A COMPARISON BETWEEN DIFFERENT APPROACHES TO INDUSTRIALLY SUPPORTED PROJECTS

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ABSTRACT

Engineering and design is a vocational education with the graduates of degrees in these subjects generally being recruited into discipline specific professional roles in industry. One of the key challenges for educators is how best to develop programmes to equip their graduates for the transition from student to industrialist. One approach which can be used is via industrially supported projects. The aim of this paper is to examine the use of whole class industrially supported projects at undergraduate level. The work focuses on the examination of two quite different projects carried out by a cohort of second year mechanical engineering and product design students at a British University. The first project was based around an open healthcare related brief with an end user as the primary industrial contact while the second was a much tighter brief directed by a manufacturer of pneumatic components for the oil and gas industry. The paper discusses some of the practicalities associated with industrial projects, including intellectual property issues and scheduling. We also examine the students' attitudes to industrial projects. These showed the students demonstrating a real appreciation for this type of work but also highlighted concerns in relation to lack of clarity in the industrial briefs and level of access to the industrial sponsors.

KEYWORDS

industrial collaboration projects, design build exercises, group work, intellectual property

INTRODUCTION

One of the key influences behind the setting up of the Conceive Design, Implement, Operate (CDIO) initiative was the need to provide engineering graduates with a skill set which went beyond engineering science, and encompassed the personal, commercial and organisational skills needed by industry [1,2]. One key feature of this, while not necessarily a formal requirement within the CDIO standards, is industrial involvement in the programme.

Industrial involvement within degree programmes can take many forms including participation by professionals in industrial advisory panels, exposure of teaching staff to industrial practice via commercial projects, guest lectures by engineers from industry and the running of live industrial backed projects for either whole class or individual students.

There have been a number of studies in this area previously which include [3-6]. The integration of direct industrial contact is also seen to be a global problem and not one which is exclusive to the West [7-9] and there have even been some quite elaborate multinational, industrial collaboration projects [10].

These projects are seen as not only important in developing technical skills but also in embedding commercial and economic awareness in the students [11]. They are however not without problems, often rooted in the quite different overall objectives and business models of Universities and commercial companies [12].

It is the involvement of industry in supporting whole class projects for students in the middle of their degrees which is the focus of this paper. The aim of this work was to evaluate some of the practicalities associated with setting up such partnerships and determine the perception of students to these type of projects.

Two contrasting projects were used in this study. The first being a very open brief health care based project with the second a much tighter brief based around the redesign of an existing industrial product.

THE CONTEXT

The Students

The class consisted of a cohort of second year undergraduate BEng mechanical engineering and BSc product design students. On completion of this academic year around half the students will progress directly to the final year of their BSc or BEng with the remainder opting for a placement year in industry before returning to their studies to complete their degrees.

The specific distribution of the students was 61 BEng engineering students, (55 male, 6 female), 21 BSc product design students. (14 male, 7 female). These students share project modules accounting for half of the year one and two content with the remainder of their programmes focussed on the specific knowledge and understanding associated with their disciplines.

In their first year and prior to undertaking these industrially linked modules the students will have followed subject specific programmes but with a common 50% content of project based learning. At level 1. the projects tend to build up from basic short one, two and three week rough and ready type exercises to encourage practical, team and project skills (eg. building a simple bridge from broken down wooden pallets) to more advanced projects such as wind turbines where a greater emphasis on engineering science in the design process and a basic introduction to commercial awareness are introduced.

Figures 1-3 show some more details of the students and their aspirations. It is notable that prior to a visit to a car factory in connection with these project based modules, around half of the students had no experience of an industrial plant (Figure 1). It is also worth pointing out that while the armed forces are always an option for engineering and design students, the cohort involved in this study have a disproportionately large number of military sponsored students due to the university being a partner in the UK Defence Technical Undergraduate Scheme (DTUS). These students are barred by the scheme from taking part in industrial placements.

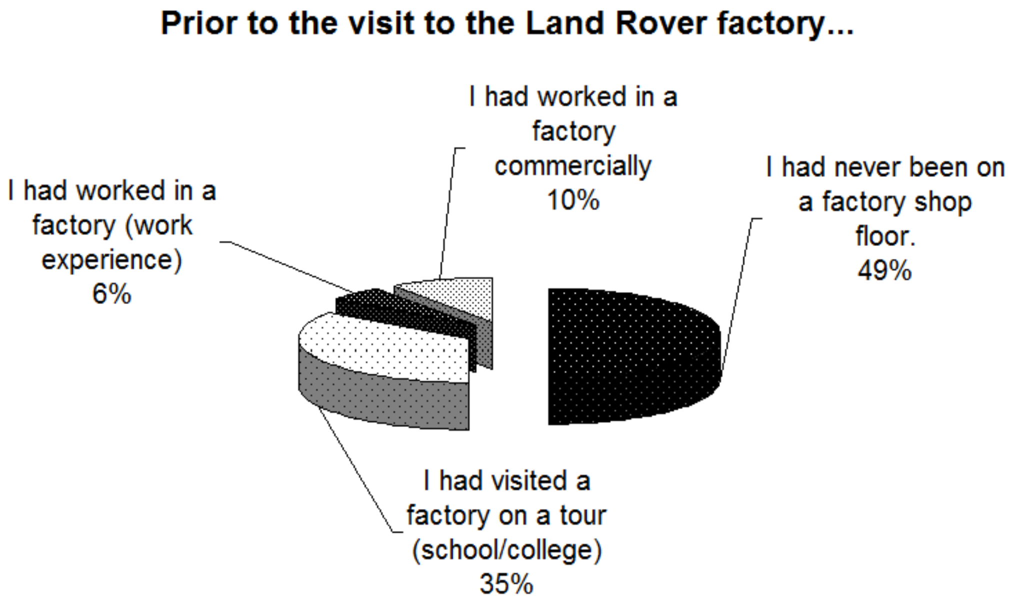

Figure 1. Industrial experience of students

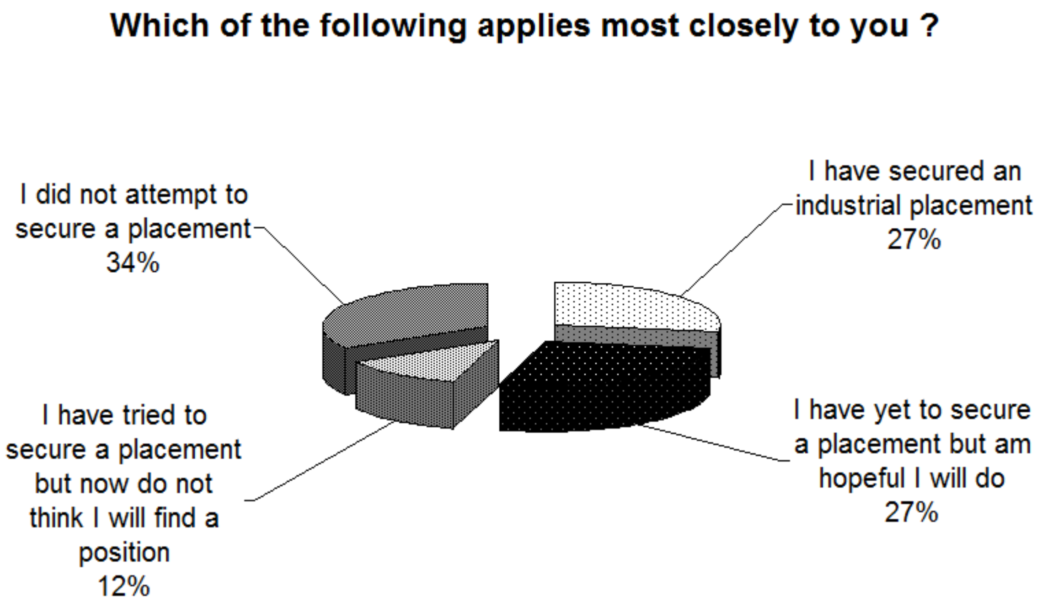

Figure 2. Industrial placement aspirations of students

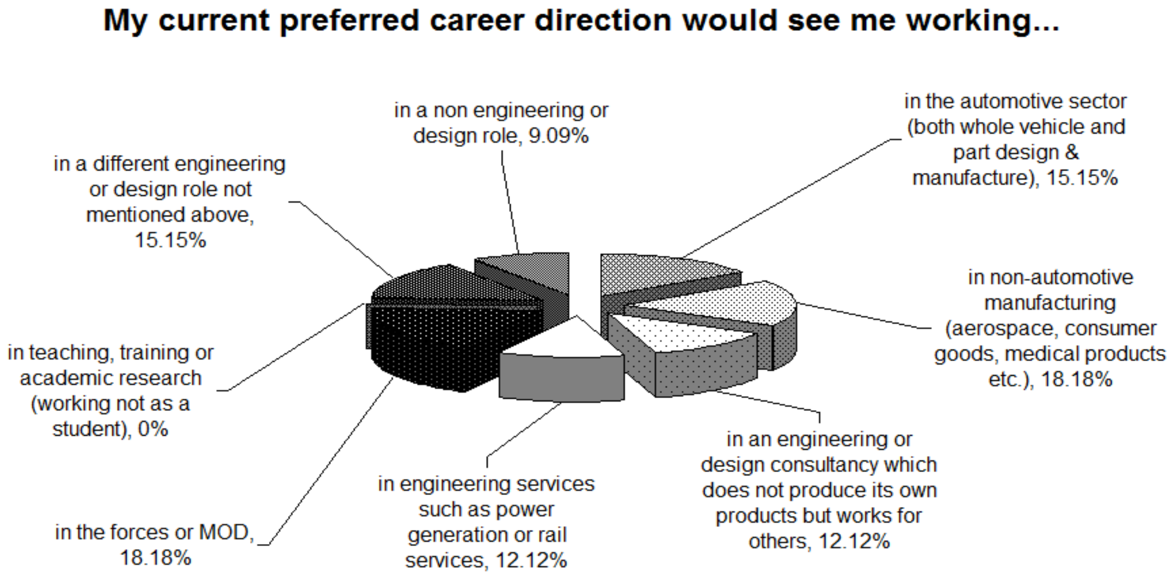

Figure 3. Career aspirations of students

The Projects

The students worked on two industrially linked projects in their second year, one in each semester. These were embedded in large modules accounting for a total of half the academic years content. Each module and project lasted 11 weeks with the project work supported by directly relevant specialist teaching in areas such as CAD, pneumatics, ergonomics, engineering economics and embedded control. In both projects students worked in groups of 4 or 5.

The first semester project was a very open healthcare brief centred on using technology to improve communication between patients and doctors. From this very open brief, students were expected to develop a functioning prototype device, with the project culminating in a "trade show" where they would demonstrate their concept. The project had been set by a local hospital Doctor who also took part in a number of sessions through the project.

The second project was a tight brief based around the redesign of a pneumatic manifold in order to reduce cost of manufacture and assembly by 30%. The functionality of the device was to remain unchanged. This project was conceived by a local manufacturing company with their engineer and marketing personnel attending sessions. This project would be a paper design with no necessity for artefacts to be produced. At the company's insistence a formal IPR and non-disclosure agreement was set up. Prizes were offered by the company for the best students, with the intellectual property rights (IPR) agreement offering opportunities for joint patent holder rights for students if appropriate.

A summary of the two projects is seen in Table 1.

Table 1
Comparison of two second year, industrially related projects

	First Semester	**Second Semester**
Theme	Design & Engineering for the User	Design & Engineering for Industry
Partner	National Health Service	Pneumatic Component Manufacturer
Industrial Personnel Involved	Doctor (end user)	Marketing, Engineering Personnel (manufacturer)
Focus	Focus on customer requirements	Focus on commercial engineering
Product	Conceptual design & prototype of healthcare product	Redesign of existing product to improve viability in market
Nature of Brief	Open, speculative brief	Tight, live brief
Sponsorship	No financial commitment	Provision of books & prizes
IPR Status	No formal IPR policy	Students signed IPR agreement
CDIO Phases	CDIO	CD

RESULTS AND REFLECTION

Figures 4 and 5 show examples of some of the work on the open brief medical project. In this case this particular group developed a device to store basic activity levels and biosigns of a patient which could be downloaded to their doctor's records at a later date. Students were expected to produce both working and physical prototypes of their devices.

Figure 4. Typical physical prototype evolution from the medical device project

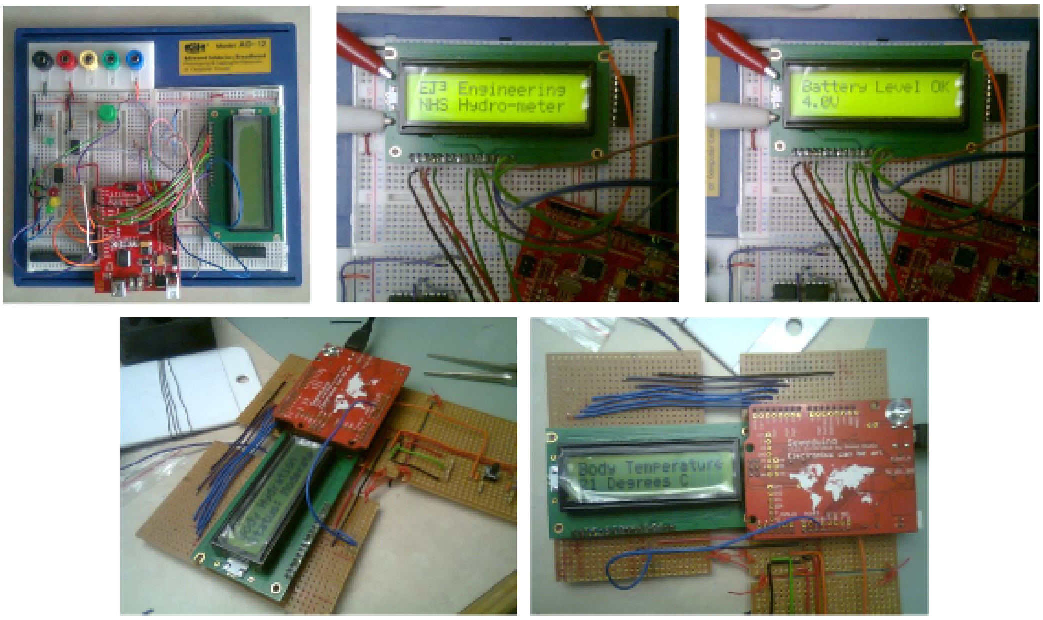

Figure 5. Typical functional prototype evolution from the medical device project

Figure 6 and 7 shows students working on the much more constrained pneumatic manifold project. In figure 6 students are disassembling a current incarnation of the manifold which they were to design. On the bench are a series of drawings supplied by the company describing the design. Students were expected to develop new designs for the manifold with the same technical performance but lower production cost than the original. No physical parts would be made in this project.

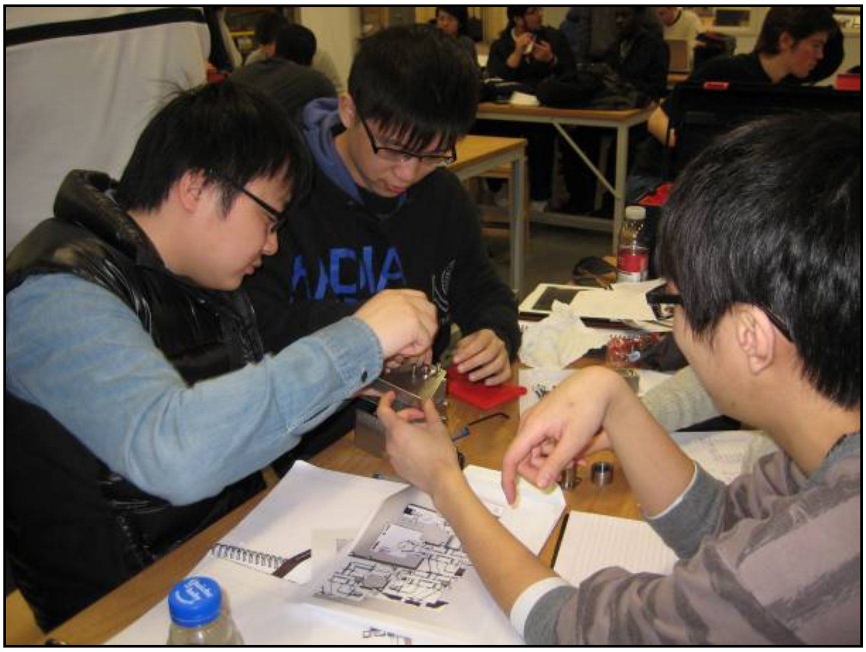

Figure 6. Students examine pneumatic manifold

Figure 7. Students consulting with industrial engineer

Student Perception

Figures 8-13 show results of survey questions asked of students following their participation in the two industrially related project modules. This survey consisted of a number of multiple choice and likert type questions together with an opportunity for students to give general comments.

Figure 8 shows that the students appreciated the contact with the industrial professionals with around 75% of students giving a positive response.

Figure 9 showed a more muted response to the overall concept of industrial projects in comparison to more conventional internally set briefs. This may be partly as a result of a perception observed among students that experiential learning is not valued as immediately as much as formally taught work. Students also expressed some frustration through the survey in relation to the degree of contact with the industrialists.

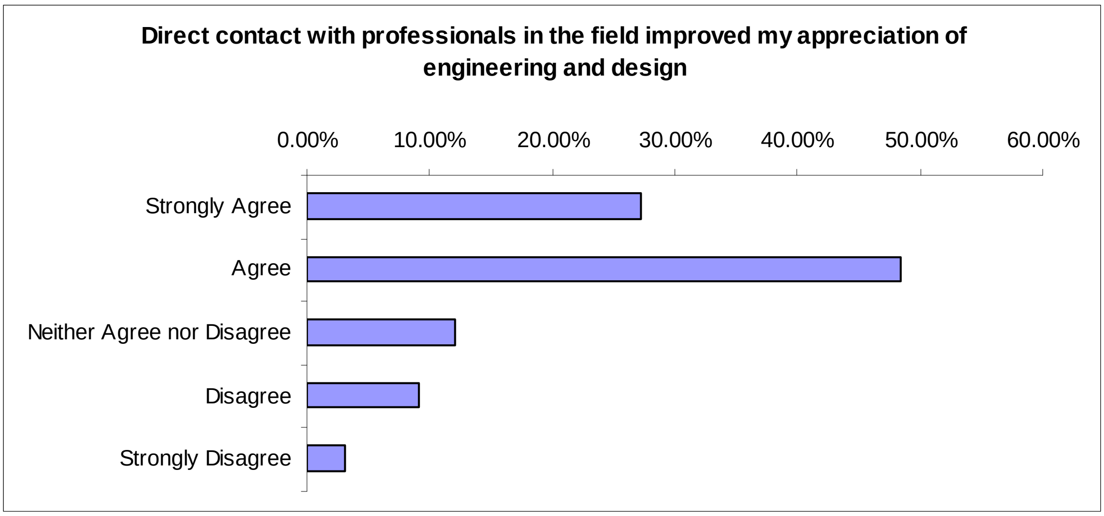

Figure 8. Student value of contact with industrial professionals

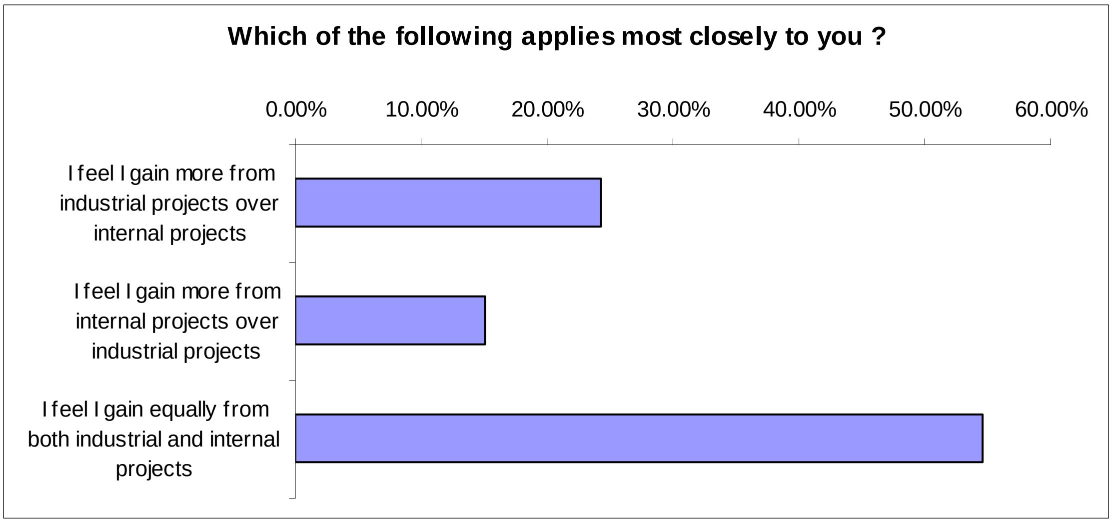

Figure 9. Student relative value of industrial and internal projects

It is expected around half of the students will spend the following year working in industry. As a result, many students were actively involved in attempting to secure placements at the same time as working on the projects. These placements are highly competitive posts with students attending interviews and assessment centres with peers from other UK universities. Confidence and experience when going to these interviews is therefore an important factor in helping students secure positions. Figure 10 shows that most students felt that the experience of industrial projects was a significant factor in supporting their applications with, 40% of eligible students agreeing (or strongly agreeing) against 15% disagreeing. It is hoped that in future the validity of this perception can be backed up with measurable improvements to the take-up rate of these students by placement partners.

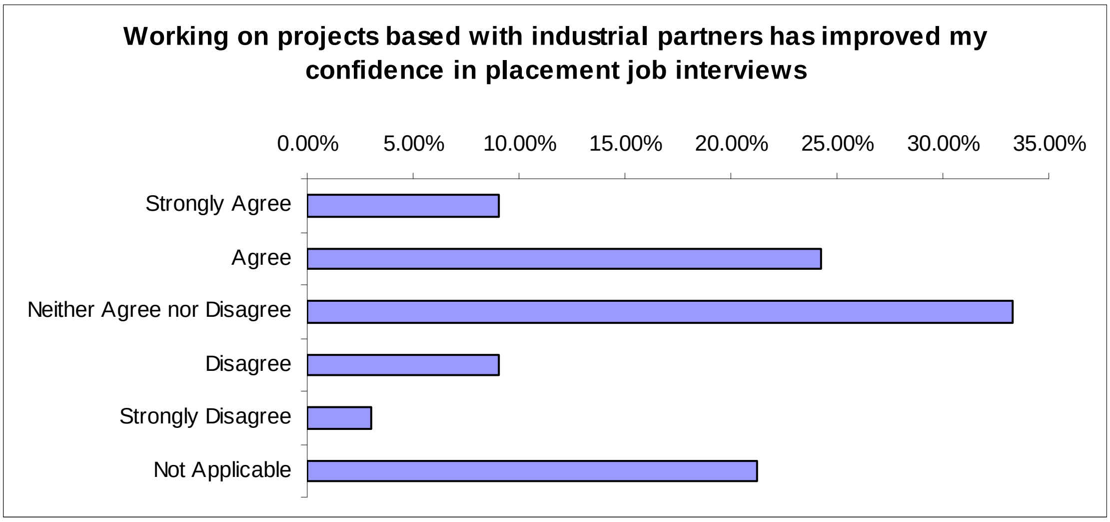

Figure 10. Student perception of use of industrial projects in improving confidence in placement interviews.

An issue which may also be of concern to tutors is how to phase in industrial involvement in the degree programme. It was shown earlier (figure 1) that students entering their degree had had little previous industrial experience and most, while having sound science and maths skills will have had little formal engineering training. This may make tutors nervous of involving such students in industrial projects for fear of their inability to cope and possible disappointment of industrial partners should results prove limited. None the less the students do appreciate industrial involvement with most in favour of early intervention. (Figure 11)

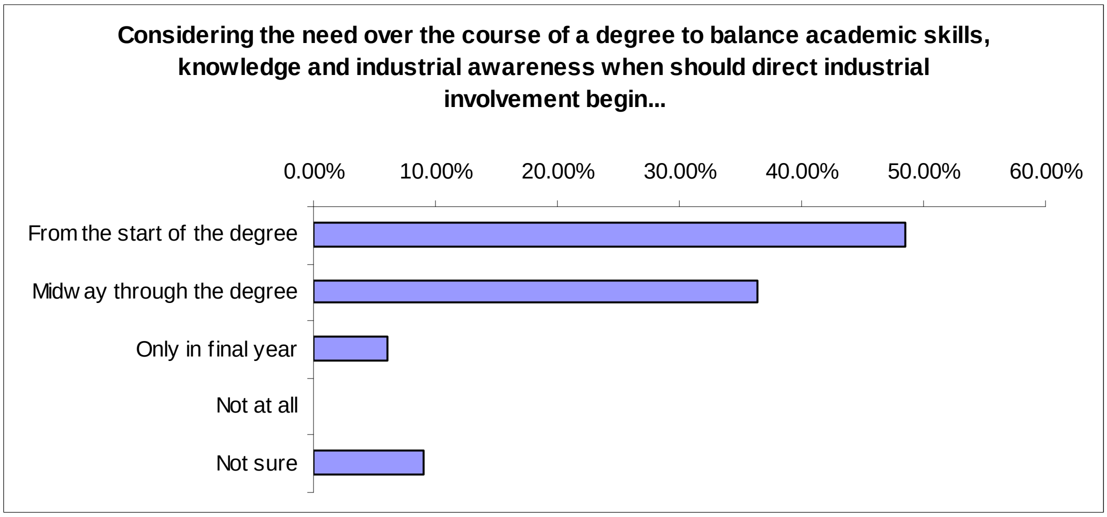

Figure 11. Student preference of when industrial projects should be introduced into a degree (based on English 3 year BSc/BEng degrees)

This is something we hope to address as we develop our programme, though careful management of 1st year projects will be required to ensure both students and company partners gain by the experience.

One of the key differences between the two projects experienced by the students was the nature of the project briefs with the medical project starting from a very open brief whereas the pneumatic has a much tighter project descriptor. Both represent scenarios which might occur in industry. Each of these offers different challenges, open briefs giving significant freedom to students but little steerage in early stages of the project. Tighter briefs offer significant constraints to the brief, limiting diversity but offering a ready framework to help start the design. Figure 12 showed that the students had no specific preference to which type of project they worked on.

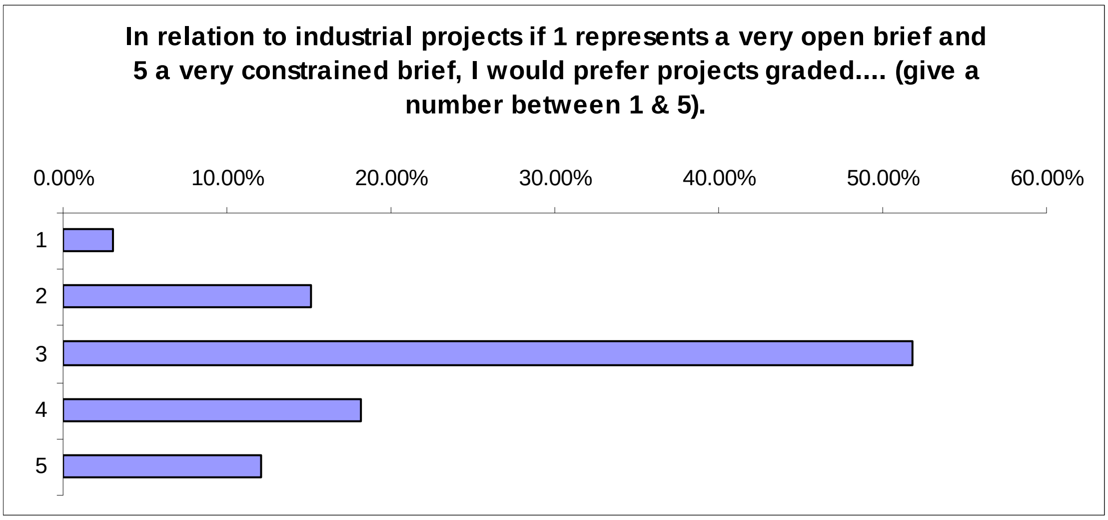

Figure 12. Type of project preferred by students

The pneumatic project featured prizes in the form of tablet PCs for the best group and bonuses in the form of data books for all students. These were offered by the industrial partner on an unsolicited basis. The medical project had no such bonuses. Students appreciated the gesture but it did not appear to be a major influencer. (Figure 13)

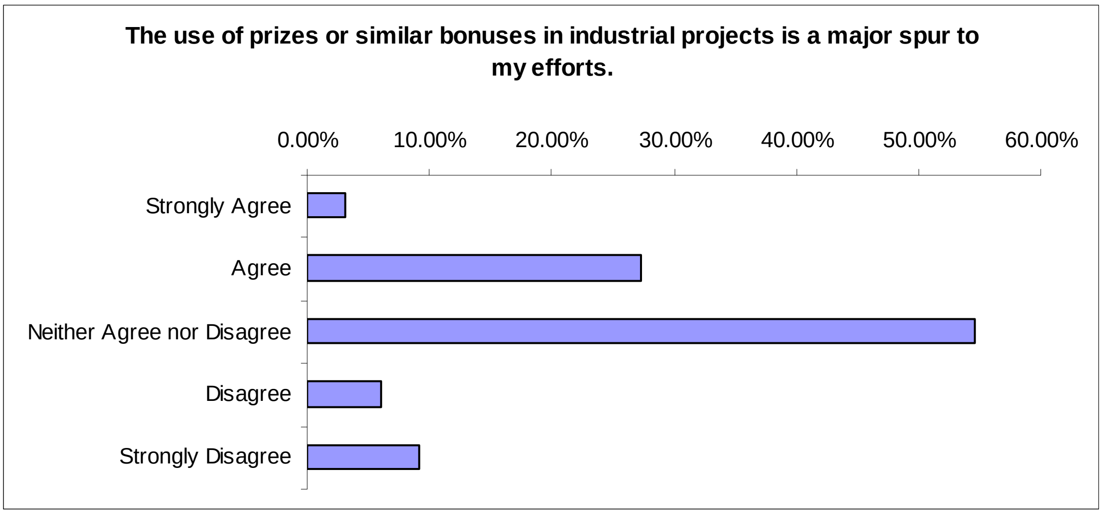

Figure 13. Student perception of prizes in industrial projects.

In addition to the survey questions table 2 shows some of the open format responses from students.

Table 2
Typical student comments based on experience of industrial projects

Due to the large amount of students, it is difficult to have enough contact with the industrial project leaders.
Very useful in my opinion and glad to see them in the course.
Gives a chance to see before a placement a more professional and perhaps realistic view of a future career.
Industrial projects have given me a chance to learn and experience aspects of engineering that I have not been exposed to else where in the course. Industrial projects have also given me a greater understanding of what is most relevant to industry and reinforced learning in other parts of the course.
The pneumatic project was very ambiguous at the beginning, and I feel this hindered progress with the project. Vital information was given in the final week during their visit and this changed everything and appeared to waste a lot of our time.
I enjoyed the NHS project, however I feel the pneumatic project is a gimmick with some nice hand-outs but that is about all.
Gives a sense of context for work done in class and gives an opportunity to apply our skills to a practical situation.
Found the projects to be challenging and rewarding
It is a great idea, and that i hope to see more of this type of involvement in the future...
Working on industrial projects within 2nd year give those who aspire to complete placement years the opportunity to see how similar companies operate and develop skills required in industry, whilst those who do not aspire to complete a placement year will still benefit from these skills which will compliment final year projects.
Ensure that the industrial project is suitable for all participants, there are some design students alongside the engineering students.
I support the industrial projects, however, they need to be more organised such as not having the engineer at sessions was frustrating at times.
Improved communication between the external company and students would have been beneficial.

While many of these comments are highly positive some more negative issues related to difficulties with the more tightly defined pneumatic project. The expectations of the company partner were very precise, namely a 30% reduction in production costs and so students felt the need for continual support from the company partner to check their assumptions and validate their concepts and this was often difficult to achieve quickly. By contrast with the medical project having a much more open brief, students were able to take more ownership and define their own boundaries.

Academic reflection

Both types of project worked well and the students appear to have benefitted significantly from the experience. The open and closed briefs did present their own challenges.

With the closed pneumatic project brief, the students' perception was very much seen as a project for a company rather than the students' own and as discussed above students were continually seeking further clarification on aspects of the project. Often these queries were very specific and could not be provided by the academics on the ground resulting in stagnation and uncertainty at some stages of the project.

The IPR issue was also quite notable in this project. IPR is an important element of the breadth of knowledge expected of graduate engineers and for students to gain practical experience of working to this was seen as valuable. None the less this was not a trivial process and drafting the agreement took considerable time. It also depended on every single student signing up to the agreement. Had any refused they would not have been able to participate and an alternative would need to be sought for these students.

The NHS project was much more open with no IPR agreement and little specific supporting information required to be given to the students. This openness however still needed careful management to ensure that the academics and industrial end user had a clear and consistent vision of the end goal and that this was conveyed to the students.

The very open nature of the project meant that several groups struggled to formulate their concepts. In internally run projects, pragmatism often dictates that individual projects are progressed to the next stage when not fully formulated to allow class coherence and ensure ultimate semester deadlines are met. In this project it was decided to adopt a more commercial approach, forcing students to revisit each stage until genuinely sound solutions were achieved. This caused some consternation among those students held back but was concerned an important move to encourage students to fully develop work at each stage of the product's development.

Industrial partner experience

The industrialists had a positive but not necessarily trouble free experience of the project. Both industrial partners, while having had some experience of final year and postgraduate individual project support were new to whole class project exercises at lower levels in the degree. This threw up challenges of not only large numbers but also a breadth of ability among the cohort and as a result the need to manage the weaker groups often proved worrisome to the partners. None the less the flip side of this was the stronger groups being able to provide the industrial partners with robust solutions to the challenges set.

CONCLUSION

Industrially tied, whole class undergraduate projects have been seen as a positive benefit by students. Students felt they were able to contextualise much of the work from lectures and internal projects while also felt better prepared to enter industrial placements.

There were however a number of issues related to both open and closed briefs which academics need to be aware of to help their students get the most from the exercises.

- Where a brief is open, it is important to ensure that a framework for the project still exists and all parties – academics, industrialists, tutors and students are aware of any boundaries, timescales and progression procedures.
- Where a brief is closed, there is a need to ensure that sufficient information is provided by the industrial partner from the outset and that communication channels allow for rapid clarification of details.
- Careful consideration of IPR issues is important. Neglecting IPR arrangements could cause issues should exploitable work result, however the time and effort needed to create acceptable IPR agreements should not be underestimated.

The work reported here is only based on a single one year's worth of projects with a single cohort of students. It is the intention to continue the reflective appraisal and development these whole class industrial projects. An important metric going forward will be the reflection of those students who have experienced placements following on from the industrial projects to determine what benefits were gained and improvements made.

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Biographical Information

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