

# ENGINEERING AND DESIGN STUDENT PROJECTS - THE IMPACT OF TEAM BASED FINAL MAJOR PROJECTS ON GRADUATE EMPLOYABILITY

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## ABSTRACT

As industry faces the challenge of a very competitive global world, the process of graduate recruitment has become increasingly competitive and complex. Engineering and design graduates need to develop a rounded profile combining; qualifications, experience of applied skills, technical knowledge and demonstrate softer interpersonal skills in preparation for employment. Traditionally, degree programmes commonly involve a significant Final Major Project (FMP) in the last year of study that applies much of the student's skills, interests and knowledge learnt during the programme.

This study seeks to establish the relative impact of individual and team based Final Major Projects for engineering and design students as they transition into their early career. Graduates were surveyed about the different skills, knowledge and experiences they gained during the Final Major Project and asked how they used those elements in their search for employment, from application through to selection and early career progression.

Results identify skills and experiences that graduates drew upon during job interviews and through to their early career. The experience of a team project increased the positive perceived impact above that of an individual project when applying and securing employment, through to early stages of career progression in engineering and design roles. Compared to individual projects, team-based projects may offer improved employability for graduates.

*Keywords: Collaboration, employability, team projects. Final Major Project*

## 1 INTRODUCTION

Globally, design and engineering skills are in great demand, indeed in the United Kingdom the Design Council has estimated that *design skills* in the workplace contribute £209 billion to the UK economy annually [1]. However, there can be a disconnect between industry expectations of graduates and the skills and expertise new graduates possess [2]. As well as the traditional technical skills and knowledge taught at undergraduate level, critical thinking and soft skills are highly valued by employers. There is an opportunity to improve how these skills are developed on design and engineering programmes at university. While team-based projects are often conducted during the early stages of degree courses, the final year of studies has conventionally allowed students to focus on a single major project. Traditionally this Final Major Project (FMP) is predominantly carried out as an individual. This study compares the experience of graduates who completed either an individual or a team-based FMP.

### 1.1 Undergraduate design and mechanical engineering at Aston University

Aston University offers BSc Product Design and BEng Mechanical Engineering courses. During the initial two years of all courses fundamental skills and knowledge are taught through various modules. Students on both design and engineering courses applying the 'Conceive Develop Implement Operate' (CDIO) methodology to complete practical assignments [3].

At Aston University the FMP is a level 6 forty credit module that runs throughout the final year of studies. On commencing their final year, students are free to choose the theme of their FMP (subject to approval by staff) and a suitable academic supervisor is assigned. The project proposal is then

reviewed during a formal assessment (comprising of a short report) in November. The final project assessment is comprised of a 10,000 word dissertation and presentation that includes prototype and discussion during a 30 minute review.

Students can undertake their FMP as an individual or they can opt to join a team project such as a hydrogen vehicle project [4]. The university assessment for team and individual FMPs is identical in terms of learning outcomes and assessment criteria through individual submissions for either option, which provides an opportunity to compare the learning experience of both types of project.

## 1.2 Skills and employment

Design skills have been described by the Design Council as a “combination of technical skills, cognitive abilities and interpersonal competencies” [1]. This study aims to address how well these skills are developed at university during the FMP and how these then transfer to employment in design and engineering roles.

This research documents the experience of Aston University graduates who have completed the FMP on BSc Product Design and BEng Mechanical Engineering courses. This insight is used to identify the skills and knowledge that graduates draw upon during the search for employment, the application process, the job interview and into their early career. This then allows the FMP to be examined in terms of student employability.

The study seeks to draw on the literature and best practice from both the project area and the employability skills area, bringing these two perspectives together into a cohesive curriculum approach that works both with the academic curriculum and accreditation needs as well as the demands of graduate employability as they transition into the workplace.

## 2 METHODOLOGY AND SURVEY

A survey titled ‘Final Major Projects - graduate employability’ has been distributed to BEng Mechanical Engineering and BSc Product Design graduates from Aston University in the United Kingdom. This survey provides primary data on the experience that the graduates gain and offers an insight into the unique skills developed through FMPs. The graduates have been asked to reflect on a list of industry relevant skills developed through the FMP - both general skills for employability, as identified by the HEA [6], as well as more specific design skills students are expected to develop during the project.

Graduates were presented with a randomised list of 30 skills that designers and engineers are expected to practice during their FMP. The ‘30 FMP skills’ have been separated into three groups as identified by Hernandez, Cooper & Jung, [7]:

1. **Knowledge and understanding** – research, project management, new product development, materials, risk evaluation, problem solving, critical thinking, manufacturing processes, applied maths and supplier liaison.
2. **Technical capabilities and methods** – prototyping, report writing, CAD, product testing, practical skills, customer research, Adobe CS, model making, graphic design and sketching.
3. **Attributes and capabilities** – creative thinking, innovation, self-motivation, decision making, time management, collaboration and teamwork, communication, leadership, presenting, listening.

The graduates were then asked how they used their FMP after graduation during their search for employment and also during their early careers.

### 2.1 Demographic

The samples surveyed are Aston University alumni who graduated between the years 2011 to 2017. The graduates are split into two groups: 1, ‘*Individual FMP*’ graduates and 2, ‘*Team FMP*’ graduates. A higher proportion of the Individual FMP graduates were BSc Design students and a higher proportion of the Team FMP graduates were BEng Engineering students. The general trends identified are true of both the design and engineering students when conducting Team or Individual FMPs.

### 2.2 Response

The size of the sample is limited as some graduates were not in contact or did not respond, the number of Team FMP respondents is further limited by project cycles conducted (2011 – 2017) and may compromise the quality of findings.

## 2.3 Feedback

Insight about the impact of Team FMPs was gathered during communication with the graduates surveyed. This established how the perception of the skills gained specific to the team project have impacted their search for employment, subsequent job interviews and during their early career development. This will help in understanding the value of such projects and establish guidelines on the best practice in running team based final year projects to enhance the learning of specific skills.

## 3 RESULTS AND ANALYSIS

71 Aston University Design and Engineering graduates responded to the survey. The graduates were asked to describe their FMP - 18 completed a Team FMP and the remaining 53 completed an Individual FMP.

### 3.1 Final Major Project skills

The graduates were asked to identify the top 5 skills that they improved during their FMP from the '30 FMP skills' list. The results displayed in Figure 1, have been normalised as a percentage for both the Team FMP and Individual FMP respondents.

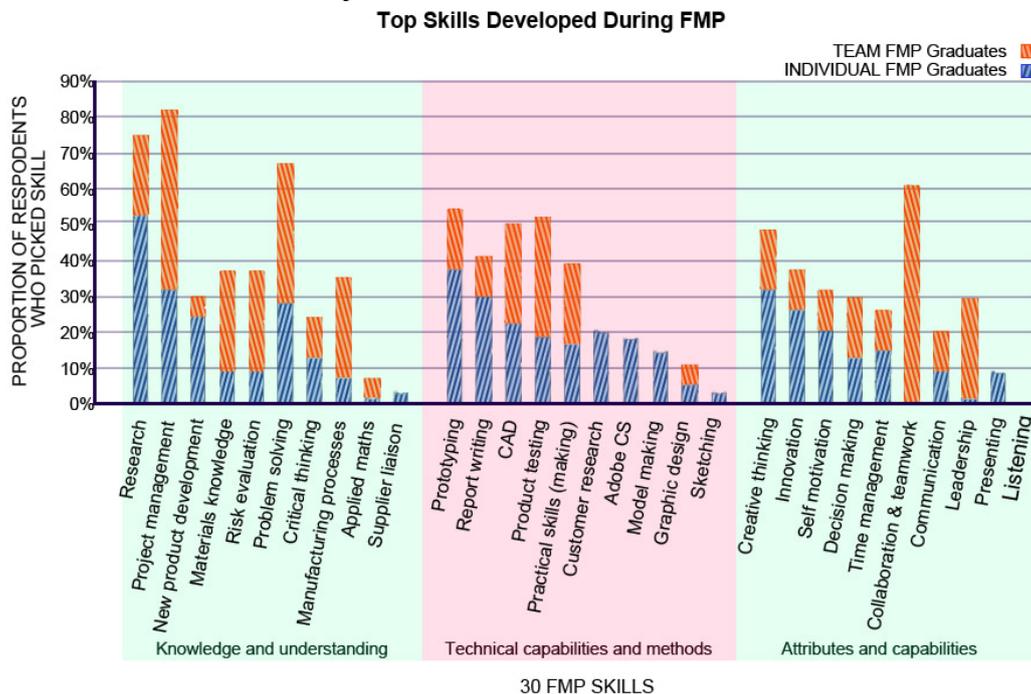


Figure 1. Graduates identified their 'top 5 skills' developed during their FMP

From Figure 1, the top five skills improved during the FMP overall are:

1. project management, 2. research, 3. problem solving, 4. prototyping and 5. teamwork.

Most of these skills can be developed in either a team or individual FMP format, however, Individual FMP graduates were unable to identify improvement in collaboration and teamwork as a top skill.

Individual FMP and Team FMP graduates selected different FMP skills that they most improved:

**Top Individual FMP skills:** research (53%), prototyping (38%), project management (32%), report writing (30%) and creative thinking (30%).

**Top Team FMP skills:** collaboration and teamwork (61%), project management (50%), problem solving (38%) and product testing (33%).

Generally, the team projects formed part of a competition to build and test working vehicles. These projects were structured and had defined outcomes. Collaboration and teamwork are key to such projects, and is identified in Figure 1, as the top improved skill for Team FMP graduates. The nature of the team competition projects may have also promoted improvement in problem solving and product testing skills. Technical capabilities that may be better promoted through Individual FMPs may require more careful guidance to develop on team projects.

### 3.2 Early graduate career

The graduates were questioned about their first professional role on graduating from Aston University. The graduates were then asked how their FMP enhanced their personal profile, the results are displayed in Figure 2.

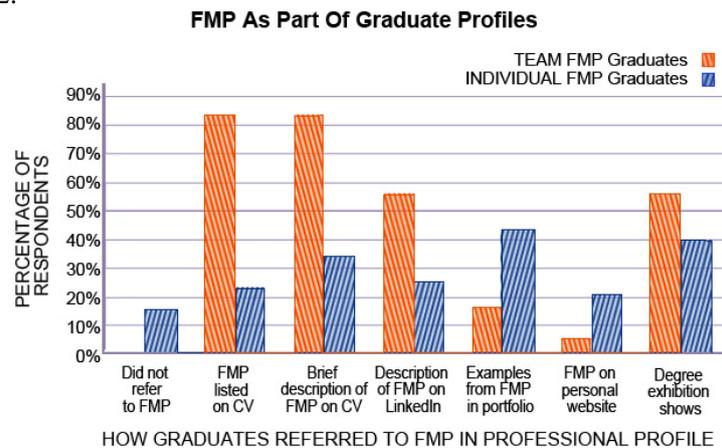
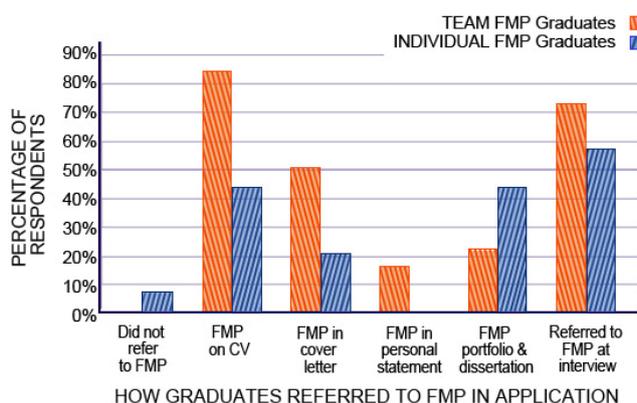


Figure 2. How team and individual FMPs are reflected in a graduate's professional profile

Of the graduates surveyed only 8 (11%) said they did not refer to their FMP to enhance their professional profile, all 8 completed individual projects. This response suggests a level of pride in the work created during the FMP and that graduates find the FMP useful to showcase their ability. They were asked about the influence of their FMP in securing employment, the results are displayed in Figure 3.

#### Graduates Referring To FMP In Job Applications



#### Graduates Discussing FMP In Job Interviews

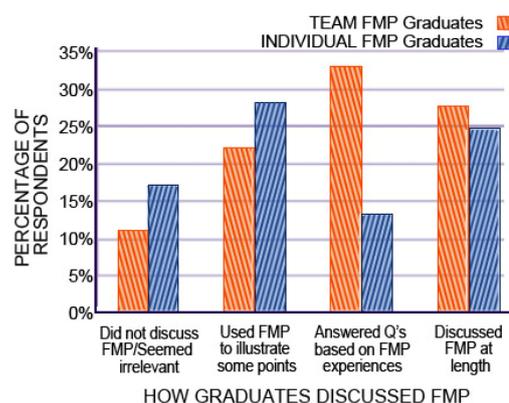


Figure 3. How individual and team FMPs are referred to during application for jobs

Figure 3. shows that the majority of respondents (83%) referred to their FMP when applying for a graduate job. Only 4 respondents (6%) did not use their FMP to support their job application. This suggests that the FMP is an important body of work to graduates when providing employers with evidence of skills and knowledge.

As Figure 3. displays, 83% of the Team FMP graduates referred to their project in their CV while only 43% of the Individual FMP graduates did so. 73% of Team FMP graduates referred to their FMP experience during a job interview while only 57% of the Individual FMP graduates did so.

The graph on the right hand side of Figure 3. displays a breakdown of how the FMP was discussed during an interview. During a job interview, a higher proportion of Team FMP graduates answered questions based on the FMP experience and talked in depth about their project. Proportionally more Individual FMP graduates used the project to illustrate some points or did not refer to the project at all. This suggests that the Team FMP provided graduates with the opportunity and confidence to demonstrate their skills and experience, helping them to secure a job.

### 3.3 Early career skills

Students were asked to describe how their experience completing their FMP has helped during their career to date. A higher proportion (78%) of Team FMP graduates described their FMP as a positive

influence on their careers, whereas only 62% of the Individual FMP graduates stated the value. The respondent's descriptions were then translated into the '30 FMP skills' identified and are displayed in Figure 4.

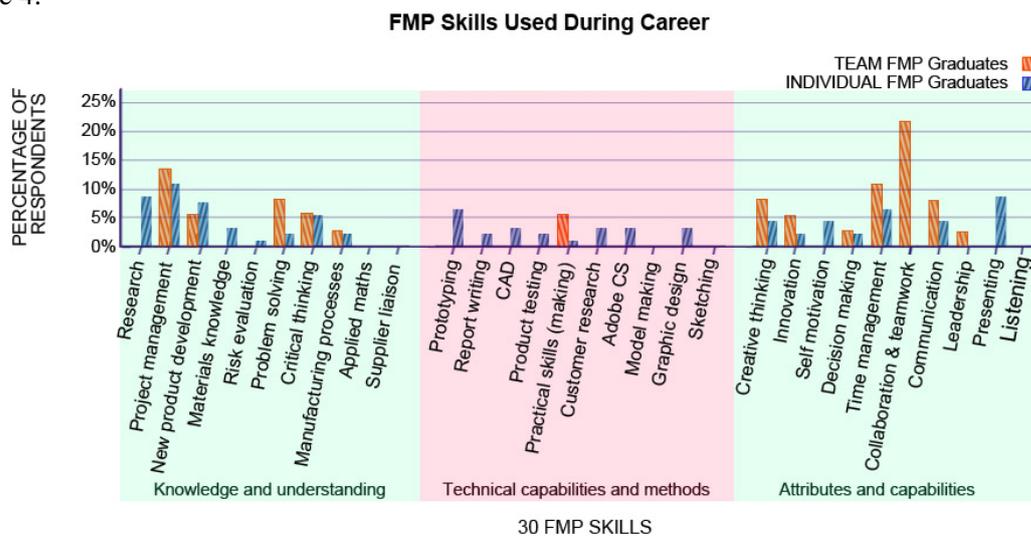


Figure 4. '30 FMP skills' used during early career as described by graduates surveyed

From the data displayed in Figure 4, attributes and capabilities form 59% of the skills described by the Team FMP graduates as 'useful during early career'. Collaboration and teamwork can be identified as a key skill developed during the team project. Respondents focused on soft skills and knowledge used during early employment and the lack of technical skills is an area to address for the Team FMPs.

### 3.4 Feedback

The Final Major Project is clearly a valuable undertaking and enables graduates to demonstrate design skills to employers. From the survey it is evident that the structured team projects delivered at Aston University offer students more to discuss during job interviews. When describing how they have used the skills developed during the FMP, Team FMP respondents describe a complex mix of "independent working" and the "soft skills of working within teams of engineers and designers" as being useful within the workplace. One Team FMP graduate described how "the soft skills that I had learnt from the Final Major Project had prepared me in ways which I did not expect" by being able to "quickly adapt/learn the knowledge required, communicating effectively with team members, being well organised and keep a track of and record all your work".

## 4 CONCLUSIONS

This study demonstrates the positive impact of team projects and highlights the value to graduates as they progress into their design and engineering career. The challenge then is to give students the opportunity to engage with such a team-based project while still satisfying the demands of the curriculum and accreditation bodies for course outcomes. Staff on the Aston University team project were asked to outline some key pedagogic elements that can help to ensure the projects offer the appropriate ingredients of technical and inter-team challenges. Final year team projects can require increased resources in terms of planning, space and equipment. However, this should be seen in the context of multiples of students being supported. The evidence of this survey demonstrates a strong potential to enrich the learning experience for students, providing them with a range of very valuable skills and experiences to take into their career.

Ownership and responsibility of tasks can prove challenging in team projects so clear briefing and student lead project planning are beneficial. The Aston staff ran short team building 'design and make' projects at the start of the final year to help practice and contextualise the approaches needed. Low risk mistakes and lessons learned allowed students early progress in areas such as; project planning, communication and time management within the wider context of the team. This promoted critical thinking and allowed the students to form a more considered approach to their FMP.

This survey has provided a more detailed dataset than could be presented in this paper, further analysis should provide insight into how design and engineering graduates develop their careers and how this may influence the structure and support given to FMPs.

#### 4.1 Recommendations for supervising a team based final major project.

A valuable aspect of the team projects run at Aston University was that the project prototypes were tested at a competition. External competitions, such as the Shell Eco challenge and the Formula Student projects have well established elements or gateways that can be applied to all team projects [8]. There is also the value of peer and public testing which again can be developed into any team project. The nature of structured team projects promotes both teamwork and communication skills, while testing a prototype at a competition develops problem solving and creative thinking skills.

Some elements to consider when establishing a team-based FMP are:

- Use gateways to assess progress and allow open feedback within the team environment.
- Add formal learning and assessment elements for best practice for key soft skills such as team building, listening and review, leadership and communication.
- Include regular team building and add in contingency periods in the project planning.
- Include an external competitive or showcase element to expose students to a wider context.
- Relevance and context is key to student engagement, arrange alumni reviews and industry visits to help to contextualise the value of the projects to their own future careers.

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