A diverse profession

by Joe Eades, Deputy Chairman, Chemical Engineering Technical Committee, IES; Vice Chairman, IChemE, Singapore; and Co Founder and Managing Director, Ispahan Group, Singapore.

An enigma to many, chemical engineers are playing an increasingly important role in shaping society. They have a major impact on the everyday lives of all people, by helping to create technologies and products that enhance the quality of life.

Chemical engineers are employed in a variety of industries.

Chemical engineers are involved in the design, operation and maintenance of multi-million or even multi-billion dollar process plants that produce medicines; tyres and petrol for cars; toothpaste, shampoo and other toiletries; fuel for power plants; plastics used in TV sets and in children's toys; fertilisers for growing grains, fruits and vegetables; and a range of other products.

Ensuring a sustainable supply of these day-to-day essentials, that everyone now takes for granted, is not an easy challenge. As demand for oil is expected to exceed supply sometime in the next five to 10 years, vast capital projects are underway to replace some of this demand with gas. In the Gorgon Project in Australia, for example, an estimated US$ 57 billion is being invested to build Australia's largest Natural Gas Plant to meet global demand. Singapore is responding with Singapore LNG Corporation opening its first Liquefied Natural Gas terminal. The terminal is due to come on-stream in 2013, with a capital investment that is said to be around S$ 1.5 billion, and with a further S$ 500 million announced recently, to increase capacity.

By combining the energy, chemicals (petrochemical and speciality) and biopharmaceuticals output, it can be seen that process industries contribute close to a third of Singapore's total GDP (2010).

Jurong Island is one of the top 10 integrated petrochemical complexes in the world and there is a significant concentration of process industries in Tuas, as well. Given the number of chemical and energy projects being commissioned and due to come on-stream in 2012, including the ExxonMobil Singapore Parallel Train Project and the LANXESS butyl rubber facility, these numbers are expected to increase significantly in the years to come.

In addition, chemical engineers are also working in the offshore sector, where Singapore is responsible for converting 70% of the world's FPSOs (Floating Production, Storage and Offloading units) and has 70% of the world market for jack-up rigs used

to extract oil and gas. Combined with the developments in alternative energy and the engineering houses here, chemical engineers are quietly contributing to much of the region's future.

Here in Singapore, it would be good for members of the younger generation, who already have their eyes fixated on a career in the CBD, to look a little further, to the developments in Jurong and Tuas.

Many do not realise that chemical engineers are generally creative types, who use abstract thought processes in identifying and solving problems and challenges every day, whether in chemical processes, or as risk advisors in insurance or as financial analysts and traders. The systems integration approach is appreciated at all levels. Although the solutions may not always look aesthetically pretty, they have form and function and must operate optimally and safely, every day.

As a discipline, chemical engineers are highly sought after. According to MOM, in June 2011, chemical engineering was among the top paid jobs in Singapore, ranking as the 17th best paid profession in Singapore. A lot of chemical engineers are getting poached by the banking and finance sectors, at graduation, attracted by higher starting salaries. It is a loss to the industry and young graduates are encouraged to try working in the field of chemical engineering for, at least, two years, before making that decision. They do not realise that, quite often, around the 5- to 10- year point, a chartered chemical engineer may well be able to demand more than their counterparts in financial services sector. The actual job in chemical engineering, is nothing like what may have scared students off during their degree course. It is also good if chemical engineering graduates are open to exploring companies that they may never have heard of, as they are not brand names, but are still some of the biggest global employers.

Chemical Engineering has also become a good training ground for leaders in business and in politics. Some of the most powerful men in the world have a chemical engineering background. Examples are Xi Jinping, the new leader of China's Communist Party; Jerzy Buzek, President of the European Parliament; Jack Welch, the famous former Chairman and CEO of General Electric (GE); and Mukesh Ambani, Chairman and CEO of the Indian conglomerate, Reliance Industries.

After getting their grounding, many chemical engineers diversify and have interesting and varied career paths. The first African-American woman in space, Mae Carol Jemison, studied chemical engineering.

So what does the future hold for chemical engineering as a profession? Chemical engineers will continue to work in classical sectors like energy, oil & gas, refining, pharmaceuticals and the environment (water, renewable energy, waste and food production - the new nexus of global importance for the survival of mankind, as a result of climate change), but many in the profession will become heavily engaged in solving many of the upcoming sustainability challenges, together with politicians, economists, architects and others. As time moves on, the solutions are becoming much more complex and the need to implement them, urgent. These solutions need to be much more than just greening a few tower blocks and installing solar cells on the roofs. To get to the 60%-80% change that the Stern Report describes, there needs to be a rethink of town and city planning with complete systems integration, to include buildings, water, energy, waste, infrastructure, and food security. This means that governments around the world need to bring in chemical/process engineers at the urban planning stage to apply their skills and logic in mass-, heat- and energy- balances, to not just chemical processes, but also to water, energy, food and other materials, and this is where big global changes can be made and opportunities created.

Singapore has done a good job in focussing on many of these long term sustainability areas. The focus on water technologies and becoming a global water hub is to be applauded and the investments in the clean energy sector and in health and well-being are also visionary. The one area that Singapore, as a city state, will struggle to address is food security. It just does not have the space.

In general, food security pressures have become even more intense because of the rapidly growing global population resulting in increased migration to cities combined with lower yields from crops due to global warming, Young engineers should therefore consider applying their skills here, too, whether in waste to energy/fertiliser technologies or in optimising the production yields.

In chemical plants, not only do chemical engineers size distillation columns, reactors, vessels and piping systems, they also develop the automation strategy and, in many cases, also take on the specification of the chiller plants, boilers and other equipment, usually associated with M&E consultants in the building trade.

In primary pharmaceuticals, chemical engineers mix together pretty nasty chemicals, sometimes even chemical weapon precursor grade materials, with many other materials, to make molecules some of which did not exist before, but which may cure a type of cancer, or reduce cholesterol or high blood pressure. Even more obscure is the world of biopharmaceuticals where they may be fermenting Chinese hamster ovary cells to make cancer cures, and all of these processes described are performed here in Singapore.

Later on, in what are called secondary pharmaceuticals, chemical engineers have to specify the equipment and processes to make billions of tablets, each with exactly the right dose of those drugs. Not only do they have to design the processes, they also need to design the infrastructure to be able to heat up, cool down,

destroy the waste products, recycle streams where possible, and design waste water treatment plants or incinerators to destroy the residual waste streams.

When contractors build the plants, chemical engineers have to carry out regular inspections to check that the plant is laid out correctly. Near the end, chemical engineers would want systems handed over as a whole plant and not in zones. This generally does affect the schedule a little from the contractor's point of view, but getting the whole plant operating speeds it up by maybe even six months. The most dangerous time in the whole operation is the commissioning phase when the first flammable or toxic materials are introduced.

In the refinery industry, chemical engineers take crude oil and refine it in hundreds of distillation columns, splitting the various components out. This is more challenging now with much more 'sour crude' on the market, that is high in sulphur which corrodes steel pipes and equipment. A lot of work has to be done to ensure that the correct materials are selected and the process does not have any hiccups. Many engineers have to check the assay of every tanker coming in and simulate it to optimise the plant and ensure it can be operated stably as, unsurprisingly, oil from Iraq is very different from oil from Sarawak. Later, downstream, the petrochemical plants take this feedstock and convert the materials even further into plastics and rubber, and materials that then get blended into end products such as shampoo, car tyres or TV sets.

The industry is a high-hazard industry and needs special care and attention. To ensure Process Safety, operators must ensure they operate, maintain and inspect their plants safely every day. If a refinery is well run, there will be only the occasional hiccup that might lead to a loss of containment. It is managing the prevention of these losses of containment and the measures in place to mitigate that 'loss of containment' that is the pillar behind Process Safety.

Singapore overall has been relatively lucky to-date, with only a couple of incidents, one being the Singapore Refinery fire in 1988 and more recently, the fire at Shell Bukom in October 2011. These brought home the need for vigilance. Proper Process Safety Management (PSM) systems need to be in place and competent people, including chemical engineers need to be part of this process. Proper Management of Change (MOC), a transient workforce and the human factors necessary to develop a good safety and learning culture are some of the biggest challenges that must be addressed, otherwise there is a risk that these incidents could get significantly worse.

The consequences to Singapore would be disastrous if incidents occurred here, such as what happened in South Korea in October 2012 or in Shanghai, China in 2009. In South Korea, 8 t of Hydrogen Fluoride leaked from a tanker, with reports indicating that five workers were killed in the initial leak, 3000 were sent to hospital, and 200 hectares of land were contaminated. In Shanghai, the pneumatic testing of the LNG terminal killed one worker and nearly flattened the facility.

In order for the annual workplace fatality rate in Singapore to be kept below the national target of 1.8 fatalities, by 2018, there must a strong focus on Process Safety.

Working towards recognition for chemical engineers

There is a need to recognise and acknowledge qualified chartered chemical engineers and process safety specialists with experience and competence in the workplace.

An example of a place where this is being done is Queensland, Australia. There, IChemE has been licensed to award the professional engineering status to qualified candidates.

To ensure Singapore's position as a world class chemicals and energy hub, the republic needs something similar and IES is exploring this with IChemE.

The IES Chemical Engineering Technical Committee will initially have three subcommittees - the petrochemical subcommittee which will be chaired by Ng Mee Lin, a representative from SCIC; the pharmaceutical subcommittee which will be chaired by a representative from ISPE; and a Process Safety subcommittee.

Volunteers are invited to join. More information may be obtained from Kok Sun (email: koksun@iesnet.org.sg) or Joe Eades (email: Joe.eades@ispahan.com).

A joint IES/IChemE student council has also been set up, to engage students with industry in a variety of forums, with careers seminars, sports days and other activities to bring the industry and student community closer together.

"IES members are also welcome to join the many talks as we work to align our activities here in Singapore. We are keen to expand our support in the committee so we can endeavour to run more events to build upon the success of the APPChE conference which drew over 700 attendees in 2012", said Mr Joe Eades, Deputy Chairman, Chemical Engineering Technical Committee, IES; Vice Chairman, IChemE, Singapore; and Co Founder and Managing Director, Ispahan Group, Singapore.