Adding Value(s) to the Process; Chemical Engineering Education for the 21st Century

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Chemical engineers have always been in the business of adding value to processes, whether that be in the production of food and drinks, chemicals, fossil fuels or bio/pharmaceuticals writes University College Cork's Professor Edmond Byrne.

Embrace broader context and values

However, in the context of contemporary 21st century challenges and crises, there is an increased imperative for professional attributes and an outlook which seeks to embrace broader context and values.

Chemical engineering emanated at the end of the 19th century out of the need to combine a knowledge of chemistry with the mechanical and structural design expertise provided by mechanical engineers to efficiently and safely achieve the fractionation of oil and other processes, for the benefit of society.

Process and chemical engineers proceeded to apply their expertise to the development of a range of products and processes which impacted positively upon society, from ranging from food and drinks production, to plastics and pharmaceuticals.

However, as with all well-meaning technological developments, there is scope for downsides, often not originally foreseen.

The Jevons' Paradox

The Jevons' Paradox, named after the 19th century economist who foresaw increased consumption as a result of efficiency gains (as a result of lower unit cost), rather than the opposite, for example in the development of the steam engine which used coal to help drive the Industrial Revolution and imperial prowess, is one such sticky truism that has repeatedly endured.

Oil of course replaced coal as the fuel of choice, and with abundant oil supplies, humanity, through engineering ingenuity found multiple uses, including the combustion engine and personal travel made over increasingly shorter times and longer distances.

The inventor of the plastic bag during the middle of the last century did so with the intent of it being a reusable and durable alternative to paper which could lead to reduced tree felling and associated environmental benefits.

Meanwhile, incredible advances in pharmaceutical and latterly biopharmaceutical production have led to a range of illnesses being successfully treated and even cured, extending lives and quality of life and wellbeing of people all over the world.

However, as we now stand about to enter the third decade of the 21st century, we face increasing uncertainty around societal wellbeing. Even in the past year, the vista of a climate crisis has risen to new levels, increasingly recognised a symptom of an unsustainable global societal construct fuelled by an insatiable consumerism.

Environmental degradation

Other symptoms include nexus issues around food, water, energy, environmental degradation, biodiversity loss and human wellbeing (including increased levels of stress, depression, anxiety and obesity, in particular among the world's wealthier populations).

Fossil fuels and plastics, so long the proud poster children of the chemical engineer, are increasingly about as loved or acceptable as tobacco or asbestos.

Pharmaceutical companies often stand accused of supporting an endemic of prescription drugs, including opioids, and others which are regularly prescribed inappropriately. Old certainties seem less so, as the apparent linear march of progress, through optimistic techno-economic control and expansion seems less secure.

It is in this context that we as engineers, and engineering educators reside. We are charged with seeking to help define fit-for-purpose chemical engineers to help navigate our way through the middle of the 21st century, and beyond.

In such a world, mere core technical 'knowledge' is no longer sufficient, if it ever was. Neither are the added attributes of 'skills' (analysis, synthesis, communication, leadership, teamwork), which are of course, increasingly important.

In addition, and to an ever great extent, contemporary engineers require appropriate 'attitudes', or an explicit recognition of, and comfort in, expounding the values of ethical professional engineering practice.

These are of course made explicit in for example, Engineers Ireland's Code of Ethics, to which all professional engineers must adhere.

However, to an ever-increasing extent, emerging considerations around sustainability are impacting not just on broader society, but are going the core of our business models.

For example, Ireland is seen as potentially vulnerable as a future investment destination if it is seen to be a laggard on meeting its climate responsibilities, while companies, both national and multinational, are exposed to similar forces.

Steering the ship in an appropriate direction

It is up to us, as engineers too, to play our part in steering the ship in an appropriate direction, but we need to do this with others, as the answer are not always in the technological domain, but also reside in the social, political, economic and ethical.

The Institute of Chemical Engineers, in its evolving vision document for the profession, 'Chemical Engineering Matters' has identified four 'key challenge areas confronting society' where chemical engineers will have central involvement: water, energy, food and nutrition, health and wellbeing.

These they suggest require 'technical skills and knowledge, but [in addition, chemical engineers] will need to contribute to the complex technical and in some cases ethical debates that surround the issues.'

At University College Cork, we are endeavouring to produce graduates fit for this task. Our process and chemical engineering programme won the IChemE's Sustainability Teaching Award in 2016, and next June, UCC will host the 10th Engineering Education for Sustainable Development (EESD2020) conference, the first time it has come to Ireland, under the theme 'Building Flourishing Communities'.

In its second century, chemical engineering, as with all the engineering profession has a lot to offer yet and a central role to play in enhancing societal wellbeing!

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