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Pathways to success in engineering degrees and careers

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About the Engineering and Materials Education Research Group (EMERG)

Established in 2011, EMERG is based in the School of Engineering at the University of Liverpool and researches, develops, shares and supports best teaching and learning practice within the University of Liverpool and nationally in 4 main areas:

- research and development of specialist engineering teaching methods and technologies, with an emphasis on e-learning
- development and support for academics who wish to increase their skills as professional educators
- distribution of teaching materials, research findings and learning resources for universities and schools
- the management of local initiatives such as overseas student support and engineering competitions.

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Foreword

The UK is approaching a state of crisis with engineering skills. Employers cite skills shortage as a major threat to growth. Yet, the UK has too few young people taking subjects in schools that lead to professional engineering careers, and many of those young people who do pursue engineering subjects at university are not choosing to take up careers in engineering businesses. These two facts are causing a skills shortage in many of our leading engineering companies and an even greater shortage in the thousands of small and medium enterprises that are the supply chain for major organisations.

The UK higher education sector graduates approximately 21,000 engineers from first degrees each year across all domiciles. However, some five thousand of these are from non-EU countries and do not remain in the UK either because of strict visa rules or because they wish to return home. This is talent we can ill afford to lose at this present time. Only 14,000 UK-domiciled students graduate from engineering degree programmes across higher education institutions and as the report shows, only 10,500 of these students graduated from courses with significant engineering content.

This report undertaken by the University of Liverpool Engineering and Materials Education Research Group on behalf of the Royal Academy of Engineering highlights the graduate skills supply issues in engineering through detailed examination of routes into and out of higher education for future professional engineers.

The report demonstrates that a wide range of qualifications are taken prior to university and presents interesting information on destinations from pre-1992 and post-1992 universities. The report also provides an analysis on pathways taken by students through HE for each of the main disciplines within the engineering subject group.

We are indebted to Dr Tim Bullough and his team at the University of Liverpool for this detailed analysis of pathways into engineering higher education and career destinations of engineering graduates.

Professor Helen Atkinson CBE FREng
Chair, Standing Committee for Education and Training

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Executive summary

Engineering students and programmes

In 2012, 10,421 full-time UK-domiciled engineering students graduated from bachelor's and integrated master's degrees with >60% engineering content, from 90 different UK universities. 87.4% of these graduates were male and 12.6% female. There were additionally about half this number of international (non-UK domiciled) engineering graduates, as well as about 1,600 part-time engineering graduates, and over 2,000 UK-domiciled graduates from engineering programmes with less than 60% engineering content.

61.7% of the full-time UK-domiciled engineering students graduated from the 45 pre-92 institutions. Almost half of all engineering students who attended a pre-92 institution studied either mechanical engineering (26%) or civil engineering (23%), while in the post-92 sector the most popular programmes were related to electrical and electronic engineering (29%). Across the whole sector, most graduates were from mechanical engineering (26.2%), civil engineering (22.2%), and electronic and electrical engineering (20.8%) degree programmes.

Mechanical engineering attracted the lowest proportion of females (8%) whereas the programmes in chemical, process and energy engineering attracted the highest proportion of females (21%).

Entry qualifications

62% of all engineering graduates had mathematics at A-level, Scottish Higher or Advanced Scottish Higher level, and 54% had physics A-level (or Scottish equivalents). In the pre-92 sector, 86% enter with a mathematics A-level (or Scottish equivalents), and 75% have physics at this level. Students entering the post-92 sector hold a wider variety of qualifications with just 50% holding A-levels (and Scottish equivalents) and only half of these holding a recognised mathematics qualification.

Engineering students are more likely to have A and B grades in maths and physics A-levels and Scottish Highers than the national population, especially for female students. Female students' entry qualifications in maths and physics are generally better than those of males. 49% of all male engineering students who hold an A-level in maths have a grade A (compared to 44% of males nationally), while 60% of all female engineering students who hold an A-level in maths have a grade A (compared to 47% nationally).

Only 3.3% of female students nationally who obtained grade A in A-level maths (2.3% for grade B) subsequently went on to study engineering, compared to 11.9% (12.6% for grade B) of male students nationally. About 10% of female students nationally who obtained grades A or B in physics A-level went on to study engineering, compared to 20% for male students. A similar pattern is seen for the Scottish Higher qualifications.

Graduation

Of the 10,421 full-time UK-domiciled engineering students graduating:

- 32.5% graduated with an integrated masters degree
- 65% with a bachelor's degree
- 2.5% leave with an ordinary degree.

For Integrated Masters graduates:

- 38% of integrated master's graduates receive a first class degree
- 46% receive a 2:1
- 6.4% receive a 2:2 or lower
- 10% receive an integrated master's degree which is awarded without a classification.

For bachelor's graduates:

- 23% receive a first class degree
- 40% receive a 2:1
- 29% receiving a 2:2
- 8% a third class degree or lower.

There is evidence to show that higher attainment in mathematics at entry corresponds to a better engineering degree classification at graduation, and higher attainment in maths, or maths and physics, at entry corresponds to the highest continuation rates after the first year of study. Those with 'no maths at all' at entry show the highest non-continuation rates after the first year, with almost 17% of such students no longer in higher education after their first year of study, compared to less than 10% non-progression for students with A or B grades in maths A level. However, those graduates with no maths background at entry (mainly in the post-92 sector) who manage to progress past their first year of study do equally as well in their final degree as those who do have a maths qualification at entry.

First destinations after graduation

About six months after the engineering graduates leave university, 66.3% were working full-time, 12.5% were engaged in full-time study, 8.4% were unemployed and looking for work while the remaining 12.8% were pursuing part-time work or study, travel or something else. However,

just 38.8% of all engineering graduates hold full-time professional engineering jobs six months after graduation.

Of those graduates working full-time, 58.5% were in professional engineering jobs, 32.9% in professional non-engineering jobs, and 8.6% in non-professional jobs. 79.1% of the full-time working graduates with an integrated master's degree were working in engineering professional jobs, compared with just 50.4% of full-time working bachelor's graduates.

Gender issues

The report identifies gender issues in the study of engineering and subsequent employment success. Female students' entry qualifications in maths and physics are generally better than those of male students, with proportionally larger numbers of female students studying in the pre-92 sector (15%) than the post-92 sector (8.7%). The final degree classifications of female graduates from integrated master's degrees are the same as for male graduates, but female graduates obtain proportionally more first and 2:1 classification bachelor's degrees.

The proportion of graduates from the pre-92 universities who are in full-time employment is similar for males and females, whether they have graduated from bachelor's or integrated master's degrees; however there are some gender differences in the type of employment. The 62% of female integrated master's graduates who are in full-time employment in engineering professional jobs is ten percentage points lower than their male counterparts. Working female graduates are more likely than male working graduates to be in non-professional or non-engineering professional jobs. Similarly, the 53% of female bachelor's graduates who are in full-time employment in engineering professional jobs is 4% lower than their male counterparts in the pre-92 sector. For bachelor's engineering graduates from the post-92 sector, the gender differences are more pronounced with only 30% of female bachelor's graduates who are in full-time employment being in engineering professional jobs, some seventeen percentage points lower than for their male counterparts. A 14% greater proportion go into non-engineering professional

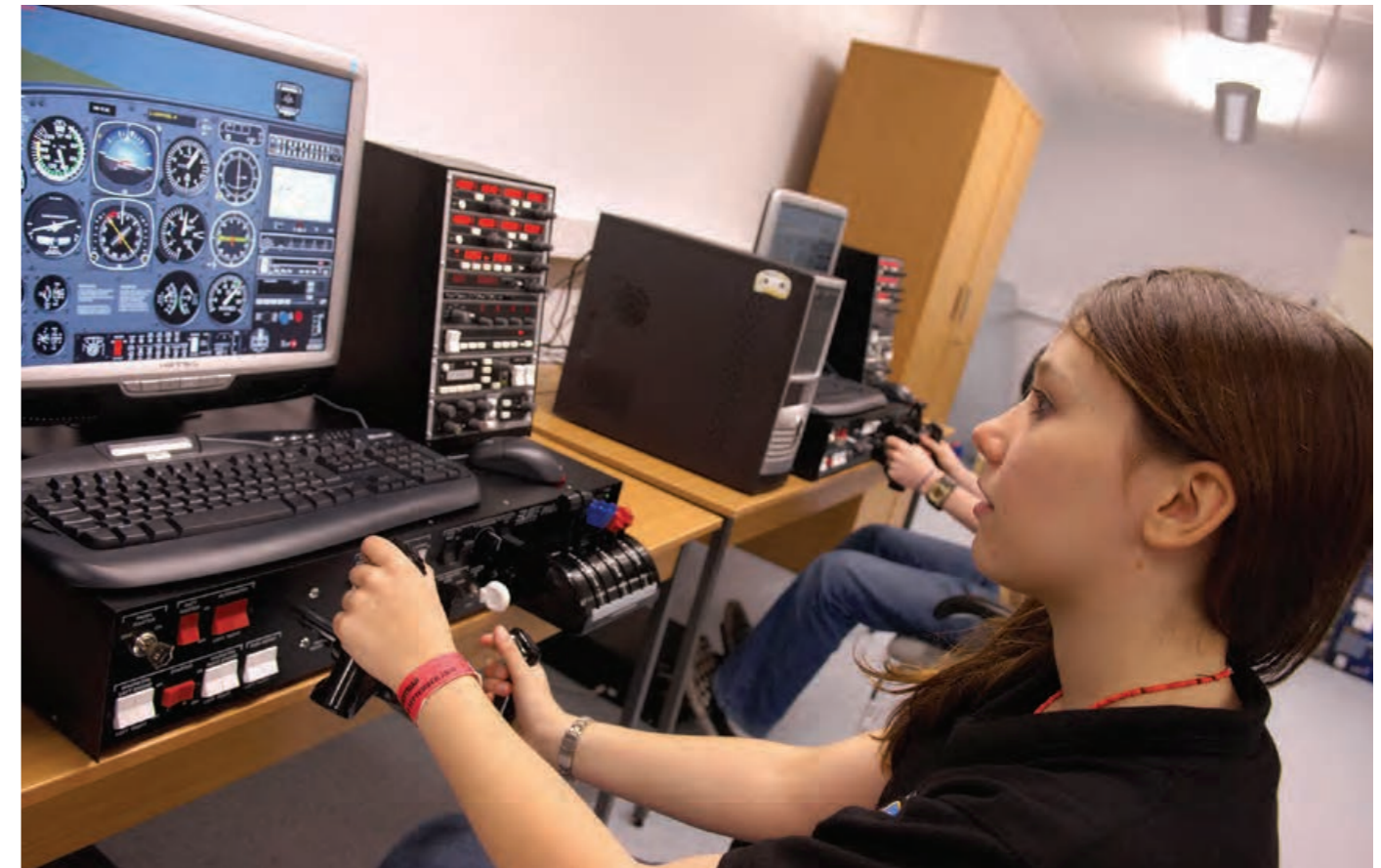


Image courtesy of the University of Liverpool

jobs. The number of integrated master's graduates in the post-92 sector was relatively small (181 graduates in total), but proportionally they are the most successful at securing employment in an engineering professional job, achieved by 79% of both male and female graduates. Female engineering graduates are less likely than their male counterparts to be unemployed six months after graduation (8.6% male unemployment vs 7.3% female unemployment), and this has been found to be the case in other studies¹.

Recommendations

Maths as an entry qualification

More work should be undertaken to investigate alternative approaches to school and university qualification routes to identify those which would maximise the talent pool for the engineering profession. It is surprising, for instance, that all high school students studying any science A-level, are not expected to study sufficient maths topics up until the age of 18 to the extent that they would then be able to study engineering (or any other science/technology discipline) at university. University curricula could then be developed for a larger pool of potential engineering students.

It is clear that better mathematics qualifications upon entry correspond with higher attainment in engineering degrees, and those students with poor mathematics on entry are more likely to drop out of engineering higher education altogether. Good maths qualifications are

Graduates with no maths background at entry (mainly in the post-92 sector) who manage to progress past their first year of study do equally as well in their final degree as those who do have a maths qualification at entry

¹ Improving the employment chances of Engineering Graduates 2014 <http://epc.ac.uk/wp-content/uploads/2014/04/Session-1-Robin-Mellors-Bourne-Employment-diversity-research-summary.pdf>

required by many universities particularly in the pre-92 sector. On the other hand, the post-92 sector successfully graduates many engineering students who do not have recognised maths qualifications at entry. Clearly a lot of high-calibre school leavers are limited in their opportunities for studying engineering at university due to decisions made years previously as to which subjects they should study.

Curriculum differences across UK higher education

More work should be done to identify the suitability of non-A-level qualifications, and understand the differences in curriculum and graduate attributes, between pre- and post-92 engineering programmes. Post-92 universities are mainly admitting bachelor's students with a wide range of non-A-level and A-level entry qualifications, but are graduating similar proportions of firsts, 2.1s as in the pre-92 sector which admits primarily A-level entrants with A-levels in the sciences and maths.

MEng provision in post-92 universities

The engineering profession should look into ways of encouraging more students with good entry qualifications to study MEng at post-92 universities and investigate why it is that fewer engineering students graduate with an MEng degree from the post-92 sector than in the pre-92 sector. Although there are relatively few MEng graduates from the post-92 institutions, those graduates appear to be very employable with greater proportions entering professional engineering jobs than from any other sector.

Female graduates leaving the engineering profession

Female engineering graduates are more likely than males to be employed in non-engineering professional jobs six months after graduation. More work should be done to understand whether this is related to female engineering graduates having skillsets and/or attributes that make them more attractive than male engineering graduates to recruiters looking to fill non-engineering professional vacancies, or whether females are more willing to take any professional employment rather than

wait until an engineering job becomes available, or whether they are put off engineering careers for some reason.

PhD study by UK engineering graduates

It was surprising to many engineering academics, particularly at pre-92 universities, how few UK engineering graduates' first destination was as a PhD research student. Recruitment of UK engineering graduates as academic staff in engineering departments is often challenging, and although international academics have made a tremendous contribution to engineering higher education in the UK, they inevitably have limited experience of the UK schools and qualifications system, engineering undergraduate education and the UK engineering profession. A debate is needed as to the appropriate balance between encouraging the best engineering graduates into employment to support industry and the wider economy as opposed to encouraging and incentivising them to become the academics of the future.

Longitudinal career information about engineering graduates

The 2012 graduating cohort analysed in this study was the first for which entry qualifications could be linked with degree results and first destinations. It would be useful to extend this study to include longitudinal (3-year after graduation) destination data when it becomes available, plus add further graduating cohorts at some point in the future. The engineering profession should also investigate whether career development data recorded by its professional bodies can be linked to this data.

Other subjects contributing to engineering

There are a range of other subjects that contribute to engineering which have not been included in this study because of the nature of the data collection. These include degrees in computer sciences, physical sciences, mathematics and other subjects. A further study needs to be undertaken to better understand their contribution to engineering skills.



Female engineering graduates are more likely than males to be employed in non-engineering professional jobs six months after graduation

Glossary of terms

Advanced Scottish Higher. An optional qualification in Scotland undertaken after a student completes Scottish Highers. The content is considered broadly equivalent to A levels, and can include first-year Scottish degree material. Therefore Advanced Highers can be used to gain direct entry into the second year of a degree in Scotland.

A-levels. General Certificate of Education Advanced Levels are UK academic qualifications for students completing secondary (pre-university) education. They are considered to be at level 3 of the UK National Qualifications Framework.

Bachelor's degree. An undergraduate academic degree qualification awarded after typically three or four years studying a degree programme at a higher education institution. It is considered to be at level 6 of the UK National Qualifications Framework.

BEng and BSc. Bachelor's degree awards which may be associated with the study of engineering in the UK. Sometimes BEng awards are associated with degrees aimed at the CEng accreditation route, with BSc awards aimed at IEng or non-accredited routes.

BTEC. BTEC is a vocational related qualification offered by Edexcel/Pearson awarding.

Chartered Engineer (CEng) and Incorporated Engineer (IEng). An engineer that is registered with the engineering council, requiring demonstration of professional competences and commitment developed through education and working experience, as set out in the professional standard, UK-SPEC. The CEng title is protected in civil law and usually requires an accredited academic qualification in engineering at master's level, plus further training and professional practice. The IEng title usually requires an accredited academic qualification in engineering at bachelor's level, and professional experience. Twenty-two professional engineering institutions are licensed by the Engineering Council to assess candidates for CEng and IEng registration.

DLHE. Destinations of Leavers from Higher Education is an annual statistical survey carried out by HESA (the Higher Education Statistics Agency) to determine the type of employment or further study that graduates are engaged in about six months after graduation.

Engineering Council. Britain's regulatory authority for registration of professional engineers and engineering technicians recognised by the British government as the national representative body for the engineering profession in the United Kingdom. It is responsible for the accreditation of educational and training programmes in engineering.

Entry qualifications. These are the minimum level of qualifications that an entrant must obtain in order to gain access to UK Higher Education. The qualifications requested by universities for entry onto their undergraduate engineering programmes can be quite varied. Often, students will be asked to obtain a certain number of UCAS 'tariff points', which can typically vary from 220-320 for most engineering programmes. Institutions may also request specific qualifications and grades appropriate to the study of engineering, typically ranging from A*A*A to BBB at A-level where one of the subjects must be mathematics and one must be a science, preferably physics. Entry to Scottish Universities typically require from AAAA to BBBB for Scottish Highers which must include maths and either physics or technological studies.

HESA. The Higher Education Statistics Agency is the UK body which collects and disseminates higher education statistical data.

HNC. A Higher National Certificate is a qualification offered primarily by colleges of further education and can provide a vocational pathway into higher education. It is considered to be at level 4 of the UK National Qualifications Framework, broadly equivalent to first year of university.

HND. A Higher National Diploma is a qualification offered primarily by colleges of further education and can provide a vocational pathway into higher education. It is considered to be at level 5 of the UK National Qualifications Framework, broadly equivalent to second year of university.

Integrated master's degree. This is an extended undergraduate master's degree, with an additional year of study at master's level. Typically the first two or three years of study are common with the equivalent bachelor's degree. An accredited integrated master's degree provides the academic knowledge and understanding required for Chartered Engineer. Normally, progression through an integrated master's degree requires a sustained minimum academic level of achievement after the first year of study. It is considered to be at level 7 of the UK National Qualifications Framework, equivalent to a postgraduate master's degree. Because an accredited integrated master's degree fully provides the academic knowledge and understanding required for Chartered Engineer, graduates with this qualification can be the preferred choice for engineering recruiters.

JACS. The Joint Academic Coding System is used by HESA and UCAS to classify academic subjects of study at universities in the UK. The main engineering degree disciplines are given the letter H followed by numbers 1-8 (see table 1).

MEng, MSc and MSc(Eng). Master's degree awards which may be associated with the study of engineering in the UK. An MEng is the usual integrated master's degree award, while MSc and MSc(Eng) are often awards related to postgraduate master's.

OCR. Oxford Cambridge and RSA is the UK award body for the Cambridge Nationals general and vocational qualifications.

Postgraduate (PG). Study for a higher degree, such as a master's or PhD, for which a first degree, such as a bachelor's degree, is generally required for entry.

Post-92 HEI/University. A higher education institution (university) that was a former polytechnic or college, given university status in 1992 or more recently.

Pre-92 HEI/University. A higher education institution that was a university before 1992.

Sankey Diagram. Sankey diagrams are used in this report to illustrate the 'flow-through' or proportioning of students through degree programmes and/or into employment, using arrows whose widths are proportional to the number of students and the proportions of types of students at each stage.

Scottish Highers. One of the national school-leaving certificates in Scotland. A university entrance qualification at level 6 on the Scottish Credit and Qualifications Framework.

SOC code. Standard Occupational Classifications are determined by the Office of National Statistics (ONS) to classify common occupations in terms of a job's skill level and content. They are used in the HESA DLHE surveys to classify the type of employment of a graduate. Some SOC codes in engineering are considered to represent "professional" employment.

SQA. The Scottish Qualifications Authority is responsible for accrediting educational awards in Scotland, including Scottish Highers and Advanced Highers as well as a variety of Scottish vocational qualifications (SVQs).

UCAS. The Universities and Colleges Admissions Service processes applications to almost all full-time undergraduate degree programmes at British universities and colleges. It provides a central service through which prospective students apply for undergraduate study.

UK-domiciled. The definition used by HESA for UK-domiciled students is those students whose normal residence prior to commencing their programme of study was in the UK including Guernsey, Jersey and the Isle of Man.

Undergraduate (UG). Study for a first degree (bachelor's or integrated master's) that typically involves 3-5 years of post-secondary education at a university.

Introduction

The Royal Academy of Engineering's 2012 report *Jobs and growth: the importance of engineering skills to the UK economy*² provided good evidence that demand for graduate engineers in the UK exceeds supply. Graduate engineers are recruited by both engineering and non-engineering employers, and while UK employers could (and do increasingly) recruit international engineering graduates, it would clearly be beneficial if UK universities could produce a sufficient pool of home-grown engineering graduates to meet the demand.

Following on from this, the Royal Academy of Engineering *Skills for the nation: engineering undergraduates in the UK* report³ provided an overview from an admissions perspective of UK engineering higher education, provided by 182 independent institutions (109 universities and 73 FE colleges) that offer a wide variety of engineering programmes. UK engineering higher education enjoys a good reputation for quality at home and internationally (there is about one international undergraduate student studying in the UK an engineering first degree for every two UK engineering students), and this is underpinned by an effective and internationally recognised system of accreditation undertaken by the professional engineering institutions.

The report found strong demand for the engineering programmes in the UK's most established universities, mainly in the pre-92 sector, attracting well qualified students. However, despite many post-92 universities having accredited degree programmes and the staff, facilities and resources that go with these, they attract students in lower numbers and with lower entry qualifications, and the proportion of students accepted through clearing is twice

that found in pre-92 universities. It was suggested that these factors are inhibiting post-92 institutions from playing their full role in the supply of quality engineering graduates.

A major aim of this current study was to build on the earlier findings in order to map out in more detail the very complex landscape of engineering higher education. In particular, to analyse the detailed datasets now available which allow the tracking of engineering students from the admissions process through to degree award and on to the graduates' first destination in employment or further study. The complexity of engineering higher education, and limitations on the availability of data, have required us to limit the analysis specifically to the near ten-and-a-half thousand UK-domiciled engineering students who graduate each year with full-time bachelor's or integrated master's degrees in engineering from 90 different institutions. While this does exclude international students, part-time UK-domiciled students, and a small number of students who have repeated years of study during their degree, it does include the great majority of students of interest to UK recruiters of engineering graduates.



Image courtesy of the University of Liverpool

The report aims to identify whether engineering higher education in both pre-92 and post-92 sectors is attracting school students of both genders in healthy numbers, and with the most appropriate qualifications in order for them to succeed in becoming graduates attractive to employers. The hope is that this information will be useful to those providing guidance to students considering the study of engineering at university level, and to universities providing engineering degree programmes, as to issues related to successful progression through to degree award, and employment thereafter ideally

in professional engineering jobs. The report provides a reliable and detailed analysis of the demographics of UK-domiciled engineering students in higher education, including numbers, entry qualifications, engineering disciplines studied, degree types and awards, and first destinations, with comparisons between genders and university sectors.

The findings have been discussed with academic and admissions staff in a number of universities to clarify and contextualise the data.

² Jobs and Growth, Royal Academy of Engineering . 2012. www.raeng.org.uk/news/publications/list/reports/jobs_and_Growth.pdf

³ Skills for the Nation, Royal Academy of Engineering. 2013. www.raeng.org.uk/news/publications/list/reports/Engineering_Undergraduates_in_the_UK.pdf

Indicators of success for engineering students and graduates

In this study, 'success' has mainly been related to two measurable indicators relevant to engineering degrees and careers:

- a 'good' degree award outcome, often considered in the UK to be the award of a first or 2:1 degree classification (and also unclassified integrated master's degrees*) for undergraduate (bachelor's and integrated master's) study, as this may be a prerequisite for employers recruiting engineering graduates or for entry into postgraduate study. Recent media attention has highlighted that almost 70% of all graduates are now awarded either a first or 2:1 degree classification, with the Association of Graduate Recruiters (AGR) stating that some companies are now considering only hiring students with a first-class degree⁵.
- a graduate's success in obtaining professional employment (preferably full-time in an engineering-related professional job) soon after graduation, or progression into further postgraduate study at master's or doctoral level. HESA's Destination of Leavers from Higher Education (DLHE) datasets are available to provide this 'first destination' data, obtained from a survey of the majority of graduates about six months after their graduation (in early 2013 for our summer 2012 graduating cohort).

A more complex indicator also considered in this study is the extent to which students successfully progress through their degree programmes. Students can repeat years of study, undertake industrial placements while suspending their studies for a year, transfer between programmes, and move between universities, as well as leaving higher education, and tracking students from available data can be ambiguous. However information related specifically to progression and drop-out at the end of the first year of study is presented.

Recent media attention has highlighted that almost 70% of all graduates are now awarded either a first or 2:1 degree classification, with the Association of Graduate Recruiters (AGR) stating that some companies are now considering only hiring students with a first-class degree

⁴ See * on page 20 for further detail
⁵ <http://www.telegraph.co.uk/education/educationnews/9373058/Top-jobs-restricted-to-graduates-with-first-class-degrees.html>

UK engineering students: numbers and disciplines

The cohort considered in this study is the UK-domiciled students who graduated from a full-time undergraduate engineering degree (bachelor's or integrated master's) in 2012. This cohort of 10,421 is just over 40% of the 25,000 students who accepted a place at UK HE institutions to study full-time or part-time for an engineering bachelor's degree, integrated master's, foundation degree, HND or Foundation year.

In this cohort, 87.4% (9,105) of the students were male, and 12.6% (1,316) female. HESA only began to collect students' entry qualification data for the first time in the academic year 2007/08, and therefore all full-time students that began a three-, four- or five-year degree programme on or after this date can be tracked in HESA datasets from entry qualification through to graduation, and on to first destination six months later. This does, unfortunately, currently preclude reliable inclusion of students undertaking part-time study and a small number of students who have repeated years of study during their degree.

Students were only included if they were considered to graduate from an undergraduate engineering degree programme with $\geq 60\%$ engineering content according to HESA conventions. The reason for excluding programmes where no individual H JACS code was 50% or less was to allow the different engineering disciplines to be separately identified and to avoid any double counting in the data. Analysis of the numbers of potential engineering students that this excludes from the cohort considered in this study is as follows:

- 140 students whose total engineering content is $\geq 60\%$ (and are likely to be on accredited programmes) but with no individual H JACS code of 50% or more. The most popular examples include 'mechatronics engineering' and 'electrical and mechanical engineering' programmes.
- 604 students whose programmes are classed as containing 50% engineering with the other 50% having a non-engineering JACS code. Two programmes in this category with the highest numbers of students include music technology and construction engineering management. It is thought unlikely that many of these students would be on accredited engineering programmes.
- 203 students on programmes whose total engineering content is 40% or less, such as those studying games technology, music technology or creative product design. It is unlikely that these programmes would be accredited by the engineering professional bodies.

The JACS coding system (Table 1) was used to identify the specific engineering discipline associated with the students' degree programme. It should be noted that other subjects also contribute to engineering but are not included in the JACS subject group. These include computer science, physical science and mathematics among others.

The 10,421 full-time, UK-domiciled engineering students that graduated at the end of the 2011/12 academic year (in summer 2012) came from 90 different UK higher education institutions; 62%

of the students graduated from the 45 institutions from the pre-92 sector, and the remaining 38% of students graduated from the 42 institutions from the post-92 sector. Students from three other institutions classed by HESA as 'Specialist Colleges' that offer first degrees in engineering whose programmes contain $\geq 60\%$ engineering, are grouped with the post-92 universities in this study. These two higher education 'sectors' (pre-92 and post-92) have been used in previous studies related to engineering education⁶, and a complete list of the universities in each sector is provided in Appendix C.

JACS Code	Description
H1	General engineering
H2	Civil engineering
H3	Mechanical engineering
H4	Aerospace engineering
H5	Naval architecture
H6	Electrical and electronic engineering
H7	Production and manufacturing engineering
H8	Chemical, process and energy engineering
H9	Others in engineering
H0	Broadly-based programmes within engineering and technology

Pre-92 institutions	No. of students	Percentage
H3 Mechanical engineering	1,668	25.9%
H2 Civil engineering	1,470	22.9%
H6 Electrical and electronic engineering	991	15.4%
H8 Chemical, process and energy engineering	751	11.7%
H1 General engineering	644	10.0%
H4 Aerospace engineering	629	9.8%
H7 Production and manufacturing engineering	243	3.8%
H5 Naval architecture	24	0.4%
H9 Others in engineering	8	0.1%
H0 Broadly-based programmes within engineering and technology	1	0.0%
Total	6,429	

Post-92 institutions	No. of students	Percentage
H6 Electronic and electrical engineering	1,174	29.4%
H3 Mechanical engineering	1,065	26.7%
H2 Civil engineering	839	21.0%
H1 General engineering	373	9.3%
H4 Aerospace engineering	225	5.6%
H7 Production and manufacturing engineering	193	4.8%
H8 Chemical, process and energy engineering	62	1.6%
H9 Others in engineering	46	1.2%
H5 Naval architecture	15	0.4%
H0 Broadly-based programmes within engineering and technology	0	0.0%
Total	3,992	

Pre-92 universities may have a stronger emphasis on traditional mathematical skills in engineering science, and thus on topics such as computer-aided engineering, manufacturing and design, providing a slightly different set of learning outcomes

As will be shown, post-92 universities tend to admit students with a far wider range of backgrounds than is the case for pre-92 universities, and are more likely to have BSc degrees (alongside their BEng degrees) aimed at the IEng route for some of these students. They would also tend to have more part-time students. Engineering degree programmes in pre-92 universities may have a stronger emphasis on traditional mathematical skills in engineering science aspects of their curricula, and this is often reflected in their admissions requirements and required learning outcomes, while post-92 curricula may place more emphasis on the development of technical and transferable skills and thus on topics such as computer-aided engineering, manufacturing, management and design to ensure that a slightly different set of learning outcomes are met.

Tables 2 and 3 show the relative popularity of engineering degree disciplines (by JACS code, Table 1) among full-time UK-domiciled students in the pre- and post-92 university sectors. Almost half of all engineering students that attended a pre-92 institution studied either mechanical engineering (26%) or civil engineering (23%), while in the post-92 sector the most popular programmes were related to electrical and electronic engineering (29%). Across the whole sector, the most graduates were from mechanical engineering (26.2%), civil engineering (22.2%), and electronic and electrical engineering (20.8%) disciplines.

It was felt important to confirm the size of our cohort of 10,421 full-time UK-domiciled engineering students graduating at the end of the 2011/12 academic year, with previous estimates of the UK engineering student population and supply of engineering graduates into the UK labour market. The Royal Academy of Engineering's report 'Skills for the nation: engineering undergraduates in the UK'

(2013) used admissions data supplied by UCAS to identify that about 24,900 students accepted a place at UK HE institutions to study full-time or part-time for an engineering bachelor's degree, integrated master's, foundation degree, HND or Foundation year in 2012. This number included international students applying through UCAS, and all students on programmes with engineering content (including when less than 60%). A dataset⁷ of all final-year engineering students at UK universities in 2010 indicated that the engineering student final-year population in that year was made up as follows:

Full-time UK-domiciled bachelor's and integrated master's students on JACS H programmes with $>60\%$ engineering (ie equivalent to our cohort)	42.1%
HNC, HND, foundation degree and diploma course students	22.1%
Full-time international bachelor's and integrated master's students on JACS H programmes with $>60\%$ engineering	20.5%
Bachelor's and integrated master's on JACS H programmes with $<60\%$ engineering	8.8%
Part-time bachelor's and integrated master's on JACS H programmes with $>60\%$ engineering	6.5%

42% of the 2012 total UK engineering graduating student population (24,900 students) is about 10,500 students, which is comparable with the 10,421 UK-domiciled full-time engineering students in the HESA dataset used in the current study. The authors are therefore confident that there are about ten-and-a-half thousand full-time UK-domiciled engineering students graduating from bachelor's and integrated master's degrees each year in the UK with $\geq 60\%$ engineering subject content.

Almost half of all engineering students that attended a pre-92 institution studied either mechanical engineering (26%) or civil engineering (23%), while in the post-92 sector the most popular programmes were related to electrical and electronic engineering (29%)

Table 1. JACS principal subject codes for engineering.

Table 2. Disciplines studied by UK-domiciled full-time engineering students at pre-92 institutions.

Table 3. Disciplines studied by UK-domiciled full-time engineering students at post-92 institutions.

⁶ Skills for the nation: engineering undergraduates in the UK (2013) at <http://www.raeng.org.uk/publications/reports/skills-for-the-nation-engineering>

⁷ (provided for an HEA analysis of National Student Survey results in 2010 (<http://www.materials.ac.uk/pub/nss2010.asp>))

UK engineering students: university entry qualifications

For the pre-92 sector, 87.4% of students had their highest entry qualification recorded as an A-level (or equivalent) while the post-92 universities admit students with much more varied 'highest entry qualifications'. Almost half the post-92 students enter with an A-level or equivalent, and the other half entered with one of 37 different non-A-level HESA highest entry qualification types

HESA datasets record for each engineering student a set of entry qualifications of relevance to their admission on to their degree at university. It includes qualification type, subject and grade, generally obtained directly from UCAS as part of the university admissions process. Separately, HESA records a student's 'highest qualification on entry' as a qualification type.

The percentages of the 10,421 UK-domiciled full-time 2012 engineering students who entered their university studies with one or more A-level, or other common entry qualifications such as BTEC HNC/HND etc. relevant to engineering study, are shown in Table 4.

- 59.5% of all the engineering students had mathematics at A-level or Scottish Higher (with 2.8% of these holding Advanced Higher as well as Higher level maths)
- 51.5% had physics at A-level or Scottish Higher (with 2.7% of these also holding Advanced Higher level physics).

In the pre-92 sector, 81.3% have mathematics A-level (or Scottish Higher) and 70.4% have physics at this level. The entry qualifications in the post-92 sector are more varied; fewer hold mathematics and physics qualifications, but a greater proportion of those with A-levels have A-levels in Design and Technology, Electronics, and Computing. A significant proportion of the engineering cohort had none of the entry qualifications itemised in Table 4, including the majority in the post-92 sector.

It should be noted that HESA obtain information on a student's entry qualifications from university returns. The universities will have obtained this qualification data from UCAS at the end of

the admissions process. UCAS gather entry qualification data directly from the A-level, BTEC and other awarding bodies. There are circumstances in which it is known that an individual student would appear to have no entry qualifications in university returns to HESA, including a small number of students who do not obtain their entry qualifications in the same year they enter university (which could include some mature students, and deferred-entry UCAS admissions), and students who do not record their BTEC registration number on the UCAS application forms. Accurate recording of BTEC entry qualifications in HESA datasets, especially for students entering soon after such data was first recorded (in 2007/8), was highlighted to us by a number of universities as being an issue. Universities were unsure at that time exactly how to record BTEC qualifications (especially BTEC qualifications below HNC/HND level) in their returns to HESA, and this coincides with the entry years for the cohort of students considered in this study. This work has therefore tended to focus more on A-level and equivalent entry qualifications, for which there is a great deal of confidence in the recorded data. (See Table 4).

Table 5 shows the grades of maths and physics A-levels or Scottish Highers held by engineering students who hold this entry qualification in the pre-92 sector.

Table 4. The percentage of engineering students holding each entry qualification (any grade) as recorded by HESA.

	Pre-92 (%)	Post-92 (%)	Whole cohort (%)
A-level maths	70.0%	22.1%	51.6%
A-level physics	59.8%	18.8%	44.1%
A-level chemistry	26.6%	5.5%	18.5%
A-level general studies	14.0%	7.3%	11.4%
A-level further maths	13.0%	0.7%	8.3%
A-level biology	10.6%	4.3%	8.2%
Scottish Higher maths	11.3%	2.6%	7.9%
A-level D&T	7.8%	7.3%	7.6%
Scottish Higher physics	10.6%	2.3%	7.4%
A-level geography	6.6%	4.8%	5.9%
A-level electronics	3.9%	2.3%	3.3%
A-level computing	3.2%	3.0%	3.1%
Advanced Scottish Higher maths	4.4%	0.3%	2.8%
Advanced Scottish Higher physics	4.2%	0.3%	2.7%
AS level maths only (no BTEC, access course, OCR diploma)	1.2%	2.6%	1.7%
BTEC HNC/HND engineering	0.6%	3.3%	1.6%
OCR national diploma	0.0%	0.2%	0.1%
Access courses	0.0%	0.0%	0.0%
Those that hold none of the qualifications requested	13.3%	57.7%	30.3%
Total number of students	6,429	3,992	10,421

Table 5. Maths and physics A-level and Scottish Higher grades held by pre-92 cohort.

Entry qualification grades obtained	Percentage holding Maths A-level or Scottish Higher	Percentage holding Physics A-level or Scottish Higher
Grade A	59.6%	44.7%
Grade B	26.5%	28.8%
Grade C	10.5%	17.5%
Grade D	2.7%	7.0%
Grade E	0.7%	2.0%
Total number holding this qualification	5,225	4,530

The majority (59.6%) have a grade A in mathematics, with 86.1% holding an A or B grade. Similarly 73.5% entering with A-level (or equivalent) physics qualifications have grades A or B.

In contrast to the recorded entry qualifications in table 4, figures 1 and 2 (see page 16) show the engineering student cohort's 'highest qualification on entry', as also recorded in HESA datasets, for graduates from the pre-92 and post-92 sectors respectively. For the pre-92 sector (Figure 1), 87.4% of students had their highest entry qualification recorded as an A-level (or equivalent) (with Table 4 indicating that for the majority of students this would be maths and/or physics). The remaining 12.6% of engineering students

at pre-92 institutions have many different 'highest entry qualifications'.

Figure 2 shows that post-92 universities admit students with much more varied 'highest entry qualifications' than in the pre-92 sector. Almost half the students do enter with an A-level or equivalent, (although Table 4 suggests that about half of these A-level entrants do not have maths A-level at either AS or A level). The other half of post-92 university graduates entered with one of 37 different non-A-level HESA highest entry qualification types, as shown.

While Table 4 suggested that only 3.3% of engineering students at post-92 institutions enter with a BTEC HNC/HND

Figure 1. Pre-92 students' 'highest qualification on entry'. Apart from A-levels, there were 18 different recorded qualification types.

** Other qualifications (held by $\leq 0.5\%$ of the pre-92 cohort) are: First degree of UK institution (0.4%), Access course (not QAA recognised 0.3%), Access course (QAA recognised 0.3%), Other credits from UK HE institution (0.2%), Mature student admitted on basis of previous experience (0.2%), Foundation course at FE level (0.2%), Graduate of other overseas institution (0.2%), Dip. HE (0.1%), Foundation Degree Higher degree of UK institution (0.1%), Other HE qualification of less than degree standard (0.1%), Student has no formal qualification (0.1%).

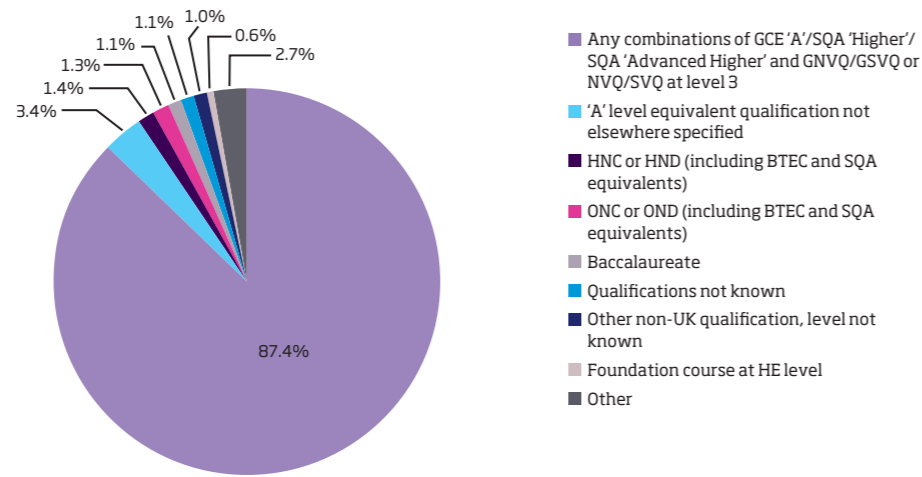
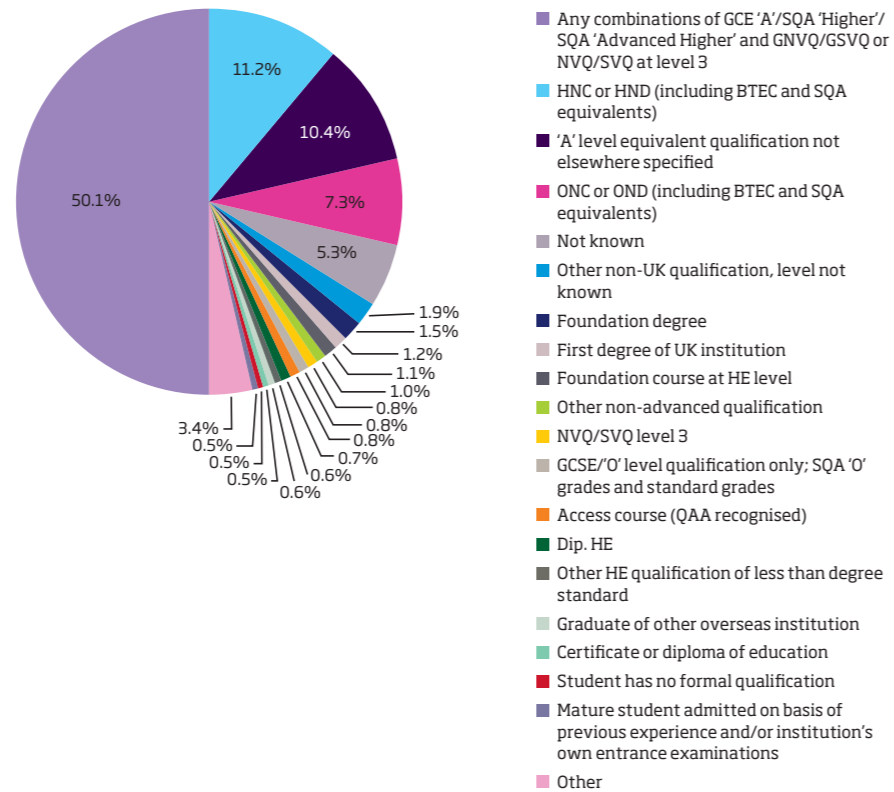


Figure 2. Post-92 students' 'highest qualification on entry'. ***Other qualifications held by $\leq 0.5\%$ of the post-92 cohort are:

Professional qualifications (0.4%); Other credits from UK HEI (0.4%); Access course (not QAA recognised 0.3%); Baccalaureate (0.3%); GNVQ/GSVQ level 3 (0.3%); Graduate equivalent qualification (0.2%); Foundation course at FE level (0.2%); Accreditation of Prior (Experiential) Learning (APEL/APL) (0.2%); Higher degree of UK institution (0.2%); Advanced Modern Apprenticeships (0.2%); NVQ/SVQ level 2 (0.1%); Postgraduate diploma or certificate, excluding PGCE (0.1%); Graduate of EU institution (0.1%); NVQ/SVQ level 4 (0.1%); GNVQ/GSVQ level 5 (0.1%); OU credit(s) (0.1%); Postgraduate equivalent qualification not elsewhere specified (0.1%); GNVQ/GSVQ level 4 (0.1%).



in an engineering subject (aerospace, automotive, electrical and/or electronic, general, manufacturing, mechanical or operations engineering), Figure 2 implies about 11% of entrants have a BTEC HNC/HND in some subject recorded as their 'highest entry qualification'. Possibly these are non-engineering BTEC HNC/HND qualifications, but as already stated, HESA acknowledge that recorded data associated with BTEC entry qualifications is possibly unreliable for our cohort. For this reason the study does not include further analysis of BTEC qualifications.

As 52% of the engineering student cohort considered in this study hold either an A-level or Scottish equivalent qualification

in mathematics (Table 4), and 44% hold such qualifications in physics, and as confidence in mathematics and physics is often considered to be one of the important indicators of potential for success on engineering degree programmes, it was considered important to look in detail at the maths and physics A-level (and equivalent) qualifications held by engineering students in this cohort.

Figures 3 and 4 show the maths grade distribution for male and female engineering students in our cohort who have mathematics A-level, or Scottish Highers, entry qualifications respectively. Also indicated are the grade distributions obtained nationally by all students who

A-level and Scottish Highers entry qualifications held by engineering students

Figure 3. Proportions of A-level maths grades A-E for male and female engineering students who held this qualification at entry (50.7% of males (4,618 students) and 58.0% of females (763 students) in our cohort). Also shown are the proportions of A-level maths grades A-E achieved by the national population achieving this qualification in 2009 (41,763 males and 28,773 females).

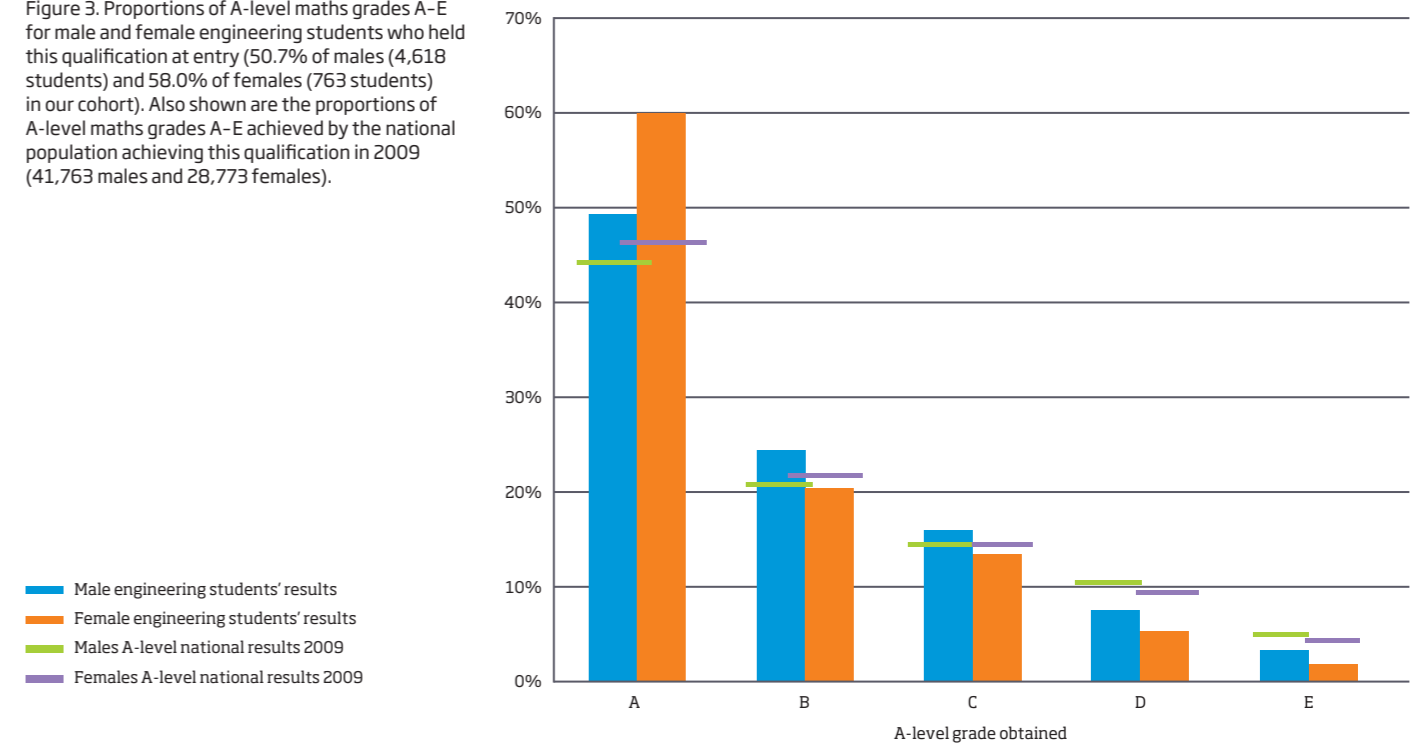
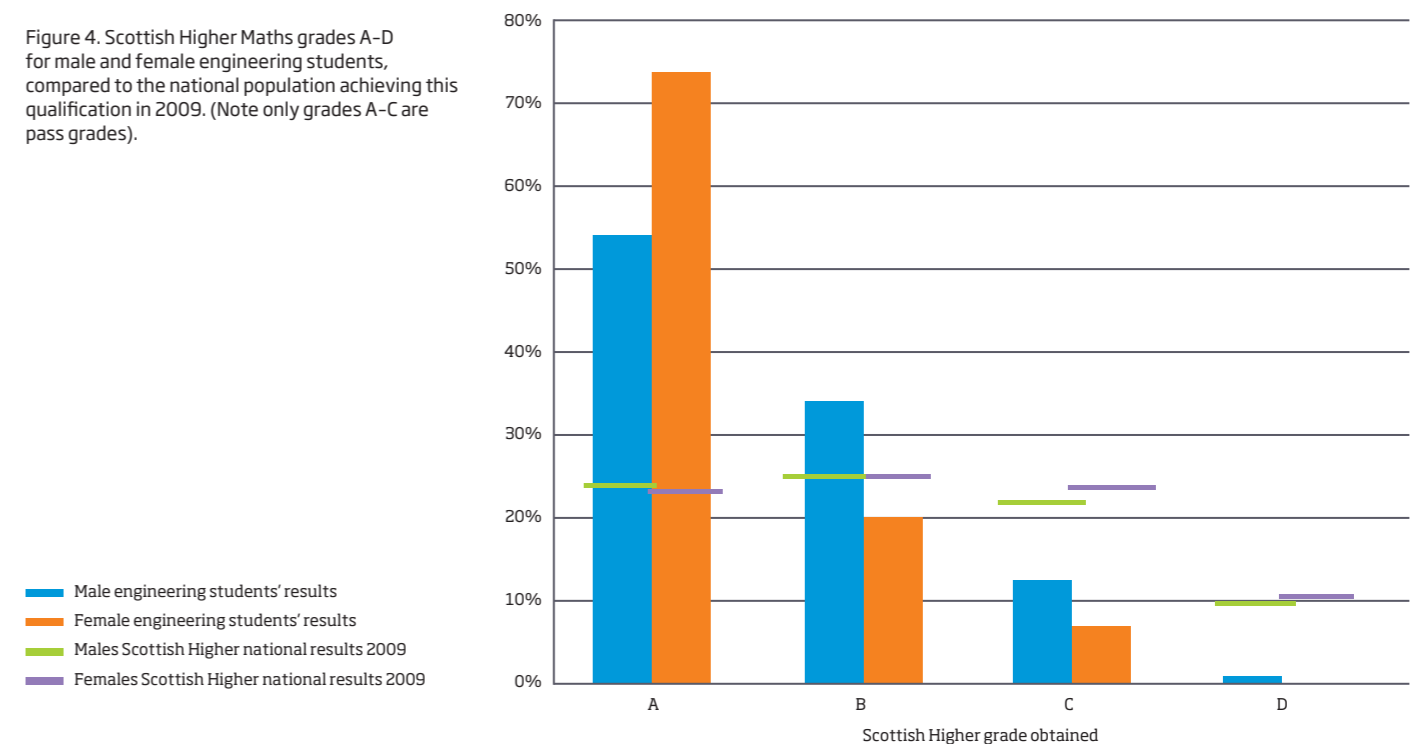


Figure 4. Scottish Higher Maths grades A-D for male and female engineering students, compared to the national population achieving this qualification in 2009. (Note only grades A-C are pass grades).



achieved these qualifications in 2009 (the year the majority of BEng graduates in our cohort would have entered university). As might be expected, a higher proportion of students with 'A' grades in maths at A-level or Scottish Highers are admitted to study engineering than the proportion achieved by the national population who take the qualification. 49% of all male engineering students who hold an A-level in maths have a grade A (compared to 44% of males nationally, Figure 3), while 60% of all female engineering students who hold an A-level in maths have a grade A (compared to 47% nationally). Female engineering students have better maths A-level qualifications on average than males, and the grade differences are even more pronounced for Scottish Highers (Figure 4).

However, while 41,763 male students and 28,773 female students achieved A-level grades A–E in maths nationally in 2009, only 3.33% of the female students that obtained an A grade (457 out of 13,710 female A-level students) subsequently studied engineering, compared to 11.9% of male students that obtained an A grade (2,266 out of 19,030 male A-level students).

Similarly, only 2.3% of female students that obtained a grade B in A-level maths (153 out of 6,531 females) studied engineering, compared to 12.6% of the males (1,135 out of 9,042 males). Overall, just 2.7% of the female students that obtain grades A–E in A-level maths (763 out of 28,773 females) subsequently studied engineering, compared to 11.1% for male students (4,618 out of 41,763 males).

A similar pattern is seen for the Scottish Higher maths qualifications in 2009. Overall, 1.6% of the female students that obtained a pass grade (A–C) in maths (106 out of 6,665 females) subsequently studied engineering, compared to 10.1% of males (722 out of 7,141 males). For those with grade 'A' maths at Scottish Higher level, 3.7% of females (78 out of 2,085 females) subsequently studied engineering compared to 16.5% of males (389 out of 2,362 males).

Clearly, even though the total numbers of male and female school students taking maths A-level (or Scottish equivalents) are not too dissimilar, and while engineering at university is attracting a significant proportion of the best maths-qualified school-leavers (just over 8% of school-leavers with A grades at A-level maths), there are significant gender differences with engineering attracting typically only

a quarter to a fifth of the best maths-qualified female school leavers compared with male school leavers.

The study of physics to A-level (or equivalent) is also often considered an important indicator of potential for study of engineering at university. Figures 5 and 6 show the grade distributions for the 44% of engineering students who hold physics A-level and Scottish Highers, respectively, alongside the grade distribution for the national population. Engineering students are more likely to have 'A' and 'B' grades in physics than the national population, with female students holding slightly higher proportions of 'A' grades compared to male students.

There are greater gender differences than for maths in terms of the overall numbers of male and female school students in the national population leaving with A-level grades A–E in physics in 2009 (21,776 male students and 6,348 female students).

- 8.7% of these female students (553 out of 6,348 females) subsequently studied engineering, compared to 18.6% for male students (4,044 out of 21,776 males).
- About 10% of the female school students that obtained either grade A (236 out of 2,380 females) or grade B (145 out of 1,458 females) in A-level physics subsequently studied engineering, compared to about 20% of the male school students that obtained an A grade (1,433 out of 7,030 males) or B grade (972 out of 4,671 males). For the Scottish Higher physics qualifications in 2009, 4.6% of the female school students that obtained a pass grade (A–C) in physics (94 out of 2,055 females) subsequently studied engineering, compared to 14.0% for male school students (680 out of 4,853 males).
- For those achieving grade 'A' physics at Scottish Higher level, the proportions subsequently studying engineering increased to 5.9% for females (52 from 877) and 17.2% for males (334 from 1,946 males).

Clearly, engineering study at university is attracting a greater proportion of the best physics-qualified school-leavers compared with maths-qualified school leavers (eg just over 18% of A-level physics students achieving A grades subsequently study engineering, compared with just over 8% of A-level maths students with A grades). However there are significant gender differences, although perhaps slightly less so than was the case with maths,

Figure 5. Proportions of A-level physics grades for male and female engineering students who held this qualification at entry (44.4% of males (4,044 students) and 42.0% of females (553 students) in our cohort). Also shown are the proportions of A-level physics grades A–E achieved by the national population in 2009 (by 21,776 males and 6,348 females).

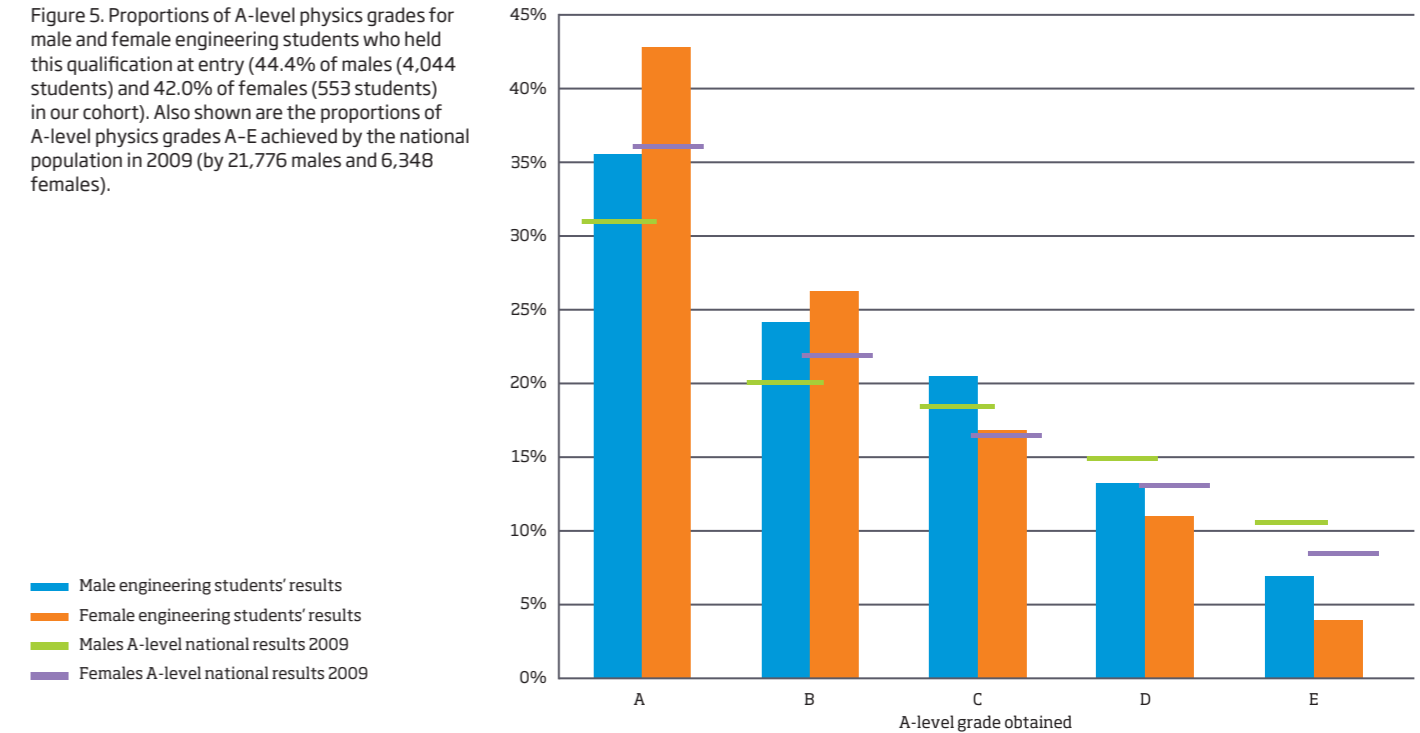
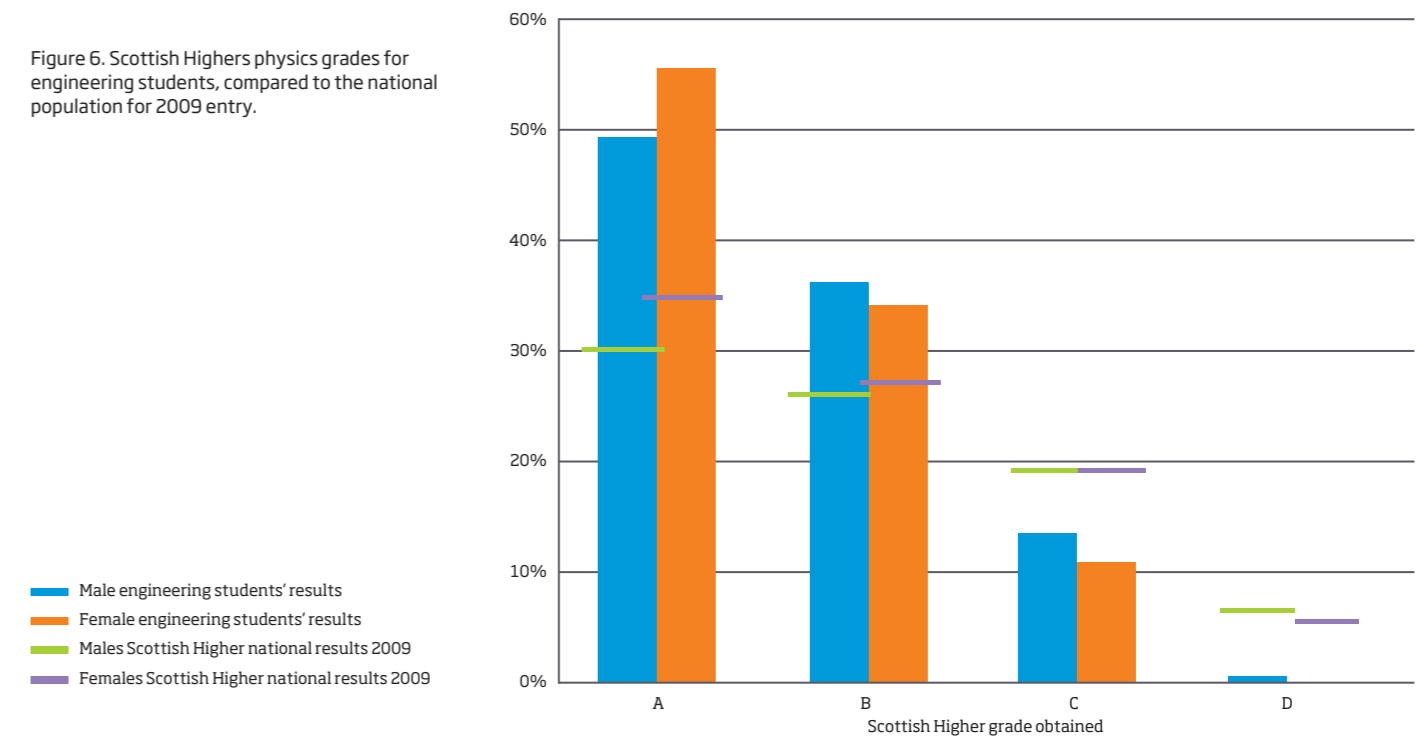


Figure 6. Scottish Highers physics grades for engineering students, compared to the national population for 2009 entry.



with engineering attracting about half the proportion of the best physics-qualified female school leavers (about 10% of those achieving grades A or B) compared with male school leavers.

A recent report by Professor John Perkins (2013)⁸ suggested that the reason for the low numbers of females in the engineering profession was female subject choices at school. While girls are now just as likely

as boys to obtain GCSE grades A*–C in mathematics and triple science, there are large gender differences between males and females in the number obtaining A-levels in mathematics and striking differences in the number undertaking A-level physics. The report concludes that "The gender gap in A-level physics constricts the number of women in the talent pipeline for engineering."

⁸ Professor John Perkins' Review of Engineering Skills (Nov 2013) Department for Business Innovation and Skills. URN BIS/13/1269

Even though the total numbers of male and female school students taking maths at A-level are not too dissimilar, there are significant gender differences with engineering attracting typically only a quarter to a fifth of the best maths-qualified female school leavers compared with male school leavers

Obtaining a 'good' engineering degree: overview

32.5% of all engineering students graduated with an integrated master's degree in 2012 and 65% graduated with a bachelor's degree. The post-92 sector is more oriented towards bachelor degree programmes with just 4.5% of post-92 students graduating from integrated master's programmes

The degree awards for all UK-domiciled full-time engineering students who graduated in 2012 are shown in Figure 7. The cohort is divided by degree type (integrated master's, bachelor's and ordinary degree), degree classification, and gender.

32.5% of all engineering students graduated with an integrated master's degree in 2012. 84% of these graduates were male and 16% female. Overall, 38% of integrated master's graduates received a first class degree, 46% received a 2:1 classification and 10% received an 'unclassified' master's degree.

Similarly, a significant number of post-92 universities may award their integrated master's degrees with 'merit' and/or 'distinction' (or 'commendation'), rather than using the first class, 2:1 etc classification system. 72 from the 105 integrated master's graduates from post-92 universities had A-level or Scottish Higher maths. Although the majority had only grade C in maths, this is still much higher than for the general post-92 student population. Hence it has been assumed that these also represent 'successful' degree outcomes. Unclassified integrated master's degrees are therefore referred to in this report as 'MEng (not classified)' to clearly distinguish them from 'unclassified' bachelor's and ordinary degrees which may refer to graduates who fail to achieve the minimum requirements of a classified Honours degree or bachelor's graduates from universities such as Cambridge which do not classify their bachelor's degrees.

65% of engineering students graduated with a bachelor's degree, of whom 89% were male and 11% female. For these bachelor's graduates, 23% received a first class degree and 40% received a 2:1 classification, with a further 29% receiving a 2:2. Just 8% received a third class degree or lower. 2.5% of engineering graduates were awarded an ordinary degree.

Comparisons of degree awards for engineering students graduating from universities in the pre- and post-92 sectors can be seen in Figure 8 (see page 22).

- The pre-92 sector graduated 61.7% (6,429) of all the UK-domiciled full-time engineering students, 84.9% of whom were male and 15.1% female. It produced almost equal numbers of integrated master's and bachelor's degree graduates (49.9% and 48.8% respectively).
- A very slightly higher proportion of female students (52.8%) graduated with integrated master's degrees compared with bachelor's degrees (49.3%) in this sector.
- Of the students who obtained an integrated master's degree, about 93% obtained either a first or 2:1 (or MEng without classification), with no significant difference between genders.

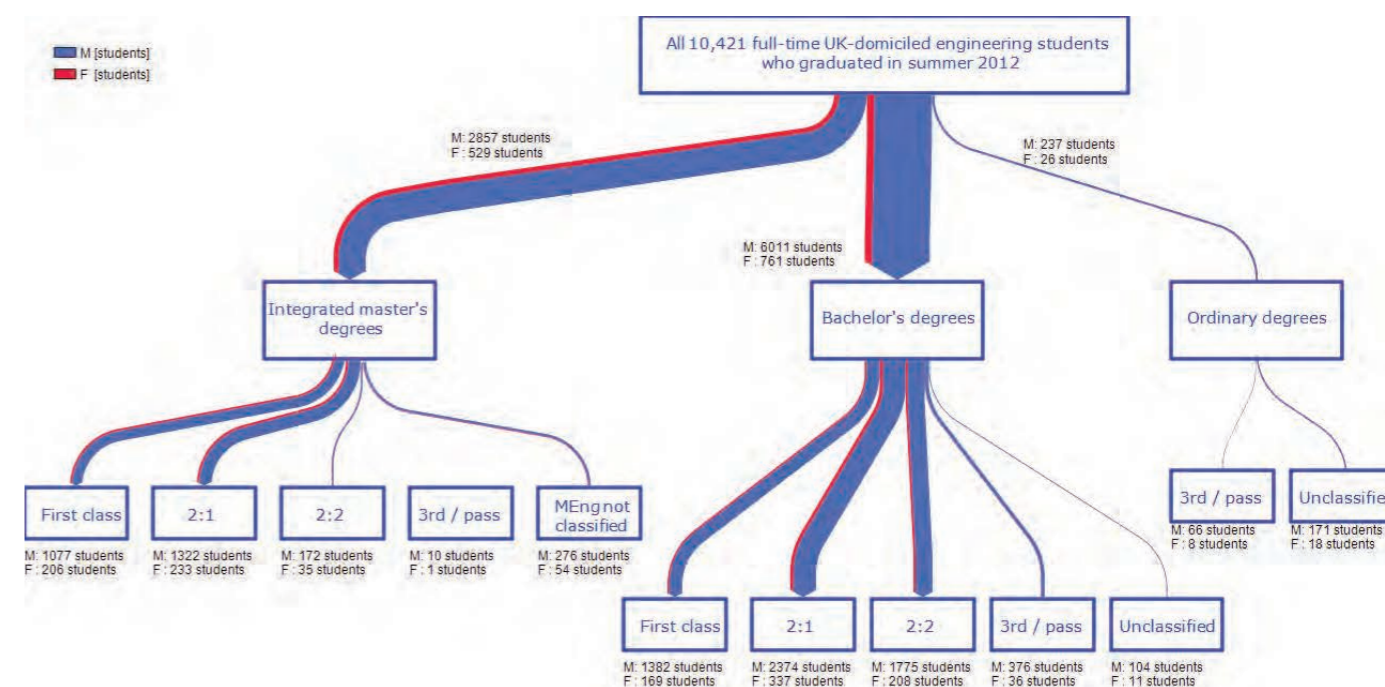


Figure 7. Sankey diagram showing the degree awards for all engineering students who graduated in 2012. Blue shading is for male students (M); red shading for female students (F:).

- For bachelor's degree graduates, 58% obtain a first or 2:1, with the percentage being slightly higher for females (62.4%) compared with males (57.3%).

The post-92 sector graduated 38.3% of all engineering students in 2012, 91.3% of whom were male and 8.7% female. 91% of UK domiciled students at post 92 universities left with a bachelor's degree and 4.5% from integrated master's

programmes, 91% of its UK-domiciled full-time graduates left with such a degree, compared with 4.5% graduating from integrated master's programmes. For bachelor's degree graduates in the post-92 sector, 67.2% obtained a first or 2:1. As with graduates from the pre-92 sector, this percentage was slightly higher for female students (72.2%).

It should be noted that there is some inconsistency regarding an 'unclassified' degree award in the HESA dataset. About 7% of pre-92 and 59% of post-92 integrated master's awards are recorded as 'unclassified'. A very small number of pre-92 universities, such as the University of Cambridge, do not classify their integrated master's MEng, which is the normal degree award for their engineering students. Of the 225 students graduating with an unclassified MEng degree in the pre-92 sector, 219 students entered with 'A' grades in both maths AND physics A-level or Scottish Higher qualifications. This work has therefore identified such non-classified integrated master's degrees and assumed that they generally represent high achieving graduates.

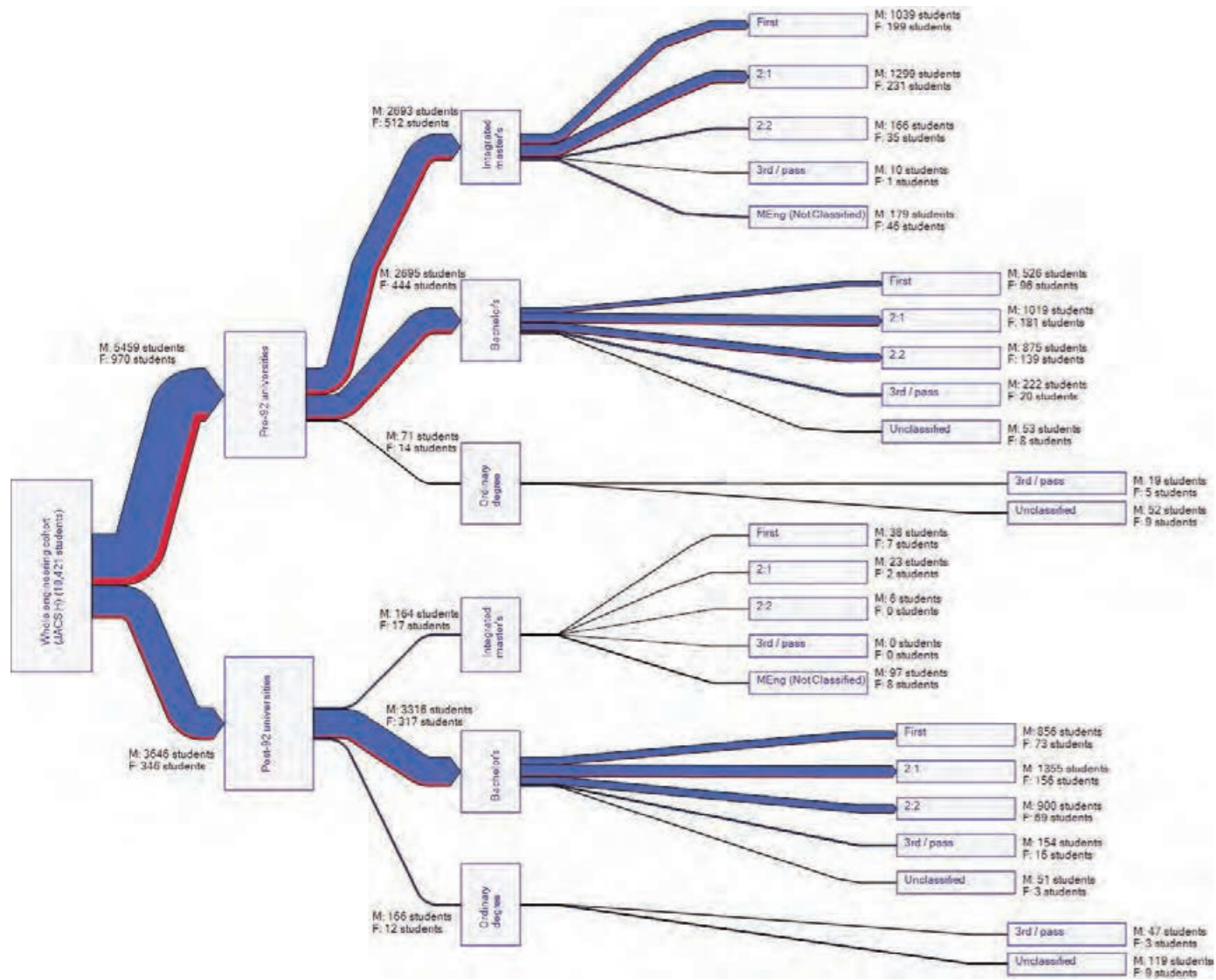


Figure 8. Sankey diagram comparing degree awards for engineering students from universities in the pre- and post-92 sectors for the 2011/12 graduating cohort. Blue shading is for male students (M); red shading for female students (F). Equivalent Sankey diagrams showing degree award data for graduates from each engineering discipline (JACS codes H1-8) can be found in Appendix A.

First class or 2.1 degrees are not restricted to those engineering students with the best A-level maths entry qualifications

Obtaining a 'good' engineering degree: how important are A-level maths and physics?

Figures 9 and 10 (see page 24) show the proportions of final degree classifications obtained by UK-domiciled, full-time, integrated master's and bachelor's engineering students who entered with A-level maths grades A-E, and with no maths A-level.

Slightly greater proportions of students with an A grade at A-level maths graduate with a first or 2.1 (including MEng without classification) from both bachelor's and integrated master's degrees (Figure 9), but there is no statistical correlation between maths grade and degree classification at integrated master's or bachelor's level. First class or 2.1 degrees are not restricted to those engineering students with the best A-level maths entry qualifications.

As will be shown in the next section, students with weaker maths qualifications on entry, and particularly those with no prior maths qualifications, tend to show higher non-continuation rates after the first year of study. Given that some weaker students are no longer in the education system, this may account for the lack of correlation between A-level maths grades and final degree classifications. Other reasons could include institutions' increasing remedial support for those students with a weaker maths background which thereby boost weaker students' level of maths during the degree programme or the introduction of engineering programmes, in some institutions which have greater focus on management and business rather than maths.

For male students studying engineering, figure 10 shows a moderate correlation between grade of maths A level at entry and the proportion graduating with a first or 2:1 (or MEng without classification)

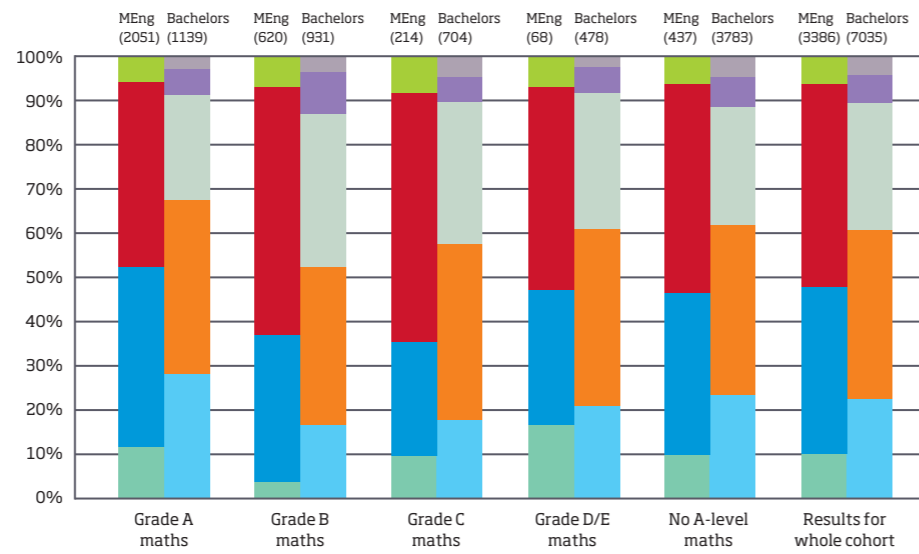
for integrated master's and bachelor's degrees combined (Spearman $r = -0.949$, $p = 0.05$). There is no statistical correlation between the grade of maths A-level and obtaining a first or 2:1 degree for female students. However, there is a high correlation between grade of maths and obtaining a first class degree, (Spearman $r = -1$, $p < 0.001$), even though the numbers of female graduates are relatively low. Overall, for both male and female students combined, a moderate correlation is seen between maths A-level grade and graduating with a first class degree (Spearman $r = -0.949$, $p = 0.05$).

Comparing graduates from pre-92 and post-92 universities for bachelor's and integrated master's degrees combined (Figure 11 (see page 24)):

- the percentage graduating with a 2:1 or above shows a moderate correlation (Spearman $r = -0.949$, $p = 0.05$) with maths A-level grade in the pre-92 sector while there is no such statistical correlation in the post-92 sector
- when we consider just those graduating with a first class degree, for those that enter university with A-level maths there is a high correlation between the maths entry grade and the percentage graduating with a first in the post-92 sector (Spearman $r = -1$, $p < 0.001$) whereas there is no comparable correlation in the pre-92 sector.

Figure 9. Degree classifications of integrated master's (MEng) and bachelor's graduates who entered with A-level maths grades A to E, or with no maths A-level (numbers in brackets show the total number of graduates in each group).

- Unclassified degree (Bachelors - incl ordinary degrees)
- 3rd/pass (Bachelors - incl ordinary degrees)
- 2:2 (Bachelors)
- 2:1 (Bachelors)
- 1st (Bachelors)
- 3rd/pass (Bachelors)
- 2:2 (MEng)
- 2:1 (MEng)
- 1st (MEng)
- Unclassified degree (MEng)



Of the 3,246 engineering students who entered with A or B grades in both maths and physics A-levels or Scottish Highers:

- 35.4% went on to achieve a first
- 40.4% a 2.1
- 7.4% achieved an MEng without classification.

If this is then compared with the 637 engineering students who entered with maths A-level or Scottish Higher at grade A or B, but without a physics A-level or Scottish Higher:

- 30.8% went on to achieve a first
- 46.6% a 2:1
- 0.2% (1 student) achieved an MEng without classification.

This compares to the whole cohort average where:

- 27.2% achieve a first
- 40.9% achieve a 2.1
- 3.2% obtain an MEng without classification.

Figure 10. Degree classifications of male and female engineering graduates that entered with an A-level maths grade A to E, or no maths A-level (numbers in brackets show the total number of graduates in each group).

- Unclassified degree (Female)
- 3rd/pass (Female)
- 2:2 (Female)
- 2:1 (Female)
- 1st (Female)
- Unclassified MEng (Female)
- Unclassified MEng (Male)
- 3rd/pass (Bachelors)
- 2:2 (MEng)
- 2:1 (MEng)
- 1st (MEng)
- Unclassified MEng (Male)

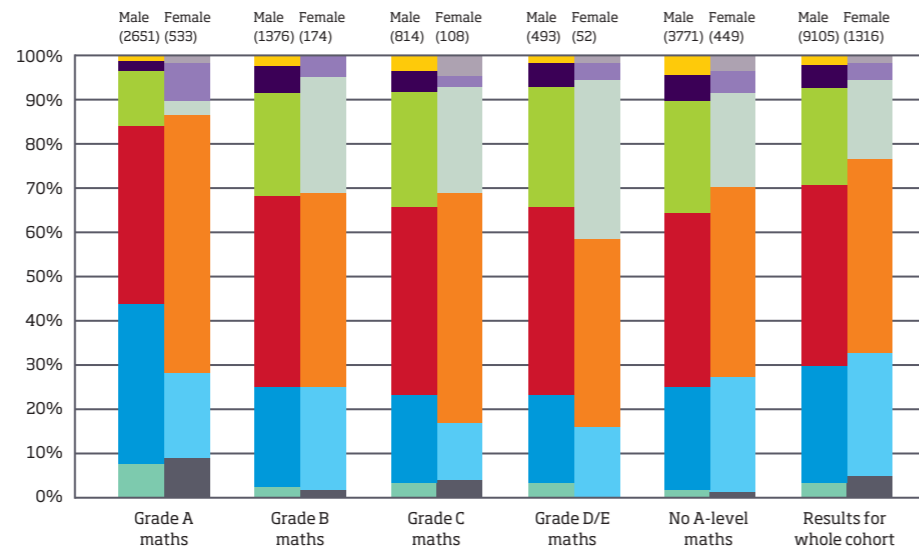


Figure 11. Degree classifications of engineering graduates from pre-92 and post-92 universities that entered with A-level maths grades A to E, or no maths A-level (numbers in brackets show the total number of graduates in each group).

- Unclassified degree (Post92)
- 3rd/pass (Post92)
- 2:2 (Post92)
- 2:1 (Post92)
- 1st (Post92)
- Unclassified MEng (Post92)
- Unclassified MEng (Pre92)
- 3rd/pass (Pre92)
- 2:2 (Pre92)
- 2:1 (Pre92)
- 1st (Pre92)
- Unclassified MEng (Pre92)

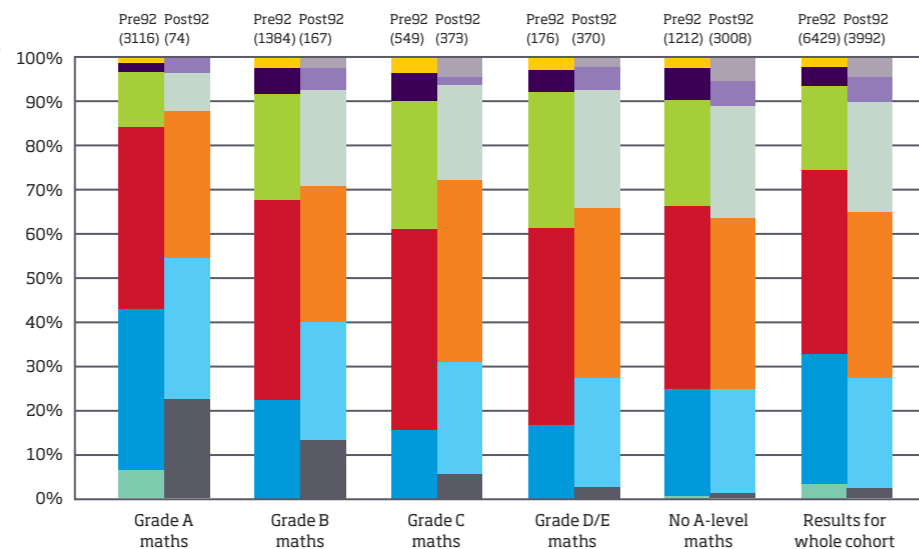


Image courtesy of the University of Liverpool

Obtaining a 'good' engineering degree: progression rates

The cohort of graduates considered in this study are those students that had successfully passed each year of study as originally planned without having to repeat or add additional years of study, or without changing course or leaving higher education. Hence 'non-continuation' has no meaning for our cohort. 'Non-continuation' is a term used by HESA to identify whether a student continues on a degree programme from one year to the next at the university they originally entered, or whether they transfer to a different university, or leave higher education completely. Retention of students has significant financial implications for universities.

Figure 12 compares the non-continuation rates at the end of the first year of study for UK-domiciled students with a variety of entry qualifications, all of whom entered university in 2007/08 (the first year of the three entry years for our cohort) and were studying full-time for degrees with $\geq 60\%$ engineering content. Higher attainment in maths, or maths and physics, at entry corresponds to the highest continuation rates after the first year of study. Those with 'no maths at all' at entry show the highest non-continuation rates, with almost 17% of such students no longer in higher education after their first year of study.

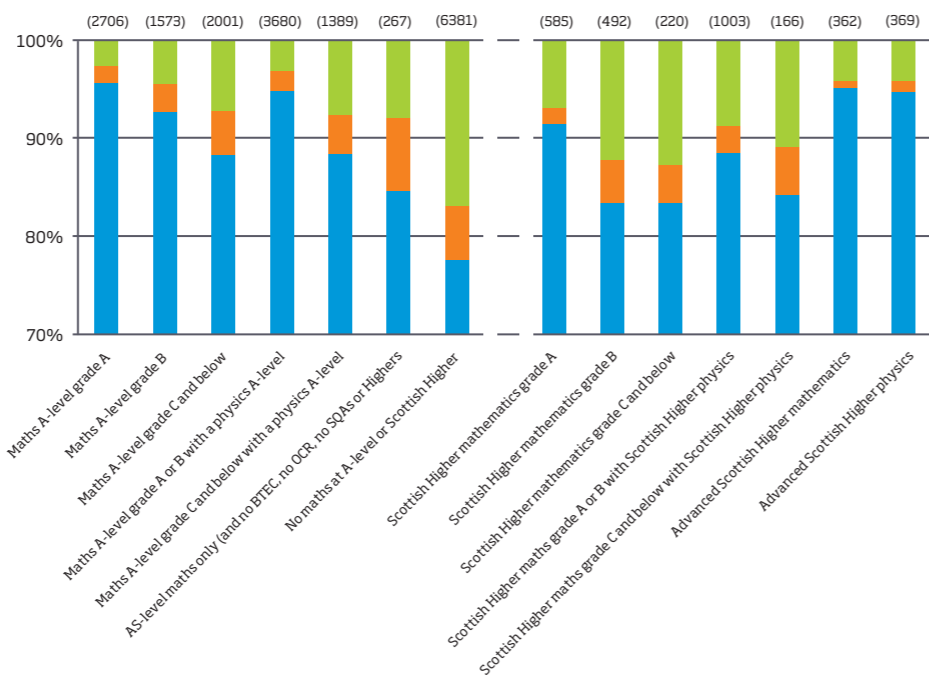


Figure 12. Non-continuation by entry qualification and grade - non-exclusive datasets (numbers in brackets show the total number of students in each group).

- No longer in HE
- Transfer to a different HEI
- Continue/qualify at same HEI

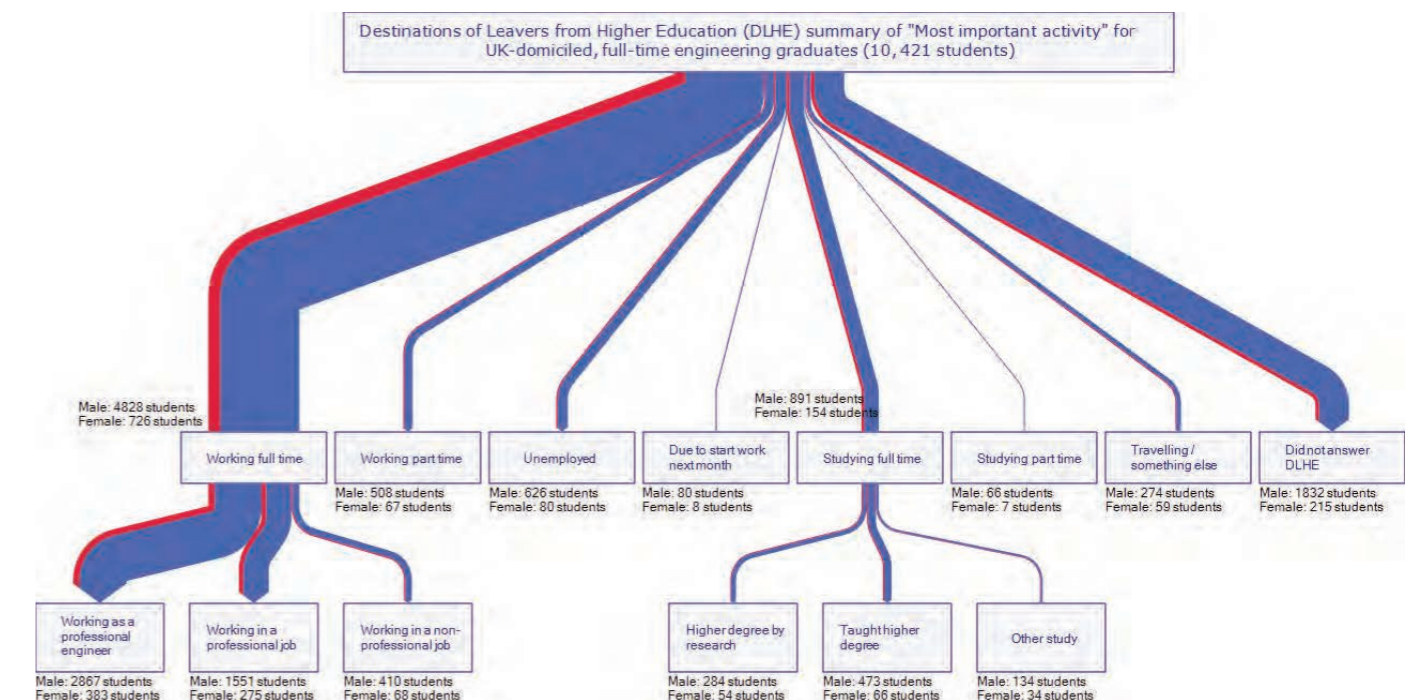
Obtaining a professional engineering job: overview of first destinations

Successfully obtaining a graduate-level professional job is often considered as the reward for success in higher education. For the engineering profession, there is also a desire to maximise retention of engineering graduates in engineering professional jobs.

The main measure of graduates' post-university career path, linked directly to their university studies, is the annual *Destinations of Leavers from Higher Education* (DLHE) survey, for which all higher education institutions have to survey a minimum of 80% of their UK-domiciled graduates starting about 6 months after they graduate, and return the data to HESA. Other more long-term surveys of graduates' careers are now being undertaken. DLHE data is collected by paper surveys, email and phone calls, to the

graduate or their next-of-kin, and asks for information including the graduate's 'most important activity'. This gives an indication of whether the graduate is in full-time or part-time employment, or further study (most likely postgraduate master's or PhD research), or doing something else such as travelling. For those in employment, a judgement is made by the university as to the standard occupation code (SOC code) of each graduate's job, based on the stated job title and duties. Some of these SOC codes are taken to indicate the graduate is in a

Figure 13. The "first destinations" of our engineering graduate cohort, by gender. Blue shading is for male students; red shading for female students.



Of those engineering graduates that were working full-time (5,554 graduates) - 58.5% were in a professional engineering job

'professional' job, including one SOC code associated with 'engineering professionals'.

Figure 13 illustrates the first destinations of the 2012 graduating cohort of UK-domiciled full-time students. Of the 8,374 engineering graduates who answered the DLHE survey (80.4% of the 10,421 graduates in that year):

- 38.8% of the cohort were in full-time work in professional engineering occupations (39.4% of males and 34.8% of females)
- 21.8% of the cohort were in full-time work in professional non-engineering occupations
- 5.7% of the cohort were in full-time non-professional occupations
- 12.5% (1,045) were in full-time study
- 8.4% of the graduates were unemployed and looking for work
- 12.8% were pursuing part-time work, travelling or something else.

Of the graduates in full-time study (1,045 graduates):

- 51.6% were on taught higher degrees (mainly postgraduate master's)
- 32.3% undertaking a higher degree by research (presumably PhD research)
- 16.1% pursuing 'Other study' which could include a postgraduate certificate or diploma, an undergraduate certificate or diploma, another first degree or a professional qualification.

The proportion of graduates in full-time work who are female (13%) is the same as the proportion of the whole graduate cohort who are female (13%).

A slightly greater proportion of those in further study are female (15%), primarily due to the greater proportion doing research degrees who are female (16%). The proportion of unemployed engineering graduates who are female is 11%.

Of those engineering graduates that were working full-time (5,554 graduates):

- 58.5% were in a professional **engineering** job,
- 32.9% were in a **non-engineering** professional job,
- 8.6% were in non-professional jobs.

The SOC occupational classifications are shown in Figure 14 for the 5,554 engineering graduates who responded to the first destinations survey and who were

in full-time work. The 58.5% of full-time working engineering graduates who were in professional **engineering** jobs (SOC 212), and the 8.6% in non-professional jobs, are in the first two columns. The remaining 32.9% of working engineering graduates in **non-engineering** professional jobs are the sum total of all the remaining SOC codes shown.

Although SOC212 'Engineering professionals' is used in this study as the primary indicator of employment in a professional engineering job, other SOC codes could also indicate this. An example is SOC213 'IT and telecommunications professional' which is especially relevant for graduates from electrical and electronic engineering degrees (H6). For these H6 graduates specifically, while 31.1% are categorised as SOC212 'Engineering professional', 19.6% are SOC213 'IT and telecommunications professional' (see Appendix B for discipline versions of figure 13). Similarly, some of SOC 112 'Production managers and directors' and SOC 311 'Science, engineering and production technicians' could also be engineering professional jobs.

Figure 13 indicated that female engineering graduates appear to be proportionally slightly less likely than male graduates to be in an **engineering** professional job, and more likely to be in a **non-engineering** professional job. These gender differences can also be seen in figure 15, which shows that working female graduates are about 6% less likely to be in engineering professional jobs compared with their male counterparts, and instead they are slightly more likely to work in non-engineering professional employment, particularly within sectors such as business and finance (SOC242/353), sales and marketing (SOC354), and design (SOC342).

Figure 16 shows the first destination data separately for graduates from each university sector and degree award.

- Of the 2,745 integrated master's graduates who responded from the pre-92 sector, 73.3% were working full-time 6 months after graduation, 10.6% were undertaking full-time study and 6.4% were unemployed.
- Of those working full-time, 71.4% were working in engineering professional jobs, 24.6% had a non-engineering professional job, while 4.0% were in a non-professional job. Of the 10.6% of pre-92 integrated master's graduates who were in full-time further study,

Figure 14. **The standard occupation codes (SOC) of all full-time working engineering graduates** (all SOC codes <0.5% are amalgamated under 'All other non-engineering professional jobs').

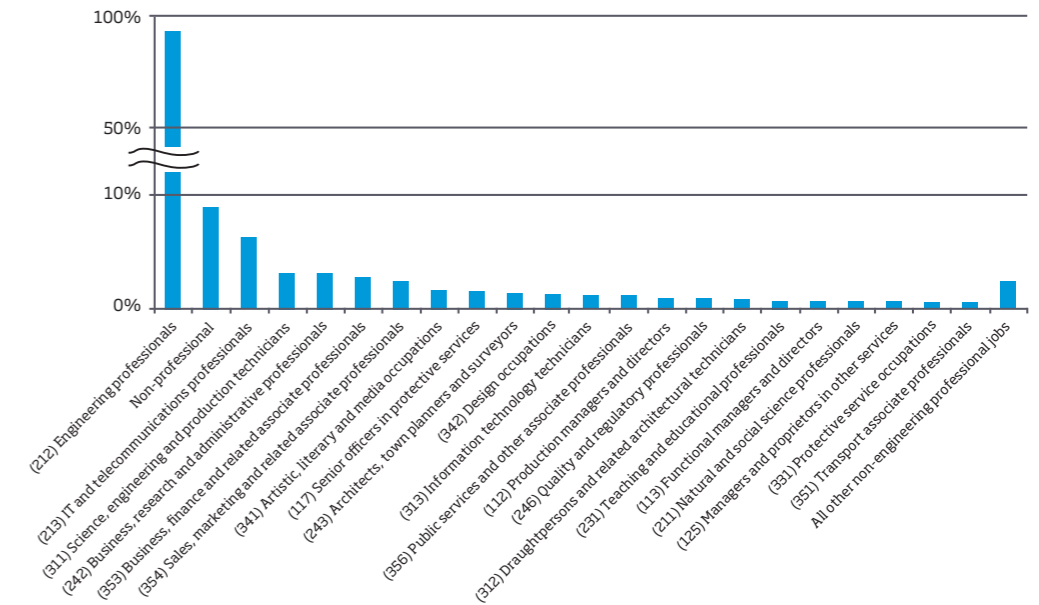
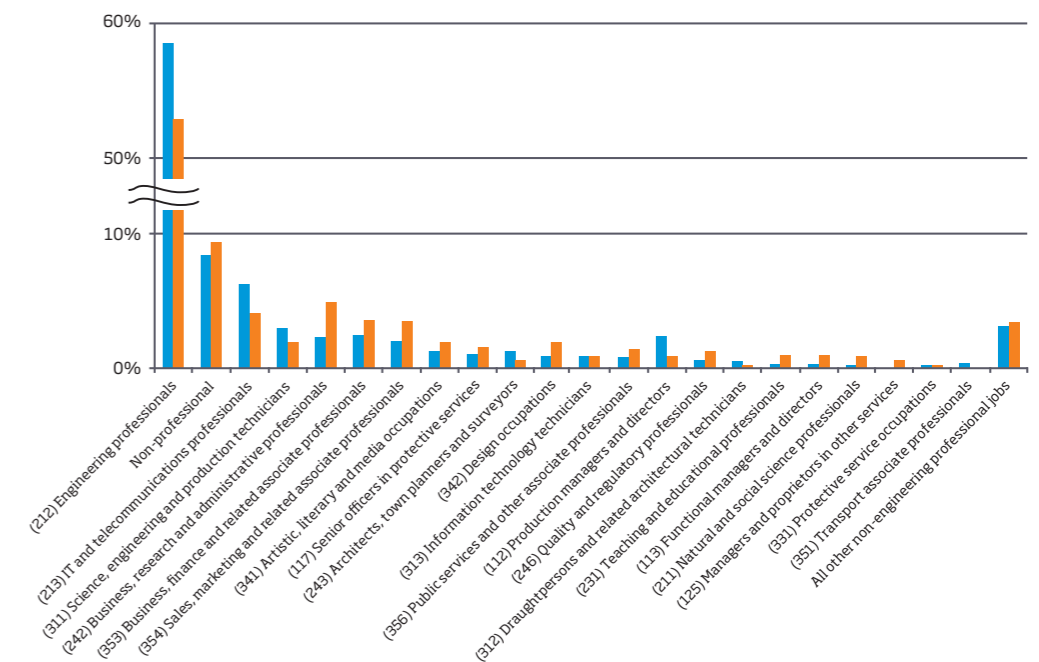


Figure 15 **Gender differences between standard occupation codes (SOC) of full-time working engineering graduates.** (all SOC codes <0.5% are amalgamated under 'All other non-engineering professional jobs').

Male
Female



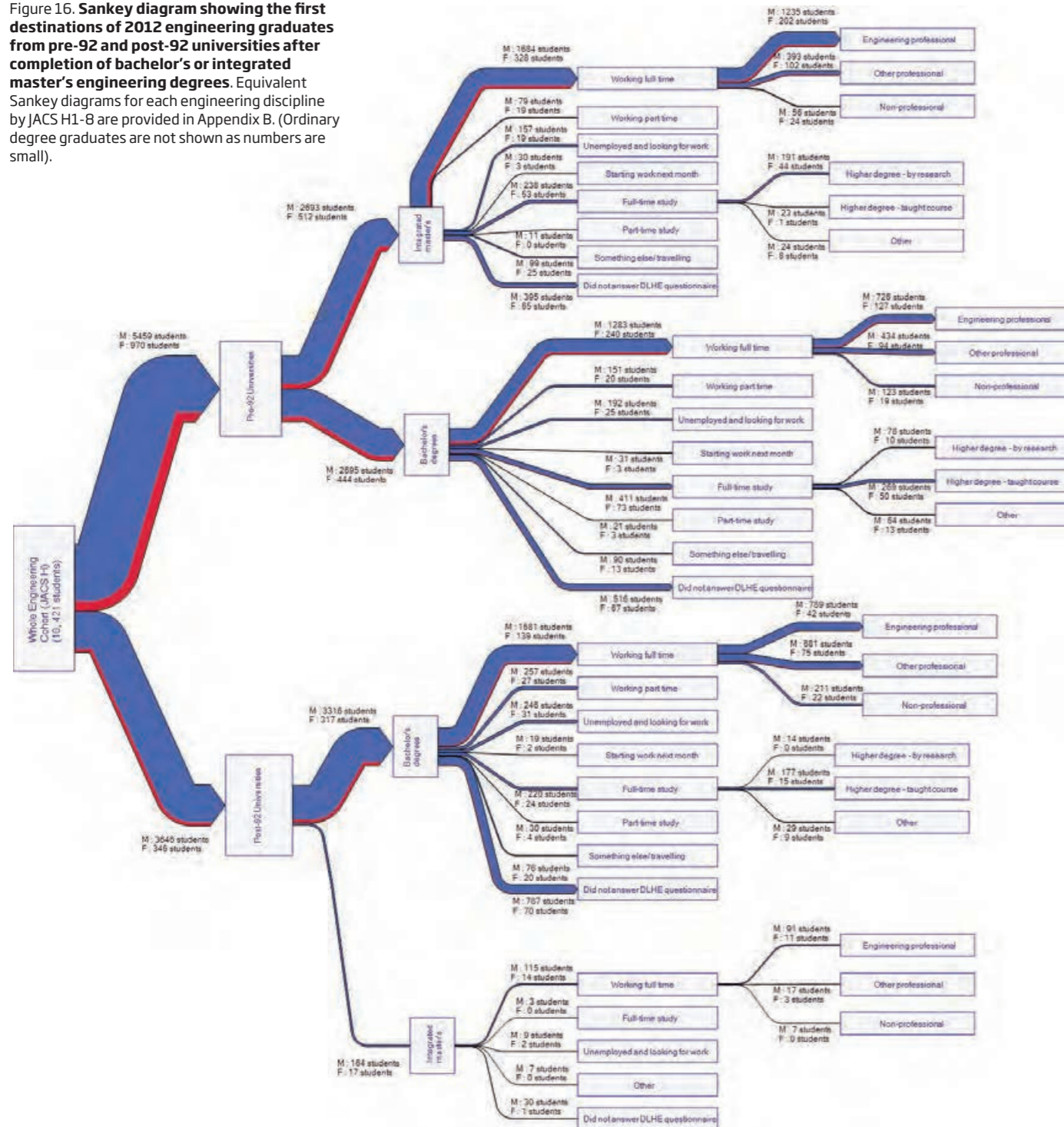
Of the 1,045 engineering graduates whose first destination was full-time study, 32.3% were undertaking a higher degree by research (presumably PhD research) which represents just 3.2% of the whole graduating cohort, and just 5% of pre-92 graduates

80.8% were undertaking research degrees and 8.2% taught higher degrees.

- Of the 150 integrated master's graduates that responded from the post-92 sector, 86.0% were working full time six months after graduation with 2.0% undertaking full-time study and 7.3% being unemployed. Of those working full time, 79.1% were pursuing careers as engineering professionals with 15.5% working in a non-engineering professional job and 5.4% working in a non-professional job.

- 59.6% of bachelor's graduates from the pre-92 sector were working full-time, and 56.0% of these were in engineering professional jobs.
- 34.7% of full-time working bachelor's graduates had a professional job that was not in engineering, and 9.3% held a non-professional job.
- 18.9% of pre-92 bachelor's graduates were undertaking further study, with the majority of them (65.9%) undertaking a taught higher degree, and 18.2% pursuing a higher degree by research.

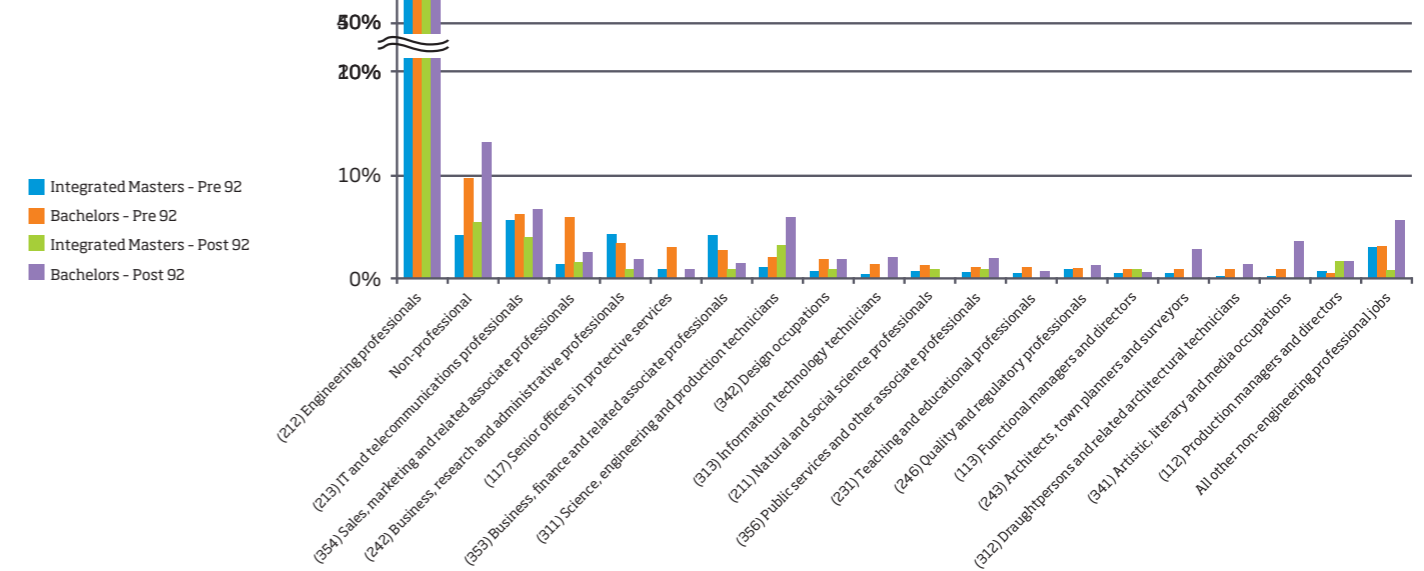
Figure 16. Sankey diagram showing the first destinations of 2012 engineering graduates from pre-92 and post-92 universities after completion of bachelor's or integrated master's engineering degrees. Equivalent Sankey diagrams for each engineering discipline by JACS H1-8 are provided in Appendix B. (Ordinary degree graduates are not shown as numbers are small).



- 8.5% of bachelor's graduates from the pre-92 sector were unemployed.
- A higher proportion of bachelor's graduates from the post-92 sector (65.6%) were working full-time than in the pre-92 sector.
- Of the post-92 full-time workers, 45.7% were in engineering professional jobs, 41.5% in a professional job that was not in engineering and 12.8% held a non-engineering job.
- 8.8% of bachelor's graduates in this sector were undertaking full-time study, and again the majority were undertaking taught higher degrees (78.7%) with only 5.7% undertaking a higher degree by research.
- 10.0% of the post-92 bachelor's graduates were unemployed.

Figure 17 compares the SOC codes of full-time working engineering graduates from

Figure 17 The Standard Occupation Codes of full-time working engineering graduates by degree type and institution type. (all SOC codes where the percentages across all categories are <0.5% are amalgamated under 'All other non-engineering professional jobs').



Graduating with an integrated master's degree rather than a bachelor's degree significantly increases the likelihood of gaining a professional engineering job

integrated master's and bachelor's degrees, separately for pre-92 and post-92 sectors. It shows that integrated master's working graduates are more likely than bachelor's graduates to be employed in professional engineering jobs for graduates from both sectors, with overall 71.9% of integrated master's working graduates having an engineering professional job compared with 50.0% for bachelor's graduates. Only 4.1% of full-time working integrated master's graduates are working in 'non-professional' jobs, compared with 11.6% of bachelor's graduates. **Graduating with an integrated master's degree rather than a bachelor's degree significantly increases the likelihood of gaining a professional engineering job**, for graduates from both pre-92 and post-92 sectors, as might be expected.

Figures 15 and 17 do indicate that employment in the finance or banking sectors (SOC242 'Business, research and admin' and SOC353 'Business, finance and related...') may be attracting some integrated master's and bachelor's engineering graduates, especially females from the pre-92 sector. However the

numbers are less than 5% of all working graduates, and there are clearly other non-engineering occupation sectors which attract engineering graduates in similar numbers.

While the proportion of graduates from the pre-92 universities who are in full-time employment is similar for males and females, whether they have graduated with bachelor's or integrated master's degrees, there are gender differences in the type of employment.

- The 62% of female integrated master's graduates from the pre-92 university sector who are in full-time employment in engineering professional jobs is 10% less than the proportion for their male counterparts.
- Similarly, the 53% of female bachelor's graduates from this sector who are in full-time employment in engineering professional jobs is 4% less than the proportion for their male counterparts.
- Working female graduates are more likely to be in non-professional or non-engineering professional jobs.

While the proportion of graduates from the pre-92 universities who are in full-time employment is similar for males and females – there are gender differences in the type of employment

For bachelor’s engineering graduates from the post-92 sector, the gender differences are more pronounced with:

- only 30% of female bachelor’s graduates who are in full-time employment being in engineering professional jobs, some 17% less than the proportion for their male counterparts.
- a 14% greater proportion of females go into non-engineering professional jobs.

The number of integrated master’s graduates in the post-92 sector was relatively small (181 graduates in total) but proportionally they are the most successful at securing employment in an engineering professional job, achieved by 79% of both male and female graduates.

Table 6 shows the proportion of engineering graduates holding each degree award and classification who are working full-time, and the proportions of such full-time working graduates who have professional engineering, non-engineering professional, and non-professional

jobs. Also shown are the percentages of unemployed graduates with each degree award and classification.

- Graduates with better degree classifications, or an MEng rather than BEng degree award, are more likely to be in full-time employment, more likely to have a professional engineering job, and less likely to be unemployed.
- MEng graduates are 5–10% more likely to be working, and 15–25% more likely to be working in a professional engineering job, compared to BEng graduates with the same degree classification. This concurs with other studies showing that employers, particularly larger ones, express a clear preference for graduates with either an MEng or a BEng plus MSc, regarding these qualifications as a fast route to chartered status⁹.
- Graduates with 1st class degree classifications are about half as likely to be unemployed as those with a 2.1 degree for the same degree award.

Appendix A: Sankey diagrams showing degree award data and first destinations for each engineering discipline (JACS codes H1-H8)

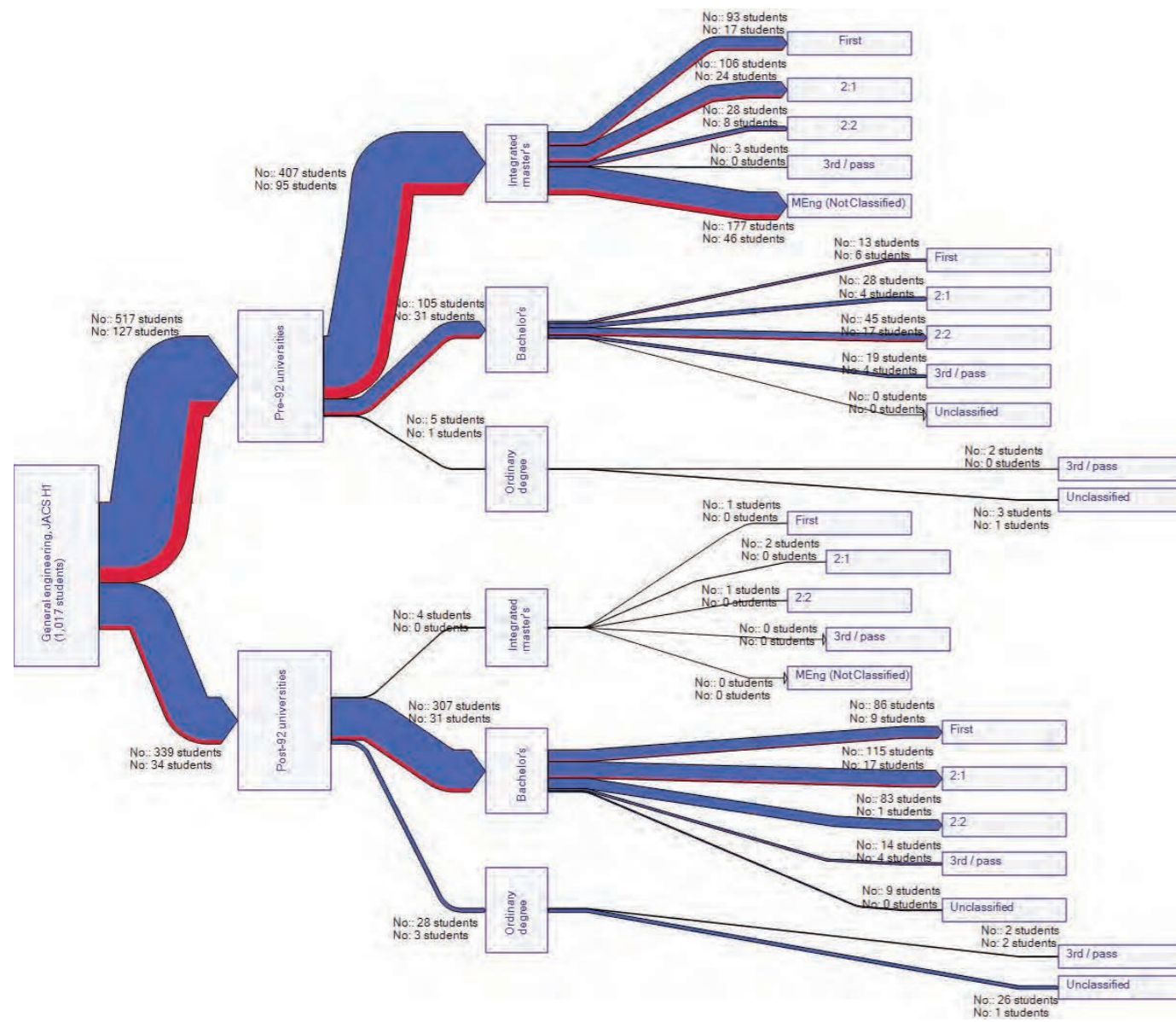
The data presented in the main body of this report considers the engineering graduating cohort as a whole. The Sankey diagrams in this appendix present, for each engineering discipline level using the JACS codes indicated in Table 1, the degree award and first destination data (equivalent to Figures 8 and 16 in the main report) for graduates from each engineering discipline.

	MEng Graduates			BEng Graduates				
	MEng without classification	First class honours MEng	Upper second class honours MEng	First class honours BEng	Upper second class honours BEng	Lower second class honours	Third class honours/pass	Unclassified BEng
Percentage of graduates classification who are working full-time (number of such graduates)	72% (237)	68% (867)	60% (936)	60% (930)	54% (1466)	40% (867)	29% (144)	35% (107)
Percentage of full-time working graduates with each degree classification in a professional engineering job	65%	77%	71%	56%	51%	40%	38%	57%
Percentage of full-time working graduates with each degree classification in a non-engineering professional job	34%	20%	24%	39%	38%	41%	37%	29%
Percentage of full-time working graduates with each degree classification in a non-professional job	1%	3%	5%	5%	11%	19%	25%	14%
Percentage of graduates with each degree classification who are unemployed	2%	3%	8%	4%	7%	9%	15%	35%

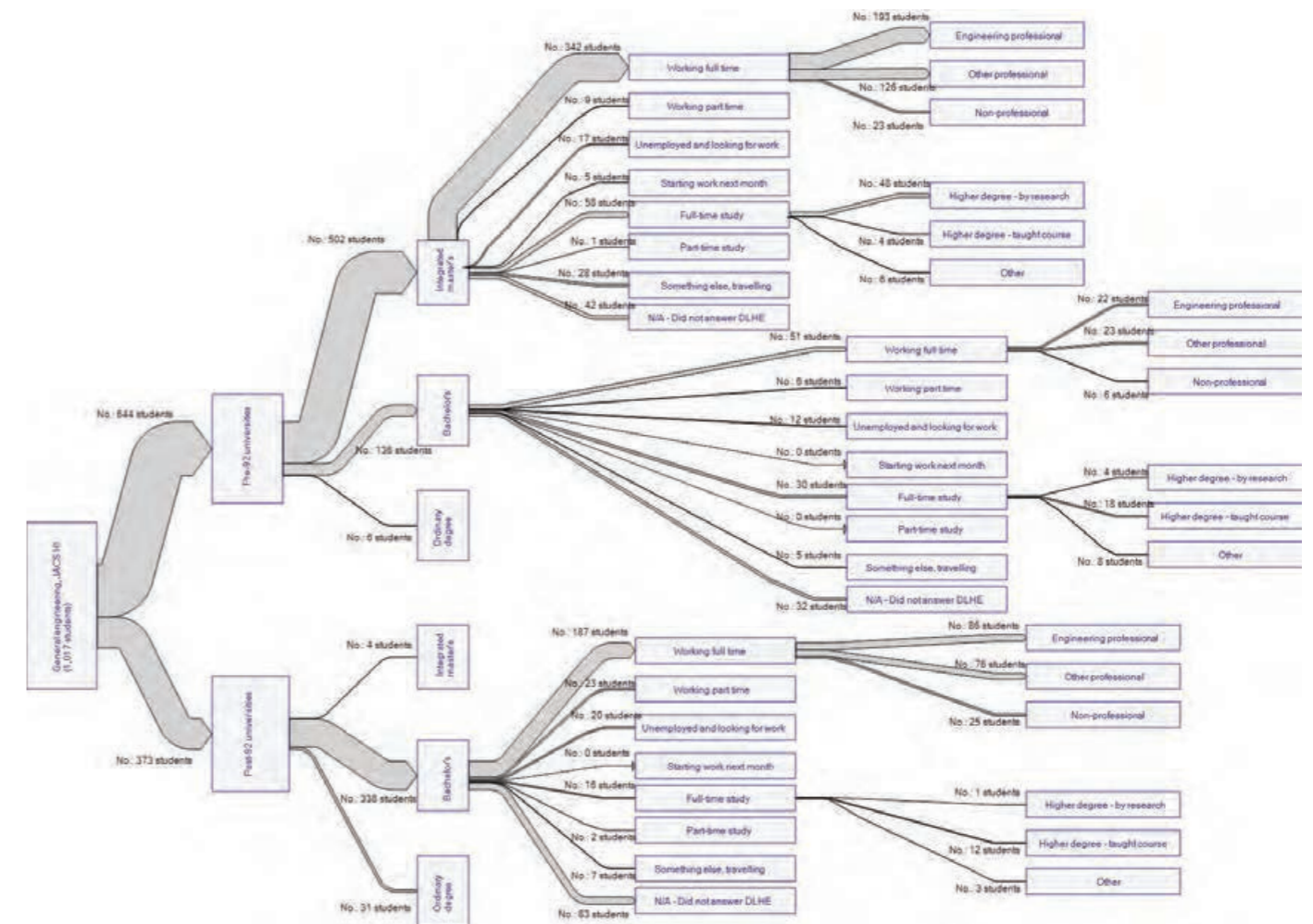
Table 6. Proportions of engineering graduates with each degree award and classification who are in full-time work (top row) or unemployed (bottom row). Rows 2–4 indicate the proportions of full-time working graduates in professional engineering, professional non-engineering, and non-professional jobs respectively.

H1 general engineering

Degree award data for H1 general engineering. There are 1,017 students undertaking general engineering degrees with 80% male, 20% female population. There is a significant number of integrated master's degrees that are 'not classified' and these are thought to be engineering degrees obtained at the University of Cambridge, who do not assign overall classifications to their degrees.

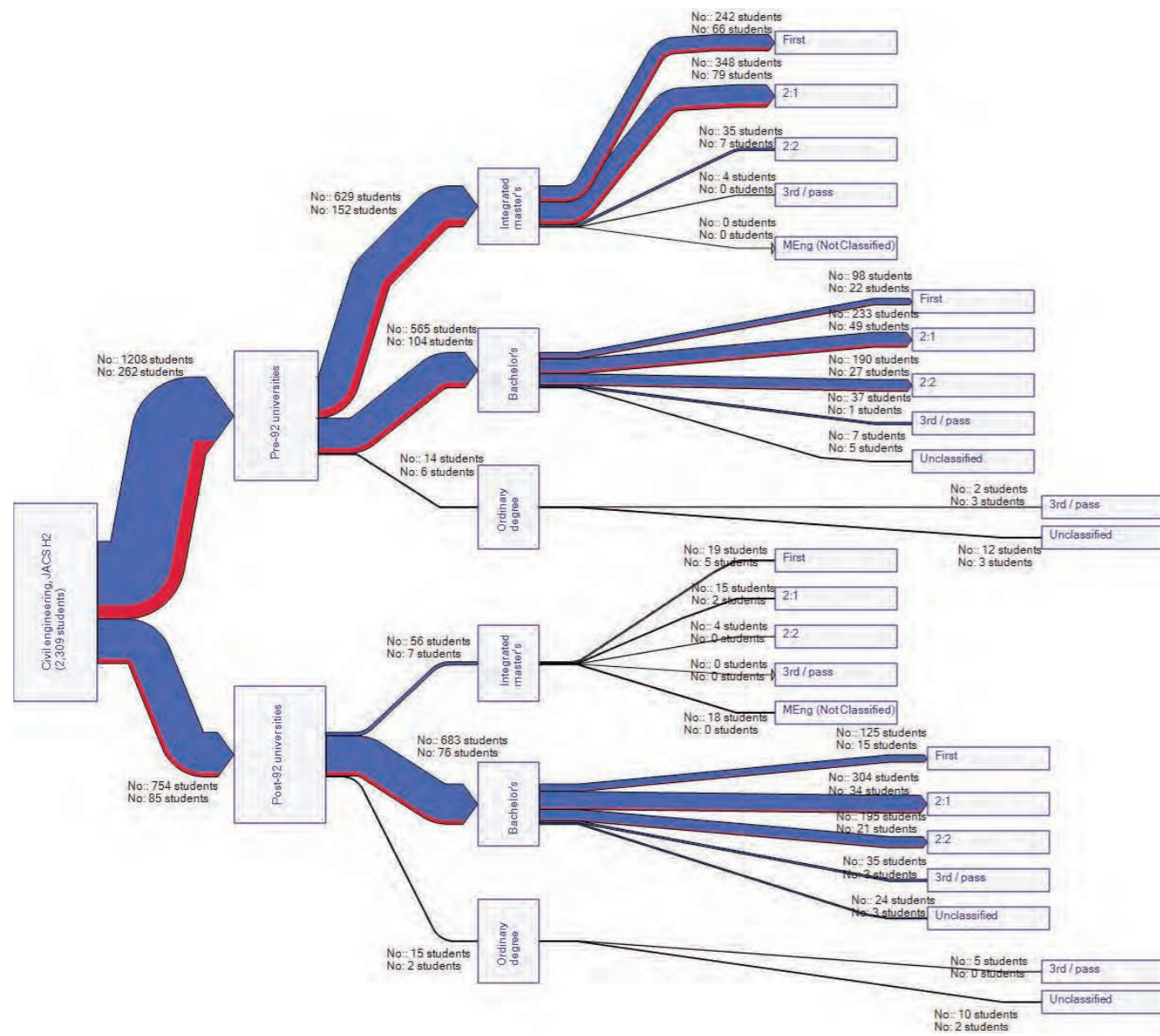


First destinations data for H1 general engineering. (1,017 students)

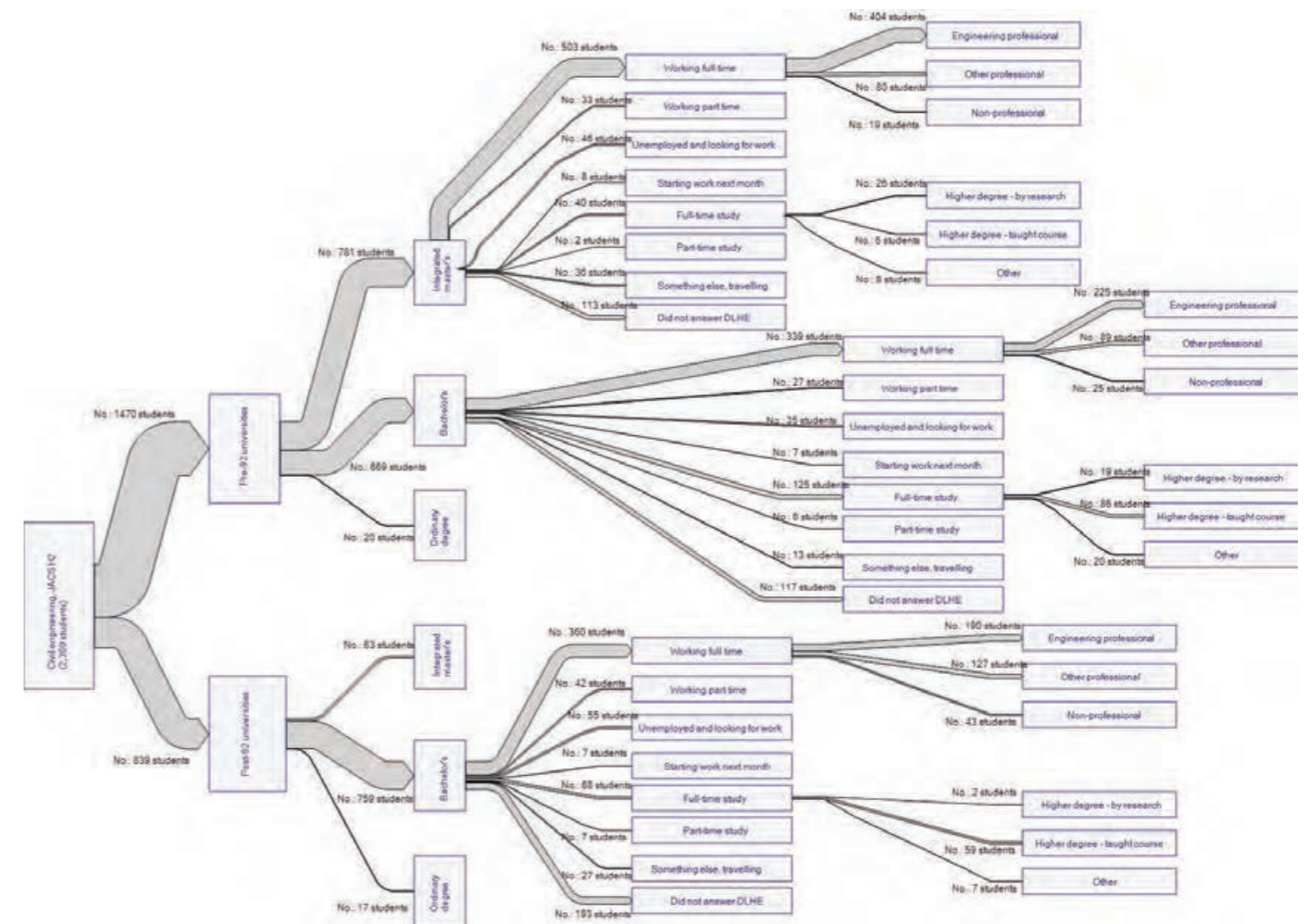


H2 civil engineering

Degree award data for H2 civil engineering. There are 2,309 students undertaking civil engineering degrees with an 85% male, 15% female population.

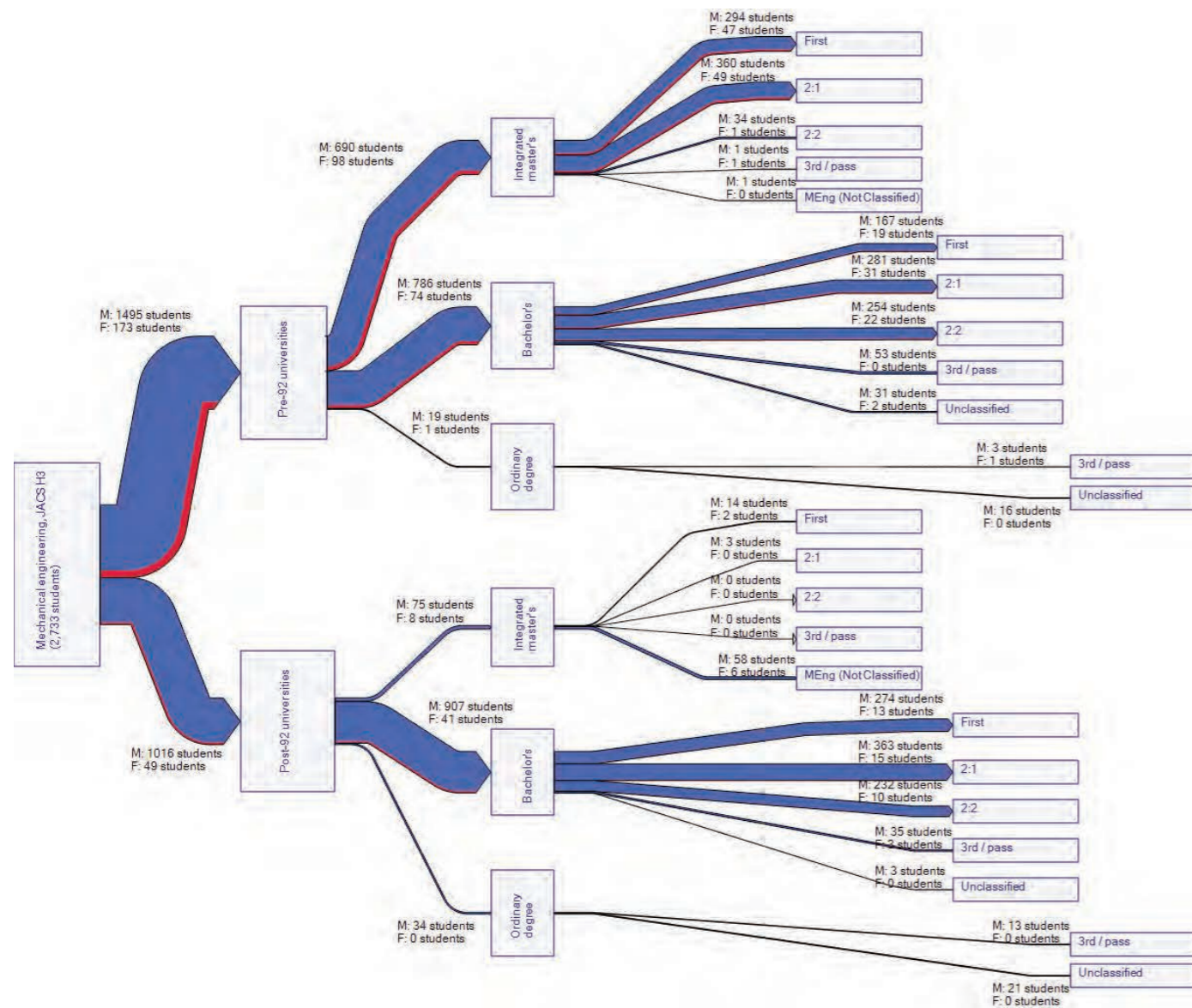


First destinations data for H2 civil engineering. (2,309 students)

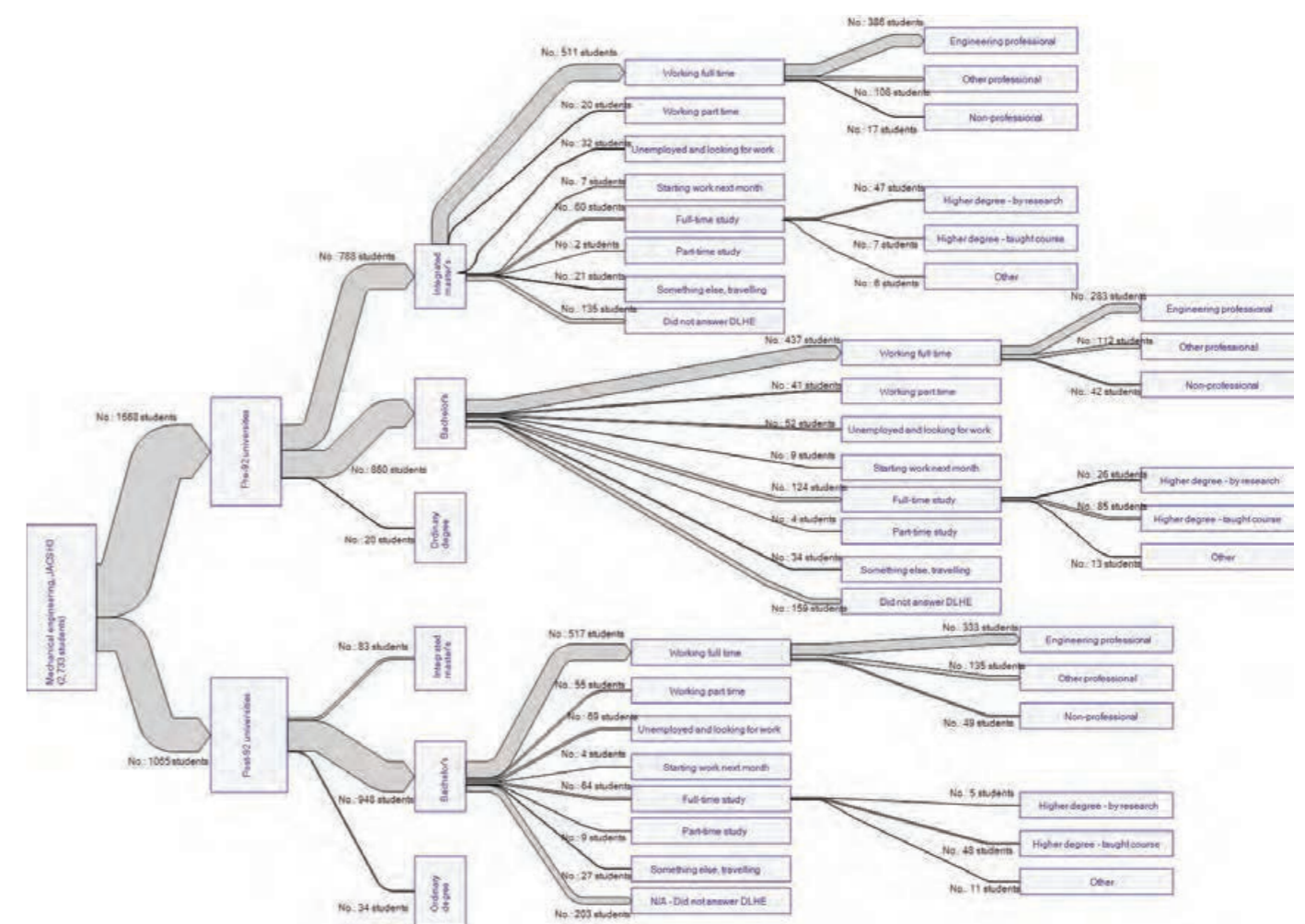


H3 mechanical engineering

Degree award data for H3 mechanical engineering. There are 2,733 students undertaking mechanical engineering degrees with a 92% male, 8% female population.

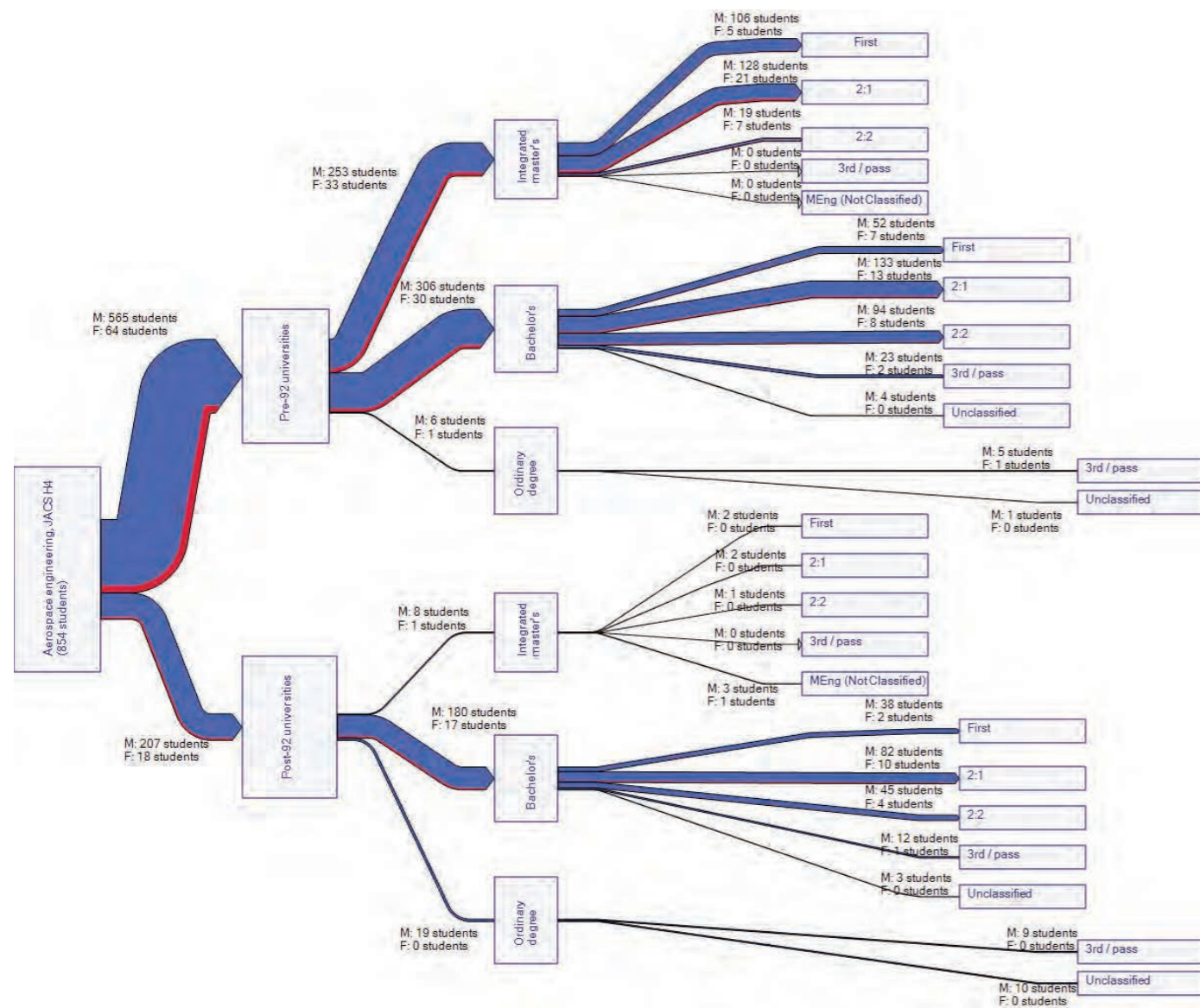


First destinations data for H3 mechanical engineering. (2,733 students)

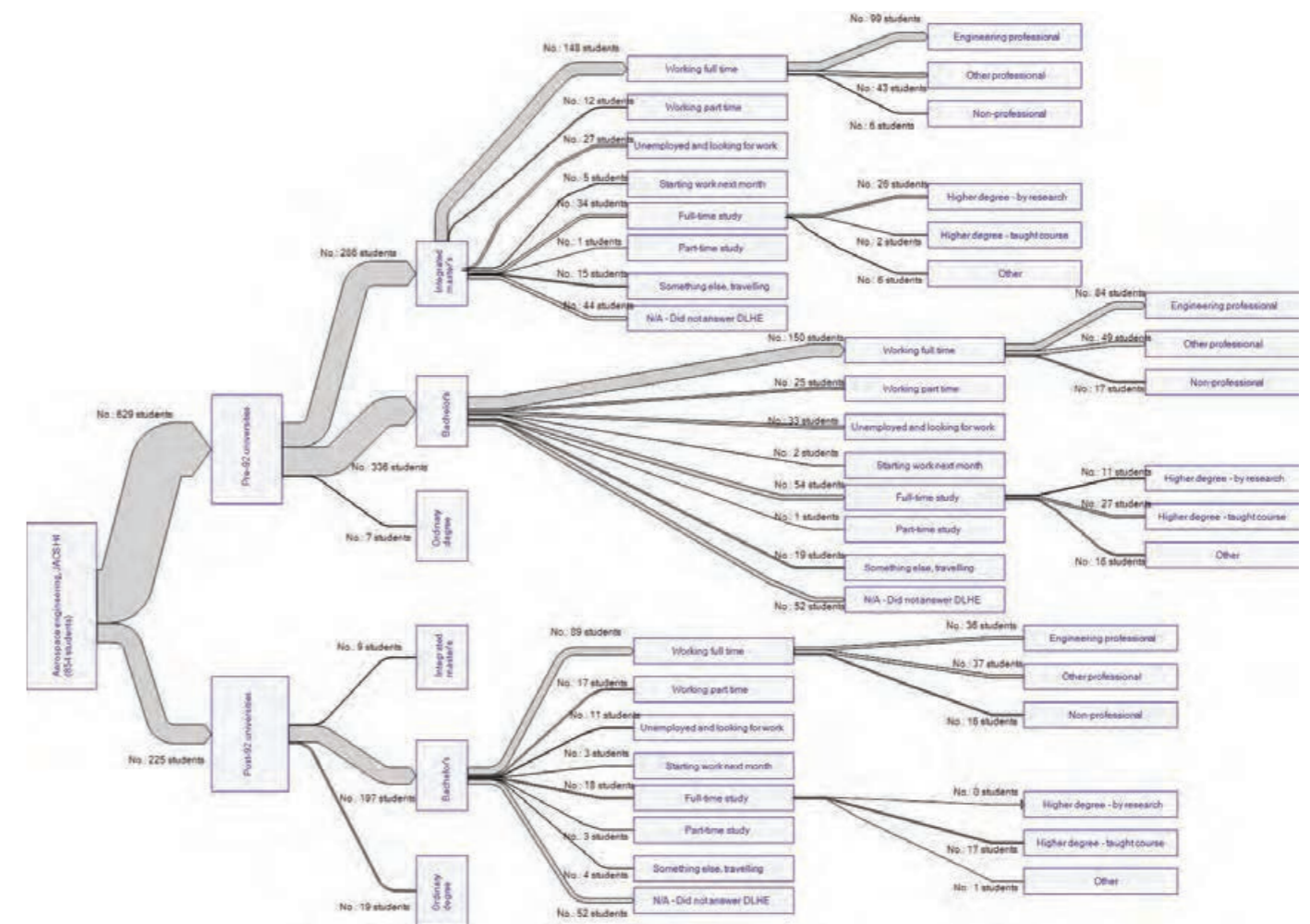


H4 aerospace engineering

Degree award data for H4 aerospace engineering. There are 854 students undertaking aerospace engineering degrees with a 90% male, 10% female population.

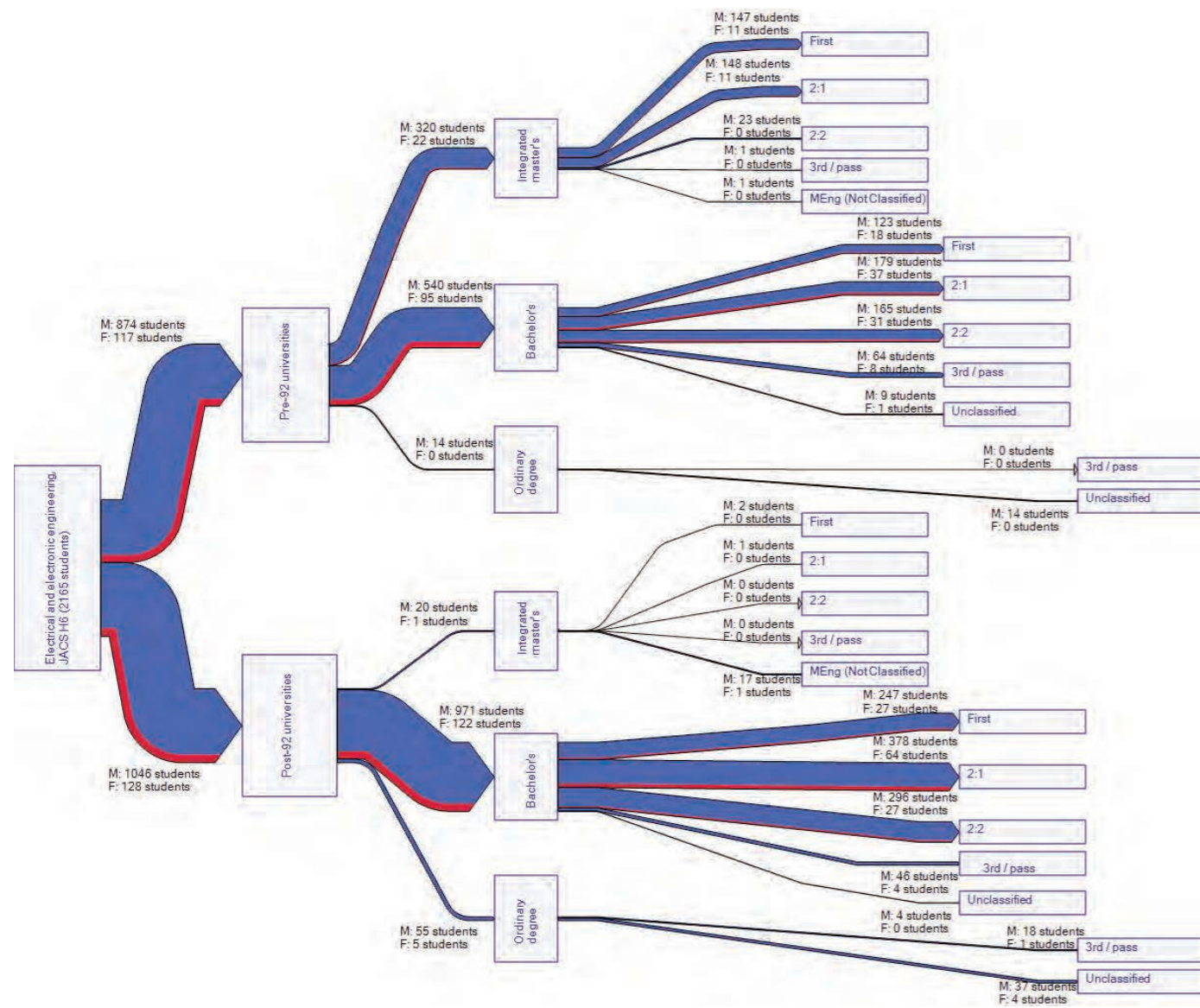


First destinations data for H4 aerospace engineering. (854 students)

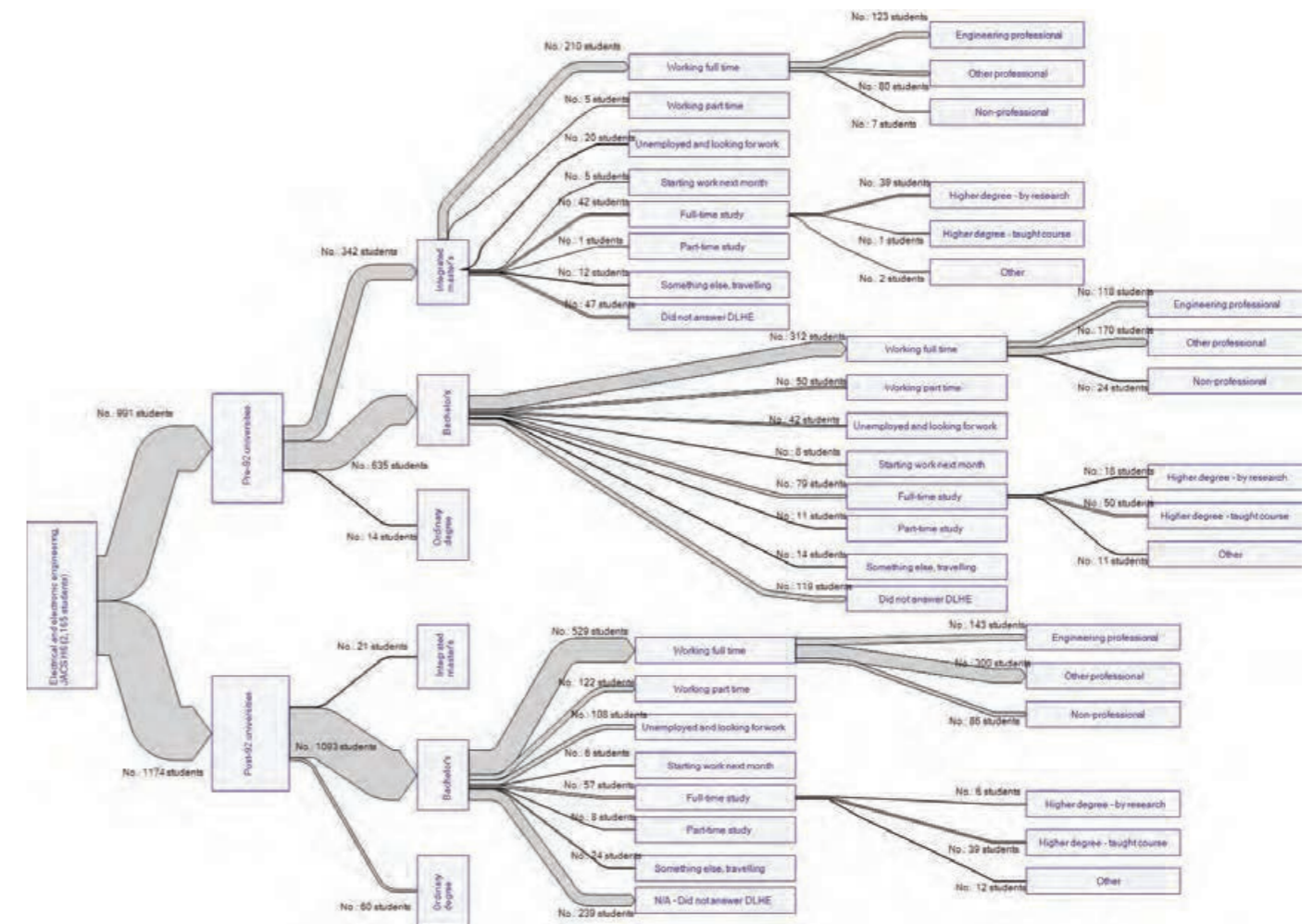


H6 electrical and electronic engineering

Degree award data for H6 electrical and electronic engineering. There are 2,165 students undertaking electrical and electronic engineering degrees with an 89% male, 11% female population.

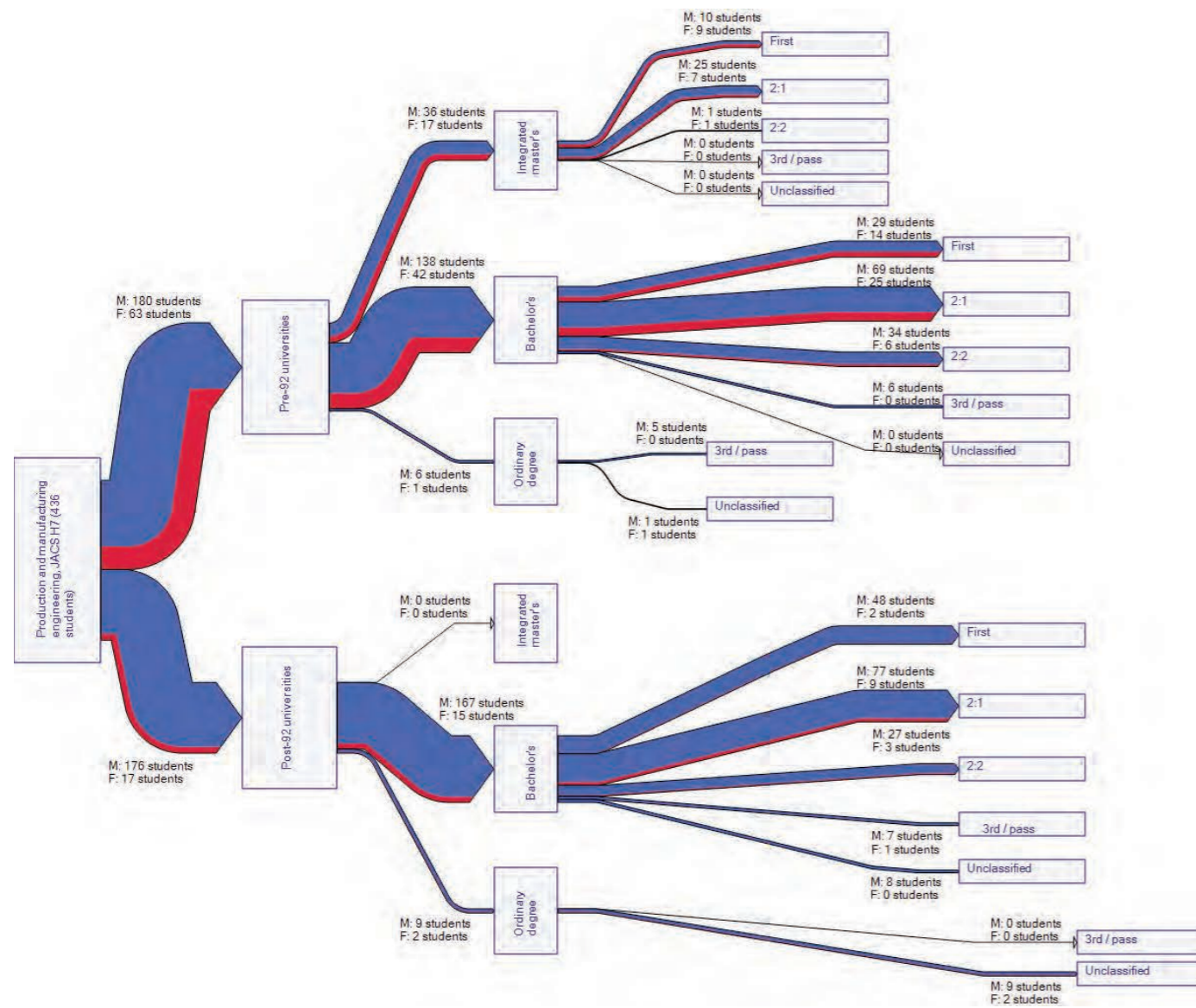


First destinations data for H6 electrical and electronic engineering. (2,165 students)

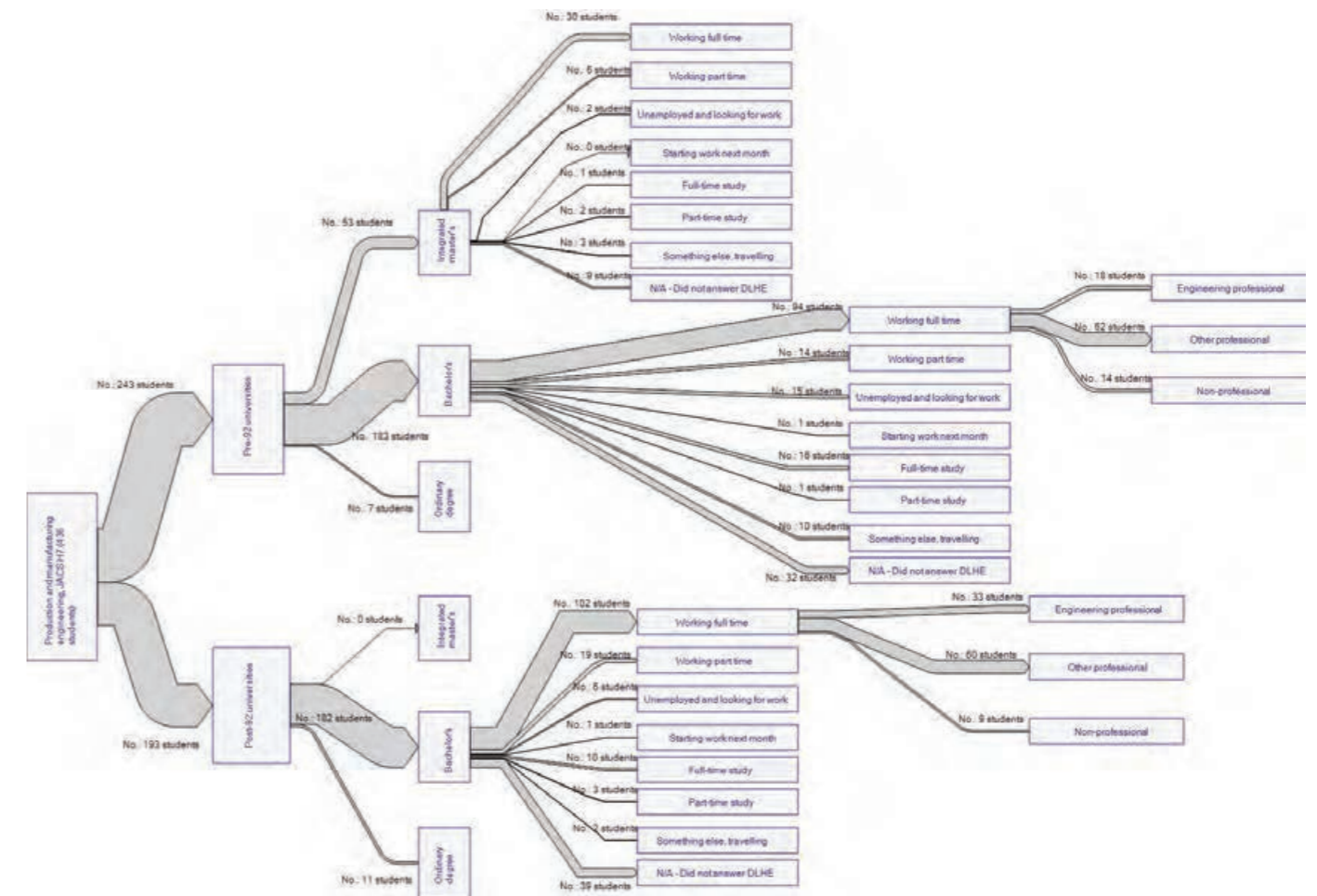


H7 production and manufacturing engineering

Degree award data for H7 production and manufacturing engineering. There are 436 students undertaking production and manufacturing engineering degrees with an 82% male, 18% female population.

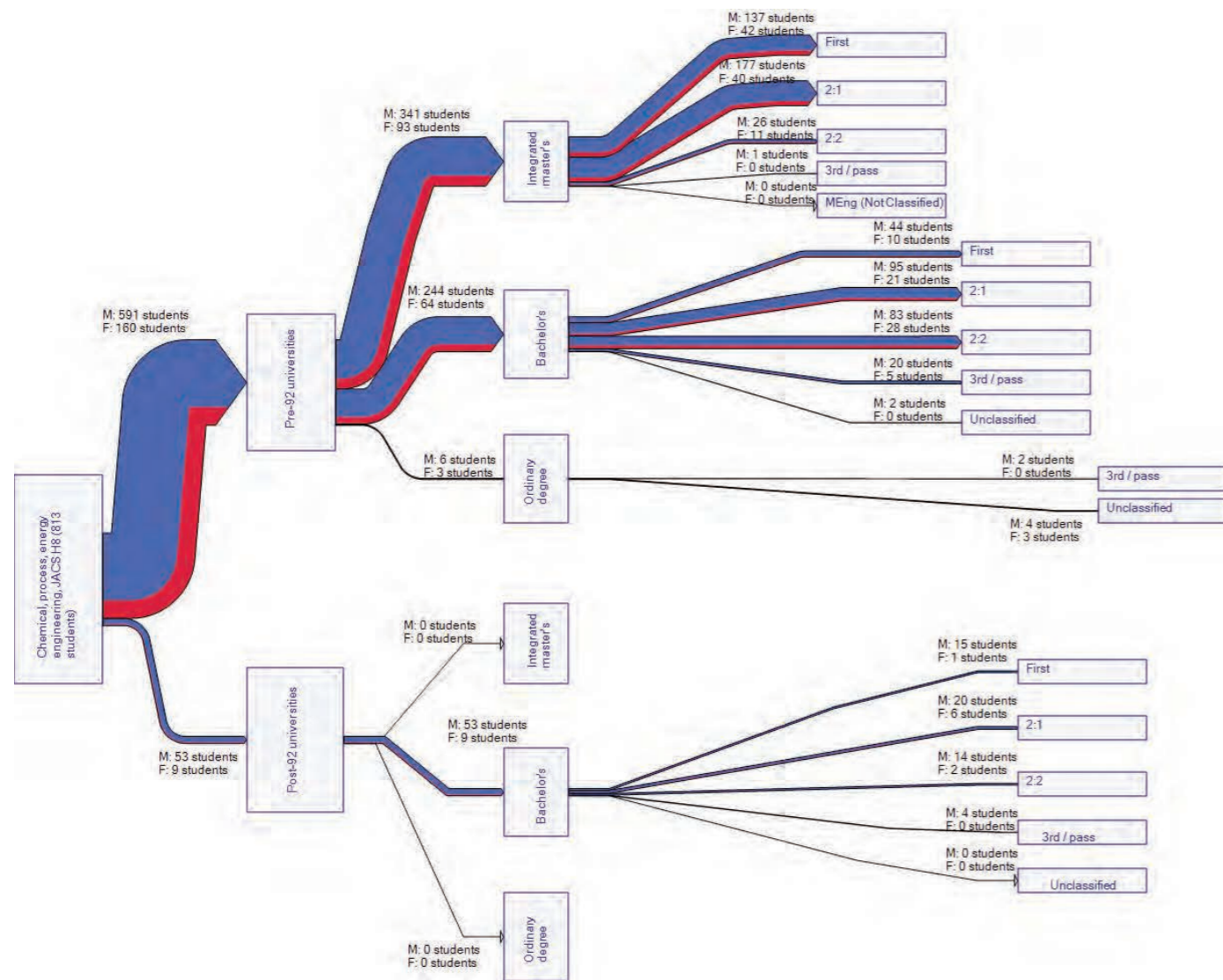


First destinations data for H7 production and manufacturing engineering. (436 students)

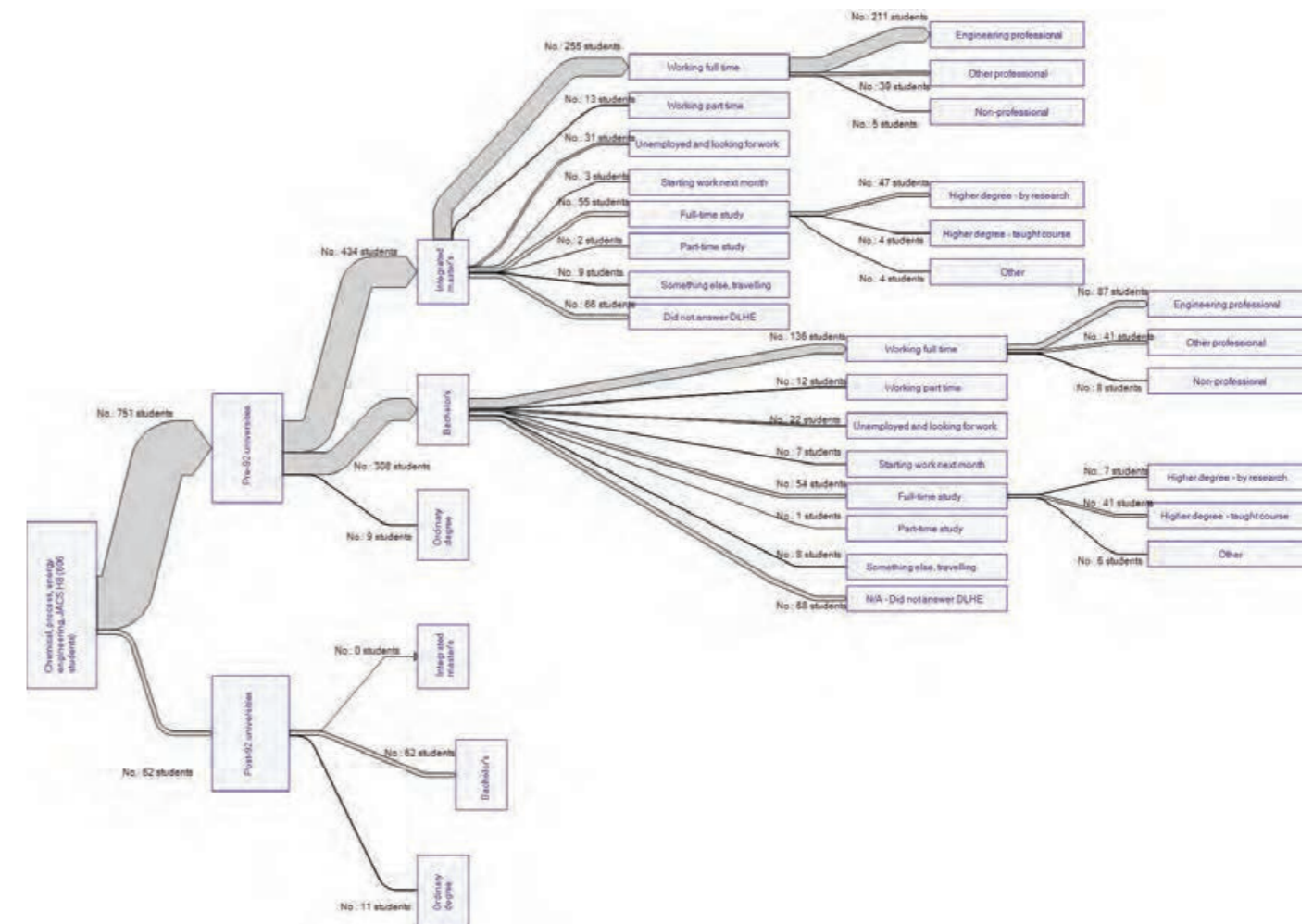


H8 chemical, process and energy engineering

Degree award data for H8 chemical, process and energy engineering. There are 813 students undertaking chemical, process and energy engineering degrees with a 79% male, 21% female population.



First destinations data for H8 chemical, process and energy engineering. (813 students)



Appendix B:

pre-92 and post-92 institutions

(Note: This is a complete listing; not all of these institutions offer degree programmes in engineering)

Post-1992	Pre-1992
0002 Cranfield University	0001 The Open University
0007 Bishop Grosseteste University College Lincoln	0108 Aston University
0009 Buckinghamshire New University	0109 The University of Bath
0010 Central School of Speech and Drama	0110 The University of Birmingham
0011 University of Chester	0111 The University of Bradford
0012 Canterbury Christ Church University	0112 The University of Bristol
0013 York St John University	0113 Brunel University
0014 University College Plymouth St Mark and St John	0114 The University of Cambridge
0016 Edge Hill University	0115 The City University
0017 University College Falmouth	0116 University of Durham
0018 Harper Adams University College	0117 The University of East Anglia
0021 The University of Winchester	0118 The University of Essex
0023 Liverpool Hope University	0119 The University of Exeter
0024 University of the Arts, London	0120 The University of Hull
0026 University of Bedfordshire	0121 The University of Keele
0027 The University of Northampton	0122 The University of Kent
0028 Newman University College	0123 The University of Lancaster
0030 Ravensbourne	0124 The University of Leeds
0031 Roehampton University	0125 The University of Leicester
0032 Rose Bruford College	0126 The University of Liverpool
0033 Royal Academy of Music	0127 Birkbeck College
0034 Royal College of Music	0131 Goldsmiths College
0035 Royal Northern College of Music	0132 Imperial College of Science, Technology & Medicine
0037 Southampton Solent University	0133 Institute of Education
0038 University of Cumbria	0134 King's College London
0039 St Mary's University College, Twickenham	0135 London Business School
0040 Leeds Trinity University College	0137 London School of Economics and Political Science
0046 The University of Worcester	0138 London School of Hygiene and Tropical Medicine
0047 Anglia Ruskin University	0139 Queen Mary and Westfield College
0048 Bath Spa University	0141 Royal Holloway and Bedford New College

Post-1992	Pre-1992
0049 The University of Bolton	0143 The Royal Veterinary College
0050 Bournemouth University	0145 St George's Hospital Medical School
0051 The University of Brighton	0146 The School of Oriental and African Studies
0052 Birmingham City University	0147 The School of Pharmacy
0053 The University of Central Lancashire	0149 University College London
0054 University of Gloucestershire	0151 University of London (Institutes and activities)
0056 Coventry University	0152 Loughborough University
0057 University of Derby	0154 The University of Newcastle-upon-Tyne
0058 The University of East London	0155 The University of Nottingham
0059 The University of Greenwich	0156 The University of Oxford
0060 University of Hertfordshire	0157 The University of Reading
0061 The University of Huddersfield	0158 The University of Salford
0062 The University of Lincoln	0159 The University of Sheffield
0063 Kingston University	0160 The University of Southampton
0064 Leeds Metropolitan University	0161 The University of Surrey
0065 Liverpool John Moores University	0162 The University of Sussex
0066 The Manchester Metropolitan University	0163 The University of Warwick
0067 Middlesex University	0164 The University of York
0068 De Montfort University	0167 The University of Edinburgh
0069 The University of Northumbria at Newcastle	0168 The University of Glasgow
0071 The Nottingham Trent University	0169 The University of Strathclyde
0072 Oxford Brookes University	0170 The University of Aberdeen
0073 The University of Plymouth	0171 Heriot-Watt University
0074 The University of Portsmouth	0172 The University of Dundee
0075 Sheffield Hallam University	0173 The University of St Andrews
0076 London South Bank University	0174 The University of Stirling
0077 Staffordshire University	0176 University of Wales Trinity Saint David
0078 The University of Sunderland	0177 Aberystwyth University
0079 Teesside University	0178 Bangor University
0080 The University of West London	0179 Cardiff University
0081 University of the West of England, Bristol	0180 Swansea University
0082 The University of Chichester	0184 The Queen's University of Belfast
0083 The University of Westminster	0185 University of Ulster
0085 The University of Wolverhampton	0204 The University of Manchester

References

Post-1992	Pre-1992
0086 The University of Wales, Newport	
0087 Glyndŵr University	
0089 Cardiff Metropolitan University	
0090 University of Glamorgan	
0091 Swansea Metropolitan University	
0095 University of Abertay Dundee	
0100 Queen Margaret University, Edinburgh	
0104 The Robert Gordon University	
0105 The University of the West of Scotland	
0106 Glasgow Caledonian University	
0107 Edinburgh Napier University	
0193 Stranmillis University College	
0194 St Mary's University College	
0196 University of the Highlands and Islands	
0202 London Metropolitan University	
0203 The University of Buckingham	
0211 Leeds College of Art	

1. UKCME NSS report
2. Information on tariff points assigned to each UK qualification <http://www.ucas.com/how-it-all-works/explore-your-options/entry-requirements/tariff-tables#>
9. Unemployment of engineering graduates: the key issues (2012). Professor Helen Atkinson and Martin Pennington, Engineering Education 7(2), 7–15

Notes



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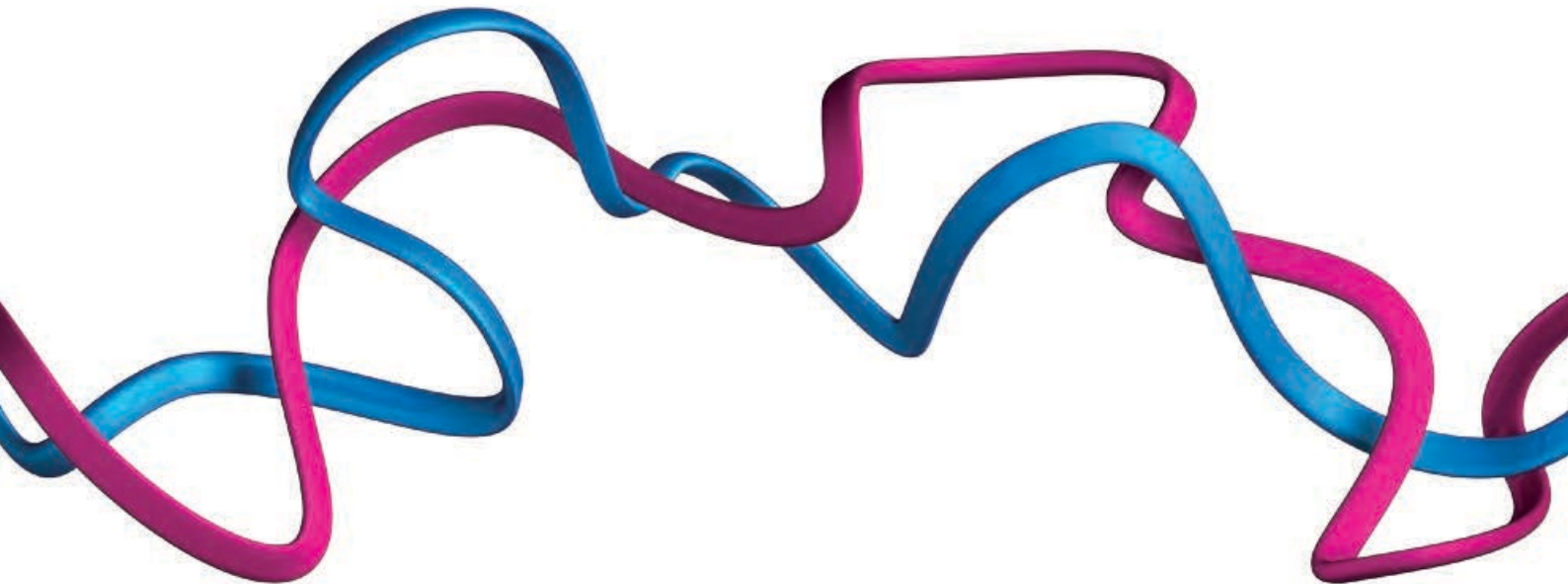
To create a system of engineering education and training that satisfies the aspirations of young people while delivering the high-calibre engineers and technicians that businesses need.

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