

The Engineering Academy: increasing access to engineering.

Dr Gordon M. H. Flockhart¹, Dr Barbara A. Keating², Dr Andrew McLaren^{1,2}

¹ Engineering Academy, Faculty of Engineering,
University of Strathclyde, Glasgow, G1 1XW, UK

² Department of Mechanical and Aerospace Engineering,
University of Strathclyde, Glasgow, G1 1XW, UK

Abstract

The Engineering Academy (EA) is an integrated programme between the University of Strathclyde, partner colleges and industry to widen access to undergraduate degrees in engineering. A partnership model was developed where students successfully complete an enhanced HNC at a partner college before transferring to second year of their chosen undergraduate degree within the Faculty of Engineering.

EA entry requirements are lower than direct entry applications. Additional contextual information based on postcode; the Scottish Index of Multiple Deprivation; schools with low progression to university; or time in care, is used in selection. The programme also aligns with and accepts adult learner applicants from the Scottish Wider Access Programme.

Three enhanced HNC pathways: Chemical Engineering, Electronic and Electrical Engineering and General Engineering require bespoke student transition activities tailored to the engineering discipline.

The presentation will follow the evolution of the EA programme model from its inception to current day. This will include changes in the programme management; the establishment of curriculum and subject working groups to review, refine and share teaching practice; and development of transition activities. The results of these show a successful transition model into undergraduate engineering degrees for students from a range of backgrounds.

1. Introduction

The University of Strathclyde was awarded funding from the Scottish Funding Council in 2013 to provide 80 additional funded places to widen access to engineering and to meet the growing needs of industry by addressing key skills shortages across a number of engineering sectors of importance to the Scottish and UK economy. The Engineering Academy (EA) grew from a curriculum mapping exercise undertaken in 2011 to investigate the barriers to student progression from college to university. The aim of the EA was to better integrate education at

college and university and to involve industrial partners to provide students with an enriched education experience and provide them with relevant industry experience thus increasing their employability. The academic model is based on a 1 + 3 structure where the first year of study is undertaken in a further education (FE) college but integrates university taught material leading to articulation to second year in a range of BEng Honours undergraduate degree programmes. In addition to this, the programme incorporates practical skills training and industry support via student sponsorship and industrial work placements. A diagram of the programme is shown in Figure 1. Through the EA, students can progress to degrees within one of the following Faculty of Engineering departments: Biomedical Engineering; Chemical and Process Engineering; Civil and Environmental Engineering; Design, Manufacture and Engineering Management; Electronics and Electrical Engineering; Mechanical and Aerospace Engineering; and Naval Architecture, Ocean and Marine Engineering.

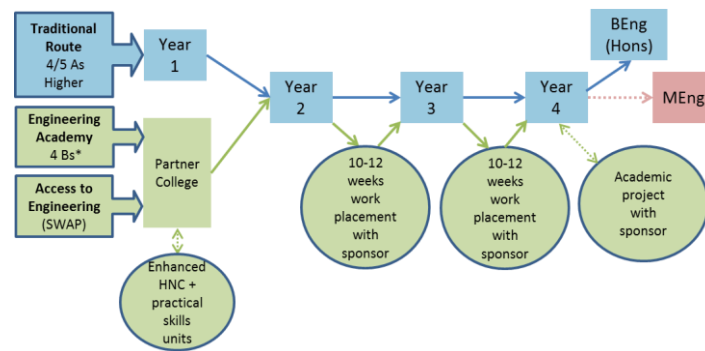


Figure 1. Progression routes through in the Engineering Academy

The EA is a new model of partnership working towards providing the necessary level of academic support to facilitate a successful transition from FE to higher education (HE). Students of the EA are recruited by the university and are fully registered students of the University throughout their whole learner journey. The programme's entry requirements of 4 Highers at Grade B are lower than direct entry applications. In addition, contextual information based on the applicants postcode and the Scottish Index of Multiple Deprivation (SIMD); attendance at a school with low progression to university; or if the applicant has spent time in care, are used to help make an appropriate offer. Through partnership working with the Scottish Wider Access Programme a pathway in to the EA has been established for adult learners via an Access to Engineering course. As a result of these measures, the EA has increased the number of students from SIMD 20/40 areas, see figure 2. Local development plans have also been implemented with our college partners to further increase widening access.

The management structure of the EA comprises of a programme Director and three Associate Directors focussing on the college partnership, industry engagement and academic content respectively. The EA is supported by six academic co-ordinators and two administration staff to manage recruitment and general activities.

We believe the key benefits to students are:

- Opportunities for financial support from year 2 onwards
- Paid summer placements between year 2 and 3 and year 3 and 4

- Specific mentoring and professional development with a sponsoring company
- An enhanced educational experience including specific mentoring and professional development with the sponsoring company
- Increased employment opportunities as a result of an enhanced CV and prior industrial experience.

The first intake of students to the EA was in 2013 and this paper will review the development of the EA over the last 4 years discussing the challenges experienced and the mitigating actions taken to evolve and develop the programme to its current day structure.

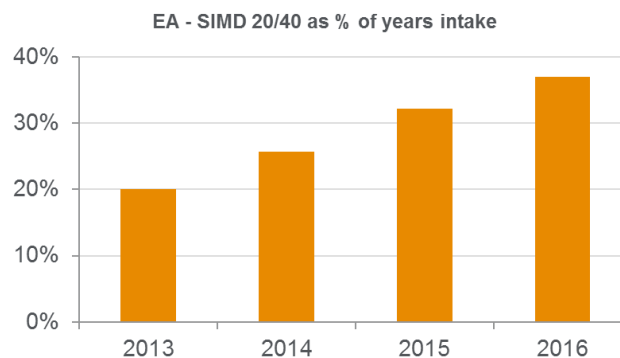


Figure 2. Percentage of students entering the Engineering Academy from SIMD 20/40 postcodes

2. Curriculum Development

In 2011 a curriculum matching exercise was undertaken to evaluate the academic content within a wide range of Higher National units provided by the Scottish Qualifications Authority (SQA) in comparison to the taught material that makes up Year 1 of a number of engineering courses and to investigate the potential barriers for progression from further to HE. Based on this ground work, further detailed academic comparisons were made in consultation between college partners and academic departments to identify the key units required to develop appropriate pathways to access a range of engineering degrees within the Faculty of Engineering. It was important to ensure articulation aligned against national frameworks and SQA's Higher National Certificates (HNC) qualifications. To meet the needs of the diverse range of degree programmes that students could progress on to; it was necessary to develop three custom pathways: chemical engineering, electronics, and mechanical engineering. In each pathway, the curriculum was chosen to ensure the 12 mandatory Higher National (HN) units at level 7 of the Scottish Credit and Qualifications Framework (SCQF) were incorporated to embed an HNC qualification in to the programme. An additional three or four units were also added to enhance the HNC qualification and help to provide sufficient academic content to allow progression to year 2 of the degree programme. The incorporation of the HNC qualification limited the overall degree of customisation of the pathway; however the benefit of the HNC qualification provided flexibility in terms of the learner pathway and potential exit qualifications.

Due to the specialist discipline of chemical engineering a discrete pathway was created which embedded an HNC in Chemical Process Technology with a total of 18 HN credits, 4 of which were SCQF level 8. The Chemical Process Technology HNC award was revised by SQA in June 2016. The new content was reviewed in partnership between the college and university and taking in to consideration feedback from the previous three cohorts of EA students, the curriculum was modified and the total credit count was reduced to 16 in alignment with the two other HNC pathways.

Similarly, a discrete pathway to progress to electronic and electrical engineering was also required. Through the curriculum review exercise it became evident that an HNC in Electrical Engineering did not provide sufficient electronics to cover year 1 of the Electronic and Electrical Engineering degree programme. The embedded HNC qualification was built around the SQA's HNC in Electronic Engineering but with a total of 15 HN credits. Finally, to meet the needs of the remaining five academic departments within the Faculty of Engineering, a pathway based on the Mechanical Engineering HNC was established. To address the breadth of the degree programmes that students could articulate to through this pathway, a 16 credit HNC was specified. To manage the total number of credits and not over burden the students it was decided to not include SCQF level 8 maths content within this pathway.

In addition to the HN units making up the embedded HNC, the EA students in the Mechanical Engineering and Electronic Engineering HNC pathways also undertake HN unit Engineering: Practical Skills which is worth 2 HN Unit credits. The students undertaking the Chemical Process Technology HNC complete Performing Engineering Operations Level 2.

For all three HNC pathways, progress to year 2 is subject to the academic criteria of completing and passing all of the HN units, obtaining an A grade in the HN Graded Unit and completing the practical skills units. The embedded HNC qualifications are thus enhanced HNCs, extending the academic content of a standard 12 credit HNC and in combination with discipline specific transition programmes delivered by the university facilitate the 1 + 3 articulation model. If students do not meet the criteria to progress to year 2 of the programme then they have the potential to be awarded an HNC qualification. If they wish to continue their education they could remain at college to obtain a Higher National Diploma (HND) and ultimately could return to HE by re-applying through the standard route.

In 2014, SQA released the new Engineering Maths framework, at this stage the curricula were reviewed and the EA adopted the new framework. For the Chemical Process Technology HNC, Mathematics for Science 1 & 2 was replaced with Engineering Maths 2 to 5 increasing the maths provision. For the Electronic Engineering HNC the maths content was also increased by adopting the SCQF level 8 unit Engineering Maths 4. The Mechanical Engineering HNC incorporated Engineering Maths 1 to 3.

Mathematics underpins all engineering subjects. Monitoring of interim maths assessments for mechanical engineering students indicated poor performance. Due to the different maths content in the different HNC pathways, an analysis of the whole EA cohort's performance in year 2 maths has been undertaken and is presented in Table 1.

Table 1. Performance analysis of Engineering Academy Year 2 Maths

SQA Engineering Mathematics Highest Level Undertaken	Engineering Academy UoS 2 nd Year Maths Average Mark (%)
3	46
4	56
5	74

There is clear correlation between performance in year 2 and the level of maths undertaken in year 1. In comparison to undergraduate students undertaking maths in year 1 at university the average of non-Engineering Academy students enrolled on BEng degree programmes is ~50% and for students enrolled on MEng degrees is ~70%. Feedback from Chemical Engineering students who studied maths to the highest level in college did highlight that there is some repetition of the curriculum. Potentially the maths content of year one of the Chemical Process Technology HNC could be reduced; however the high performance in maths of these students in second year gives a boost in confidence and this increased self-efficacy is very valuable to a successful transition to university learning. The level of maths content in the other two HNC pathways is currently being reviewed to ensure a suitable balance of engineering topics is maintained but sufficient maths is included to improve the academic performance of students in year 2 of their degree.

Pathway specific working groups have been established between college and university lecturers to better understand the breadth of material covered, style of teaching and sharing of teaching resources between college and university. These working groups meet when required to address any issues that arise with academic content or to review curricula changes.

3. Transition Support

One of the original motivations in establishing the EA was to widen access to engineering and try to overcome potential barriers for students progressing from FE to HE. An important aspect of the learner journey is the transition between college and university. Many existing FE/HE articulation agreements provide pathways to second or third year of university and often the students only start studying in the university at the point of transfer. The transition from FE to HE has a number of challenges such as gaps in academic knowledge. Academic staff typically assume all students have studied in first year and all have the same knowledge. Students must also adapt to a different teaching style which is less didactic and the learner must take more responsibility. Students must become familiar with new learning logistics i.e. virtual learning environments. Another important aspect of the transition is the social aspect. Students joining degree programmes in year 2 or 3 must integrate in to established cohorts. They may not have a feeling of belonging or may feel isolated when working in groups with students who already know each other. Additional challenges that students from widening access backgrounds may experience include financial pressures, less opportunity for part-time work due to the increased workload of HE. The students may also experience less family

and peer support. The EA attempts to address some of these challenges through a transition programme in year 1.

Students joining the EA are registered students of the university from day one. This gives the students access to all of the facilities at the university while they are studying at one of the partner colleges. A staggered induction programme is implemented to avoid overloading new students with information. After the students have had some time to settle in to studying at college, an induction event is held at the university. This event aims to establish a sense of belonging to the EA, defines our expectations of the students and introduces them to the University of Strathclyde systems and facilities. This is followed with an induction to their specific academic department which outlines the future opportunities available to them and to get a tour of the department facilities. This is also an opportunity for the students to meet key staff in the EA and the academic co-ordinator supporting the EA students. In 2016, the University of Strathclyde introduced an online course 'We are Strathclyde' to help students transition to university and this was made available to all EA students in year 1 and 2 and have been made a compulsory part of the EA induction.

When the EA was first established students were recruited on to the three different HNC pathways, those entering the electronics and chemical engineering pathways could only articulate to their respective departments; however students enrolled on to the mechanical engineering HNC had the opportunity to articulate to four different departments. For this pathway, the activities in semester 1 focussed on informing students about the different engineering disciplines and potential career paths available to them. At the end of Semester 1, the students were required to choose which department they wished to articulate to. This allowed the individual academic departments to deliver discipline specific activities in semester 2 only. One of the challenges faced by this approach was balancing the number of students across departments; however in the second intake there was a very large demand for students to articulate to the Department of Mechanical and Aerospace Engineering. We believe this may be due to the association of the embedded HNC in Mechanical Engineering. This resulted in approximately 50 students articulating to the department and the large increase in the second year population had a number of implications for delivering teaching due to capacity limitations. Ultimately, this was not sustainable.

To address this issue three changes were made. The Mechanical Engineering HNC pathway was renamed General Engineering, the number of students articulating to the Mechanical and Aerospace Engineering Department was capped and a revised recruitment approach was implemented. The aim of this was to better manage the balance of student numbers across all departments and to allow department specific activities to commence earlier in the academic year. Students apply to the EA through UCAS using one UCAS code. The new process requested students to select their articulation department rather than HNC pathway. Once the cap was reached for mechanical engineering students were offered articulation to other departments. This approach has been successful, manages student expectations and allows improved transition support from academic departments delivered throughout the whole academic year. To manage and co-ordinate this increased provision, the EA recruited a third Associate Director to oversee transition support and academic development.

The transition programme consists of a range of different activities, many of these activities have been designed around feedback from previous cohorts of students who have helped us identify gaps in knowledge. The range of activities includes lectures, tutorials, laboratories and

workshops. Practical laboratories provide students opportunities to become familiar with the equipment used in university and to experience undertaking a practical laboratory and preparing a formal laboratory report. Activities on general skills such as report writing, independent research of topics and presentation skills are also included. Feedback on report writing and presentation skills etc. is provided to students throughout the year. Students have also had the opportunity to attend field visits where appropriate, i.e. in Civil and Environmental Engineering. Another area of activities, focusses on introducing students to specific software packages i.e. mathematical tools or computer aided design tools. Where possible the EA students also get the opportunity to meet and work with university year 1 students to help cohort integration. Overall, these activities have helped students to make a smoother transition from year 1 to year 2.

4. Conclusions

The Engineering Academy is a new model of partnership teaching between further and HE attempting to facilitate the transition to HE to address the current and anticipated growing skills shortage in engineering. Through targeted recruitment the Engineering Academy has increased access to students from a range of backgrounds and provided industrial work place opportunities to help enhance the students CVs and employability. Engagement with industry has led students undertaking a wide range of internships, many have returned to companies for subsequent internships and a small number of companies have offered 1 year internships to our students. The first intake of Engineering Academy students will graduate in the summer of 2017; however approximately 50% of these students have transferred to MEng programmes and will continue their studies which is an excellent measure of success of the programme.