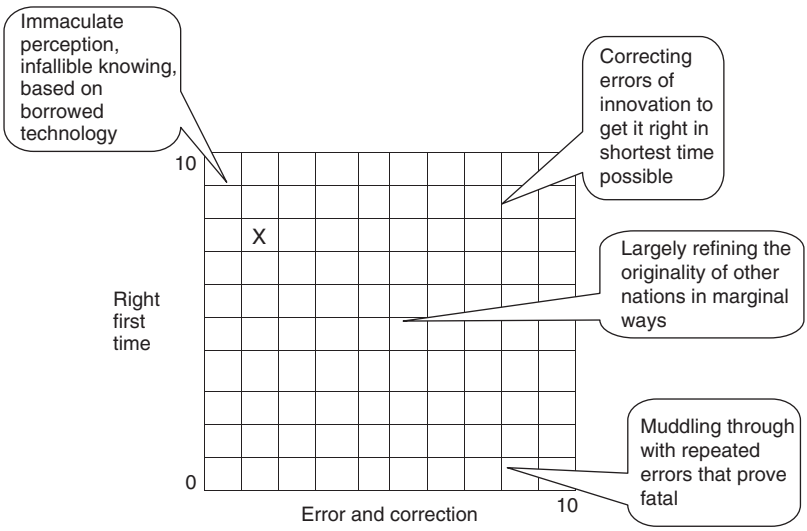
We concluded that Singapore had long behaved and was still behaving like a 'Catch-up Economy'. These economies tend to take

their cue from the values of already developed nations in North America and Europe and imitate their practices at lower cost, supplying the markets which pioneer economies had already created. This strategy is fine until the 'catch-up' economy actually draws level with its British and American rivals, at which point it needs to innovate and create markets, not just serve them. Singapore had reached parity. The time for 'technopreneurship' or innovation in high tech was now.

RIGHT FIRST TIME VS. ERROR AND CORRECTION

We argued that Singapore's education system was too oriented to 'right first time' application of technologies developed in the West. It ignored the contrasting logic of error and correction, by which innovative ideas are developed by trial and error and by successive approximations to an innovative ideal. So many Singaporean jobs owed their existence to technologies created elsewhere that the process engineers outnumbered the research engineers and the implementers outnumbered the originators. This was having a damaging effect on entrepreneurship.

In short, we located Singapore in the top-left corner of Grid 1.1. It concentrated on the application of knowledge already codified and



GRID 1.1 Right first time vs. error and correction