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Engineering

A subject-based aspect report by Education Scotland on provision in Scotland's Colleges on behalf of the Scottish Funding Council

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Transforming lives through learning

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1. Introduction and methodology

Introduction

The Education Scotland publication, *External Quality Arrangements for Scotland's Colleges, updated August 2013* [1], specifies that Education Scotland will produce a number of subject-based aspect reports each year. These reports complement, in a subject-specific context, the generic evaluations of learning and teaching in Education Scotland's external review reports of colleges. Colleges should act on the recommendations contained in these reports. College inspectors will monitor action towards implementation of these recommendations as part of their normal dialogue with colleges, and will wish to discuss issues arising from subject-based aspect reports during annual engagement visits.

In preparing this report, inspectors visited a sample of five colleges, drew on the findings of published Education Scotland reviews of colleges, including the Modern Apprenticeship (MA) Pathfinder Review of Engineering and examined other relevant publications and reports. They consulted with key stakeholders, including employers and professional bodies.

This report evaluates college programmes within the engineering subject area. Programmes covered by this report are offered at levels 4 to 8 of the Scottish Credit and Qualifications Framework (SCQF). These programmes provide education and training in response to an increasing demand for engineers in manufacturing and engineering companies across Scotland and internationally.

Methodology

The five colleges in the sample were visited twice during the fieldwork. Inspectors evaluated the quality of provision through observations of learning and teaching, and discussions with learners, teaching staff and curriculum managers. They also held discussions with local employers and other stakeholders. Colleges gave inspectors access to a range of curriculum documentation, including learning and teaching material, planning and self-evaluation reports. The list of colleges visited during the fieldwork for this report can be found in Appendix 1.

This aspect report evaluates current practice, and identifies important areas for discussion and further development amongst practitioners. The report examines progress made by colleges on recommendations made in the 2007 report *Engineering in Scotland's Colleges* [2]. It also identifies practice worthy of dissemination found by inspectors and sets out recommendations for improvement.

[1] http://www.educationscotland.gov.uk/Images/ExternalQualityArrangementsColleges2013_tcm4-813723.pdf
[2] http://www.educationscotland.gov.uk/Images/eisc_tcm4-712708.pdf

2. Summary of key findings

Engineering provision in Scotland's colleges is characterised by many strengths:

- Colleges have effective and positive collaborative arrangements in place with a wide range of local and national employers, industry partners, key trade bodies, equipment manufacturers and suppliers.

- Almost all colleges have effective strategic links with their local authorities, particularly in relation to Developing the Young Workforce (DYW) and other senior phase initiatives.

- The majority of college engineering departments have close and effective partnership arrangements with the Energy Skills Partnership (ESP). These arrangements contribute to Continuing Professional Development (CPD) activities for staff, development of distance learning programmes in engineering, resource sharing, networking opportunities and updating of national qualifications.

- Colleges provide a wide range of engineering subjects predominately at SCQF levels 4 to 8. They also provide a well-considered range of Skills for Work (SfW) programmes, access courses, higher level diplomas, professional body awards and a few colleges offer degree level awards at SCQF level 10.

- Colleges continue to grow and adapt their engineering provision in line with ever-changing industrial and technological demands, often developing tailored and bespoke programmes for employers and industry.

- All colleges have recognised and endeavoured to improve the gender imbalance in engineering programmes, by developing provision to attract female learners through bespoke engineering programmes and expanding the number of Science, Technology, Engineering and Mathematics (STEM) subjects. In a few colleges, engineering departments have set challenging targets to address the gender imbalance. However, overall female participation in engineering programmes has not improved over the last seven years.

- Almost all learners are engaged and motivated in learning activities that are purposeful and planned well. Learners use well-equipped classrooms and workshops effectively to develop valuable vocational skills and enhance their learning.

- Most learners use blended learning resources and Information and Communications Technology (ICT) well to support their learning, including the Virtual Learning Environment (VLE). Learners are motivated when teaching staff use ICT and VLE teaching resources effectively to enhance the learning experience.

- Almost all teaching staff demonstrate good knowledge of current industry practice. They have effective links with industry and encourage learners to reflect on their learning from the workplace.

- The majority of colleges have modern, high quality industry-standard workshop facilities supplemented with good quality teaching areas.

- Supportive relationships are evident between staff and learners across almost all engineering programmes, with teaching staff providing effective guidance to learners on their progress.

- Assessment of learner progress is systematic and effective across almost all engineering programmes. Teaching staff use assessment well to set objectives and targets, measure skills and knowledge gaps and identify progress in learning.

- Completed successfully rates for all categories of engineering programmes have improved over the past five years, significantly so in most categories.

- Learners gain useful underpinning knowledge and practical skills during their engineering programmes, which prepares them well for employment or further study.

- The majority of learners who successfully complete their programme progress to further study or employment. Colleges work effectively with the university sector and have developed articulation routes to suit progression opportunities from their Higher National (HN) programmes.

- Programme teams responsible for engineering have well-established and comprehensive self-evaluation processes for evaluating and enhancing curriculum provision. Learner involvement in programme review, evaluation and enhancement activities is effective in the majority of colleges.

- Colleges have made good progress in addressing most of the recommendations for improvement highlighted in the previous Education Scotland report: *Engineering in Scotland's Colleges,* October 2007.

- However, there are a number of areas for development necessary to improve the overall experience for learners:

- Colleges do not identify sufficiently in their Regional Outcome Agreements (ROA) or communicate explicitly to employers, what partnership activities they are jointly developing to address improvements to employment outcomes for engineering programmes. As a consequence, most employers do not associate their partnership activities with colleges as contributions to government priorities for DYW.

- Colleges and employers work well together to make good use of work placements and work experience. However, the number of engineering work placements is not sufficient to meet the growing demand for engineering learners and apprentices.

- Only one third of colleges include in their ROA, specific commitments and actions on gender balance in STEM subjects. Very few colleges specifically mention female participation in engineering programmes as explicit indicators.

- Female participation on engineering programmes remains very low with only 4% female learners on Further Education (FE) programmes and 2% on Higher Education (HE) programmes. Female learners are not as successful as males, except on full-time HE engineering programmes.

- Some learners do not use the VLE routinely as a substantial resource and general college resources, such as library personal computers (PC), are not always available at times learners need access, or they lack specialist software.

- Some learners are not adequately challenged by the level of mathematics. This does not prepare these learners well for more advanced levels in following years.

- Some learners are not sufficiently challenged by the level of practical exercises in their programme. Learners who complete their tasks early have to wait for the rest of the class to catch up.

- The majority of learners are involved in the design of their course. However, only a few learners are involved in planning or contributing to learning approaches used by teaching staff.

- The completed successfully rate in full-time HE engineering programmes is six percentage points below the latest published national sector performance levels.

- There are inconsistent approaches to collation of learner views in colleges and the majority of actions focus on physical improvements to course provision, rather than learning and teaching activities and approaches.

- In the majority of colleges, there is insufficient evaluation of, or improvements made to, learning and teaching by teaching staff, especially in relation to theory classes.

3. Background and context

The engineering sector is a critical part of Scotland's economy. The number of engineering enterprises in Scotland over a five year period to 2013 grew by 10.3%, significantly outperforming all other home nations. In the last twelve months, the number of engineering enterprises grew by 3.5%.[3] However, for many parents and females in particular, engineering is often considered an unfavourable career choice.

Engineering is beginning to break free from outdated attitudes with the introduction of STEM subjects to the compulsory school curriculum. The introduction of SfW programmes, established through partnerships between colleges and schools, has provided an effective conduit from STEM subjects into college programmes for young engineers. These programmes are increasingly introducing more female learners into engineering studies and careers, in addition to increasing the overall number of young people interested in an engineering-related occupation.

The *Curriculum for Excellence Implementation Plan 2013-14 – Progress Report January 2014* [4] shows that progress is being made in STEM for early years and broad school based education. Education Scotland is working to deliver a number of national initiatives to provide framework support for the Senior Phase curriculum in relation to STEM and college partnerships. In particular*; On-going support for National STEM Coordinator with a view to facilitate greater partnership working between schools, industry, further education / higher education (FE/HE). p15*

The *Curriculum for Excellence Implementation Plan 2014-15* [5] sets out the Scottish Government's approach to STEM and the following national objectives are relevant to the work of the college sector:

- *College Development Network: Input to Curriculum Network events to update practitioners on national qualifications. Target food and drink, ICT, computing science and science, technologies, engineering and mathematics subjects. p4*

- *Education Scotland: Collaborate with Energy Skills Scotland, Skills Development Scotland and other key partner organisations and networks to develop a strategy for promotion of careers in the energy sector (with the model developed to be extended to other STEM sectors). p8*

- *Education Scotland: Continue to engage with Education Authorities and other key partners to promote relevant and innovative contexts for interdisciplinary learning in STEM including community resilience, the circular economy and citizen science. p8*

Engineering education and development in Scotland is also catered for by STEM Central, a portal to STEM education and career resources[6].

[3] http://www.engineeringuk.com/Report/Download/ (needs login)
[4] http://www.educationscotland.gov.uk/Images/CfEImplementationProgressReport2013to14_tcm4-829957.pdf
[5] http://www.educationscotland.gov.uk/Images/CfEImplementation%20Plan2014to15_tcm4-829949.pdf
[6] www.educationscotland.gov.uk/stemcentral

This high level strategic focus on the wider curriculum that feeds into engineering, together with STEM activities and the fast expanding energy sector, has led to a revitalisation of engineering training and skills development. Modern engineering encompasses an extensive range of technologies and industries, which continues to grow. Relatively new engineering sub-sectors which feature in Scotland's economy and in the programmes delivered by Scotland's colleges include: space, aeronautical, renewables, composite materials and agri-tech.

In recognition of the growing requirement for skilled jobs, and an ambition to equip all young people for employment, the Scottish Government published *Developing the Young Workforce - Scotland's Youth Employment Strategy* [7]. This seven year national plan to improve employment options available for young people has key messages for the further education sector:

- *The new regional colleges should have a primary focus on employment outcomes and supporting local economic development. This should be underpinned by meaningful and wide ranging partnerships with industry and should be at the forefront of ROAs and their measurement.*

- *A focus on STEM should sit at the heart of the development of Scotland's Young workforce.*

- *The Scottish Funding Council (SFC) and colleges should develop an action plan to address gender disparities within college education. This should be underpinned by realistic but stretching improvement targets. The SFC should report on this annually.*

The Skills Investment Plan for Scotland's engineering and advanced manufacturing sector [8] outlines plans in response to future skills and employment demands for the engineering sector. This plan identifies skill gaps and shortages in the engineering sector of around 18% and the underrepresentation of women in the engineering workforce compared with the wider workforce.

All colleges and SFC have a legal duty to mainstream equality across their work under the Equality Act 2010 Public Sector Equality Duties (PSED) Scottish duties.[9] ROAs are a key vehicle through which colleges can meet this duty. The SFC also makes mainstreaming equality a requirement for ROAs in its guidance for 2014-15.[10]

> *'Equality and diversity should be embedded throughout an outcome agreement and considered in relation to all of SFC's priorities'.*

[7] http://www.gov.scot/Resource/0046/00466386.pdf
[8] http://www.ourskillsforce.co.uk/media/536617/engineering_skills_investment_plan.pdf
[9] ECU (2012) *The public sector equality duty: specific duties for Scotland* www.ecu.ac.uk/publications/the-public-sector-equality-duty-specific-duties-for-scotland
[10] SFC (2013) College outcome agreement guidance 2014–15 www.sfc.ac.uk/web/FILES/GuidanceOA1415/College_Outcome_Agreement_Guidance_2014-15.pdf

Colleges now set three year outcome agreements. The embedding of gender equality on engineering programmes will be an essential component of these longer term agreements if improvements to gender balance are to be effected.

This report explores how colleges and the SFC are responding to the various recommendations and challenges outlined above. It examines the current provision and quality of experience for learners on engineering programmes in Scotland's colleges and is intended to stimulate wider debate on engineering education and training.

4. Programmes in engineering

Introduction

Scotland's colleges play a key role in the education and training of technicians and engineers to meet the skills requirements of employers. Skills shortages are currently the biggest challenge facing the engineering industry, due in part to insufficient recruitment over recent years and in part to an ageing workforce. To address the needs of industry, all colleges have clear strategies for their engineering provision. They deliver programmes that take good account of national, regional and local demands.

Case Study New College Lanarkshire
Heavy vehicle training centre

New College Lanarkshire has recently opened a state-of-the-art heavy vehicle training centre which is the only centre of its kind in Scotland, and one of the best in the UK. This is a good example of colleges responding to industry needs for local and national skills training in a growing and prominent employment sector of engineering. The training centre is designed to meet the needs of employers and learners working in the road transport industry. The purpose-built facility houses a combination of training classrooms and a large industry-standard workshop area, incorporating a viewing platform.

The college is working with 14 employers in the heavy vehicle sector and has developed its curriculum and training opportunities to include Scottish Vocational Qualifications (SVQ), Diplomas and Institute of Road Transport Engineers Certification (IRTEC). IRTEC is an accreditation that assesses the competence of Large Commercial Vehicle technicians.

The following qualifications are being offered at the training centre:

- SVQ Level 3 Heavy Vehicle Maintenance & Repair at SCQF level 7.
- Level 2 Diploma in Heavy Vehicle Maintenance & Repair Principles at SCQF level 5.
- IRTEC Accreditation for Large Commercial Vehicle Inspection Technician.
- IRTEC Accreditation Bus and Coach Inspection Technician.

In 2014/15, 44 full time 1st Year Heavy Vehicle Maintenance and Repair learners and 11 Heavy Vehicle 1st Year MAs were enrolled at the new centre. These learners are progressing on to 2nd Year in August 2015 along with 48 full time 1st Year Heavy Vehicle Maintenance & Repair learners and 24 Heavy Vehicle 1st Year MAs. The first group of MAs will qualify in June 2017 along with the first cohort of full-time learners certificated with a Level 3 Heavy Vehicle qualification.

The college has responded well to the needs of employers in the heavy vehicle sector, having the foresight to invest in this significant addition to the automotive section of the engineering department.

Almost all colleges offer an appropriate combination of introductory level FE programmes (SCQF levels 4 to 6) and advanced level HE provision (SCQF level 7 and 8) along with apprenticeship programmes and bespoke provision for employers. All qualifications support learners to move towards employment, further education or training and provide skills development for learning, for life and the workplace.

College engineering departments work proactively with schools to establish effective links and have developed a range of relevant SfW programmes. These programmes provide school pupils with valuable knowledge of potential careers in engineering and opportunities for study at college. Organised generally as taster courses, SfW programmes go much further than guidance and information, allowing potential young engineers to establish their preferred discipline through practical experience before committing to a career option.

A growing number of colleges are achieving STEM Assured status which provides independent, industry-backed validation for the quality of their provision. This endorsement improves the visibility of STEM subjects to employers and promotes cross-curricular collaboration for learning through increased involvement of teaching staff.

Progression pathways are very well-defined in engineering. Academic levels and training requirements are clearly set out through discussion and liaison with industry bodies. Colleges offer a range of progression opportunities including to higher level study within the college, articulation to the university sector and employment with national or local employers.

Partnership working

Colleges have effective and positive collaborative arrangements with a wide range of local and national employers, industry partners, key trade bodies, equipment manufacturers and suppliers across Scotland. Additionally, colleges interact extensively with a range of sector skills councils including: Engineering Construction Industry Training Board (ECITB); Science Engineering Manufacturing Technologies Alliance; Oil and Petroleum industry Training Organisation (OPITO); Automotive Skills; and Scottish Electrical Charitable Training Trust (SECTT). Colleges use their relationships with employers well to inform programme design and content. The majority of employers have been involved in effective partnerships with colleges for a number of years, often initiated as a result of attendance at college during their own careers.

Engineering departments regularly consult local and national employers on units for National Certificate (NC) and HN qualifications. A few colleges contribute to the development of national qualifications through their partnership arrangements with organisations such as the Oil and Gas Academy for Scotland (OGAS) and ESP, who have influence on industry and government policies.

Partnerships between colleges and employers are very effective and facilitate a number of objectives.

For employers, their close involvement with colleges allows them access to discussions relating to strategic planning for engineering provision and curriculum design. This often leads to planning of bespoke programmes relating to their industry and useful networking links to other agencies. Through their connections with colleges, employers have access to a pool of talent directly related to their employment needs. These learners have already acquired vocational competences through their training together with other valuable skills such as communication, numeracy and employability. A growing number of employers regularly recruit MAs directly from colleges, as a result of good preparatory pre-apprenticeship provision, supported by positive references from teaching staff. There are also good opportunities for Higher National Certificate/Diploma (HNC/D) engineering learners to be employed before their studies are complete, sometimes leading to graduate careers. Most engineering departments assist employers well with interviewing and selection of apprentices or potential employees.

For colleges, collaboration with industry and sector agencies provides many advantages including:

- staff gain a good knowledge of the employer's operations for programme planning and tailoring of courses;
- industrial updating and professional development for staff;
- work placement opportunities for learners;
- group site visits to companies;
- input from employers at careers events;
- guest lectures; and
- guidance for learners with interview techniques.

Employers are often consulted by colleges on the specifications for building plans when developing new engineering workshop designs, related facilities and equipment layouts.

There are many examples of joint initiatives between employers and colleges in addition to those related to programme design and delivery. These include working with Energy Skills Challenge Fund and Skills Development Scotland (SDS) for: re-skilling and up-skilling of local workforces; developing programmes for unemployed people to become skilled overhead line technicians; and re-skilling ex-military personnel as process and instrumentation technicians where there is currently a shortage and electrical to instrumentation engineering bridging courses.

There is clearly an extensive range of effective collaborative activities between colleges and employers that contribute well towards the achievement of government priorities for DYW. However, most employers do not associate their partnership activities with the recommendations of DYW. Almost all colleges do not make clear to employers their joint roles and responsibilities in response to the DYW agenda. Within college ROAs, there is insufficient identification of partnership activities that involve employers. Furthermore, development of actions specifically intended to address employment outcomes and local economic development are not communicated explicitly to employers.

For example, most colleges and local employers work well together to make good use of work placements and work experience wherever possible. A few colleges are also successful in securing high quality apprenticeships with major engineering companies. However, the number of engineering work placements is not sufficient to meet the growing demand for engineering learners and apprentices. Colleges and employers do not make available sufficient work placements for all learners and apprentices to benefit from high quality, relevant work experience. This is an essential element of engineering training, at the heart of DYW, which needs to be addressed.

Case Study Perth College
Automotive Work Experience

The body repair industry has historically found difficulty recruiting apprentices with the necessary skills to flourish in the industry. Over time this has led to a shortage of time-served technicians available in two important job roles for this industry. The consequence of falling apprenticeships for these trades is that traditional skills and techniques are being lost as older tradesmen leave the industry.

Perth College has collaborated over the past few years with employers in the automotive industry to improve success rates and opportunities for young people into apprenticeships. Through partnership with local employers, the college has developed structured work placements to give learners experience of a real life work environment through which they gain valuable trade and employability skills.

Learners on the scheme attend college for their qualification under the supervision of a member of teaching staff, who closely monitors their suitability for a work placement. The college found that some learners can be relatively anxious about work placements, therefore they are consulted on when they feel ready and sufficiently confident to take this step. On occasions, learners do not settle with one employer or trade but feel more comfortable with another. The college monitor this carefully to ensure both learner and employer are best matched.

Ten of the 12 learners that participated in the scheme last year gained full apprenticeships. The scheme is currently being expanded to more employers through the college's network of employers, with an increasing number of learners participating each year.

Almost all colleges have effective strategic links with their local authorities, particularly in relation to DYW and the senior phase. Pupils visit colleges for taster sessions and possible future study opportunities through SfW programmes. Engineering departments link well with individual schools and a few colleges offer programmes for P7 to S1. Some colleges, in collaboration with SDS, deliver foundation and advanced apprenticeships for engineering in line with DYW recommendations.

Almost all college staff work effectively with key school staff to ensure accurate and informative pre-enrolment information is provided to school pupils. Effective timetabling arrangements with local schools are particularly important to ensure opportunities for pupils to be involved with SfW programmes are maximised. This is particularly significant where regional colleges work with more than one local authority and for rural colleges where travel times may be considerable. Arrangements with schools work best when common timetables are agreed, providing learners with access to a varied choice of engineering taster options.

The majority of college engineering departments have close and effective partnership arrangements with the ESP. These arrangements contribute to CPD activities for staff, development of distance learning programmes in engineering, resource sharing, networking opportunities and updating of national qualifications.

Programmes in Engineering

Engineering and its sub-sectors cover a broad spectrum of disciplines. In addition to more traditional subjects such as electrical, mechanical, automotive, manufacturing and fabrication, there are many specialist engineering subjects offered by Scotland's colleges. These include renewables, marine, aeronautical, petroleum, instrumentation, chemical and sound. Appendix 2 illustrates the diversity of engineering provision offered in Scotland's colleges.

Many colleges offer well-developed entry-level programmes at SCQF level 4 to 6 which provide learners with a basic introduction to engineering practices. These programmes cover a useful range of practical skills that provide learners with an opportunity to match their particular interests and skills to various engineering disciplines. The programmes also incorporate core skills, particularly communications and numeracy. Specialist areas include: NC Aeronautical Engineering SCQF level 6: NC Sound Production SCQF level 6; and Offshore Engineering SCQF level 6.

Most colleges offer a good range of SVQs at SCQF levels 4-6 in engineering for a variety of careers and levels, including operatives, craft-workers and technicians. These meet the needs of local and national employers well. Level 2 SVQs tend to be delivered in college and level 3 SVQs to candidates in employment at their workplace, providing a smooth transition from learning to occupational competence. SVQ programmes support well learners' underpinning knowledge on MA programmes. Some colleges offer well-designed specific awards and bespoke programmes developed in partnership with industry. Given the range of engineering disciplines across Scotland, these tailored programmes are of key importance to local employers and industry. Examples of these are included in Appendix 2.

The majority of colleges also provide well-considered introductory craft and pre-apprenticeship programmes at SCQF levels 5 and 6. These are usually two year programmes that consolidate and further develop core skills, practical skills and underpinning knowledge. This combination develops learners' skills and understanding well, preparing them for higher levels of study or for direct entry to the workplace. All colleges maintain an important emphasis on mathematics units in all engineering programmes, particularly where the intended progression route is to an

MA or HE study. Colleges usually incorporate Scottish Qualifications Authority (SQA) awards into their programmes with core skills units, employability skills and citizenship skills to provide a broader learner experience in preparation for employment. Examples of these are included in Appendix 2.

MAs provide over-16s with an opportunity to learn skills while being employed. MAs can be delivered at a number of different levels and contain three elements:

- a relevant SVQ (or alternative competency based qualifications);
- core skills in communication, numeracy, information and communication technology, problem solving, working with others; and
- industry specific training.

Sector Skills Councils are responsible for leading on the design and development of apprenticeship frameworks to meet the needs of employers in their sector. Common frameworks include MA in Engineering SCQF level 6 and MA Fabrication and Welding SCQF level 6. A few colleges also offer MA Engineering Maintenance (Instrumentation and Control) at SCQF level 6. The majority of colleges are increasing their MA engineering provision in line with DYW recommendations, including, in a few colleges, Foundation Apprenticeships.

Almost all colleges offer a good choice of advanced level HE programmes as progression from their FE engineering programmes. These are usually HNC and HND at SCQF levels 7 and 8 in a relevant engineering discipline. HNC/Ds provide the skills and knowledge needed for employment at middle management and technician level. These awards have common core units and a range of optional units which colleges tailor well to meet local employer needs. Examples of these programmes are included in Appendix 2. Most colleges design their engineering HNDs to allow entry to the second or third year of degree courses, through articulation with a university. A few colleges offer degree provision up to Honours level, particularly colleges in the University of the Highlands and Islands (UHI) partnership.

Engineering resources and facilities are expensive to procure and maintain. As a result, some regionalised colleges have streamlined their engineering curriculum to concentrate on particular qualification levels or specific engineering subjects. In order to maintain progression routes and an appropriate range of subjects for their learners, these colleges have focussed subject delivery at one campus or have arrangements with other institutions. However, this often results in learners travelling some distance to maintain continuity in their studies.

Standardisation of qualifications such as SVQs, National Vocational Qualifications, Diplomas and City & Guilds certificates for engineering awards across the UK is difficult for learners and employers to comprehend. Benchmarking awards for different awarding bodies with different competencies and standards, presents complications for employers in determining equivalency during the recruitment process.

In addition to the range of programmes outlined above, engineering departments continue to grow and adapt their provision in line with ever-changing industrial and

technological demands. Examples of a few of these tailored and bespoke programmes are included in Appendix 2.

Case Study Forth Valley College
Virtual offshore control room

The virtual control room simulates day to day operations on a variety of specialist plant, including an oil platform in the Caspian Sea. The equipment can replicate start up, shutdown and emergency shutdown procedures on process control equipment in very realistic circumstances. Some of the issues that can be simulated include plant failure such as electrical power loss, gas leaks, helicopter incidents and marine vessels crashing into an oil rig. These all require an appropriate emergency response which can be reproduced through the use of the Distributed Control System, telephones and alarm panels.

The virtual control room gives learners an opportunity to develop their team working skills and awareness of how a control room operates under routine conditions and then dealing with unforeseen events. Each simulation allows learners to experience very realistic situations giving the impression of real life working conditions in a safe environment. The room is equipped with video cameras to record every action taken by learners, which is then replayed for discussions on actions taken and model responses. Training has been provided for Control Room Operators in a local company, fast tracking their learning process. The simulator has been widely used for apprentices to enhance their training before going offshore.

Gender balance on engineering programmes

All colleges have endeavoured to improve the gender balance in engineering programmes by developing courses to attract female learners through bespoke engineering programmes and expanding the number of STEM subjects. In a few colleges, engineering departments have set challenging targets to address the gender imbalance. The highest of these targets is around 10% female learners across all engineering programmes. A target of 10% is around twice the average level of females enrolled in engineering subjects across Scotland. However, female participation in engineering programmes has not improved over the last seven years.

The majority of colleges have introduced initiatives to improve the number of female learners including female only courses and open-day events to specifically encourage female learners to participate. Some colleges use high profile events such as National Women in Engineering Day to raise the profile of achievements of women in engineering and encourage more females to consider a career in the industry. The majority of colleges are working proactively with key stakeholders to raise awareness of employment opportunities for females by using positive role models and increasing the number of female teaching staff. Some colleges now have around 30% female teaching staff and around 50% female managers in their engineering departments. Increasingly, colleges are introducing more STEM subjects and bespoke SfW programmes to attract females into engineering and boost participation overall.

Case Study North East Scotland College
Young Women into Energy – Skills for Work

North East Scotland College offers a range of SfW programmes through its well established partnerships with local schools. Recognising the need to improve gender balance in engineering and technical subjects the college runs an industry sponsored SfW Energy programme over a full academic year. Now in its seventh year, the Young Women into Energy programme runs across eight secondary schools in Aberdeen and Aberdeenshire. Over 230 young women aged 14-17 have participated in the course and many have progressed to careers within the energy and engineering sectors.

The programme offers a mix of classroom study, industry visits and workshop activities together with an opportunity for some learners to take part in industry experience over the summer with the sponsoring company. The curriculum typically covers solar and wind energy, oil and gas extraction, conventional engineering technologies, grid systems, employability skills and careers guidance. All of these subject areas have deep-seated engineering roots. At the end of the course the learners achieve an SQA National 5 qualification at SCQF level 5.

Once completed, the course offers progression routes to traditional engineering programmes:

- SVQ PEO;
- NC Engineering Practice;
- NC Measurement and Control;
- NC Electrical or Electronic Engineering; and
- HNC/D electrical or Mechanical Engineering.

Some learners take up these options either as discrete programmes or find employment and return to college for an MA or to complete further qualifications. Alternatively, others decide to opt for degree level study directly or through articulation from second or third year college programmes.

Some engineering related subjects, such as Energy, are starting to attract more females onto engineering programmes, particularly through introductory programmes such as SfW. Non-direct engineering programmes, such as Dental Nursing and Design which have better gender balance, are also a good source for potential female engineers who are introduced through their programme to engineering-related subjects. Although targeted programmes for school pupils do have very high numbers of female learners and encourage participation in engineering generally, there is little real impact on gender balance relating to progression onto traditional FE and HE engineering subjects.

Employers are very aware of the gender imbalance that exists within the engineering industry. Some employers take action to promote employment within the industry to females by highlighting positive role models and targeting females at school career days. Employers believe the greatest barrier when attempting to correct the gender imbalance is a lack of interest from females. They suggest a range of factors lead to this including stereotyping, family or peer influence, and a lack of knowledge of the scope and opportunity within the industry. Therefore, better information relating to the engineering industry is required at a much earlier age, for example at late primary school, and well before pupils are about to choose specific subjects for the senior phase. Most employers recognise that they have a role to play in this respect and are eager to help.

The legal duties to mainstream equality for colleges and the SFC are key drivers to improving gender balance in engineering programmes. ROAs are the primary mechanism for the achievement of mainstreaming equality. The Equality Challenge Unit (ECU) has published briefings on embedding equality in ROAs to support colleges as they continue to confront the equality challenge.[11] These briefings include toolkits for the 2015/16 ROAs together with information on equality impact assessments, PSED duties, addressing SFC's equality priorities, using equality data and benchmarking.[12]

The ECU highlights that 2014/15 ROAs do include data and targets on student entry by one or more protected characteristic. However, college ROAs do not contain numeric commitments and only a few qualitative commitments in relation to student retention or success by protected characteristic. Additionally, only a third of college ROAs include specific commitments and actions on gender balance in STEM subjects. The ECU analysis of 2014/15 ROAs finds that only a few provide comprehensive data and targets for gender, with no inclusion of student retention and success presented by protected characteristic group. Clearly there remains substantial work to be done by the SFC and colleges in mainstreaming gender equality and other protected groups for engineering subjects.

Participation by gender

All colleges have recognised the need to improve gender imbalance and have introduced well-considered initiatives to overcome the issue. However, much more effort is required by all colleges, partners and sector agencies to address the low

[11] http://www.ecu.ac.uk/wp-content/uploads/external/embedding-equality-in-outcome-agreements-colleges.pdf
[12] The 2015-16 toolkit: how to embed equality in outcome agreements in colleges

number of females attracted onto engineering programmes. The latest SFC data in Appendix 3 shows that participation by females remains very low and there has been little if any improvement since the previous Her Majesty's Inspectorate of Education (HMIE) equivalent report in 2007 [13]. In comparison with the sector, where gender balance is almost equal, female participation on engineering programmes is very low, with only 4% female learners on FE programmes and 2% on HE programmes. This combines to form an overall balance across engineering programmes of 6% female learners to 94% male learners.

The latest data shows that over a five year period, FE enrolments for both genders across the sector have declined steadily. Although engineering programmes have followed this decline, in 2013-14 enrolments returned to the same level as five years ago. This may be due to the increased activity by colleges in response to DYW recommendations. Looking at percentage enrolments, there is a relatively positive trend for female participation on FE engineering programmes. The percentage of males across the sector has remained stable at 37% whereas for engineering programmes they have dropped steadily and are four percentage points lower than the 2009-10 benchmark. In contrast, the percentage of females has not fallen substantially. This may be due to the successful introduction of engineering related SfW programmes and other college initiatives to improve gender balance.

The percentage enrolments for HE programmes across the sector have increased over the five year period by two percentage points for both genders. However, the percentage of males on engineering programmes has risen by four percentage points compared with a rise of only one percentage point for females. This indicates that fewer females are participating in HE engineering programmes than five years ago and more work is required to encourage female learners onto these programmes.

Overall, the balance of participation for females all engineering programmes has not altered since 2009-10 as the percentage enrolments for FE and HE combined remains at 6%.

Success rates on engineering programmes by gender, level and mode are given in Appendix 4. Success rates on engineering programmes for both females and males have improved over the past five years in line with the trend across all subject areas. Success rates for males have improved across all categories. This is similar for females with the only exception of part-time FE, where success rates have fallen 4% over five years and 6% in the last year alone. In HE programmes, there is a significant improvement in success rates of 14% for females and 12% for males. Both of these are better than the improvement in success compared with all HE subject areas. In full-time HE engineering programmes, female success rates are 12% higher than male success rates. However, in part-time courses, female success rates are lower than male success rates for both part-time FE and part-time HE at 8% and 3% respectively. This indicates that overall, females are not as successful as males, except in full-time HE engineering programmes.

[13] http://www.educationscotland.gov.uk/Images/eisc_tcm4-712708.pdf

5. Learning and teaching

Learning Process

Almost all learners are engaged and motivated in their studies. Learning activities are purposeful and well planned. Well-equipped classrooms and workshops are used effectively by learners to develop valuable vocational skills and enhance their learning. During workshop activities, many learners share their workplace experience, which promotes a broad range of discussion relating to the lesson topic.

Learners enjoy practical lessons and feel trusted to work safely and independently. They work effectively in small teams while participating on a range of workshop activities, gaining important personal and social skills. In all practical sessions and workshops, there is a strong ethos of health and safety that matches industry practices well. Some learners contribute useful examples from participation on work placement programmes during classes to enhance lesson content and their understanding.

Most learners use blended learning resources and ICT effectively to support their learning including their college's VLE. However, more than a few learners do not use the VLE routinely as a substantial resource to access programme notes, enhance their understanding of the subject, update ePortfolios or check their progress.

Learners are routinely set tasks that encourage independent learning and development of autonomy. They take ownership of their learning by recording their progress with vocational competencies and theoretical knowledge in logbooks or ePortfolios. When working in groups, learners gain important core skills such as working with others, problem solving and communication. They are keen to support each other and sometimes form their own study groups.

Learners enjoy projects which show relevance to theoretical aspects of their programmes. Projects relating to industry-based scenarios such as pricing of contract work or design and manufacture tasks, contextualise the delivery of core skills through a range of learning activities.

Learners are supported well by teaching staff to make good use of peer learning, particularly where different abilities or study levels are evident. For example, learners use their numeracy skills to measure each other's practical work and decide whether their colleague's piece of work is satisfactory or unsatisfactory, based on the tolerances given.

Teaching process

Almost all teaching staff demonstrate good knowledge of current industry practice. They are enthusiastic about their subject and apply their expertise well, making good use of their industrial experiences to motivate learners. Most teaching staff encourage learners to make links with previously acquired knowledge and skills when undertaking new activities. Teaching staff use ICT teaching resources effectively to enhance the learning experience.

Staff make good use of opportunities to develop learners' employability skills. They promote skills for employment well and programme teams make good use of work placements through their positive relationship with local employers. They encourage learners to meet the standards required by industry and describe work-based scenarios to set expectations in relation to performance.

Almost all teaching staff use an appropriate range of practical assignments well to sustain motivation and engagement of learners in their learning. However, most teaching staff do not plan sufficient differentiation into practical learning activities. As a consequence, some learners have insufficient extension exercises and have to wait for other learners to complete their work.

Most teaching staff use questioning techniques well to check learners' understanding and progress. This keeps learners actively engaged and helps to identify where learners may need additional support. However, in the majority of theory lessons, passive learning diminishes the learning experience.

All teaching staff set high standards in both theoretical and workshop activities, often encouraging learners to go beyond the minimum requirement. Teaching staff place a strong emphasis on health and safety and quality of workmanship during classes and workshop activities. All learners adhere well to health and safety standards and sometimes use their knowledge of health and safety practice to inform their workplace experience in industry.

Planning for learning and teaching

Almost all teaching staff plan and organise their lessons well to ensure learners are fully engaged in classroom and workshop activities. Learning, teaching and assessment is well planned ensuring learners progress in line with their programme of study. Programme teams schedule delivery and assessment systematically and plan provision well.

Almost all staff incorporate practical delivery well in their lessons to develop learners' employability skills. Almost all engineering departments arrange employer visits and employer guest lectures to broaden learners' experience of engineering. In many colleges, equipment suppliers also visit and demonstrate the latest developments in engineering equipment.

Teaching staff integrate subjects well across a wide range of engineering topics. Staff work well together when designing programmes and when assessing and verifying learners' work. There are good examples of team teaching, including the use of experienced technician staff. Well-planned practical elements complement theory delivery and core skills are embedded in almost all programmes.

Case Study City of Glasgow College
CityBytes - learner-centred learning

At City of Glasgow College, the Electronics Department was tasked with improving the HNC Electronics programme content to reduce learner withdrawals and improve successful outcomes. Management and teaching staff agreed that a practical project based, learner-centred approach to learning prepares learners better for the type of work graduates encounter in industry.

The approach provides the following key advantages:

- an industry ready practical skill set;
- an improved understanding of the link between theory and practice;
- excellent grounding in the problem solving skills; and
- improved learner engagement in the programme content.

The project work is based on a single computer board which the learners build, keep and experiment on throughout the programme. This gives learners a sense of ownership for their learning and success during the programme. The approach aids teaching staff to a cover several unit topics simultaneously and cross assess multiple unit outcomes with a single in-depth practical exercise. By reducing the number of assessments, teaching staff have more time to spend on topics that learners find more difficult. Learners welcome the practical work involved in producing the computer board and are motivated to complete the project.

The computer board is designed specifically for the HNC Electronics curriculum with a programme matrix of assessments and a Practical Assessment Logbook for learners to complete. Through the project work learners benefit from greater immersive learning and teaching approaches and gain industry relevant skills such as through-hole and surface-mount soldering techniques, use of test equipment and fault finding techniques.

The newly developed content delivery was rolled out in 2014/15 for 1st year learners and initial results are positive, with all learners successfully constructing and testing their computer board. Learners carry forward the computer board into their 2nd year HND studies to develop technical 'products' as part of the Graded Unit 2 and for other 2nd year units.

Learners enjoy practical lessons and feel they are trusted to work safely and independently. However, the majority of programmes do not contain sufficient practical delivery.

The majority of learners are involved in the design of their programmes, with teaching staff often adapting provision in response to learners' needs. Examples typically include additional practical elements or providing additional support, such as mathematics drop-in classes. However, only a few learners are involved in planning or contributing to learning and teaching approaches used by teaching staff.

Almost all engineering staff teams work well together to develop mathematics in an engineering context, making it meaningful to learners. The development of Mathematics for Engineering NC and HNC units is a positive step to support learners' understanding of the significance of mathematics in engineering subjects. However, some learners are not adequately challenged by the level of mathematics in their course, which does not prepare them well for progression to higher levels of study in engineering.

Resources

Most engineering departments have benefitted from substantial investment to expand and upgrade their accommodation in line with the rising demand for engineering programmes and bespoke courses. Many colleges had neglected, or completely removed, their engineering provision during the economic downturn. With the revival of engineering, colleges and the SFC have responded well by creating purpose-built accommodation and workshops, sometimes incorporated into new-building plans. The restructuring of curriculum during regionalisation has resulted in some colleges specialising in certain engineering disciplines or certain qualification levels, giving a specialist focus to their build programme, workshop layouts and equipment types.

The majority of colleges now have modern, high quality industry-standard engineering workshop facilities supplemented with good quality teaching areas. Workshops are modelled on industrial layouts, with good quality equipment, to provide practical activities that are aligned with industrial practice. Modern workshops have a very positive effect on the learner experience as they are built specifically to support the development of practical work, which improves learner motivation and engagement. A few colleges have out-dated engineering facilities, including more than a few classrooms. However, in almost all these instances, colleges have new-build proposals or construction work well scheduled.

Access for learners to general college resources, such as library-based PCs, is not always sufficient. The majority of learners cannot access library facilities at times to suit them and most general access PCs lack the specialist software required for engineering subjects. Insufficient access to PCs and specialist software restricts the majority of learners from progressing with their studies, especially project work, outside standard lesson times.

Colleges have very good relationships with employers and industry which has resulted in a wide range of industry-standard equipment being donated to colleges

for the use of learners. Some donations are very high value, such as OGAS investing over £1m in resources at one college and at another, installation of specialist welding equipment of which there is only two in the UK. Other forms of resource sharing with industry include, in a few colleges, sharing of staff.

Case Study Forth Valley College
Fully functional process rig

Forth Valley College successfully secured a contract to deliver training for Ineos and British Petroleum apprentices which included the donation of a process training rig. Civil works were carried out by a contractor and all other installation and commissioning work was completed by six Ineos apprentices supervised by college staff. This process rig has allowed the engineering department to move theoretical subjects from the classroom into a real life working environment.

The apprentices designed an extruded aluminium structure to support services for compressed air, electrics and instrumentation and converted an old garage into a control room. This is not a simulation rig and is operated as a real industrial plant. It has seven working pumps running at 6 Bar each with a 3-phase motor operating at 400 volts, controlled from a Distributed Control System (DCS) in the control room and industry standard Supervisory Control and Data Acquisition.

The rig provides opportunities for learners to design Piping and Instrumentation Drawings (P&ID) for the seven routes, fault find mechanical, instrumentation and electrical plant and equipment, source information for risk assessments, method statements, electrical isolations and Permits to Work as well as planning gas testing and safe entry. The rig has revolutionised practical delivery for learners and is an invaluable addition to the colleges training capabilities that has been extensively used by many learners.

Over the last six years the rig has been continually updated by full-time learners and apprentices with a new DCS, new electrics and distribution boxes for weather tightness, an emergency stop system with 3 Phase 30mA Residual-Current Device (RCD) protection, new instrumentation, new control valves and recently a new compressor.

All colleges have developed their VLE to support learners. Engineering topics are often complex and ICT is very beneficial for learners to access interactive diagrams and representations of internal mechanisms. However, in general, FE learners access the VLE less than HE learners. SmartBoard technology has been implemented in almost all colleges and these are used effectively in blended learning teaching approaches, particularly for combining practical work with theory in workshop areas. This technology is used well to develop concepts, for example linking circuit diagrams to Computer-Aided Drafting (CAD) and manufacturing processes. However, in a few classes access to ICT, unreliable technology and poor access impacts on learners' progress.

Guidance and support

Learners receive helpful college prospectus information which clearly set out entry requirements, course content and progression routes. However, some learners do not receive information on course content and timetables in advance of starting their programme. Almost all inductions are carried out well and provide learners with detailed information regarding their chosen course, clearly establishing criteria that both the college and industry would expect such as health and safety, behaviour and timekeeping.

Almost all colleges interview potential learners to ensure they are placed on an appropriate programme for their ability and engineering subject preference. For those learners engaged on apprenticeship programmes, either employers interview candidates or a combination of college staff and employers carry out this process. These methods work well and ensure learners' needs and aspirations are fully considered. Almost all teaching staff use core skills assessment well, usually through software packages, to establish any additional support learners may require. All colleges support learners with additional support needs well.

There are very positive relationships between learners and staff across almost all engineering programmes, with teaching staff providing effective guidance to learners on their progress. Teaching staff are very approachable and encourage learners to progress in a positive and supportive atmosphere that encourages learning. Timetabled one-to-one progress reviews give helpful feedback to learners on their progress and targets for improvement. However, the provision of formal guidance arrangements varies across colleges. As a consequence, a few learners do not have opportunities to review their progress.

Assessment

Assessment of learner progress is systematic and effective across all engineering programmes. Teaching staff use assessment procedures well to set objectives and targets, measure skills and knowledge gaps and identify progress in learning. In almost all programmes, final assessment is rigorous and assessment approaches are determined by the awarding bodies. Teaching staff also develop imaginative on-going assessment practices based on integrated delivery such as project work to complement final assessments. A wide range of on-going assessment activities are used well by teaching staff to reinforce learners' knowledge and develop their confidence including: technical problems; question and answer sessions; online quizzes; multiple choice questions; end-of-topic assessment; and, in one college, an excellent knowledge-based competition.

Almost all engineering staff are experienced in carrying out assessments. Staff teams work well together and have representation on awarding body national review groups and subject networks. This allows them to ensure current awareness of assessment aims and practices and the sharing of ideas and developments through working together to improve assessment material. Most teaching staff integrate assessments and coordinate timing of assessments in order to minimise pressure on learners. The majority of learners are clear about assessment schedules, and manage assessments well.

At the end of lessons, most teaching staff encourage learners to reflect on the achievement of their learning objectives and their relationship to future learning or workplace examples. However, in a few cases, teaching staff do not use questioning techniques effectively to confirm learners' understanding and involve learners actively in lessons. In a few colleges, peer assessment is used to encourage learners to internalise standards and develop their critical reflection.

Most teaching staff provide helpful written or oral feedback which motivates learners to understand their future learning needs. Evaluative feedback is used well to develop learners' abilities to learn independently and identify gaps in their knowledge. In a growing number of colleges, learners use ePortfolios well to update and display their work for employers and external verifiers, submit assessments and read feedback from teaching staff.

6. Outcomes and impact

Retention and attainment

For the purposes of this report the latest five year performance indicator data from the SFC has been used to analyse trends. Details for learner withdrawal and completion rates for full-time and part-time FE and HE programmes are given in Appendix 5.

Early withdrawal rates for learners on engineering programmes in all categories have improved over the last five years and are equal to, or in most categories better than, national performance sector levels. This indicates that colleges are enrolling learners at the correct level for their ability, providing learners with good pre-entry information and supporting them well during the early months of their programme.

Further withdrawal rates for learners on engineering programmes in all categories improved over the past five years and are better than national sector performance levels. Notably, further withdrawal rates in full-time HE programmes improved significantly from 17% to 10%. Colleges are improving the number of learners continuing with their chosen programme and have maintained learner numbers through on-course support and guidance.

Partial success rates in engineering programmes across all categories have improved over the past five years and are below or equal to national sector performance levels, except full-time HE. Partial success in full-time HE programmes has only improved two percentage points over a five year period and remains six percentage points above the national sector performance level. Partial success rates increase when employers recruit learners directly into employment. Although this is a positive outcome for the learners and the majority return to college part-time to complete their studies, there is a negative impact on partial success rates.

Completed successfully rates for all categories of engineering programmes have improved over the past five years, significantly in most cases.

Completed successfully rates in full-time FE engineering programmes have improved by seven percentage points in the five year period and are four percentage points above national sector performance levels. HE engineering programme completed successfully rates have improved substantially by 12 percentage points over the past five years. However, they remain six percentage points below national sector performance levels. By combining completed successfully with partial success rates, the overall success of full-time HE engineering programmes is in line with national sector performance levels at 84%.

Completed successfully rates for part-time FE engineering programmes have improved slightly by one percentage point over a five year period. This category however, has completed successfully rates that are seven percentage points higher than national sector performance levels. In part-time HE engineering programmes, completed successfully, rates have improved significantly by seven percentage points over the past five years and are three percentage points above national sector performance levels.

All colleges use target setting and analysis of performance indicator data effectively to monitor retention and attainment. Colleges are increasingly scrutinising attendance and progress of learners closely as a means to improve attitudes, behaviours and ultimately attainment.

Overall, it can be concluded that colleges are improving their key outcomes and performing well compared with national sector performance levels. Across all categories, engineering departments are recruiting more learners onto the right programmes, retaining these learners and improving attainment rates.

Wider achievement

Almost all learners gain useful underpinning knowledge and practical skills during their engineering programme which prepares them well for employment or further study. They develop and enhance their essential and employability skills through work experience to effectively extend and consolidate their learning. However, there are insufficient work experience placements available across the engineering sector to meet a growing demand.

Learners in many engineering programmes achieve more widely, and enhance their employability options, through participating in local and national skills competitions. Success in these competitions contributes to learner motivation and raises their expectations, aspirations and confidence. The competitions are closely aligned with industry practice to promote high standards and the importance of skills for employment.

During their studies, almost all learners increase their confidence in learning and develop personal and social skills through working collaboratively with their peers. For example, a few learners are encouraged to become STEM ambassadors, working with local schools, and some of them have taken this opportunity. Almost all learners attain core skills units in communication, information and communications technology, numeracy, problem solving and working with others.

Where possible, colleges add short courses and additional awards to their engineering programmes to enhance the learner experience and provide qualifications that are useful when entering employment. Qualifications including First Aid Certificate and Moving and Handling are common additions relevant to the engineering workplace. Valuable industry recognised awards are also offered in a few colleges such as the Lloyds examination for Welder Approval to Coded Standards.

Progression

All colleges have well-defined progression routes that allow learners to progress from introductory to advance level programmes within the same institution or to a partner institution. This is particularly relevant since regionalisation whereby larger colleges in particular are focussing on distinct engineering specialisms or specific programme levels in the knowledge a nearby institution provides a progression opportunity. The majority of learners who successfully complete their programme progress to further study or employment. As engineering programmes are well

aligned with employer requirements, FE level learners are more likely to progress to higher levels of study or as a result of a successful work placement, be offered an MA.

Colleges work effectively with the university sector and have developed articulation routes to suit progression opportunities from their HN programmes, including a 2+2 structure, and direct articulation into a degree in year two or three. Engineering departments consult with local universities on the most appropriate units for HN qualifications and courses are well aligned with university articulation requirements. Where local universities are not available or do not offer relevant engineering degrees, departments make arrangements with universities further afield. Learners within the UHI network have good articulation opportunities to advanced degree level.

7. Enhancement through self-evaluation and review

Programme teams responsible for engineering have well-established and comprehensive self-evaluation processes for evaluating and enhancing curriculum provision. Approaches vary across colleges. However, they fall into two categories of informal and formal feedback.

Informal feedback is used well by teaching staff and managers to respond quickly and effectively to learner concerns about their programme. These may be directly related to the learning experience or related to wider issues affecting their learning such as guidance, funding, transport or personal matters. A prompt response to these issues is important to the learners' experience their progress and outcomes. Teaching staff meet informally and regularly with learners, gaining valuable informal feedback, through their day to day college life and have open discussions as part of the learning process.

Learners are asked to comment formally on the quality of engineering programmes through approaches including: submission of learner surveys; end-of-unit assessments; via class representatives; at course team meetings; and from other sources of college devised feedback such as '*the learner voice'.* The role of class representatives in colleges has been enhanced over recent years. Improvement actions implemented as a result of feedback from class representatives are more effective when learner views are gathered in formal review meetings with curriculum staff.

Learner involvement in programme review, evaluation and enhancement activities is effective for the majority of engineering programmes. Most programmes appoint class representatives who are formally trained, attend programme team meetings and are aware of improvements made due to their contributions. However, engineering learners, due to their full timetables at college or employment responsibilities, do not always have sufficient time to engage fully with the class representative responsibilities for attending meetings. Most learner contributions to programme review, evaluation and enhancement activities are acted upon effectively, such as course delivery, choice of units or extended practical elements.

Learner views from informal and formal feedback are collated into self-evaluation reports based on individual college processes. However, most reports and associated actions often focus on physical improvements to programme provision rather than learning and teaching.

Almost all engineering departments are set targets by their senior team for key performance indicators (PIs), requiring any indicators that fall below target to trigger further examination and action planning at quality review meetings. In the majority of departments, this has reduced early withdrawals and improved retention and achievement through better alignment of units and additional practical work for learners.

CPD for staff teaching engineering subjects is vital as engineering technology and processes rapidly change. CPD needs are identified well through performance reviews, peer group discussion and programme planning requirements.

Opportunities for industrial updating exist through the close networking relationships colleges foster with employers and industry. In a few colleges, staff are given dedicated time to carry out industrial placements to enhance or maintain skill levels. For CPD relating to learning and teaching, most colleges employ learning and teaching tutors or staff with similar roles. These staff provide helpful assistance with technology such as VLE or SmartBoards, engage in professional discussions relating to learning and teaching and in some colleges, conduct peer observations. New teaching staff are usually enrolled on the Professional Development Award (PDA) in teaching practice with progression to the Teaching Qualification Further Education (TQFE) programme.

Key stakeholders such as industry partners, schools and employers are regularly offered the opportunity to comment on programme provision through programme review, evaluation and enhancement activities. These arrangements work effectively. However, these discussions primarily focus on scheduling of units and weekly timetables to ensure stakeholder needs are met rather than learning and teaching processes.

In a few colleges, teaching staff reflect on their learning and teaching approaches well to improve the learner experience. In a few colleges there are formal arrangements for teaching staff to share teaching practice and learn from their peers.

At one college, ECITB regularly carry out observations of classroom activities and are always satisfied with their findings. In other colleges, employers have been present at lessons and report positively. However, in most colleges teaching staff do not reflect on or evaluate learning and teaching sufficiently, especially in relation to theory classes.

8. Recommendations

The Scottish Funding Council should:

- Develop and monitor closely an action plan to address gender disparities within college engineering programmes, reinforced by mandatory and challenging gender balance targets in all college ROAs.

Colleges should:

- Identify in their ROAs and communicate explicitly to employers, what partnership activities they are jointly developing to address improvements to employment outcomes for engineering programmes.

- Work in partnership with employers to increase the number of engineering work placements available to learners and apprentices.

- Include data and challenging targets on learner entry by protected characteristics in their ROAs to evaluate and improve gender balance and success rates for female learners on engineering programmes.

- Support teaching staff to enhance learners' use of VLEs in all engineering programmes and improve access to general college IT resources and specialist software.

- Ensure all learners receive adequate levels of challenge, particularly in mathematics and provide appropriate differentiation in learning for learners who complete their practical tasks more quickly than others.

- Ensure all learners are involved in planning, evaluating and contributing to learning approaches used by teaching staff.

- Improve success rates in full-time HE engineering programmes.

- Ensure teaching staff reflect on, evaluate and improve their learning and teaching approaches, especially in relation to theory classes.

Education Scotland should:

- Continue to monitor progress made in terms of the above recommendations through their annual engagements with colleges, and disseminate information on key improvements as they emerge across the sector.

Appendices

Appendix 1

Colleges visited in the fieldwork for this report:

City of Glasgow College

Forth Valley College

New College Lanarkshire

North East Scotland College

Perth College UHI

Appendix 2

Examples from the range of engineering programmes offered by Scotland's colleges. This list is illustrative rather than a complete list of provision.

National Certificate courses at SCQF levels 4–6.

- NC Engineering Systems SCQF levels 5 and 6.
- NC Fabrication & Welding SCQF levels 5 and 6.
- NC Aeronautical Engineering SCQF level 6.
- NC Electrical Engineering SCQF levels 5 and 6.
- NC Motor Vehicle SCQF levels 5 and 6.
- NC Manufacturing Engineering SCQF level 6.
- NC Measurement & Control SCQF level 6.
- NC Sound Production SCQF level 6.
- City and Guilds Automotive and Vehicle Maintenance SCQF levels 4, 5 and 6.
- NC Pneumatics and Hydraulics SCQF level 6.
- Pre-apprenticeships SCQF level 5 Electrical Engineering.
- Renewable Energy Overhead Line Technician SCQF level 5.
- Offshore Engineering SCQF level 6.
- OPITO SCQF levels 5, 6 and 7 in Hydrocarbons, Electrical, Electronics, Mechanical, Process Engineering and Petroleum.
- Institute of the Motor Industry (IMI) Motor Vehicle SCQF levels 4, 5 and 6.

Scottish Vocational Qualifications (SVQs) at SCQF levels 4-6

- SVQ level 2 and SVQ level 3 Performing Engineering Operations (PEO) at SCQF levels 5 and 6.
- Electrical, Mechanical and Fabrication and Welding at SCQF levels 5 and 6.
- SVQ level 2 Plant Maintenance at SCQF level 5.
- SVQ level 3 in Light and Heavy Vehicle Maintenance at SCQF level 6.
- SVQ level 2/3 Vehicle Body Repair at SCQF levels 5 and 6.
- SVQ level 3 Computer Numerical Control at SCQF level 6.
- SVQ level 3 Aeronautical at SCQF level 6.

City and Guilds

- City and Guilds (C&G) Diploma in Vehicle Maintenance at SCQF level 4.

Craft and pre-apprenticeship programmes at SCQF levels 5 and 6.

- Wind Turbine Technician Diploma SCQF at levels 5 and 6.
- Very High Frequency (VHF) Radio Telephony - Digital at SCQF level 5.
- Scottish Wider Access Programme (SWAP) Access to Engineering at SCQF level 6.

Higher National Certificate and Diplomas (HNC and HND) at SCQF levels 7 and 8.

- HNC/D Electrical Engineering SCQF levels 7 and 8.
- HNC/D Engineering Systems (Renewables) SCQF levels 7 and 8.
- HNC/D Mechanical Engineering SCQF levels 7 and 8.
- IMI Light Vehicle Technician SVQ 3 SCQF level 7.
- Process Engineering Maintenance (Electrical) SCQF level 7.
- Process Engineering Maintenance (Mechanical) SCQF level 7.
- Prestwick Aircraft Maintenance Licence SCQF level 8.
- HNC Aeronautical distance learning SCQF level 7.
- HNC Aircraft Engineering SCQF level 7.
- HNC Electrical Engineering SCQF level 7.
- HNC Electronic SCQF level 7.
- HNC Engineering Practice SCQF level 7.
- HNC Engineering: Fabrication and Welding SCQF level 7.
- HNC Engineering Manufacturing SCQF level 7.
- HNC Petroleum Engineering SCQF level 7.
- HND Engineering Systems SCQF level 8.
- HNC Measurement and Control Engineering SCQF level 7.
- SVQ 3 Heavy Vehicle Maintenance and Repair SCQF level 7.
- HNC Chemical Process Technology SCQF level 7.
- HND Sound Production SCQF level 8.
- HNC in Computer Aided Drafting and Design SCQF level 7.
- HNC Automotive Engineering SCQF level 7.
- HNC Pneumatics & Hydraulics SCQF level 7.
- HNC Thermo fluids SCQF level 7.

Examples of tailored and bespoke programmes

- HND Chemical Engineering for Shell.
- Engaging with Life Sciences in partnership with GlaxoSmithKline.
- Civil Aviation Authority official examination centre.
- Engineers of the Future (a five-year company sponsored programme combining a Master of Engineering (M.Eng.) Degree with vocational and practical experience) Aeronautical Engineering progression route from HNC to Bachelor of Engineering (B.Eng.).

Appendix 3

Enrolments on engineering programmes by gender.

Actual enrolments by gender

Engineering Programmes

	FE Female	FE male	HE Female	HE Male
2009-10	1,041	17,274	299	4,026
2010-11	935	16,883	317	4,322
2011-12	799	15,879	372	4,508
2012-13	840	14,747	389	4,625
2013-14	1,049	16,974	437	5,143

All Sector Programmes

	FE Female	FE male	HE Female	HE Male
2009-10	100,207	83,707	23,263	21,679
2010-11	93,130	80,714	23,764	22,158
2011-12	80,904	71,839	22,524	21,398
2012-13	73,487	66,444	22,241	21,006
2013-14	76,489	71,445	22,075	21,232

Percentage Enrolments by Gender

Engineering Programmes

	FE Female	FE male	HE Female	HE Male
2009-10	5%	76%	1%	18%
2010-11	4%	75%	1%	19%
2011-12	4%	74%	2%	21%
2012-13	4%	72%	2%	22%
2013-14	4%	72%	2%	22%

All Sector Programmes

	FE Female	FE male	HE Female	HE Male
2009-10	44%	37%	10%	9%
2010-11	42%	37%	11%	10%
2011-12	41%	37%	11%	11%
2012-13	40%	36%	12%	11%
2013-14	40%	37%	12%	11%

Percentages may not sum to 100% due to rounding.

Appendix 4

Success rates on engineering programmes by gender, mode and level

Engineering Programmes

FE

	Gender	
	Female	**Male**
2009-10	71%	78%
2010-11	68%	79%
2011-12	74%	80%
2012-13	78%	79%
2013-14	76%	81%

HE

	Gender	
	Female	**Male**
2009-10	63%	66%
2010-11	68%	67%
2011-12	71%	71%
2012-13	73%	72%
2013-14	77%	74%

All subjects

FE

	Gender	
	Female	**Male**
2009-10	70%	73%
2010-11	72%	74%
2011-12	72%	75%
2012-13	73%	74%
2013-14	73%	76%

HE

	Gender	
	Female	**Male**
2009-10	71%	63%
2010-11	73%	66%
2011-12	73%	68%
2012-13	75%	69%
2013-14	75%	71%

Engineering Programmes

Full-time FE

	Gender	
	Female	**Male**
2009-10	53%	64%
2010-11	59%	63%
2011-12	60%	66%
2012-13	70%	68%
2013-14	70%	70%

Full-time HE

	Gender	
	Female	**Male**
2009-10	55%	53%
2010-11	64%	57%
2011-12	67%	62%
2012-13	72%	62%
2013-14	76%	64%

All subjects

Full-time FE

	Gender	
	Female	**Male**
2009-10	60%	59%
2010-11	62%	61%
2011-12	64%	63%
2012-13	66%	64%
2013-14	67%	65%

Full-time HE

	Gender	
	Female	**Male**
2009-10	69%	58%
2010-11	71%	62%
2011-12	73%	65%
2012-13	74%	66%
2013-14	75%	67%

Part-time FE

	Gender	
	Female	**Male**
2009-10	82%	84%
2010-11	74%	85%
2011-12	83%	87%
2012-13	84%	84%
2013-14	78%	86%

Part-time FE

	Gender	
	Female	**Male**
2009-10	75%	78%
2010-11	76%	80%
2011-12	77%	81%
2012-13	76%	79%
2013-14	76%	81%

Part-time HE

	Gender	
	Female	**Male**
2009-10	71%	74%
2010-11	72%	75%
2011-12	77%	78%
2012-13	73%	80%
2013-14	78%	81%

Part-time HE

	Gender	
	Female	**Male**
2009-10	74%	72%
2010-11	76%	75%
2011-12	75%	76%
2012-13	76%	77%
2013-14	76%	79%

Percentages may not sum to 100% due to rounding.

Appendix 5

Data for full-time engineering programmes, 2009-10 to 2013-14

Full-time FE

Engineering Programmes

	Early Withdrawal	Further Withdrawal	Partial Success	Completed Successfully
2009-10	10%	16%	12%	63%
2010-11	9%	16%	12%	63%
2011-12	8%	15%	12%	65%
2012-13	8%	13%	11%	68%
2013-14	7%	13%	10%	70%

All Sector Programmes

	Early Withdrawal	Further Withdrawal	Partial Success	Completed Successfully
2009-10	10%	18%	13%	60%
2010-11	10%	17%	11%	62%
2011-12	9%	16%	11%	64%
2012-13	9%	15%	11%	65%
2013-14	8%	15%	11%	66%

Full-time HE

Engineering Programmes

	Early Withdrawal	Further Withdrawal	Partial Success	Completed Successfully
2009-10	8%	17%	21%	53%
2010-11	8%	15%	20%	57%
2011-12	7%	13%	18%	62%
2012-13	6%	11%	20%	63%
2013-14	5%	10%	19%	65%

All Sector Programmes

	Early Withdrawal	Further Withdrawal	Partial Success	Completed Successfully
2009-10	7%	15%	14%	64%
2010-11	6%	14%	13%	67%
2011-12	6%	12%	12%	69%
2012-13	6%	12%	12%	70%
2013-14	5%	11%	13%	71%

Data for part-time engineering programmes, 2009-10 to 2013-14

Part-time FE

Engineering Programmes

	Early Withdrawal	Further Withdrawal	Partial Success	Completed Successfully
2009-10	2%	4%	10%	84%
2010-11	2%	4%	10%	84%
2011-12	2%	3%	9%	87%
2012-13	2%	3%	11%	84%
2013-14	2%	4%	9%	85%

All Sector Programmes

	Early Withdrawal	Further Withdrawal	Partial Success	Completed Successfully
2009-10	4%	7%	13%	76%
2010-11	4%	7%	12%	78%
2011-12	3%	6%	12%	79%
2012-13	4%	6%	12%	77%
2013-14	3%	5%	13%	78%

Part-time HE

Engineering Programmes

	Early Withdrawal	Further Withdrawal	Partial Success	Completed Successfully
2009-10	3%	4%	20%	74%
2010-11	3%	4%	17%	75%
2011-12	2%	4%	16%	77%
2012-13	3%	3%	15%	79%
2013-14	2%	3%	14%	81%

All Sector Programmes

	Early Withdrawal	Further Withdrawal	Partial Success	Completed Successfully
2009-10	5%	6%	16%	73%
2010-11	4%	6%	15%	75%
2011-12	4%	6%	14%	75%
2012-13	4%	6%	14%	76%
2013-14	3%	5%	14%	78%

Appendix 6

Glossary of terms

BAE	British Aerospace Engineering
C&G	City and Guilds
CAD	Computer-Aided Drafting
CPD	Continuing Professional Development
DCS	Distributed Control System
DYW	Developing the Young Workforce
ECITB	Engineering Construction Industry Training Board
ECU	Equality Challenge Unit
ESP	Energy Skills Partnership
FE	Further Education
HE	Higher Education
HN	Higher National
HNC	Higher National Certificate
HND	Higher National Diploma
ICT	Information and Communications Technology
IMI	Institute of the Motor Industry
IRTEC	Institute of Road Transport Engineers Certification
MA	Modern Apprenticeship
NC	National Certificate
OGAS	Oil and Gas Academy for Scotland
OPITO	Oil and Petroleum Industry Training Organisation
PC	Personal Computer
PDA	Professional Development Award
PI	Performance Indicator
POE	Performing Engineering Operations
PSED	Public Sector Equality Duties
RCD	Residual-Current Device
ROA	Regional Outcome Agreement
SCQF	Scottish Credit and Qualifications Framework
SDS	Skills Development Scotland
SECTT	Scottish Electrical Charitable Training Trust
SFC	Scottish Funding Council
SfW	Skills for Work
SQA	Scottish Qualifications Authority
STEM	Science, Technology, Engineering and Mathematics
SVQ	Scottish Vocational Qualification
TQFE	Teaching Qualification (Further Education)
UHI	University of the Highlands and Islands
VLE	Virtual Learning Environment

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