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Setting up new chemical engineering degree programmes: Exercises in design and retrofit within constraints

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ABSTRACT

The rise in popularity of chemical engineering among students entering university has prompted expansion of the UK provision, through increased intake into current degree programmes and with the rise of new providers. The former entails logistical challenges of processing larger numbers through existing infrastructures whilst maintaining the student experience. The latter entails challenges of designing and introducing programmes that build harmoniously on existing non-chemical engineering provision, within the constraints of university validation procedures and physical resources, and in the face of uncertainty around student and staff recruitment, while aspiring to implement best practice in chemical engineering content and pedagogy. Following a review of the UK chemical engineering landscape and a critique of literature guidance on the appropriate content of chemical engineering curricula, this paper illustrates the issues of new programme development through the approaches and experiences of a new provider, the University of Huddersfield, which introduced new chemical engineering programmes from academic year 2013–2014. The paper addresses specifying the content of chemical engineering programmes to align with accreditation requirements and literature advice while maintaining distinctiveness. The constraints imposed by the need to specify and validate courses internally and to minimise substantive programme changes subsequently, whilst responding to the opportunities that arise as staff are recruited and to external developments and unplanned incidents, are highlighted and illustrated, in order to draw lessons that might help to guide other new entrants.

1. Introduction

As all chemical engineers know, analysing and operating a process at steady state is orders of magnitude easier than dealing with a highly dynamic process or situation. Plant modification and minor retrofit are a constant part of the refinement of plants to enhance productivity and to respond to relatively minor internal upsets and external influences while continuing to produce much the same product. Plant commissioning or substantial retrofitting projects are, by contrast, much more demanding. The introduction of new degree programmes in universities is in some respects analogous to new plant commissioning or substantial retrofitting in terms of timescale and challenge, compared with tweaking a degree programme operating more or less at steady state. And the substantial increase in demand from students wanting to study chemical engineering has prompted increases in capacity from existing providers alongside new entrants into the market, injecting a challenging dynamism into chemical engineering provision in UK universities.

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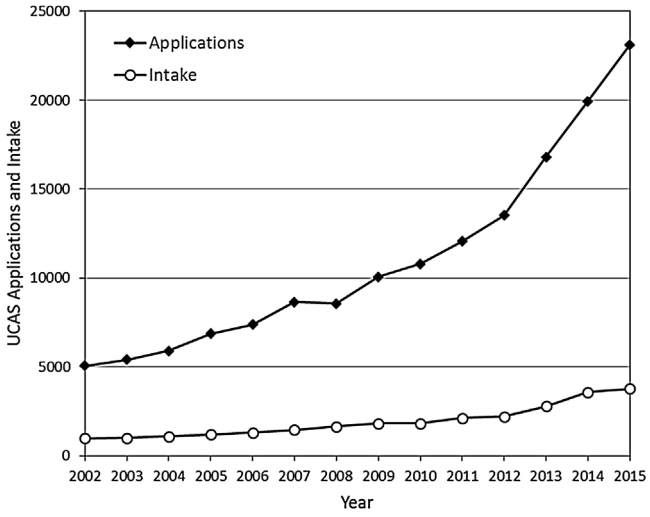

Fig. 1 – Applications and intake to UK chemical engineering programmes, 2002–2015.
Source: **https://www.ucas.com/corporate/data-and-analysis/ucas-undergraduate-releases/ucas-undergraduate-end-cycle-data-resource-5.**

Following a concern in the late 1990s over the health of UK chemical engineering and a steady decrease in university applications to the extent that "departments [were] desperate to fill vacancies' (Molzahn, 2004), from around 2002 chemical engineering has been very much in the ascendancy, more than quadrupling by 2015 to around 23,000 applications, converting to over 3700 acceptances of Home students onto degree programmes (Fig. 1). This success is attributed in part to IChemE initiatives such as the whynotchemeng campaign and the Roadmap, including success in conveying the message that chemical engineering aligns with prospective students' aspirations to make a positive difference to the world (Byrne, 2010); in part to the increase in university tuition fees focussing the minds of students and their parents on degree choices that promise a good return, with chemical engineering the most lucrative of the engineering professions and second only to dentistry for graduate earnings (Anon, 2015a). Whatever the reasons, these plentiful conditions have made offering chemical engineering programmes attractive to universities, whether to boost student numbers and/or quality for existing providers, or for the entry of new providers. Thus, several well established chemical engineering departments in the UK have similarly quadrupled their first year intakes from typically 75 students in 2002 to over 300 in recent years, often while increasing entry grades. Meanwhile, other universities have introduced or resurrected chemical engineering programmes. The IChemE currently lists 23 universities offering accredited chemical engineering degrees in the UK, with Aberdeen the most recent to secure accreditation following the launch of its chemical engineering programmes in 2006. However at least half a dozen new entrants are emerging. The University of Bradford had closed its chemical engineering programmes in 2002 following a drop in intake to 16 students, but in 2010 it reopened chemical engineering within its School of Engineering. Hull took its first BEng chemical engineering students in 2013; in the same year Huddersfield introduced a 50:50 BSc in Chemical Engineering and Chemistry within its School of Applied Sciences then, encouraged by the uptake, brought in a full BEng in Chemical Engineering in 2014. The donation of Shell's former R&D site at Thornton to the University of Chester in 2013 prompted the university to create the UK's first new Faculty of Science and Engineering in over 20 years; the new faculty took its first cohort of students in September 2014, with chemical engineering part of the suite of courses benefitting from the 48 science and engineering buildings on the 66-acre site – a unique situation that will undoubtedly deliver a distinctive and valuable student experience. The Universities of Lancaster and Wolverhampton are both currently investing £12M in new engineering facilities, including chemical, the latter taking its first entry in 2015. Sheffield Hallam University is listed on UCAS as offering chemical engineering programmes for 2016, with Brunel also planning to introduce chemical engineering. Thus the scale and scope of UK chemical engineering provision have expanded in response to the attractiveness of our discipline to students.

Interestingly, it appears the demand has not prompted a wider scope of chemical engineering specialisms within individual departments; on the contrary, some departments appear to have rationalised their provision into fewer programmes in order to cope with the larger student numbers, no longer needing to cast the net so widely. Thus, for example, Byrne (2006), noting the attractiveness of specialist programmes for enticing students, lists six specialist options from the University of Manchester on top of its straight MEng Chemical Engineering; for 2016 UCAS lists just three specialisms. Sheffield had six MEng specialisms and still does (albeit slightly different). Newcastle and Heriot-Watt both had four and now have three. Compared with the diversity of specialisms listed by Byrne (2006), the current offerings on UCAS appear somewhat streamlined, a retraction perhaps into undifferentiated commodity processing in the face of large student numbers, with breadth offered instead by a broader scope of providers each with narrower portfolios.

2. Designing, or retrofitting, a chemical engineering programme

To a chemical engineering educator, it is attractive to contemplate sitting down with a blank sheet and designing the "perfect" chemical engineering programme. But engineering is "design under constraint" – in this case, constraints of what prospective students are capable of mastering, of what staff are capable of delivering, of what the infrastructure is capable of servicing, of what content can be squeezed into 3- and 4-year programmes, of what employers and accrediting bodies demand, and of the underlying vision for the type of graduate the programme aims to cultivate. Judgements must be made based on appropriate objective external guidance, adapted to local context, and undoubtedly coloured by personal or collective preferences, principles and prejudices. In most cases a blank sheet scenario is unavailable, and design of a programme is either based on a rearrangement, possibly radical, of existing staffing and infrastructure resource (e.g. as described by Gomes et al., 2006), or retrofitting around a basis of material drawn from existing courses possibly in chemistry, biology, mechanical engineering, materials science or mathematics, or from a common Year 1 engineering intake. In some ways this is more helpful than complete blank-sheet freedom, as the presence of constraints is more conducive to creativity than their complete absence, and existing strengths and opportunities help in conceiving the distinctive features and emphases of a prospective new programme and in devising a feasible pathway to build it.