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University–industry teaching collaborations: a case study of the MSc in Structural Integrity co-produced by Brunel University London and The Welding Institute

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The paper presents an evaluation of an MSc in Structural Integrity co-produced by Brunel University London and industry partner The Welding Institute (TWI), designed to supply 'work-ready' graduates. Pre-, mid- and post-course quantitative surveys were administered to students, and two mid-term focus groups were conducted. Pre- and post-course quantitative surveys were administered to industry supervisors. Seventy-seven per cent of students chose the MSc because it was co-designed with industry. Student expectations of the course and skills attainment were largely met; hopes for employment decreased due to a downturn in the oil and gas industry; industry supervisors were 'bridging scientists' between Brunel and TWI for largely altruistic reasons. The paper concludes that being 'work-ready' is composed of technical and 'soft' skills, employer engagement being important for the latter. It recommends integrating group-placed students with industry employees, including within social spaces; and tax incentives for employers engaging with postgraduate training provision.

Keywords: Brunel University London; higher education; Master's teaching; engineering; structural integrity; The Welding Institute; University–industry collaboration

Introduction

A 2010 report for the UK's Department of Business, Innovation and Skills (BIS) observed that while postgraduate education was valuable for UK economic growth and international competitiveness, 'HEIs [Higher Education Institutions] need to be more pro-active in providing postgraduates with the opportunity to develop the core competencies they need to succeed in a competitive job market', ensuring 'transferable skills training is embedded as standard in the funding and design of all postgraduate research programmes' (BIS 2010, 6). Reports for BIS and The Cabinet Office highlighted similar issues. Conlon and Patrignani (2011) demonstrated economic benefits of postgraduate education for individual earnings and returns to the Exchequer. Milburn maintained, 'Universities have a crucial role in ensuring that everyone who graduates is equally equipped with the tools to succeed in the workplace' and university education should provide workplace capabilities training for all students, including 'communication, team work and organisational skills' (2012, 6, 67).

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In response, in 2013 the UK's Higher Education Funding Council for England (HEFCE) launched its Postgraduate Support Scheme (PSS), a £25 million publicly funded competitive programme to stimulate initiatives promoting postgraduate taught education, particularly among under-represented groups,[1] in areas aligned with government growth strategies.[2] This was the largest UK intervention in postgraduate education, involving 40 HEIs in 20 projects, and lending support to approximately 2000 students. It encouraged HEIs to create innovative models of taught postgraduate education that challenged gaps in traditional education and requirements of employers in industry, 'including engineering, international business, university research, entrepreneurship and small and medium-sized enterprises' (Wakeling 2015, 4, 6).

Demand for people in science, engineering, and technology (SET) occupations is widely acknowledged as vital for sustainable economic growth (Royal Academy of Engineering 2012; Perkins 2013), and it is anticipated the UK will need 830,000 SET professionals to meet employment demand for the period 2012–2020 (Royal Academy of Engineering 2012, 23). However, 39% of engineering businesses have difficulty recruiting SET skilled staff (Engineering UK 2015), and 25% of engineering employers believe engineering courses do not provide appropriate knowledge and technical skills required for employing graduates (Perkins 2013, 42). As part of the PSS, Brunel University London (Brunel) sought to address an acute shortage of 'work-ready' postgraduate students with in-depth knowledge of the science and technology of Structural Integrity, a field of engineering concerned with the safe design and assessment of components and structures under load.

Brunel provided 20 scholarships (tuition fee plus stipend) for a one-year postgraduate Structural Integrity MSc 'co-produced' (i.e. co-designed, co-delivered, and co-supervised) with the industry group The Welding Institute (TWI). The aim was to produce employable graduates with in-depth knowledge of Structural Integrity. While employer–university–student partnerships were part of all PSS projects (Wakeling 2015), the co-produced nature of the Brunel MSc made it the first UK Master's programme (taught and research) of its kind in this field. Policy drives to produce more work-ready students have encouraged HEIs to collaborate with industry, yet instances of collaboration are rare in postgraduate Master's programmes, particularly in engineering (Masethe and Masethe 2004). Co-produced industry courses, where students are taught and undertake research together in an industry setting, are scarcer, with work-placements remaining the most common form of HEI–industry association.

The paper presents an evaluation of the delivery, perceived benefits, and drawbacks of the co-produced MSc from the viewpoint of students and industry partners. While Wakeling (2015) conducted a comprehensive evaluation of the PSS, summarising the findings from 20 projects, this did not capture in-depth data on each scheme. The uniqueness of the co-produced Structural Integrity MSc means that exploring the outcomes of this model of course delivery, particularly regarding future employability, is a vital contribution to policy discussions regarding Master's course teaching and management, especially given the dearth of academic literature on Master's teaching generally (Bamber 2015).

Drawing on pre- and post-course student and supervisor surveys, mid-course student surveys and focus groups, the paper analyses student and industry supervisor experiences of the MSc. In so doing, the paper provides information on the co-delivered MSc, identifies barriers to university–industry collaboration (Bruneel, D'Este, and

Salter 2010) and adds to an existing body of research exploring student and industry experiences and expectations of student work-placements (Soltani, Twigg, and Dickens 2013).

Below, we provide an overview of the policy context surrounding HEI–industry collaborations, particularly relating to employability; different types of current HEI–industry taught education collaborations, and student and supervisor experiences of these; and highlight previous co-produced engineering Master's courses. We then describe the vision and format of Brunel's Structural Integrity MSc and present our findings and discussion.

Literature review

During the 1980s, universities began to focus on developing skills undergraduate and graduate students required to gain employment (Wilson 2012). Equipping students with 'work-based' skills was held to bring economic benefits (Lambert 2003), and human capital theory (Keeley 2007) suggested that producing 'industry-ready' students would entail a more 'productive' workforce. It is now accepted that HEIs must contribute to economic development and competitiveness by acting as catalysts of knowledge production (Williams et al. 2013), such that this knowledge can be used and adapted by the economy and society (Borrell-Damian 2009). Therefore, having students with 'work-based' skills is a means of guaranteeing this economic competitiveness in an increasingly global market-place (Andrews and Higson 2014, 271). Developing students' skills to move into industrial roles is now viewed as fundamental for graduate readiness to work and is linked to increased employability (Jackson 2015).[3] The relationship between employability and work-readiness was central to the design of Brunel's Structural Integrity MSc.

Employability and work-based skills

Enhanced employability is believed to produce economic benefits by increasing international competitiveness, and is discussed widely in policy and academic circles in the UK and internationally (Bowers-Brown 2004; Harvey 2005; Cranmer 2006; BIS 2011; OECD 2012). For example, 'employability' is defined by the UK's Confederation of British Industry (CBI)[4] as 'a set of attributes, skills and knowledge that all labour market participants should possess to ensure they have the capability of being effective in the workplace' (BIS 2012, 10). Evidence on the relationship between student possession of work-based skills and employability is presented in many policy documents (BIS 2012; Higher Education Careers Service Unit 2013, 10; Heyler and Lee 2014; Bothwell 2015).

Growing weight placed upon developing students' work-based skills has led more HEIs to adopt initiatives to increase student employability (Fallows and Steven 2000; Farenga and Quinlan 2015), prompting much academic debate. Scholars have advocated a hesitant approach to the political use of the term 'employability', questioning the conceptualisations and definitions upon which it is based (Holmes 2001; Hinchliffe and Jolly 2011), and its relationship to HEIs and work-based skills (Wilton 2011; Tymon 2013; McCowan 2015). Heyler and Lee (2014, 366) noted that '"employability" was not a fixed notion and … will change and evolve with the market and world'. Others attempted to deconstruct the term to ascertain which particular work-based skills correlate to the concept. Discussions tended to focus on skills acquisition, with less

attention given to the development of attributes and knowledge. However, for Rao (2014) it is 'soft' interpersonal skills such as attitude and behaviour (Tobin 2007), as opposed to 'harder' technical skills, which create increased employability. Work-based learning is believed to promote soft skills, including maturity, emotional intelligence, team-building, communication, and critical thinking (Branine 2008; Huq and Gilbert 2013, 552).

HEI–industry collaboration

One outcome of HEIs' drive to produce students with work-based skills is closer integration with industry (Williams, et al. 2013), the context within which Brunel's Structural Integrity MSc was developed. As Hynes, Costin, and Birdthistle (2011, 16) stated, to equip students with work-based skills, education 'must extend outside the classroom into the industrial arena' – a point supported by others (Cranmer 2006). Indeed, the UK's 2010 Wilson Review of business–university collaboration commissioned by HEFCE concluded, 'every full-time undergraduate student should have the opportunity to experience a structured, university-approved undergraduate internship during their period of study' (2012, 5).

University–industry teaching collaborations are achieved in several ways. We do not aim to provide a comprehensive list of examples of collaboration and delivery, but offer illustrations of practice in the UK and internationally. Undergraduate examples include mentorships (Jackson 2015); sandwich degree and internship work-placements (Duignan 2003; Heyler and Lee 2014)[5]; and bespoke collaborative degree programmes. Beyond undergraduate study, there are postgraduate collaborative industrial doctoral programmes, including engineering programmes where students spend 75% of their time in industry (Kitagawa 2014); and graduate internships such as those at Teesside University, UK, which provide students with work-based learning (Heyler and Lee 2014). Cultivating 'employer engagement and involvement in developing, supporting and directly funding provision or sponsoring individuals' is therefore firmly on the radar (Blackwell and Higson, 2014: 241).[6]

The breaking-down of knowledge production boundaries between industry and academia (Morris, Pitt, and Manathunga 2012) led to increasing numbers of undergraduate and doctoral internships and work-based placements. Yet less attention has been paid to driving Master's course industry-academia collaboration. Consequently, few HEI postgraduate Master's courses directly produced in collaboration with industry are available in the UK or internationally. Brunel's Structural Integrity MSc co-produced with TWI is the first UK Master's programme of its kind in the field. There have, however, been several international examples of engineering Master's programmes co-produced with industry, with two notable examples. First, a Master's programme in Oil and Gas engineering was piloted in Australia in 1999, designed to satisfy an industry need for engineers skilled in all aspects of developing and operating an offshore oil and gas field (Ronalds 1999). Industry played a key role in designing and delivering the course, which included a teaching and research element. Reported benefits included industry's contribution being seen to both augment the expertise of local universities and to ensure industrial relevance. Moreover, industry personnel found teaching to be both stimulating and rewarding (Ronalds 1999). Second, in Sweden, Mälardalen University offered a Master's programme with an extended thesis performed as a joint effort between industry and academia (Isovic, Wallen, and Gustafsson 2013). The programme developers believed long-term benefits included increased employment opportunities for students and recruitment

opportunities for industry and the public sector, and providing a springboard for new research and educational projects (Isovic, Wallen, and Gustafsson 2013).

Expectations, experiences, and perspectives on work-based programmes

While HEI and industry collaborative efforts have increased, research on employer and student expectations, experiences, and perspectives on work-based programmes is emerging, although underdeveloped (Gamble, Patrick, and Peach 2010; Bukaliya 2012; Soltani, Twigg, and Dickens 2013; Swanson and Tomkovic 2014; Branine and Avramenko 2015; Jackson 2015). Such research is important for monitoring work-placement quality, benefits, and drawbacks. For example, Andrews and Higsons' study of perceptions of employers and graduates of skills development in Business and Management courses in four European countries found that combining a sandwich placement year or a shorter (likely unpaid) internship with studies was vital in students gaining skills and work experience desired by employers (Blackwell and Higson, 2014, 243; Andrews and Higson 2014). Helyer and Lee (2014) similarly reported student and employer perspectives on an internship programme in a North East England university, and the value of internships for skills acquisition and employment progression. More broadly, students are increasingly aware of the need for additional skills and attributes – employability skills – for career success (Tomlinson 2008) and view work experience as a means to achieving this (Tymon 2013). What sets Brunel's Structural Integrity MSc apart from the above work-placements is that students are taught together by industry supervisors, and spend their time together researching in industry. By providing data on this unique course model, the paper seeks to add to the above evidence-base.

Brunel's Structural Integrity MSc

The co-produced Structural Integrity MSc was specifically designed to provide a specialised workforce tailored to industry needs. While graduate engineers in metallurgy, mechanical engineering, or material sciences are trained to acquire specialist knowledge in Structural Integrity, graduates from this programme are capable of overseeing all aspects of inspection and evaluation regimes, and possess necessary and up-to-date knowledge and skills, thus minimising the training needs of their employers. Students are expected to build highly analytical skills and industrial knowledge, and thus be ahead of other MSc graduates, and undergraduates with standard placement experience.

The programme was developed as the flagship training platform of the Brunel-TWI led National Structural Integrity Research Centre (NSIRC) funded by HEFCE, industry, and three other universities (Cambridge, Manchester and UCL). Students spent six months on the taught element of the MSc based at Brunel (October 2014 to March 2015) including two taught modules at TWI (November 2014 and January 2015), followed by six months based at TWI (April to September 2015) for revision, examinations, and a research dissertation overseen by a TWI supervisor. Forty-four per cent of teaching was delivered by TWI professionals, and TWI delivered 63% of the programme. This provided students with access to facilities and expertise not available in an academic setting, giving the opportunity to learn highly technical and up-to-date industrial standards, and to participate in industrial projects working in teams with professionals.

Methods

The evaluation employed quantitative surveys, qualitative interviews, and focus groups. Student surveys were conducted at the commencement of the course in November 2014 to provide quantitative data on demographics, students' rationales for choosing the MSc, and expectations about the upcoming experience. All students ($n = 22$) were emailed a request to complete an online survey using the software *SurveyMonkey*. Three reminders were sent. All students completed the survey (100% response rate).

Course administrators requested that all students participate in a mid-term evaluation of the MSc during the dissertation phase in June 2015. This involved completing a quantitative mid-term survey and joining a qualitative focus group, designed to investigate students' experiences of the course. Sixteen students completed the survey (76% response rate; $n = 16/21$),[7] and participated in two focus groups ($2 \times n = 8$ students).

Student surveys conducted at the end of the course in September 2015 quantitatively assessed retrospective experiences and explored whether initial expectations of the course were met. Similar email recruitment methods were used for the 21 students completing the MSc. Nineteen students completed the survey (90% response rate).

To evaluate the MSc course from the perspective of TWI supervisors, a similar pre- and post-course survey methodology was employed, with a similar recruitment method. The first survey was conducted in March 2015 – prior to the students' commencement at TWI – and provided quantitative data on TWI supervisor demographics, past and present experiences of postgraduate teaching (as a student or lecturer), expectations about their upcoming role, and perspectives on their involvement in the MSc. All 15 potential supervisors completed the survey (response rate 100%). Changes to the supervisor schedule meant that two participants did not supervise a student, however their survey responses were analysed as their responses as potential supervisors remained valid. A post-course survey was conducted in September 2015 for 13 supervisors, which quantitatively assessed supervisor experiences, and explored any changes in perspective. Similar email recruitment methods were used and 12 supervisors completed the survey (92% response rate).

An additional email survey will be sent to the graduates in September 2016 to begin gathering longitudinal data on postgraduate study and employment destinations (Wilton 2012).

Results

Sixty per cent of students were British (or had established indefinite residency, so were entitled to pay the same tuition fees as British students), 31% were European. Eighty-two per cent were male, 18% female. Forty-five per cent were aged 21–24 years; 32% aged 25–29; 18% aged 30–39. Sixty-eight per cent were white, 18% Asian. No students reported disability. Ninety-one per cent reported attendance at non-fee paying schools and most students' parents (59%) were not in professional employment.

Students' reasons for choosing the MSc

Seventy-seven per cent chose the MSc because the course was co-designed with industry (Ronalds 1999). Students felt that while the course was not the only degree of its kind, '[No other courses] had the diverse range of topics that we are studying … we cover all aspects of what TWI work on'. The TWI link ensured modules were

related to industry ('more industry relevant knowledge') allowing students to 'learn about the nature of the work', and acquire the soft skills related to 'what life is like as an engineer' (Soltani, Twigg, and Dickens 2013).

Sixty-eight per cent selected Brunel because they were offered a scholarship and thus financial independence: '[We] don't have to focus on trying to fund the course so we have more time to focus on the course'. In some cases this outweighed course content: 'it was extremely important otherwise I would have gone to another university … it was less important in terms of choosing the course'.

Were pre-course expectations met?

Post-course survey results demonstrated 84% were happy they chose the MSc ('great course, glad I did it'). It met the expectations of 74%, specifically regarding academic knowledge (95%), and learning research skills (79%) and industry skills (89%): 'I'm pretty satisfied with what the course has delivered'; 'course content was pretty much what I expected it to be'.

Student expectations about graduate employability prospects

Pre-course, 73% of students expected to be more likely to find employment on completion of the MSc, and 68% to be ready for an industry job (see Table 1). Forty-six per cent believed that they would be employed in industry by course completion. Thirty-six per cent felt that, compared with students from other MSc courses in the field, they would have a better chance of gaining employment (see Table 2). This low figure may relate to half the students planning to continue studying (50%), and awareness that, being in its first year, prospective employers may not understand what the MSc offered ('not everybody knows what Structural Integrity is').

Table 1. Student and supervisor expectations of what students will gain from the MSc.

By the end of the MSc students expected to/had …	Pre-course surveys				Post-course surveys			
	Students		Supervisors		Students		Supervisors	
	%	No.	%	No.	%	No.	%	No.
Increased employability (more likely to find a job)	72.7	16	40.0	6	52.6	10	75.0	9
Ready for a job in industry	68.2	15	26.7	4	57.9	11	25.0	3
Full-time or part-time job in industry	45.5	10	0.0	0	–	–	–	–
Professional skills and in-depth knowledge of field	72.7	16	33.3	5	52.6	10	50.0	6
All the skills to specialise in field	54.5	12	13.3	2	31.6	6	25.0	3
Training that directly meets the needs of industry	59.1	13	20.0	3	31.6	6	41.7	5
More prepared for a job in industry than other similar MSc graduates, given this course is collaborating with industry	63.6	14	86.7	13	57.9	11	66.7	8

Table 2. Student and supervisor long-term expectations for students following the MSc.

What are students' longer term expectations about this MSc?	Pre-course surveys				Post-course surveys			
	Students		Supervisors		Students		Supervisors	
	%	No.	%	No.	%	No.	%	No.
Provide necessary skills to start/ advance their careers	68.2	15	60.0	9	57.9	11	50.0	6
Give skills necessary to become a high-quality engineer	86.4	19	40.0	6	52.6	10	58.3	7
Provide the basis to pursue a PhD in this area	50.0	11	53.3	8	57.9	11	58.3	7
Have a better chance of getting a job than students from other MSc courses in the field	36.4	8	26.7	4	31.6	6	41.7	5
Have better links with industry than students from other MSc courses in the field not collaborating with industry	59.1	13	53.3	8	36.8	7	58.3	7

Furthermore, at the time of the focus groups (mid-course), students were still waiting for the course to become Chartered – a requirement for applications to graduate roles.

Echoing the employability and work-based placement literature (Soltani, Twigg, and Dickens 2013), mid-course 94% felt that their understanding of up-to-date technology and industrial standards was beneficial to career development, and 88% that exposure to TWI's professional environment had made them industry ready for the employment market, aiding their 'soft skills' development of a good working attitude. Reacting to a comment about how smartly dressed students were, one focus group participant stated: '[We] don't look like students we feel more professional. Being integrated with industry develops you as a person'.

Were expectations about employability met?

Student expectations about their employability prospects were lower post-MSc (see Tables 1 and 2): 53% believed the course provided them with the necessary skills to become a high-quality engineer (compared with 86% pre-course); 53% believed they had increased employability (73% pre-course); 58% felt they were ready for a job in industry (68% pre-course); and compared with other graduates on courses not collaborating with industry, 37% believed they had better links with industry (59% pre-course). Seventy-four per cent believed exposure to TWI's professional environment made them industry ready for the employment market (compared with 88% in the mid-term survey). Students held similar pre- and post-course views about being better prepared for a job in industry than graduates from other courses (58% post-course vs. 64% pre-course) and having a better chance of employment given the course was collaborating with industry (32% post-course vs. 36% pre-course).

This drop in expectations may be related to several factors. First, students were aware of a sharp downturn in oil and gas industry recruitment due to a crash in prices and its consequences for their futures ('lack of job prospects'). The course promised they would be 'industry-led engineers ready to start work', and these prospects had now diminished. Some students were considering PhDs to 'postpone employment',

'it's an extremely good course but in the current downturn we have just been unfortunate'. Second, was a perceived lack of practically based applications delivered through learning: several students expected the course 'would be more practical' and that 'we would travel outside in the field, in the industrial part'. These students – who were considering employment post-course rather than a PhD – felt that this lack of practical element 'would have an impact on our future career prospects'. This belief, however, was not unanimous: 'for sure, we are prepared for industry'. Finally, some viewed the course as a basis for doctoral studies (50% wished to take on a PhD pre-course compared with 58% post-course: '[my] aim was to progress onto a PhD and this course provided me that opportunity'). Six students would, or had already considered Brunel as a place of PhD study due to the availability of the course ($n = 6$) and scholarships offered ($n = 4$).

Overall, by the end of the course 26% of student respondents had found a job in the engineering sector; and 21% had been offered a PhD place, compared with 45% students who thought they would have a job by the end of the course.

Students' experiences in an industry setting

The research experience at TWI was viewed as the 'most beneficial [part of the course] because we actually get to work on a project that industry will use'. However, students were concerned that while TWI provided 'good facilities and environment', they wanted to feel more 'integrated'. They discussed this in terms of socialisation: 'so we could go to lunch with the department' rather than 'sitting on a separate table', and in terms of project work and industrial experience:

> I initially thought that we would be working in an office with people who are actually working on projects. Instead we are in a room downstairs just working on the theory side and doing inspections, so we are more isolated than I expected.

> I think the biggest expectation for us when we came to TWI was to be able to work in the department, not to be isolated … we really wanted the true industrial experience. Still, we are able to speak with our supervisors daily and they are available for us whenever we ask for advice.

Supervisors' expectations and experiences of their role on the MSc

Pre-course, 73% of supervisors recognised that supervising a student would be beneficial to their career – although 67% noted that no such formal opportunities existed in terms of career development. Supervisors mainly stated altruistic reasons (60%) for undertaking the role of 'bridging scientists' between Brunel and TWI (Subramanian, Lim, and Soh 2013), such as helping to train the next generation of engineers (Ronalds 1999), although industry-specific reasons were also cited, including identifying prospective employees (40%).

Post-course, 75% recorded having a good experience (compared with 53% initially). However, as *per* their expectations, supervising students was time-consuming (92% vs. 93% pre-course) and 50% felt that their student(s) helped them with their current workload (vs. 73% pre-course; see Table 3). This may account for why supervisors were more likely to view their role altruistically post-course (82% vs. 60% pre-course). Three were concerned that MSc students could be affected by, for example, industry supervisors being too busy for the students or not knowing all the 'answers'.

Table 3. Supervisors' expectations of how helpful students would be to their current workload.

How helpful will a student be/was the student with your current workload?	Pre-course		Post-course	
	%	No.	%	No.
Very helpful	13.3	2	8.3	1
A little helpful	60.0	9	41.7	5
Not very helpful	13.3	2	16.7	2
Unhelpful	13.3	2	33.3	4

Supervisors' expectations about graduate employability

Echoing previous literature suggesting supervisors recognise the importance of work-placements for skills acquisition (Heyler and Lee 2014), pre-course 87% felt that by course completion students would be more prepared for an industry job than other similar MSc graduates, given the collaboration with industry. However, far fewer thought that compared with other students from similar MSc courses, it would provide students with a better chance of employment (27%). This may be because, contrary to the findings of previous literature (Soltani, Twigg, and Dickens 2013), for supervisors the primary purpose of the university–industry collaborative course was not for students to find employment, with just 20% of supervisors viewing this MSc as beneficial for providing the necessary skills for future employment and 40% believing that students will have increased employability by the end of the course. Rather, 93% viewed the added benefit of the course as providing students with research experience in an industry setting, 60% saw long-term benefits as advancing student careers, and 53% pursuing a PhD – the latter aligning with the fact that 50% of students were considering a PhD on commencement of the MSc (see Tables 1, 2 and 4).

Were expectations about employability met?

Post-course, supervisors retained their pre-course beliefs that the experience students received of research in an industry setting was the greatest course benefit (92% vs. 93% pre-course; 100% vs. 87% pre-course, compared with other similar courses not collaborating with industry; see Tables 4 and 5). However, post-course – and in accord with previous literature (Andrews and Higson 2014) – supervisors were much more optimistic that not only did the MSc offer students increased employability (75% vs. 40% pre-course; see Table 1), but also a better chance of getting a job than other MSc students (42% vs. 27% pre-course).

Table 4. Supervisors' views on benefits of the MSc for students compared with typical MSc courses.

What was the added benefit to students who took part in this MSc over students who undertake a typical MSc?	Pre-course		Post-course	
	%	No.	%	No.
Necessary skills for future employment	20.0	3	58.3	7
A good working attitude	26.7	4	58.3	7
Experience of research in an industry setting	93.3	14	91.7	11
Forming links with industry for future job opportunities	53.3	8	41.7	5
There is no added benefit	0.0	0	8.3	1

Table 5. Supervisors' views on benefits to students who completed the MSc.

What benefits did the students gain from this particular MSc in Structural Integrity?	Pre-course		Post-course	
	%	No.	%	No.
Academic knowledge	53.3	8	58.3	7
Necessary skills for future employment	53.3	8	75.0	9
A good working attitude	60.0	9	75.0	9
Experience of research in an industry setting	86.7	13	100.0	12
Forming link with industry for future job opportunities	20.0	3	25.0	3

Table 6. Supervisors' views on whether the MSc was more or less beneficial than an typical MSc course.

Is this Structural Integrity MSc more or less beneficial than a typical MSc course?	Pre-course		Post-course	
	%	No.	%	No.
Much more beneficial	26.7	4	33.3	4
A little more beneficial	66.7	10	33.3	4
Not really beneficial	6.7	1	16.7	2
Not beneficial at all	0.0	0	0.0	0
Not sure	0.0	0	16.7	2

While supervisors viewed the course as improving students' employability, only 42% felt that students finished the course with training that directly met the needs of industry, and 25% believed that students had all the skills to specialise in this field. While these figures were higher than pre-course expectations (20% and 13%, respectively; see Table 1), a lower proportion of supervisors felt that students were more prepared for an industry job than other similar graduates (67% vs. 87% pre-course; see Table 1). Only 25% of supervisors thought that the students were actually ready for a job in industry post-course compared with 58% of supervisors pre-course. More supervisors viewed the course as providing students with the long-term skills to become high-quality engineers (58%) and advance their careers (50%; see Table 2).

Supervisors were more likely to note benefits of the MSc post-course in terms of receiving necessary skills for future employment (75% vs. 53% pre-course; 58% added benefit from other MSc courses vs. 20% pre-course) and a good working attitude (75% vs. 60% pre-course; 58% added benefit from other MSc courses vs. 27% pre-course; see Table 5), matching students' comments about the benefits of working at TWI for developing soft skills. Yet, overall, there was a decrease post-course in the proportion of supervisors viewing the MSc as more beneficial than a typical MSc (66% of supervisors [33% much more beneficial; 33% a little more beneficial] compared with 93% pre-course; see Table 6).

Discussion

Below, we discuss whether the aim of producing 'work-ready' employable students in this specialised area of engineering was met; explore key issues that arose during the delivery of the course; and provide recommendations for future course delivery, thus contributing to literature on higher education management and policy.

Did the MSc deliver on its expectations?

The PSS fund enabled Brunel and TWI to enhance their collaboration – previously only research-oriented – with the joint development and delivery of a Master's course. The partnership allowed students to benefit from a unique environment in which professionals and academic researchers worked together. The industry relevance of this Master's course made it stand out from other courses, attracting students by providing industry-relevant knowledge, perceived to promote 'work-readiness' and enhance employability – traits shown to be important when students select postgraduate courses (Ellison and Purcell 2015, Chapter 2).

The importance of employer engagement in the curriculum was reinforced in the survey results, being a very strong reason (77%) for choosing the Structural Integrity MSc. The decrease in students' beliefs about employment prospects post-course did not relate to the course itself, but reflected students' realisation that the recent fall in oil prices made jobs in industry scarce, adding evidence to the idea that employability is more than a set of skills, but also related to the market and economic factors (Heyler and Lee 2014).

Supervisors' experiences and sustainability of the MSc

There is little research exploring industry supervisors' views on postgraduate taught education, with existing evidence suggesting views are mixed (Wakeling 2015, 73). Our study found supervision an altruistic endeavour, being relatively time-consuming, impacting more on workloads than expected, and with little incentives for supervisors' career progression. Some students found that industry supervisors were, on occasion, relatively busy: a point noted previously about internship supervisors (Bukaliya 2012). Thus, while the design of the MSc demonstrates Brunel's and TWI's strong commitment to university–industry collaboration (Wakeling 2015, 77), others have noted the need to balance such collaborations to ensure that both parties receive sustainable benefits (Soltani, Twigg, and Dickens 2013). Our findings highlight the general industry effort required to maintain similar courses and high supervisory standards, and prompt questions about course sustainability more broadly.

For the Structural Integrity MSc, an option would be to incorporate a rewards-based system for supervisors, based on career development or remuneration. Other industry groups that lack the incentive of government funding may question whether there are sufficient benefits in investing resources, including supervision time, in similar courses. This is especially true given concerns that students can 'run off' with skills after the financial investment in them (Wakeling 2015, 75); and when (as was the case for this MSc) many students continue onto PhDs, industry has less chance of recruiting graduates. Thus, a potential 'policy lever' is to provide tax incentives to persuade employers to engage with postgraduate training provision (Wakeling 2015, 78).

Employability, soft skills, and work space

Being 'work-ready' is multi-faceted, composed of both hard, technical skills, and soft skills. Echoing previous literature, our findings demonstrate that time at TWI allowed students to gain soft skills, with supervisors being more optimistic about students acquiring these skills post-course compared with pre-course (Andrews and Higson 2014). The MSc was also valuable in providing technical skills. However, a number

of students were disappointed by a bias towards research rather than practical skills. For students who wished to be more 'work-ready', the practical element of working 'in the field' was an essential industry skill felt to be lacking.

In the case of this MSc, in which students experienced the work environment as a collective group, being work-ready required more than just the technical, practical, and soft skills highlighted in the literature. Rather, it required considerations related to work space. Students were very concerned that they were segregated from industry employees, both in the work environment and socially. While we lack information on supervisors' perspectives on this, or how it affected students' employability, these findings highlight the importance of 'space' and integration for student experience, and as an element of 'work-readiness'. Previous literature on the sociology of space, from geography and science and technology studies, suggests that architecture and space play an integral role in the production of social networks, the generation of ideas, knowledge production, and research activity (Gieryn 2002; Henke and Gieryn 2008; Yaneva 2010). As Bonetta noted, 'architects have begun to pay attention to a newer concept – the need for interactive spaces in which scientists can meet and talk to each other' (Bonetta 2003, 719). Corroborating this was the fact that post-course, students did not feel that they had strong links with industry, arguably hindered by workplace segregation issues. We therefore believe that for group-based work experience, to ensure students receive the necessary industry skills required to be 'work-ready', attention should be paid to integrating students with industry employees, including within social spaces.

By the end of the course, 26% ($n = 5$) of student respondents had found a job in the engineering sector.[8] While this paper has explored students' and TWI supervisors' views on the perceived benefits and drawbacks of an MSc designed to produce 'work-ready' graduates, a limitation of the study is that we do not yet know the perspectives of potential employers about the industry readiness of this student cohort or the value employers ascribe to 'hard' or 'soft' skills learned in industry when recruiting graduates.[9]

In conclusion, our evaluation of the Structural Integrity MSc represents a case study example that demonstrates to other HEIs and employers what may be achieved, and provides guidance on how co-produced courses may most effectively be approached (Wakeling 2015, 78). It has supplied evidence for a more nuanced understanding of what it is to be 'work-ready' or to have 'employability'. Finally, in terms of higher education policy and management, it highlights the importance of employer engagement in education, specifically for soft skills attainment. However, it cautions policy-makers, academics, and stakeholders to consider the sustainability of industry–university co-produced education regarding benefits to industry and industry supervisors, and stresses the need to integrate group-placed students with industry employees, including within social spaces.

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Notes

1. Group composition is determined by individual universities, based on their recruitment history, for example, a student from a background under-represented in a specific discipline, such as a female wishing to study traditionally male-dominated STEM subjects like engineering. See http://www.findamasters.com/funding/guides/hefce-postgraduate-support-scheme.aspx.
2. In England, government identified priority sectors are, 'aerospace, automotive, life sciences, agricultural technologies, international education, the information economy, professional and business services, nuclear power, oil and gas, offshore wind and construction' (Keep 2014, 254).
3. There is a body of literature critical of human capital theory and the employability approach to educational reform. For example, the relationship between skills and economic gains are neither straightforward nor certain, raising doubts about the extent to which governments should intervene in markets (Keep and Mayhew 2010; Grugulis, Holmes and Mayhew forthcoming); focusing on individual skills acquisition ignores the role of employers' demand for skills (Holmes and Mayhew, 2015, 10); and the lens of human capital theory overplays individual rewards accrued from investing in skills (Holmes forthcoming).
4. CBI is the UK's premier business lobbying organisation, providing a voice for employers at a national and an international level.
5. Sandwich degrees and internships are not necessarily novel, but the last decade has seen an increased drive to promote such work-based learning.
6. In the UK, for instance, a 2007 Workforce Development Programme allocated over £100 million for at least 35,000 new students to HEIs that are co-supported by their employers. See: http://www.hefce.ac.uk/pubs/rereports/Year/2011/evalwfdp/Title,92268,en.html
7. One student left the course.
8. One graduate took a post with an Italian aerospace company; one graduate was offered employment by a UK engineering consultancy, but later declined; three other graduates took up positions with TWI (and later a fourth graduate joined TWI) suggesting that the MSc is at least producing the 'industry-ready' graduates TWI envisaged.
9. To understand employers' views, we have suggested that the longitudinal survey to be administered to students in September 2016 identifies engineering sector employers, who will be asked to complete a survey on perceptions of the work-readiness of the MSc graduates, including the employability value of 'hard' technical skills and 'soft' interpersonal skills learned in industry.

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