ROYAL ACADEMY OF ENGINEERING

GATSBY

Engineering facilities in further education colleges in England

May 2016

Image courtesy of Furness College

Engineering facilities in further education colleges in England

May 2016

The Gatsby Charitable Foundation
The Peak, 5 Wilton Road, London SW1V 1AP
T +44 (0)20 7410 0330 www.gatsby.org.uk
Registered Charity number 251988

Cover image courtesy of Burnley College.

Author
The report summarises the research from a joint project, commissioned by the Royal Academy of Engineering and the Gatsby Charitable Foundation. The report was written by Hannah Stanwix (Project Officer, Gatsby Charitable Foundation) with inputs from Dr Rhys Morgan (Director of Engineering and Education, Royal Academy of Engineering), Stylli Charalampous (Head of Further and Higher Education, Royal Academy of Engineering) and Jenifer Burden (Director of Programmes, Gatsby Charitable Foundation).

Acknowledgements
The project team gratefully acknowledge all those colleges who participated in the research. The team would particularly like to thank the colleges that kindly provided images for the final report: Burnley College, Furness College and Walsall College.

The work on the initial research and survey by Aleksandra Stamenkovic is gratefully acknowledged.

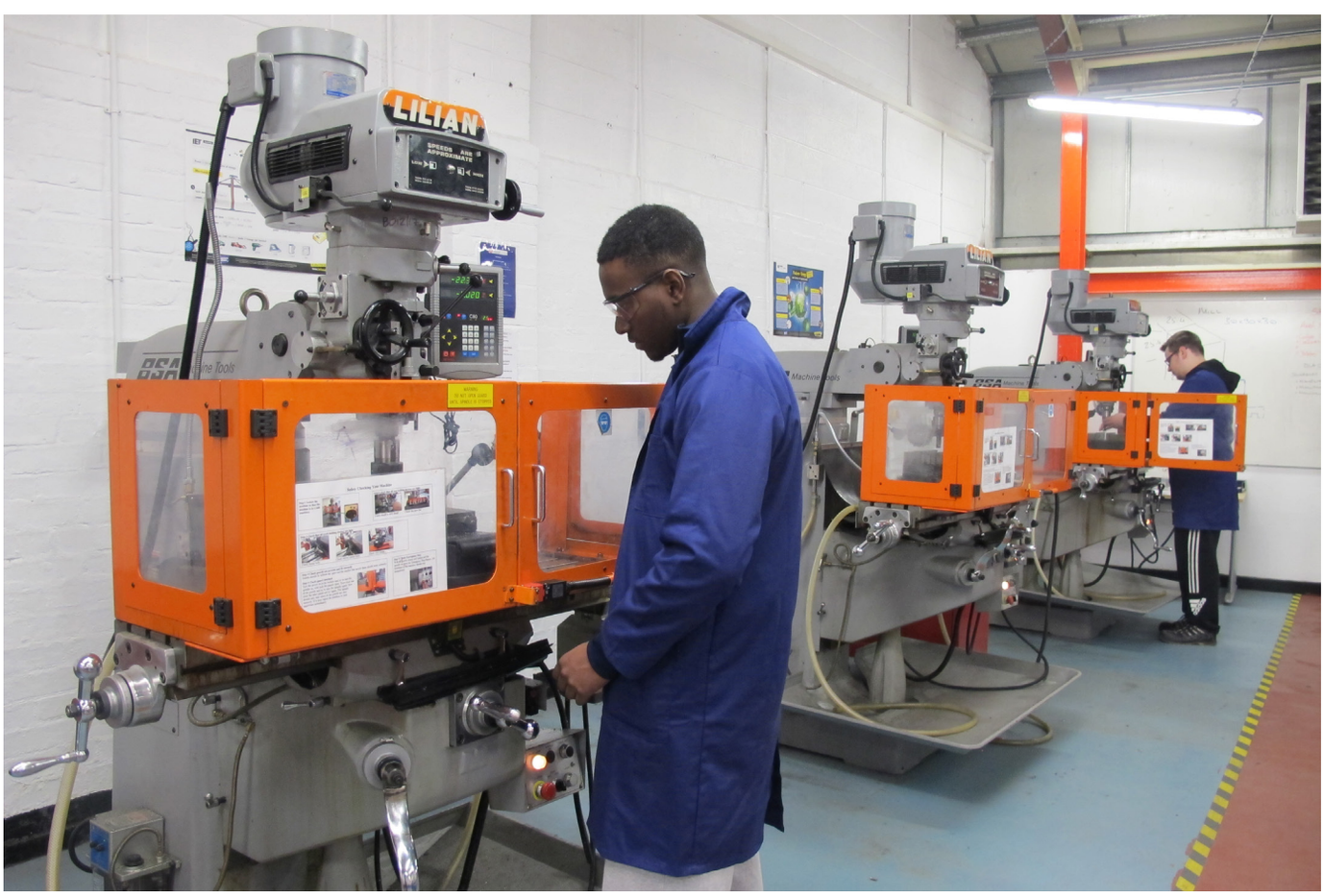


Image courtesy of Walsall College

Contents

Introduction

Technical education enables an individual both to acquire the technological and science knowledge base, and develop the practical skills and attitudes required for work in technician roles. Technical education is defined here as science, engineering and technology (SET) education and training at Levels 3-5. In England, this training is predominantly delivered by the further education (FE) sector.

The expense of installing and maintaining equipment, particularly for engineering, is a significant cost factor for FE colleges in providing technical education. While some decisions about the allocation of capital funding for FE are made at the national level – for example, the National Colleges programme – the bulk of responsibility for distribution of the skills capital budget for FE (£330m in 2015/16) has recently shifted to Local Enterprise Partnerships (LEPs)[1], which have a remit for skills development in their locality.

Each LEP has a strategic economic plan that sets out its priority areas for investment to promote growth in the local area. For all 39 LEPs one or more technical industries feature in their economic plan. For example, 30 LEPs are seeking to further develop engineering and advanced manufacturing industries, with others focusing in areas such as IT, energy provision, or life sciences[2]. Clearly the capacity of the local FE infrastructure to deliver high-quality technical education is critical to these ambitions. This report concentrates on engineering facilities provision, but a similar process could be undertaken across any technical education route.

There is no overarching guidance for funders or college leaders as to the equipment needed by a college to deliver broad engineering education and training. Although some awarding bodies make suggestions for equipment with qualification specifications, this is not always explicit or clear. To address this issue, the Royal Academy of Engineering and the Gatsby Charitable Foundation have worked with FE colleges to identify the basic equipment that would be expected to be found in any setting offering engineering education and training at Level 3. Of course some colleges will have additional equipment that reflects specialist training offered by their institution – for example, the

1 www.gov.uk/government/collections/local-growth-deals
2 www.lepnetwork.net/resource-area/document-library/

full size sectional mock-up (two decks) submarine training facility used at Furness College with BAE Systems is somewhat unique.

We hope the report will be a useful guide for heads of engineering departments, college principals, and funding bodies. Alongside this work Gatsby has supported Greater Manchester LEP to undertake with their local FE providers an audit of engineering education and training capacity in their local area. This data has been cross-referenced with local labour market intelligence, and the outcomes from these projects are supporting the development of plans for coherent provision in these areas. The project can inform decisions regarding investment in maintaining and upgrading facilities as required, thus minimising unnecessary duplication of facilities across institutions, while ensuring good provision for niche technical education[3].

Methodology

A combination of face to face interviews and online survey were undertaken, with responses from 52 colleges in total collected. This represents a return of 25% (a total of 208 general FE colleges known to offer some engineering[4] provision were invited to complete the survey). The representativeness of the sample was determined by examining both the size and geographical location of the colleges responding. Medium-sized colleges (defined as having 5,000-10,000 students) are slightly under-represented and large colleges (10,000+ students) slightly over-represented. Geographically, there is slight under-representation in the East Midlands, North West, North East and Yorkshire and the Humber.

Prior to the face to face interviews and the online survey, the websites of all 208 colleges offering engineering were reviewed to establish the most commonly offered qualifications (as advertised at November-December 2014). This data was used to inform the survey questionnaire design (Appendix One).

3 http://neweconomymanchester.com/publications/mapping-of-engineering-and-manufacturing-training-facilities-in-greater-manchester

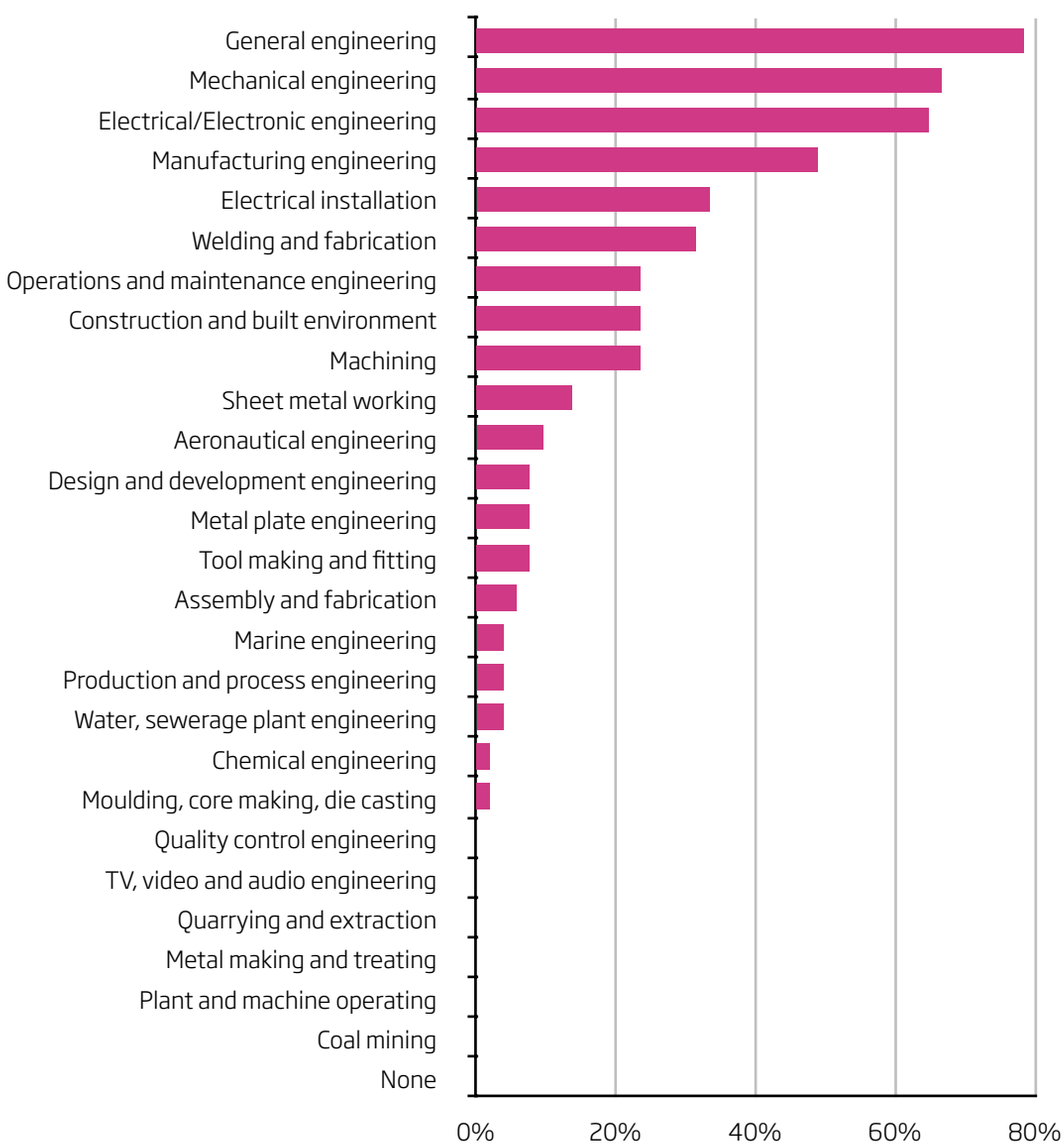
4 For the purposes of this report we have classified institutions offering engineering as colleges offering qualifications/apprenticeships in any of the following: mechanical engineering, electrical engineering, manufacturing engineering, aeronautical engineering, motorsport engineering, maintenance engineering, civil engineering, construction and built environment, mechatronics, building services engineering, operations engineering, automotive engineering, composites, electrical installation and refrigeration and air conditioning.

Section 1

What are the most common engineering areas taught in colleges?

Colleges were asked to group their engineering courses into areas of provision. The 26 categories used for this process were previously developed and trialled by the Greater Manchester LEP and providers during their audit process. The most common reported areas of provision were 'General engineering', 'Mechanical engineering' and 'Electrical/electronic engineering'. None of the surveyed colleges categorised any of their courses as 'TV, video and audio engineering', 'Quarrying and extraction', 'Metal making and treating', 'Plant and machine operating' or 'Coal mining'.

Figure 1: Engineering areas taught in FE colleges

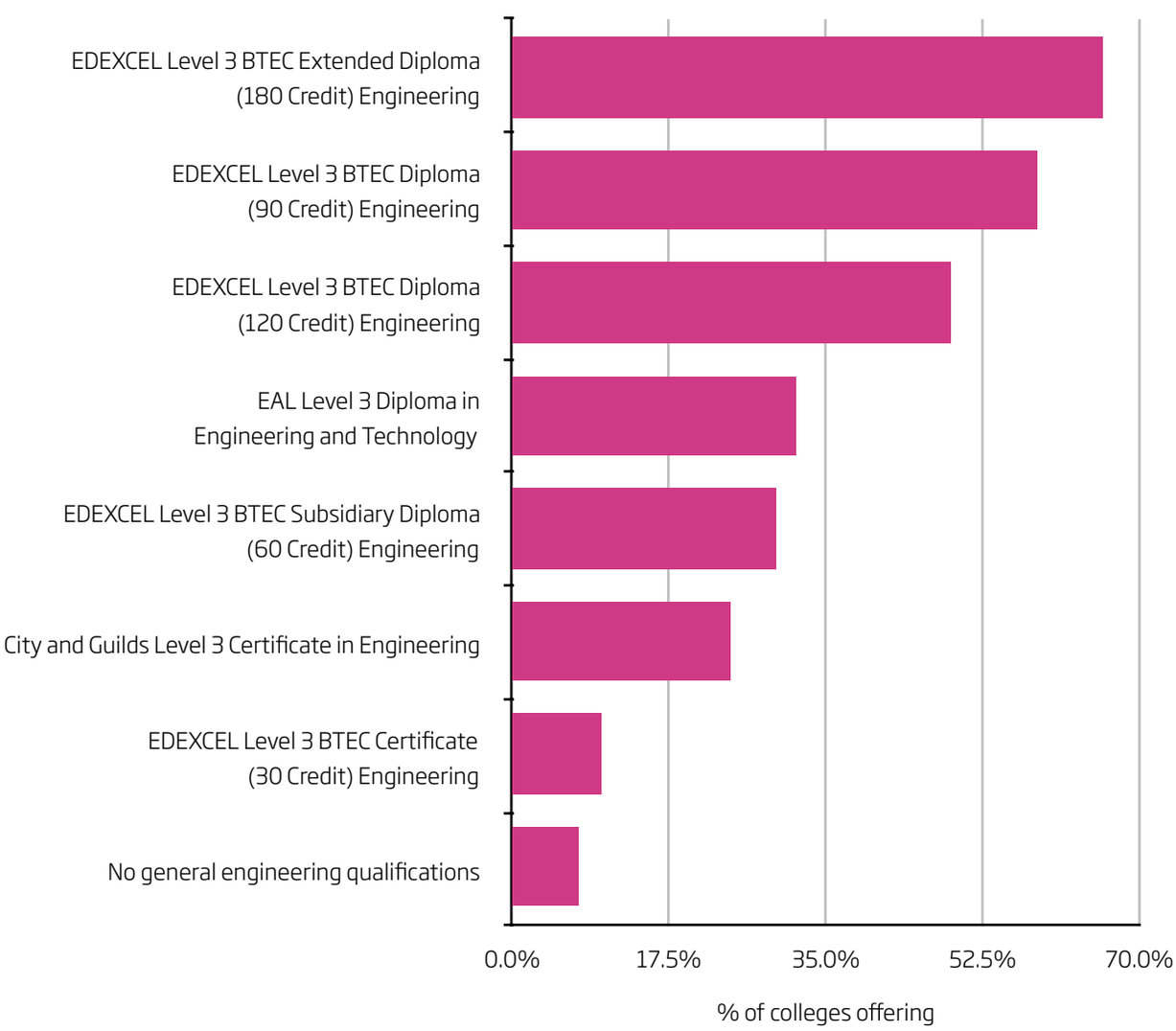


Section 2: Qualifications

Level 3 general engineering

More colleges deliver general engineering qualifications[5] than any specialist qualifications[6]. Figure 2 illustrates the most common qualifications, with the Pearson BTEC qualifications dominating.

Figure 2: Level 3 general engineering qualifications offered by FE colleges



5 General engineering was crudely defined as any qualification with either 'general engineering' or only 'engineering' (i.e. not 'mechanical engineering) in the title.
6 'Specialist' qualifications are defined here as any other type of qualification than general engineering (see above).

According to the survey results, the most commonly delivered qualification is the BTEC Extended Diploma, which is equivalent in size to three A levels. Learners are primarily enrolled on the 90- and 60-credit[7] Diploma and Subsidiary Diploma as the first year of the bigger 120- and 180-credit qualifications, although it is possible to certificate after completing the 90- and 60-credit qualifications.

It is important to note that the Level 3 BTEC general engineering specifications comprise a small core of mandatory modules that are studied alongside modules selected from a range of optional modules. The breadth of optional modules available is dependent on the size of the qualification, with the 180-credit BTEC offering a wider range of optional modules than the 90-credit specification. Figure 3 illustrates the combination of optional and mandatory modules available for different credit value qualifications[8].

Figure 3: Mandatory and optional units for Level 3 BTEC engineering qualifications

BTEC Level 3 Certificate 30 credits: Equivalent to 1 AS level
One mandatory unit (Unit 01) plus two optional units (taken from a reduced list).

BTEC Level 3 Subsidiary Diploma 60 credits: Equivalent to 1 A level
One mandatory unit (Unit 01); one specialist mandatory unit (either Unit 05 or 06); four optional units (from reduced list).

BTEC Level 3 Diploma 90 credits: Equivalent to 1.5 A levels
One mandatory unit (Unit 01); one specialist mandatory unit (either Unit 05 or 06); seven optional units (from reduced list, up to a value of 70 credits so overall is 90. Most units 10 credits, but unit 142 is worth 9 credits).

BTEC Level 3 Diploma 120 credits: Equivalent to 2 A levels
Six mandatory units (Unit 01-06; unit 03 is a 20-credit project); plus five optional units (or units that give a total of 120 credits overall).

BTEC Level 3 Extended Diploma 180 credits: Equivalent to 3 A levels
Six mandatory units (Unit 01-06; unit 03 is a 20-credit project); optional units to give a combined total of 180 credits .

The combination of optional units offered as part of a course is determined by the provider, based on consultation with employers regarding their skills requirements, and the available infrastructure – both equipment and teaching staff expertise.

Some colleges reported that they delivered Level 3 BTEC qualifications with little or no engineering equipment, by selecting the more theoretical optional modules. Further work would be required to understand the rationale for this approach. For example, colleges may be offering the BTEC qualification as part of a study programme for students who wish to progress to undergraduate level engineering studies. The utility of this approach for these students, or

7 The Pearson BTEC qualifications comprise several units with different credit values that add up to the overall qualification value. As of September 2015, the Qualifications Credit Framework will be removed, with qualifications size being expressed as 'Total Qualification Time' (made up of guided learning hours) in future.

8 https://qualifications.pearson.com/content/dam/pdf/BTEC-Nationals/Engineering/2010/Specification/9781446924112-BTEC-90c-L3-Eng-Iss3.pdf

others who are preparing to enter the workplace directly, is outside the scope of this report.

Publicly accessible qualification achievement data do not specify the combination of modules undertaken by individual students; however, as would be expected the modules most commonly delivered by colleges surveyed were the mandatory units for the larger 120- and 180-credit qualifications (Units 01-06). Unit 01 is also mandatory for the 30-credit certificate, and Unit 01 plus either Unit 05 or 06 are mandatory for the 60-credit subsidiary diploma and 90-credit diploma. Units 01-06 are described below in Table 1 and a full list of available units is provided in question 15 of the survey (Appendix One).

Table 1: Description of Units 01-06 within a Level 3 BTEC engineering qualification

Unit 01 Health and Safety in the Engineering Workplace
Unit 02 Communications for Engineering Technicians
Unit 03 Engineering Project
Unit 04 Mathematics for Engineering Technicians
Unit 05 Mechanical Principles and Applications
Unit 06 Electrical and Electronic Principles

Table 2 shows the percentage of colleges offering the optional-only modules[9] (top 10 most offered).

Table 2: Percentage of colleges offering each optional module within Level 3 BTEC engineering qualifications

	Optional unit	% of colleges offering
1	Unit 28 Further Mathematics for Engineering Technicians	64.7%
2	Unit 17 Computer Aided Drafting in Engineering	60.8%
3	Unit 16 Engineering Drawing for Technicians	54.9%
4	Unit 08 Engineering Design	52.9%
5	Unit 10 Properties & Applications of Engineering Materials	45.1%
6	Unit 35 Principles & Applications of Electronic Devices & Circuits	43.1%

9 The interpretation of the survey data is slightly hampered by the overlap of optional and mandatory units for the different qualifications. For example, Unit 04 (Mathematics for Engineering Technicians) is mandatory for the 120 and 180 credit qualifications but optional for the 30, 60 and 90 credit qualifications.

7	Unit 11 Further Mechanical Principles & Applications	39.2%
=8*	Unit 23 Welding Technology Unit 25 Selecting & Using Programmable Controllers	27.5%
=9	Unit 07 Business Operations in Engineering Unit 20 Engineering Primary Forming Processes Unit 26 Applications of Computer Numerical Control in Engineering	25.5%
=10	Unit 15 Electro, Pneumatic and Hydraulic Systems and Devices Unit 21 Engineering Secondary and Finishing Techniques Unit 22 Fabrication Processes and Technology Unit 51 Electrical Technology	21.6%

Notes
* (i.e. these two modules are both offered by 27.5% of colleges surveyed delivering Level 3 BTEC engineering).

Other engineering qualifications

While the majority of colleges responding to the survey do not offer discrete specialist engineering qualifications, approximately 30% of responding colleges also offer a specialist qualification in electrical/electronic engineering and/or mechanical engineering at Level 3. Around 20% offer a qualification in manufacturing engineering, 13% maintenance engineering and 4% aerospace engineering. The full qualification breakdowns are illustrated in Tables 3 to 7.

Table 3: Percentage of colleges offering specialist electrical/electronic engineering qualifications

No electrical/electronic engineering qualifications	41.3%
EDEXCEL Level 3 BTEC Diploma (120 Credit) Electrical/Electronic Engineering	30.4%
EDEXCEL Level 3 BTEC Diploma (90 Credit) Electrical/Electronic Engineering	26.1%
EAL Level 3 Diploma Electrical and Electronic Technology	15.2%
City and Guilds Level 3 Certificate in Electrotechnical Technology	13.0%

Table 4: Percentage of colleges offering specialist mechanical engineering qualifications

No mechanical engineering qualifications	54.2%
EDEXCEL Level 3 BTEC Diploma (120 Credit) Mechanical Engineering	29.2%
EDEXCEL Level 3 BTEC Extended Diploma (180 Credit) Mechanical Engineering	29.2%
EAL Level 3 Diploma in Advanced Mechanical Engineering Principles	12.5%

Table 5: Percentage of colleges offering specialist manufacturing engineering qualifications

No manufacturing engineering qualifications	64.6%
EDEXCEL Level 3 BTEC Extended Diploma (180 Credit) Manufacturing Engineering	18.8%
EDEXCEL Level 3 BTEC Diploma (120 Credit) Manufacturing Engineering	16.7%
City and Guilds Level 3 Certificate in Mechanical Manufacturing Engineering	10.4%

Table 6: Percentage of colleges offering specialist aeronautical engineering qualifications

No aeronautical engineering qualifications	93.8%
EDEXCEL Level 3 BTEC Extended Diploma (180 Credit) Aeronautical Engineering	4.2%
EDEXCEL Level 3 BTEC Diploma (120 Credit) Aeronautical Engineering	2.1%
City and Guilds Level 3 Certificate in Aeronautical Engineering	2.1%

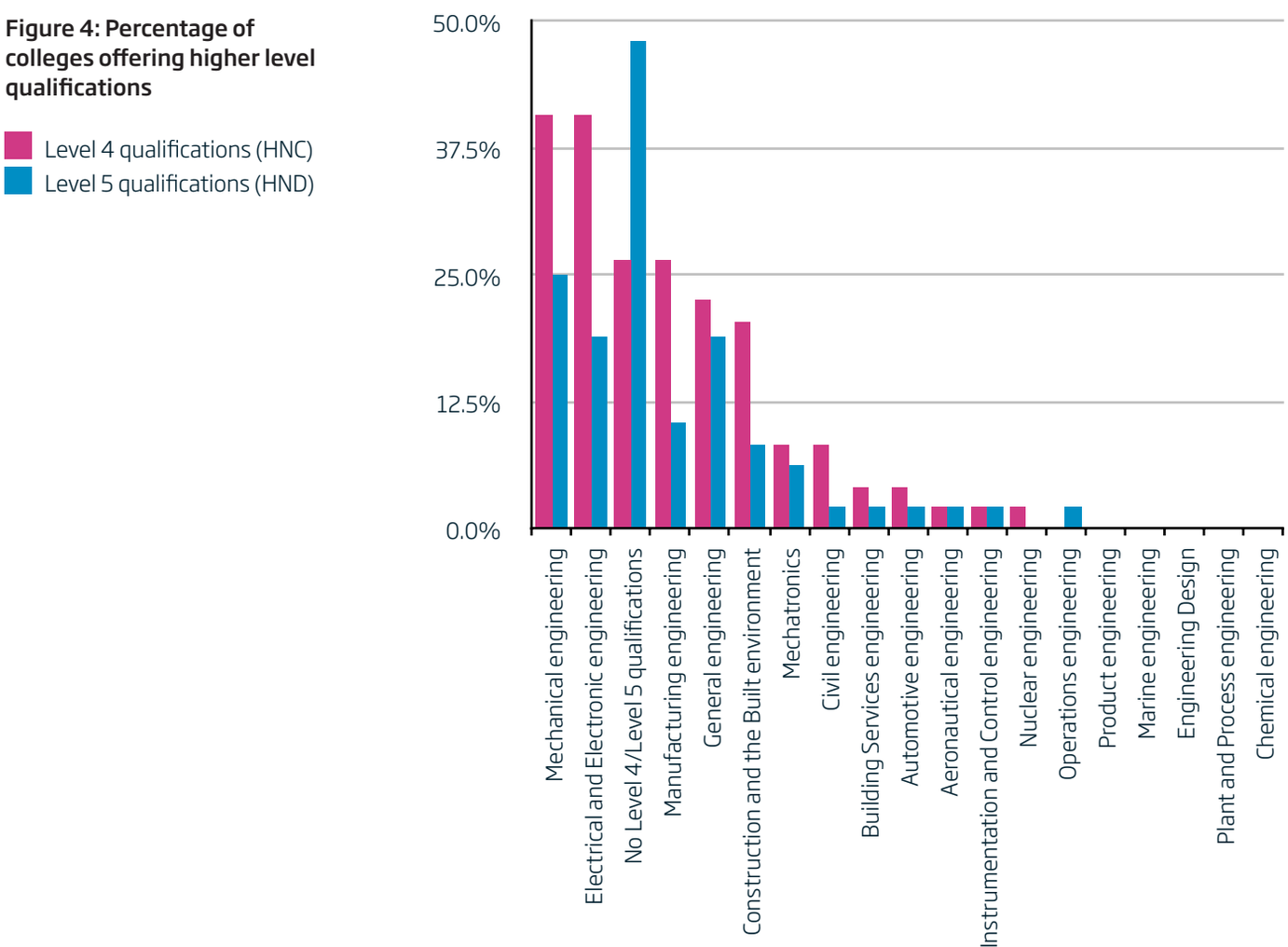
Table 7: Percentage of colleges offering specialist maintenance engineering qualifications

No maintenance engineering qualifications	77.1%
EAL Level 3 Diploma Engineering Maintenance (Electronic/Mechanical)	12.5%
EDEXCEL Level 3 BTEC Diploma (120 Credit) Operations and Maintenance Engineering	8.3%
EDEXCEL Level 3 BTEC Extended Diploma (180 Credit) Operations and Maintenance Engineering	2.1%

Higher level qualifications

Figure 4 illustrates the range of higher level (Levels 4 and 5) engineering qualifications delivered by the colleges surveyed. As might be expected, in contrast with Level 3, colleges are more likely to offer a more specialist rather than general higher level engineering qualification. The most common are mechanical engineering and electrical/electronic engineering, which are offered by 41% of colleges surveyed. Fewer colleges offer Level 5 qualifications; 25% of colleges offer an HND in mechanical engineering, and 18% offer an HND in electrical/electronic engineering. The majority of colleges offer no engineering qualifications at Level 5. Further work is required to explore progression from Level 4 qualifications and why higher level qualifications are not more commonly offered.

Figure 4: Percentage of colleges offering higher level qualifications



Section 3: Engineering equipment

Access to equipment in local employers

In 2013 the Commission on Adult Vocational Teaching and Learning (CAVTL) identified 'access to industry-standard facilities and equipment, reflecting the ways in which technology is transforming work'[10] as an essential feature of good vocational education and training.

Clearly apprentices have access to industry-standard equipment while they are in the workplace. However, a significant proportion of learners up to Level 3, particularly aged 16-18, are studying in full-time classroom-based settings (according to our survey around 55% of 16-18 year olds studying engineering at Level 3 are full-time learners) – and this is likely to continue to be the case at least for the foreseeable future. There are notable exemplars of colleges having high-quality on-site engineering facilities; however, given the cost of purchasing, updating and maintaining facilities, and the often niche requirements of technical education, it is unlikely that all colleges are able to have comprehensive industry-standard facilities on-site.

The requirement for every college offering engineering to have a large amount of expensive equipment could be circumvented if all learners had regular access to up to date, industry-standard equipment on a local employer site. However, the survey illustrates that only a small proportion of colleges have such links with their local employers. Only 25% of colleges stated their non-apprenticeship learners had access to equipment in their local employer, with majority of these positive responses being visits to local industry as opposed to a formalised equipment and expertise sharing agreement. This is not to say that colleges are not engaging effectively with local employers; however, it may be that this employer engagement only benefits those learners on apprenticeships and full-time learners do not have the same level of access to up to date, industry-relevant equipment. This calls into question whether it is appropriate for every college currently offering Level 3+ engineering education and training to attempt to do so, given the associated costs.

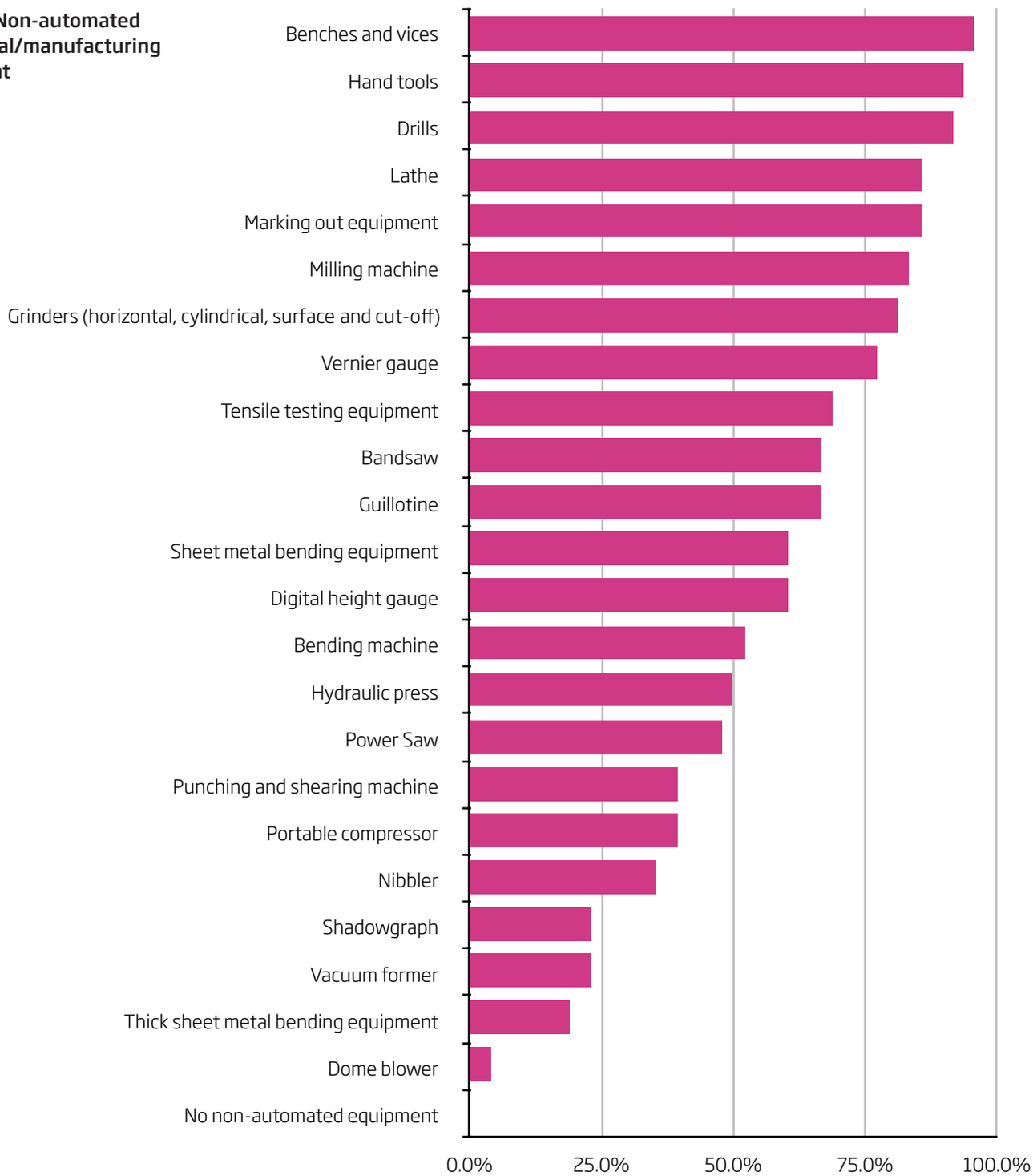
10 Commission on Adult Vocational Teaching and Learning (2013), p9

Engineering equipment currently available in FE colleges

Figures 5 - 11 illustrate the equipment currently available in those FE colleges that responded to the survey, broken down into equipment type subgroups.

Unsurprisingly, the majority of colleges surveyed have benches and vices, hand tools and drills available to their learners.

Figure 5: Non-automated mechanical/manufacturing equipment



Fewer colleges reported having automated equipment in their engineering departments, with 12.5% of respondents having no automated equipment at all.

Figure 6: Automated mechanical/manufacturing equipment

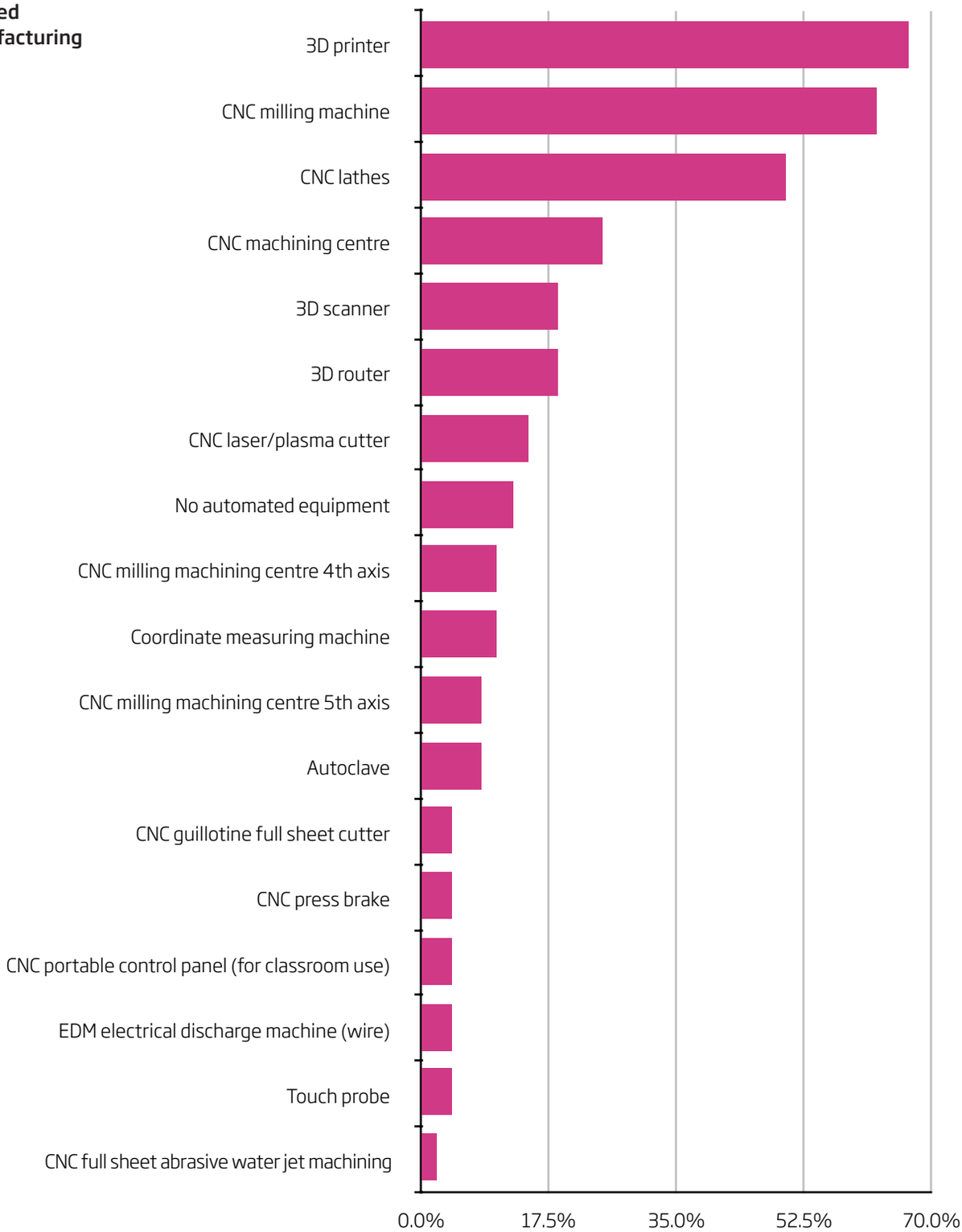


Figure 7: Pneumatics/ hydraulics, fluids and process engineering

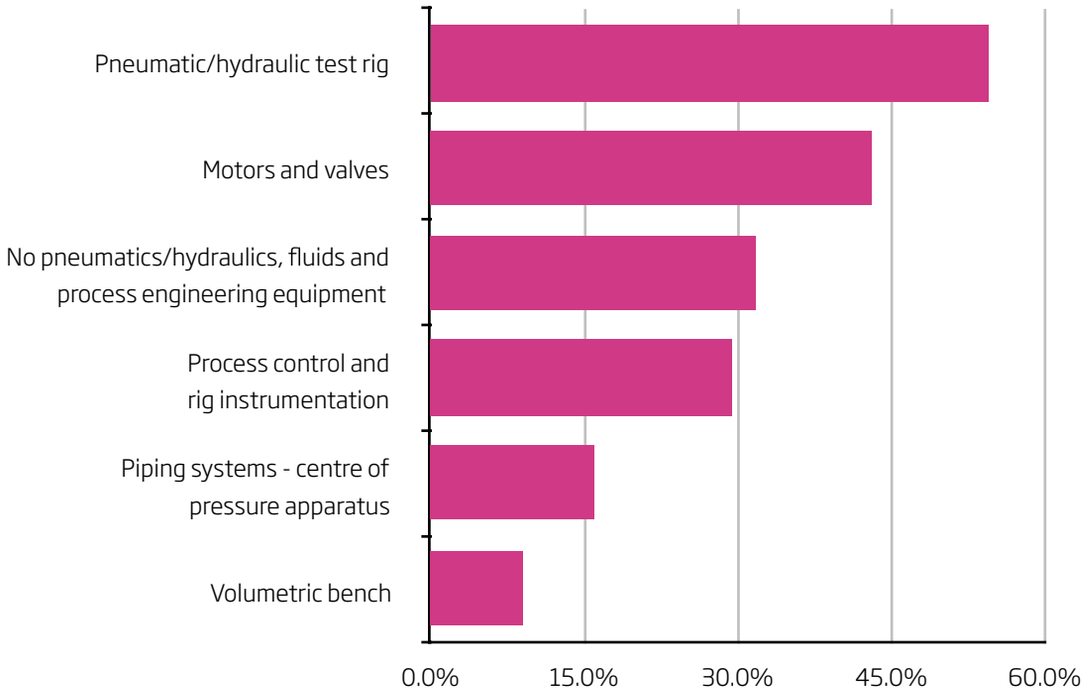
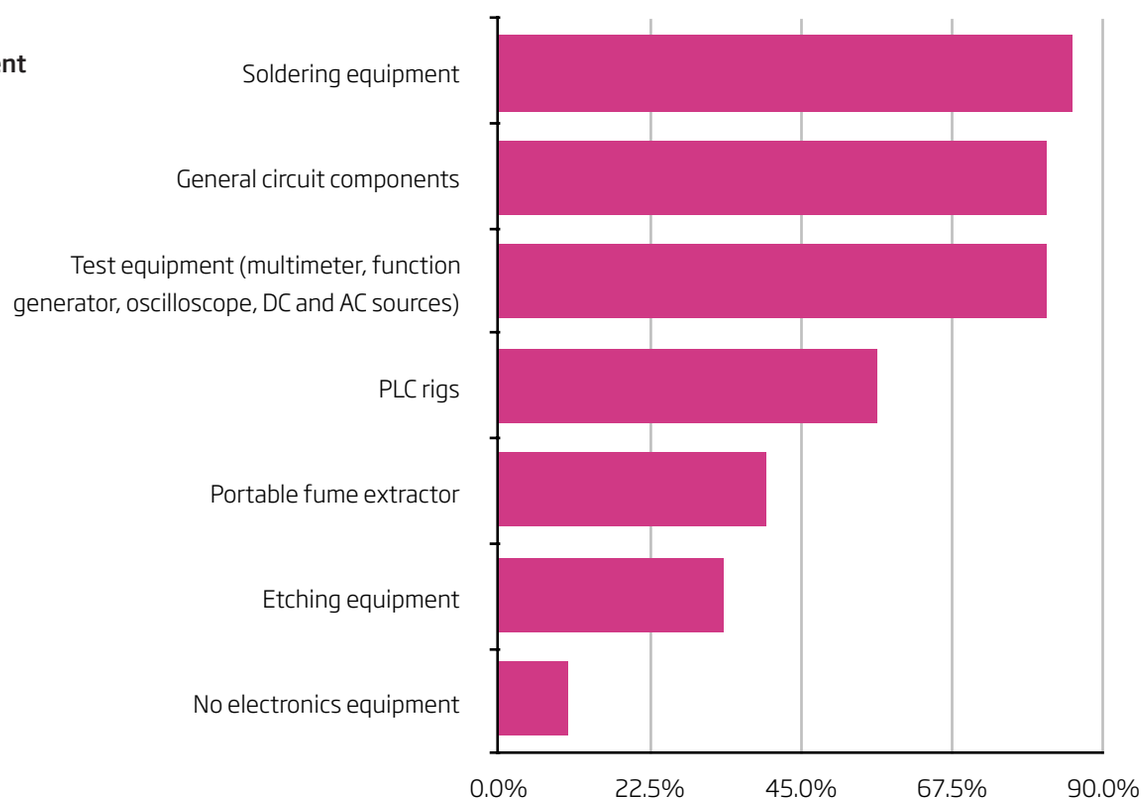
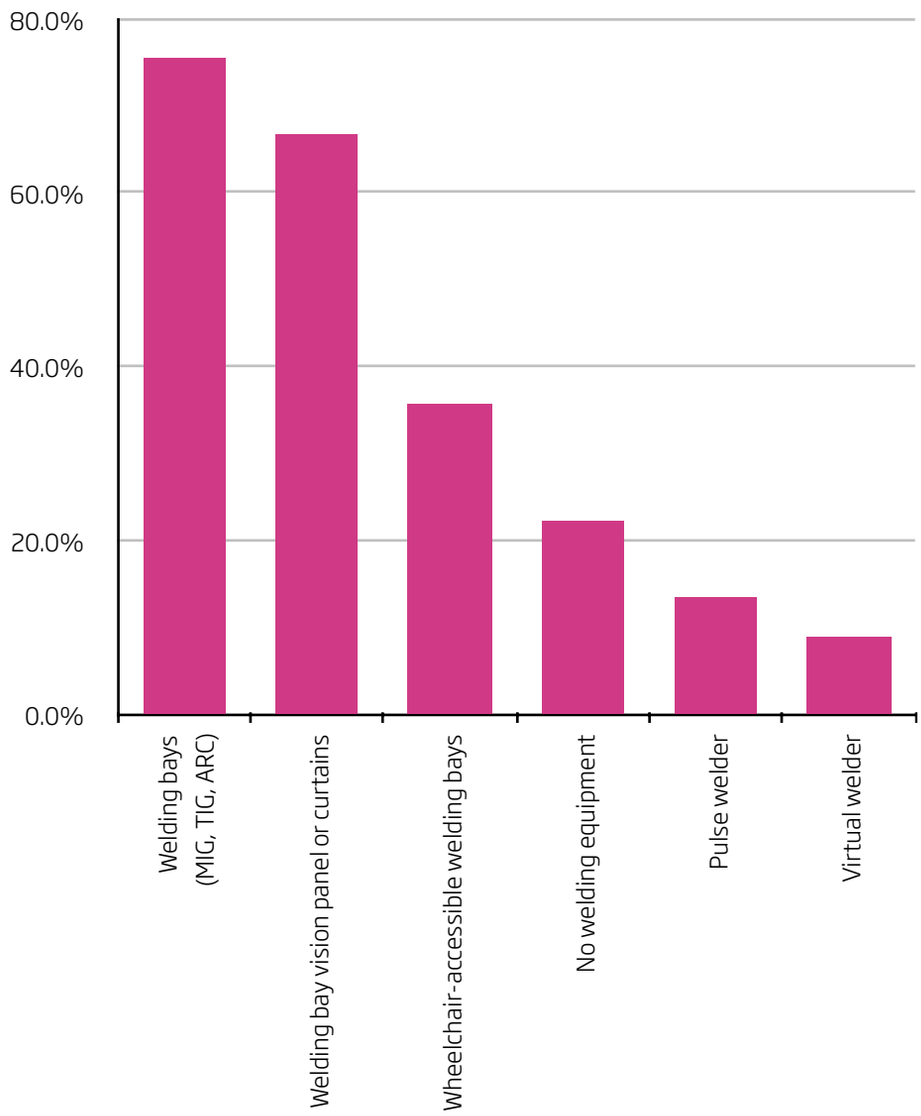


Figure 8: Electronics equipment



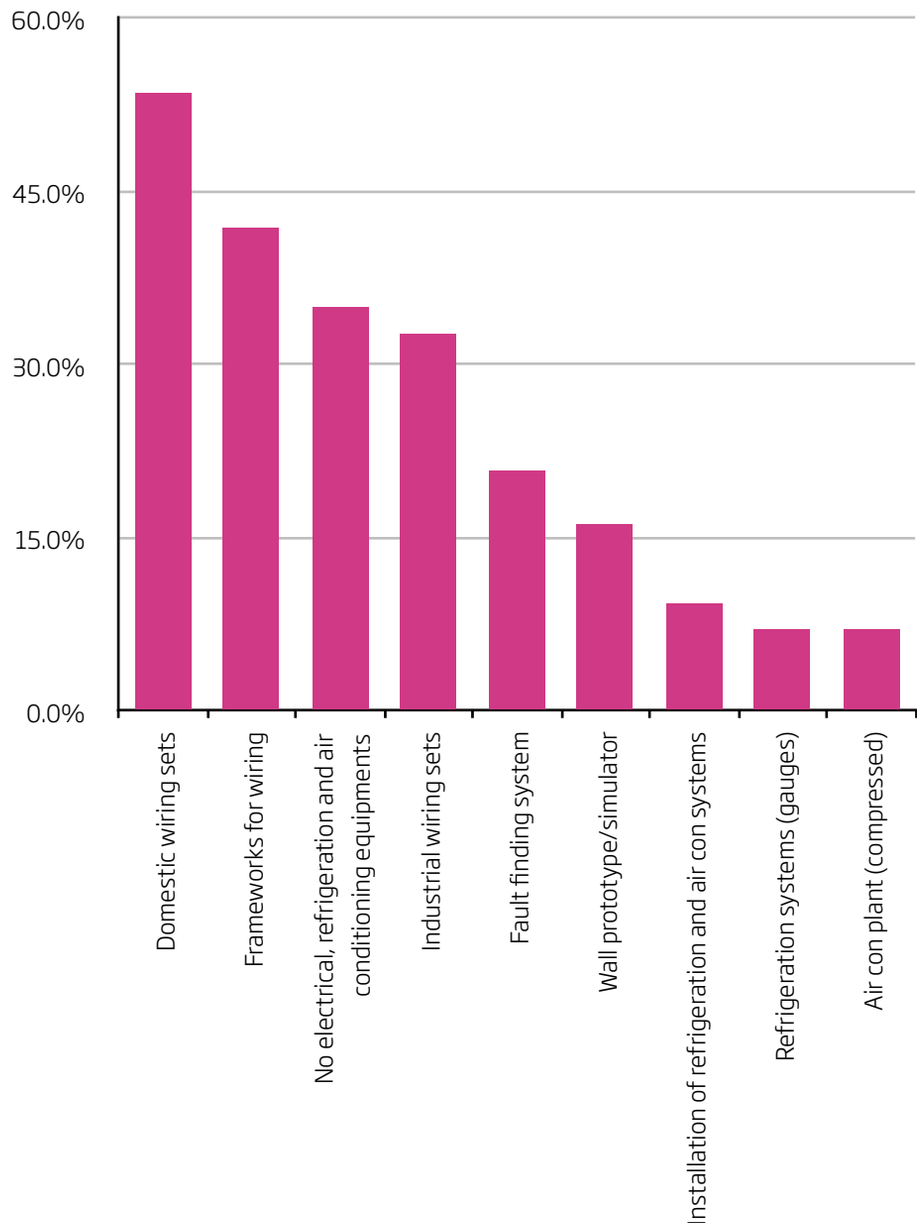
Despite expensive consumables, around three-quarters of colleges have some welding equipment although only 31% of colleges categorised their engineering provision as 'welding and fabrication' (see Figure 1).

Figure 9:
Welding equipment



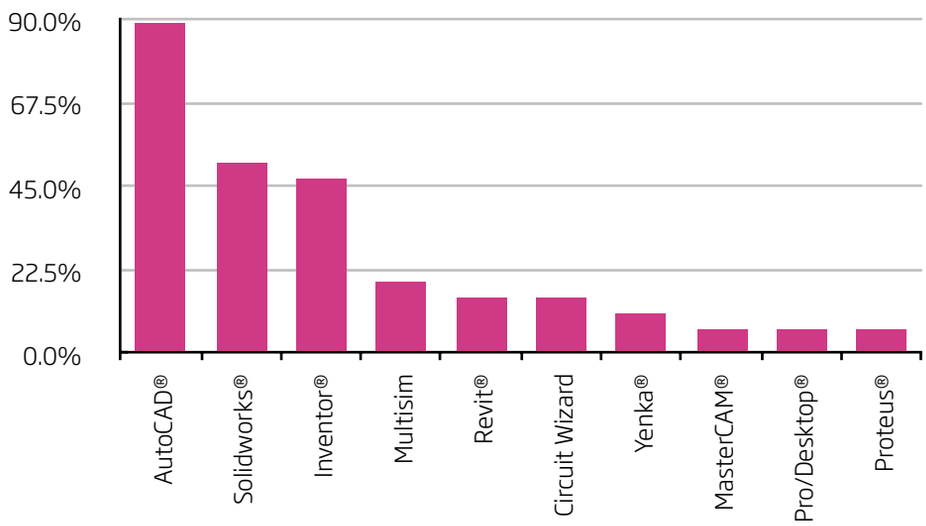
Around a third of colleges reported having no electrical, refrigeration and air conditioning installation equipment. However, due to some colleges classifying electrical, refrigeration and air conditioning installation as a construction discipline rather than engineering, there is some potential underreporting here.

Figure 10: Electrical, refrigeration and air con installation



AutoCAD is used by the majority of colleges surveyed, with around a half of colleges also using Solidworks and/or Inventor. Other software used by colleges included: ProEngineer; SPICE; Ableton Live; RSLogix; Cubase; ProTools; and CATIA.

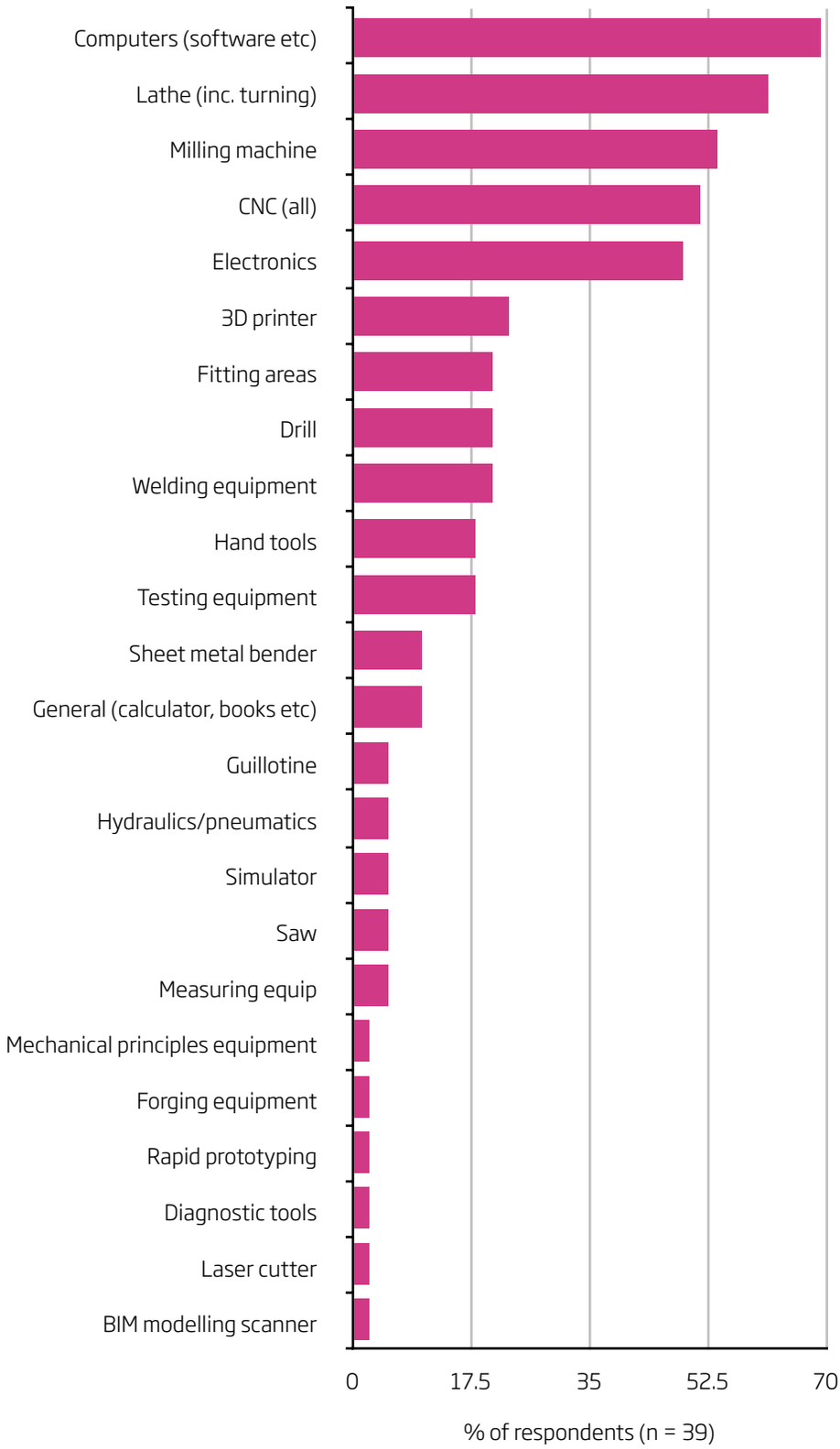
Figure 11: Software



The most important equipment for a broad engineering education

Respondents were asked to identify what they view as the six most important pieces of equipment for teaching a broad engineering qualification. The free text responses were grouped into types of related equipment and coded. The results are illustrated in Figure 12, and demonstrate the wide range of equipment engineering departments feel is essential for their job. It is interesting to compare these results with the equipment currently available in colleges. Notably for example, although 67% of colleges have a 3D printer, only 23% of respondents saw it as being important for a general engineering education. More specialist equipment for more niche areas of engineering, for example, composites, is also not captured here.

Figure 12: Respondents' views of key equipment required for provision of a broad engineering education



The employer view

The UK has well-documented skills shortages across its engineering industries[11]. FE colleges are critical providers of education and training that prepares individuals to enter and progress in engineering occupations. A list of the engineering equipment commonly available in FE colleges was sent to a range of employers for comment (see Table 8).

Table 8: Equipment commonly available in general FE colleges

Mechanical/manufacturing equipment	Electrical/electronic equipment
Benches and vices	Soldering equipment
Hand tools	Mulitmeters
Drills	Function generators
Lathes	Oscilloscopes
Milling machine	PLCs
Marking out tools (scribes, Vernier gauges, rulers etc)	PCB etching equipment
CNC milling machine	Domestic wiring sets/panels
CNC lathe	Industrial wiring sets/panels
CNC control panel	Fault finding sets
Pneumatics and hydraulics equipment	Electrical test equipment
Welding bays (MIG, TIG, ARC, Gas)	Frameworks for wiring (plasterboard, breeze block, brickwork etc)
3D printer	

Employers were asked to comment on whether this list of equipment was adequate for general engineering training at Level 3 and, if not, to identify any additional equipment.

Responses were received from employers including Airbus, Toyota and National Grid. The employers all agreed that the list of equipment in Table 8 was comprehensive for a general engineering education. However, they noted that equipment and resources are only one aspect of education and having a suitably qualified engineering teaching workforce is critical – and that teachers must be up to date with industry requirements. This issue falls beyond the remit of this report, however, warrants further exploration.

Although outside the scope of this report, it would be interesting to examine the typical utilisation of different equipment types – particularly when thinking about possible future investment in facilities and student access.

11 http://www.engineeringuk.com/EngineeringUK2015/EngUK_Report_2015_Interactive.pdf

Section 4: Conclusion

The final question in the survey provided respondents with an opportunity to add any additional comments they wished to make regarding engineering facilities provision.

Of the responses recorded, all described issues attributed to reduced funding.

Some of the survey comments illustrate the problems faced:

'Technology is developing at an ever increasing rate along with the demand for a skilled workforce. However, funding for Further Education is being cut year on year and this reduction is having a negative impact on the facilities we should be providing for learners.'

'The reduction in government funding and the loss of the ability to make significant capital bids due to a lack of capital fund allocation makes it difficult to meet some local demand. Keeping software up to date is expensive as well as the space requirements for some equipment.'

'As a college and training provider it would be fantastic to have improved utilisation of industry equipment. We have very strong industry links and often use these for factory tours and occasional work experience. It would be a big step to be able to get into the workplace with learners and use the sort of equipment that as a college we cannot afford.'

During the course of this research, two general types of colleges were identified. While there is of course variation within these general typologies, they can be classified as College A and College B. College A typically offers engineering courses up to Level 3 with some small amounts of higher provision. College A has a good standard of basic engineering equipment; however, does not have a wide range of industry-standard equipment or any more specialised or niche equipment. College B also offers engineering courses up to Level 3 but with large amounts of higher level provision. College B has high-tech, industry-standard general engineering equipment and has facilities for specialist training (for example composites or aeronautical engineering). The list of equipment in Table 8 demonstrates the level of facilities that employers would expect their college partners to have in order to provide general engineering education – clearly without large investment it is unlikely that all colleges will be able to offer this to their learners.

While this report does not directly address the cost of engineering education, it has become clear through the research that the expense of installing and maintaining up to date and industry-relevant equipment is unsustainable for some providers. In future, not all colleges will be able to offer the level of facilities required to ensure a high-quality education producing work-ready engineers. There are several options and approaches that could be considered in order to ensure industry-relevant equipment:

- A massive and sustained investment in colleges and their facilities nationally. Further work could be undertaken to explore the costings for this.
- Increased collaboration between employers and colleges, to allow a formalised access agreement to employer-based equipment.
- Increased collaboration between colleges and universities to make better use of highly equipped university engineering departments, which often are empty for long periods of the year.
- Greater local coherent planning of engineering education to prevent duplication of provision and allocate funding to more specialised institutions to ensure that more expensive, technical education can be available to meet the needs of employers and learners.

It is likely that a combination of the above will be required to ensure that high-quality engineering facilities are available nationally and that every young person is able to access an excellent general engineering education within a reasonable 'distance to learn'.

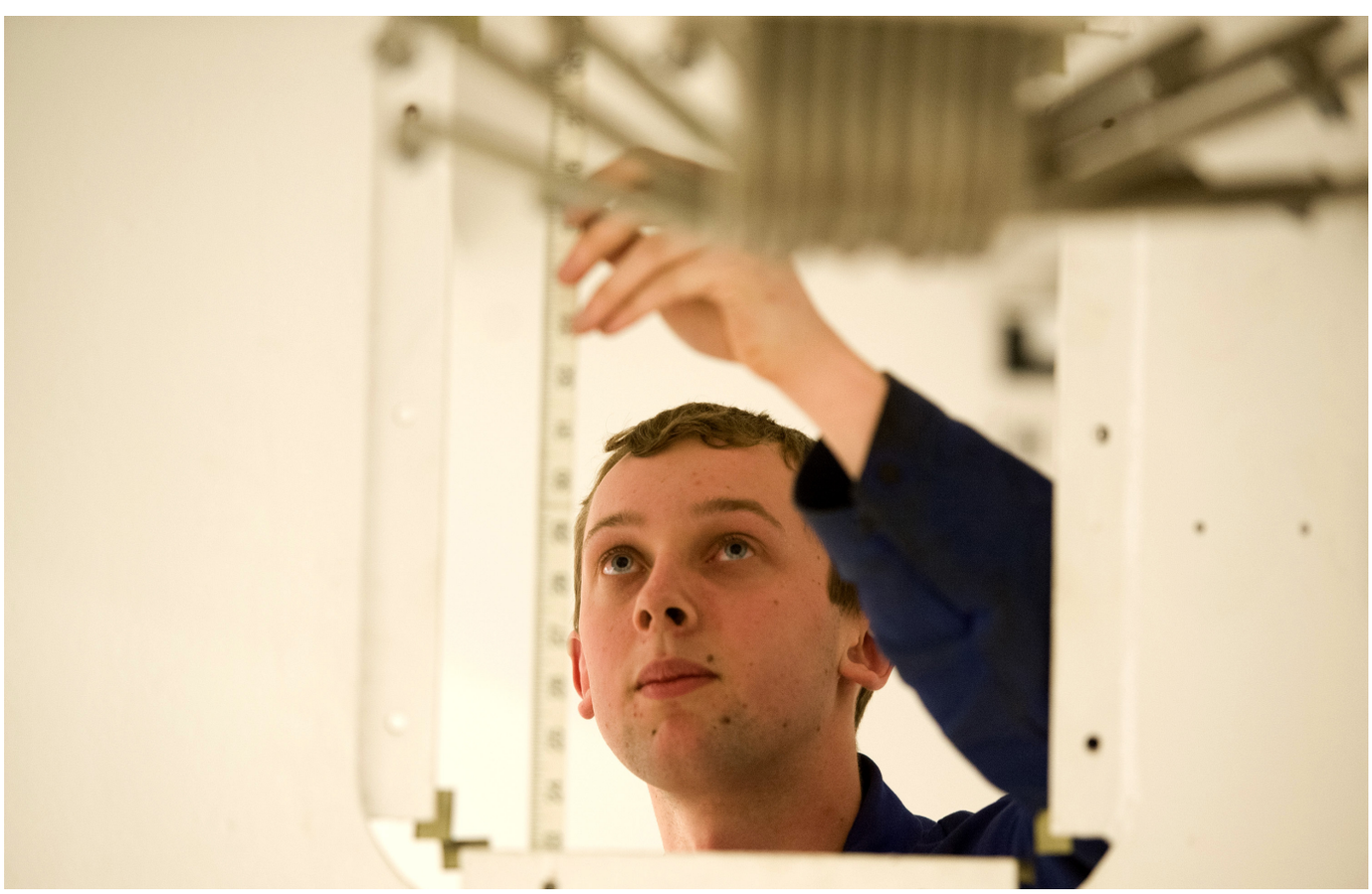


Image courtesy of Furness College

Appendices

Appendix One
Survey questionnaire
Further Education Engineering Facilities

College Information

1. College Information

Full College Name

Department

City/Town

Postcode

Email Address

2. Level 3 Engineering Student Numbers

Number of Level 3 Full Time Students (not including apprenticeships)

Number of Level 3 Part Time Students (not including apprenticeships)

Number of Level 3 Apprentices

3. Level 4 Engineering Student Numbers

Number of Level 4 Part Time Students (not including apprenticeships)

Number of Level 4 Apprentices

Engineering Areas

Please indicate all the engineering areas your qualifications can be grouped in.

4. Which engineering areas do you teach?

General Engineering

Electrical/Electronic Engineering

Mechanical Engineering

Manufacturing Engineering

Aeronautical Engineering

Operations and Maintenance Engineering

Construction and Built Environment

Other (please specify)

Level 3 Qualifications in General Engineering

Please indicate the qualifications your college provides in this area.

5. Which of these qualifications in General Engineering do you provide?

EDEXCEL Level 3 BTEC Certificate (30 Credit) Engineering

EDEXCEL Level 3 BTEC Subsidiary Diploma (60 Credit) Engineering

EDEXCEL Level 3 BTEC Diploma (90 Credit) Engineering

EDEXCEL Level 3 BTEC Diploma (120 Credit) Engineering

EDEXCEL Level 3 BTEC Extended Diploma (180 Credit) Engineering

City and Guilds Level 3 Certificate in Engineering

EAL Level 3 Diploma in Engineering and Technology

Other (please specify)

Level 3 Qualifications in Electrical/Electronic Engineering

Please indicate the qualifications your college provides in this area.

6. Which of these qualifications in Electrical/Electronic Engineering do you provide?

EDEXCEL Level 3 BTEC Certificate (30 Credit) Electrical/Electronic Engineering

EDEXCEL Level 3 BTEC Subsidiary Diploma (60 Credit) Electrical/Electronic Engineering

EDEXCEL Level 3 BTEC Diploma (90 Credit) Electrical/Electronic Engineering

EDEXCEL Level 3 BTEC Diploma (120 Credit) Electrical/Electronic Engineering

EDEXCEL Level 3 BTEC Extended Diploma (180 Credit) Electrical/Electronic Engineering

City and Guilds Level 3 Certificate in Electrotechnical Technology

Other (please specify)

Level 3 Qualifications in Mechanical Engineering

Please indicate the qualifications your college provides in this area.

7. Which of these qualifications in Mechanical Engineering do you provide?

EDEXCEL Level 3 BTEC Certificate (30 Credit) Mechanical Engineering

EDEXCEL Level 3 BTEC Subsidiary Diploma (60 Credit) Mechanical Engineering

EDEXCEL Level 3 BTEC Diploma (90 Credit) Mechanical Engineering

EDEXCEL Level 3 BTEC Diploma (120 Credit) Mechanical Engineering

EDEXCEL Level 3 BTEC Extended Diploma (180 Credit) Mechanical Engineering

City and Guilds Level 3 Mechanical Manufacturing Engineering

EAL Level 3 Diploma in Advanced Mechanical Engineering Principles

Other (please specify)

Level 3 Qualification in Manufacturing Engineering

Please indicate the qualifications your college provides in this area.

8. Which of these qualifications in Manufacturing Engineering do you provide?

EDEXCEL Level 3 BTEC Certificate (30 Credit) Manufacturing Engineering

EDEXCEL Level 3 BTEC Subsidiary Diploma (60 Credit) Manufacturing Engineering

EDEXCEL Level 3 BTEC Diploma (90 Credit) Manufacturing Engineering

EDEXCEL Level 3 BTEC Diploma (120 Credit) Manufacturing Engineering

EDEXCEL Level 3 BTEC Extended Diploma (180 Credit) Manufacturing Engineering

City and Guilds Level 3 Mechanical Manufacturing Engineering

Other (please specify)

Level 3 Qualifications in Aeronautical Engineering

Please indicate the qualifications your college provides in this area.

9. Which of these qualifications in Aeronautical Engineering do you provide?

EDEXCEL Level 3 BTEC Certificate (30 Credit) Aeronautical Engineering

EDEXCEL Level 3 BTEC Subsidiary Diploma (60 Credit) Aeronautical Engineering

EDEXCEL Level 3 BTEC Diploma (90 Credit) Aeronautical Engineering

EDEXCEL Level 3 BTEC Diploma (120 Credit) Aeronautical Engineering

EDEXCEL Level 3 BTEC Extended Diploma (180 Credit) Aeronautical Engineering

City and Guilds Level 3 Certificate in Aeronautical Engineering

Other (please specify)

Level 3 Qualifications in Operations and Maintenance Engineering

Please indicate the qualifications your college provides in this area.

10. Which of these qualifications in Operations and Maintenance Engineering do you provide?

EDEXCEL Level 3 BTEC Certificate (30 Credit) Operations and Maintenance Engineering

EDEXCEL Level 3 BTEC Subsidiary Diploma (60 Credit) Operations and Maintenance Engineering

EDEXCEL Level 3 BTEC Diploma (90 Credit) Operations and Maintenance Engineering

EDEXCEL Level 3 BTEC Diploma (120 Credit) Operations and Maintenance Engineering

EDEXCEL Level 3 BTEC Extended Diploma (180 Credit) Operations and Maintenance Engineering

Other (please specify)

Level 3 Qualifications in Construction and the Built Environment

Please indicate the qualifications your college provides in this area.

11. Which of these qualifications in Construction and the Built Environment do you provide?

EDEXCEL Level 3 BTEC Certificate (30 Credit)
Construction and the Built Environment

EDEXCEL Level 3 BTEC Subsidiary Diploma (60 Credit)
Construction and the Built Environment

EDEXCEL Level 3 BTEC Diploma (90 Credit)
Construction and the Built Environment

EDEXCEL Level 3 BTEC Diploma (120 Credit)
Construction and the Built Environment

EDEXCEL Level 3 BTEC Extended Diploma (180 Credit)
Construction and the Built Environment

City and Guilds Level 3 Certificate in Engineering Construction

Other (please specify)

Other Level 3 Qualifications

Please write down any other Level 3 engineering courses your college provides that have not been listed.

12. If any of the qualifications you provide at Level 3 have not been listed, please write them here.

Level 4 Engineering Qualifications

Please indicate the Level 4 qualifications your college provides. If you do not provide Level 4 engineering please skip this question.

13. Which Level 4 qualifications do you provide?

HNC General Engineering

HNC Manufacturing Engineering

HNC Mechanical Engineering

HNC Mechatronics

HNC Building Services Engineering

HNC Electrical and Electronic Engineering

HNC Aeronautical Engineering

HNC Operations Engineering

HNC Construction and the Built Environment

HNC Civil Engineering

HNC Automotive Engineering

HNC Product Engineering

HNC Marine Engineering

HNC Engineering Design

HNC Instrumentation and Control Engineering

HNC Plant and Process Engineering

HNC Chemical Engineering

HNC Nuclear Engineering

Other (please specify)

Level 5 Engineering Qualifications

Please indicate the Level 5 qualifications your college provides. If you do not provide Level 5 engineering please skip this question.

14. Which Level 5 qualifications do you provide?

HND General Engineering

HND Manufacturing Engineering

HND Mechanical Engineering

HND Mechatronics

HND Building Services Engineering

HND Electrical and Electronic Engineering

HND Aeronautical Engineering

HND Operations Engineering

HND Construction and the Built Environment

HND Civil Engineering

HND Automotive Engineering

HND Product Engineering

HND Marine Engineering

HND Engineering Design

HND Instrumentation and Control Engineering

HND Plant and Process Engineering

HND Chemical Engineering

HND Nuclear Engineering

Other (please specify)

BTEC Engineering Units

If you provide any BTEC engineering qualifications at Level 3, please indicate the units you teach. If you do not provide BTEC engineering qualifications at Level 3, please skip this page.

15. If you provide BTEC Engineering Qualifications at Level 3, which units do you teach?

Unit 01 Health and Safety in the Engineering Workplace

Unit 02 Communications for Engineering Technicians

Unit 03 Engineering Project

Unit 04 Mathematics for Engineering Technicians

Unit 05 Mechanical Principles and Applications

Unit 06 Electrical and Electronic Principles

Unit 07 Business Operations in Engineering

Unit 08 Engineering Design

Unit 09 Commercial Aspects of Engineering Organisations

Unit 10 Properties and Applications of Engineering Materials

Unit 11 Further Mechanical Principles and Applications

Unit 12 Applications of Mechanical Systems in Engineering

Unit 13 Principles and Applications of Fluid Mechanics

Unit 14 Applications of Thermodynamic Principles

Unit 15 Electro, Pneumatic and Hydraulic Systems and Devices

Unit 16 Engineering Drawing for Technicians

Unit 17 Computer Aided Drafting in Engineering

Unit 18 Advanced Mechanical Principles and Applications

Unit 19 Mechanical Measurement and Inspection Techniques

Unit 20 Engineering Primary Forming Processes

Unit 21 Engineering Secondary and Finishing Techniques

Unit 22 Fabrication Processes and Technology

Unit 23 Welding Technology

Unit 24 Industrial Process Measurement

Unit 25 Selecting and Using Programmable Controllers

Unit 26 Applications of Computer Numerical Control in Engineering

Unit 27 Welding Principles

Unit 28 Further Mathematics for Engineering Technicians

Unit 29 Manufacturing Planning

Unit 30 Setting and Proving Secondary Processing Machines

Unit 31 Computer Aided Manufacturing

Unit 32 Production System Design

Unit 33 Six Sigma Quality

Unit 34 Electronic Circuit Design and Manufacture

Unit 35 Principles and Applications of Electronic Devices and Circuits

Unit 36 Mechanical and Thermal Treatment of Metals

Unit 37 Structure and Properties of Metals

Unit 38 Industrial Alloys

Unit 39 Metallurgical Techniques

Unit 40 Extraction and Refining of Metals

Unit 41 Liquid Metal Casting Process

Unit 42 Quality and Business Improvement Techniques

Unit 43 Teamwork in a Continuous Improvement Environment

Unit 44 Engineering Maintenance Procedures and Techniques

Unit 45 Monitoring and Fault Diagnosis of Engineering Systems

Unit 46 Principles and Applications of Engineering Measurement Systems

Unit 47 Industrial Plant and Process Control

Unit 48 Function and Characteristics of Railway Signalling Systems

Unit 49 Installing and Commissioning Engineering Equipment

Unit 50 Industrial Process Controllers

Unit 51 Electrical Technology

Unit 52 Electrical Installation

Unit 53 Electronic Measurement and Testing

Unit 54 Monitoring and Analysing Engineering Activities

Unit 55 Railway Signalling Systems Testing and Maintenance

Unit 56 Railway Infrastructure Construction and Maintenance

Unit 57 Principles and Applications of Analogue Electronics

Unit 58 Construction and Applications of Digital Systems

Unit 59 Microprocessor Systems and Applications

Unit 60 Electronic Faultfinding

Unit 61 Features and Applications of Electrical Machines

Unit 62 Principles and Operation of Threephase Systems

Unit 63 Threephase Motors and Drives

Unit 64 Further Electrical Principles

Unit 65 Principles and Applications of Microcontrollers

Unit 66 Theory of Flight

Unit 67 Principles and Applications of Aircraft Mechanical Science

Unit 68 Principles and Applications of Aircraft Physical Science

Unit 69 Aircraft Workshop Principles and Practice

Unit 70 Aircraft Materials and Hardware

Unit 71 Inspection and Repair of Airframe Components and Structures

Unit 72 Aircraft Maintenance Practices

Unit 73 Aircraft Electrical Machines

Unit 74 Aircraft Electrical Devices and Circuits

Unit 75 Aircraft Electronic Devices and Circuits

Unit 76 Aircraft Computers and Electronic Systems

Unit 77 Human Factors in Aircraft Engineering

Unit 78 Aviation Legislation

Unit 79 Airframe Structural Concepts and Construction Methods

Unit 80 Aircraft Hydraulic Systems

Unit 81 Aircraft Propulsion Systems

Unit 82 Airframe Systems

Unit 83 Aircraft Gas Turbine Engines

Unit 84 Aircraft Electrical Systems

Unit 85 Aircraft Instruments and Indicating Systems

Unit 86 Aircraft Gas Turbine Engine and Propeller Maintenance

Unit 87 Avionic Systems

Unit 88 Aircraft Radio and Radar Principles

Unit 132 Industrial Robot Technology

Unit 141 The Principles of Photonics

Unit 142 Fault Diagnosis and Maintenance of Communications Equipment

Unit 143 Communications Technologies

Unit 144 Telecommunications Principles

Unit 146 Manufacturing of Advanced Composite Materials

Unit 148 Process Safety Management in Engineering

Other (please specify)

Engineering Equipment

16. Do you have access to equipment at a local employer that your non-apprenticeship learners can use?

Yes

No

17. If yes, please specify.

18. Which six pieces of equipment are most important for broad engineering education and why?

Reason 1.

Reason 2.

Reason 3.

Reason 4.

Reason 5.

Reason 6.

Engineering Equipment Non-Automated Equipment

Please indicate the nonautomated equipment you have in your department. If there is anything significant missing from this list, please add below.

19. Non-Automated Equipment

Benches and Vices

Lathe

Milling Machine

Drills

Grinders (horizontal, cylindrical, surface and off)

Marking Out Equipment

Hand Tools

Hydraulic Press

Punching and Shearing Machine

Sheet Metal Bending Equipment

Thick Sheet Metal Bending Equipment

Tensile Testing Equipment

Bending Machine

Digital Height Gauge

Vernier Gauge

Shadowgraph

Nibbler

Bandsaw

Power Saw

Guillotine

Vacuum Former

Dome Blower

Portable Compressor

Other (please specify)

Engineering Equipment Automated Equipment

Please indicate the automated equipment you have in your department. If there is anything significant missing from this list, please add below.

20. Automated Equipment

3D Printer

3D Scanner

3D Router

CNC Lathes

CNC Milling Machine

CNC Machining Centre

CNC Milling Machining Centre 4th Axis

CNC Milling Machining Centre 5th Axis

CNC Guillotine Full Sheet Cutter

CNC Laser/Plasma Cutter

CNC Full Sheet Water Cutter

CNC Press Brake

CNC Portable Control Panel (for classroom use)

Coordinate Measuring Machine

EDM Electrical Discharge Machine (Wire)

Touch Probe

Autoclave Other (please specify)

Engineering Equipment Fluids/ Maintenance

Please indicate the fluids/maintenance equipment you have in your department. If there is anything significant missing from this list, please add below.

21. Fluids/Maintenance

Pneumatic/Hydraulic Test Rig

Piping Systems Centre of Pressure Apparatus

Volumetric Bench

Process Control and Rig Instrumentation

Motors and Valves

Other (please specify)

Engineering Equipment Electronics

Please indicate the electronics equipment you have in your department. If there is anything significant missing from this list, please add below.

22. Electronics

General Circuit Components

Test Equipment (Multimeter, Function Generator, Oscilloscope, DC and AC sources)

PLC Rigs

Soldering Equipment

Etching Equipment

Portable Fume Extractor

Other (please specify)

Engineering Equipment Welding

Please indicate the welding equipment you have in your department. If there is anything significant missing from this list, please add below.

23. Welding

Welding Bays (MIG, TIG, MAG, ARC, Stainless Steel)

Welding Bay Vision Panel or Curtains

Wheelchair Accessible Welding Bays

Pulse Welder

Virtual Welder

Other (please specify)

Engineering Equipment Electrical, Refrigeration and Air Con Installation

Please indicate the Electrical, Refrigeration and Air Con Installation equipment you have in your department. If there is anything significant missing from this list, please add below.

24. Electrical, Refrigeration and Air Con Installation

Installation of Refrigeration and Air Con Systems

Refrigeration Systems (gauges)

Air Con Plant Compressed

Fault Finding System

Domestic Wiring Sets

Industrial Wiring Sets

Frameworks for Wiring

Wall Prototype/Simulator

Other (please specify)

Engineering Equipment Software

Please indicate the software you have in your department. If there is anything significant missing from this list, please add below.

25. Software

Inventor®

AutoCAD®

MasterCAM®

Pro/Engineer® (PTC Creo Parametric®)

Pro/Desktop®

Revit®

Solidworks®

SPICE®

ECAD™

Yenka®

Cubase®

Ableton Live®

Pro Tools

RSLogix™

Proteus®

Circuit Wizard Other (please specify)

Engineering Equipment Classroom Equipment

Please indicate the classroom equipment you have in your department. If there is anything significant missing from this list, please add below.

26. Classroom Equipment

Smart Screen

Mobile Smart Screen

Additional Laptops for Students

Drawing Boards

Computer Labs

Camera Projecting from Industrial Table

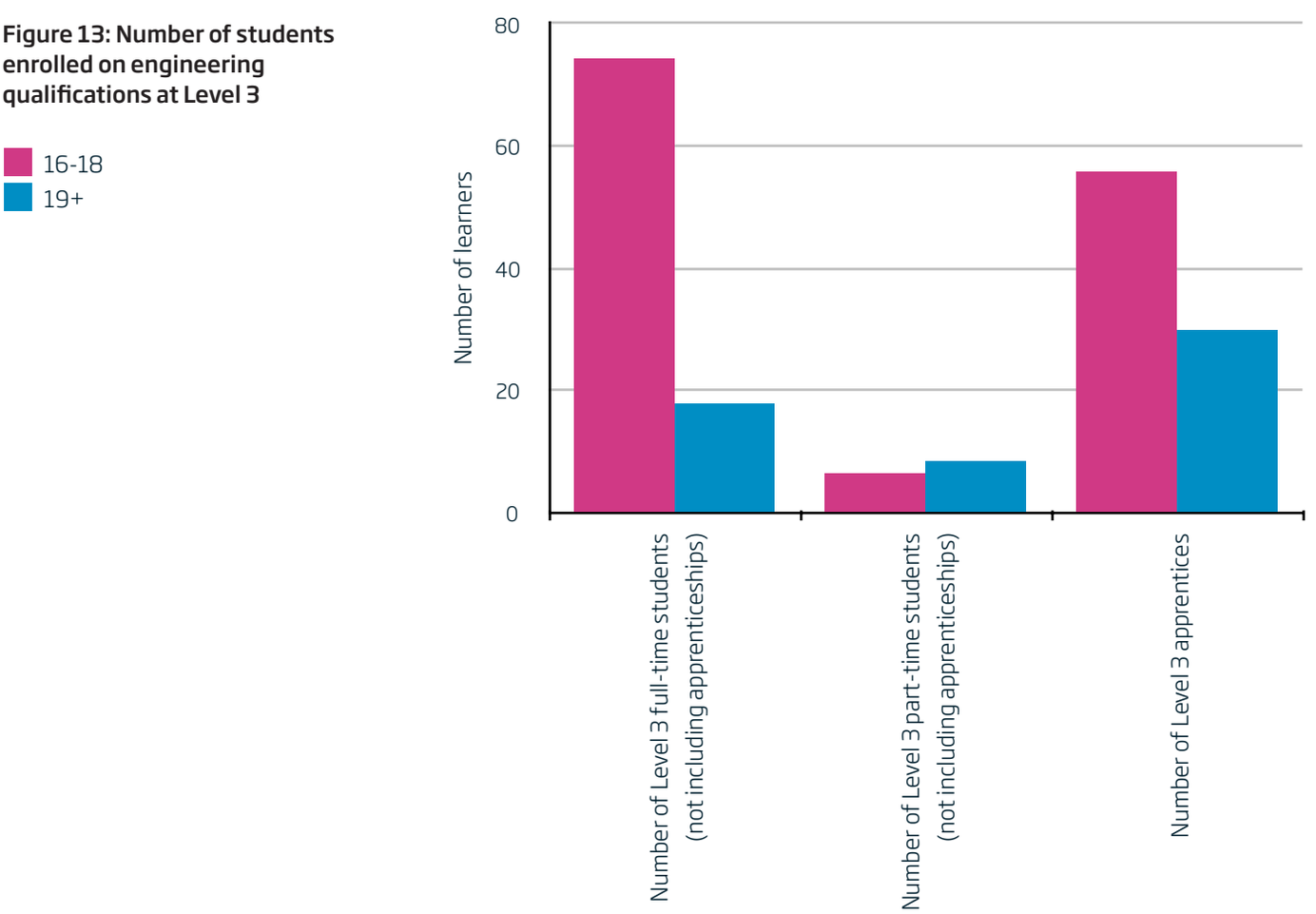
Other (please specify)

Appendix Two
Number of learners

Level 3 Engineering

In the 16-18 age group, the survey indicates that the average (mean) number of all engineering students (per college per annum) is 65 full-time, 5 part-time and 49 apprentices. In the 19+ age group, the average (mean) is 16 full-time students, 7 part-time and 26 apprentices. The full distribution of student numbers taken from the survey is illustrated below. It should be noted that there are some discrepancies when comparing these numbers with the Individualised Learner Record (ILR). This could be due to a number of factors, including: issues with college self-reporting of learner numbers; multiple learning aims being counted within the ILR; and the averages being calculated across all colleges rather than only colleges offering engineering.

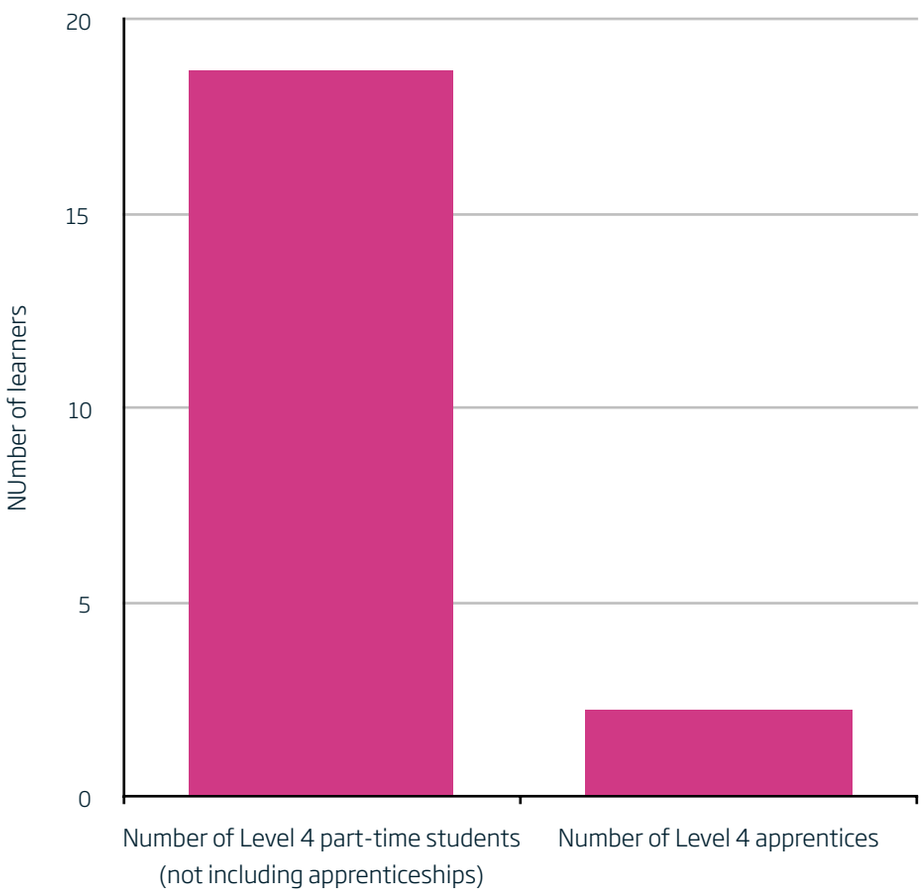
Figure 13: Number of students enrolled on engineering qualifications at Level 3



Level 4 Engineering

The average number of part-time students (per college per annum) working towards an engineering qualification at Level 4 is 28. The average number of Level 4 apprentices is much smaller, with a per college figure of 3. It should be noted that while full-time Level 4 engineering provision does exist, this information was not requested in the survey.

Figure 14: Number of students taking engineering qualifications at Level 4



Distribution of numbers of engineering students at Level 3

The following two figures illustrate the wide distribution of learner numbers at Level 3, both in the 16-18 and 19+ age groups. The colleges have each been randomly assigned an identifying number so that comparison between the two age groups is possible. As both figures show, there appears to be no relationship between number of full-time, part-time or apprenticeship learners. This warrants further investigation to understand why some colleges have relatively large numbers of full-time learners for example, and relatively small numbers of apprentices or vice versa.

Figure 15: Numbers of engineering students at Level 3, aged 16-18

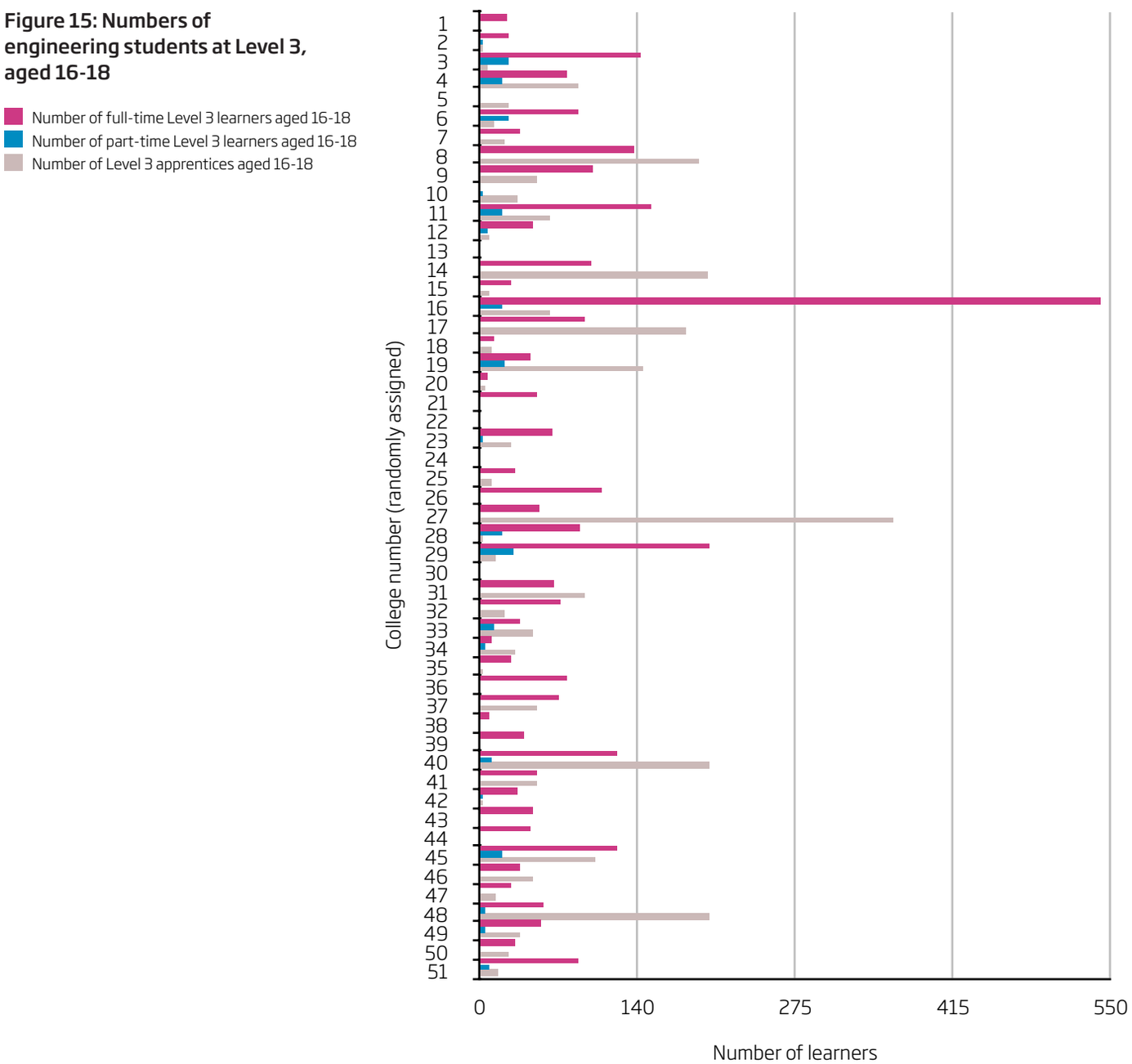
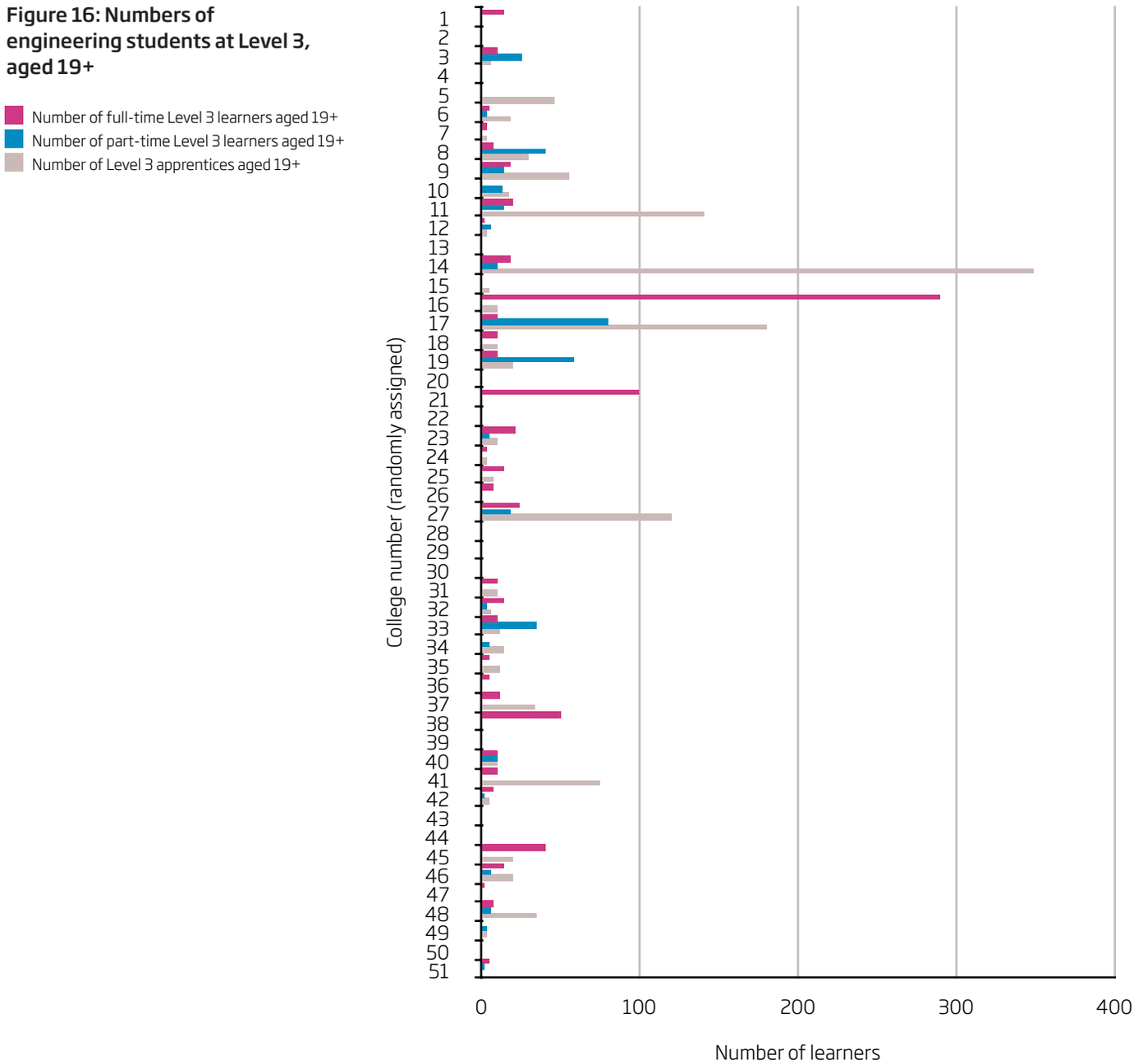


Figure 16: Numbers of engineering students at Level 3, aged 19+



Notes

Notes

Image courtesy of Burnley College

ROYAL ACADEMY OF **ENGINEERING**

GATSBY

As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering.

We have four strategic challenges:

Make the UK the leading nation for engineering innovation

Supporting the development of successful engineering innovation and businesses in the UK in order to create wealth, employment and benefit for the nation.

Address the engineering skills crisis

Meeting the UK's needs by inspiring a generation of young people from all backgrounds and equipping them with the high quality skills they need for a rewarding career in engineering.

Position engineering at the heart of society

Improving public awareness and recognition of the crucial role of engineers everywhere.

Lead the profession

Harnessing the expertise, energy and capacity of the profession to provide strategic direction for engineering and collaborate on solutions to engineering grand challenges.

Gatsby is a foundation set up by David Sainsbury to realise his charitable objectives. We focus our support on a limited number of areas:

- Plant science research
- Neuroscience research
- Science and engineering education
- Economic development in africa
- Public policy research and advice
- The Arts

We are proactive in devising projects to achieve our aims. We are enthusiastic about supporting innovation. We are analytical as we believe it is important to understand the opportunities and problems we tackle.

We take a long-term view as we do not think much can be achieved by short, one-off projects. We are always eager to form partnerships with organisations who share our goals.

Royal Academy of Engineering
Prince Philip House
3 Carlton House Terrace
London SW1Y 5DG
Tel: +44 (0)20 7766 0600
www.raeng.org.uk

Registered charity number 293074