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COLLABORATING WITH IMPACT: A LIVE INDUSTRIAL PRODUCT DESIGN PROJECT

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ABSTRACT
This paper presents work undertaken by 2nd year BSc Product Design students on a live industrial project with McGee (a construction company) and outlines the success, academic benefits, merits and future work undertaken as a result. The project was initiated by the McGee Group who initially approached the Product Design department at NTU. The collaboration was planned 6 months in advance, with a number of presentations, demonstrations and a site visit. Initially introductory presentations from both McGee and the Metropolitan Police were given in relation to cyclist safety around construction vehicles in London. Following this a demonstration of the vehicle in question was combined with an 'Exchanging Places' cycle event at the university. Two weeks into the project students were then taken on a site visit and briefing to enhance their understanding of the situation. McGee offered a cash prize for the winning team as an incentive and the project was run over a 5 week period as a group based design project in a studio environment and was additionally supported in the students applied technology classes. At the end of the project students' presented their work to representatives from McGee and the Metropolitan Police and the students' work was subsequently displayed and exhibited in the McGee headquarters before a decision on the winning teams was announced.
McGee representatives were very impressive with the student's efforts and outcomes and have since filed a patent jointly between the company and students for the winning solution. This solution is now being developed into a production-ready product by a final year student in collaboration with McGee. This innovative collaborative project resulted in McGee and Nottingham Trent University being shortlisted for and receiving two high commended awards at an industry safety award ceremony as well as a number of press releases in the local and trade media. However, the notable impact was the marked improvement in the students' motivation and attainment on this particular project, which will be explored in detail.

Keywords: Collaboration, Industry, Motivation, Impact, Product Design, Cycle Safety, Multidisciplinary.

1 INTRODUCTION

"*Between 2008 and 2013, 55 per cent of cyclist fatalities in London involved a heavy goods vehicle. A disproportionate number were construction vehicles*" (Construction Logistics and Community Safety. 2015:pp1).
An investigation conducted by the Transport Research Laboratory (TRL) for Transport for London (TfL) found that blind spots on construction vehicles were typically larger than with general haulage vehicles (Helman et al. 2013). In particular the report notes poor vision to the front and left when driving a construction vehicle (Helman et al. 2013). This finding in particular is now communicated through Exchanging Places Events run by the Metropolitan Police (Metropolitan Police 2017; Metropolitan Police 2013) and McGee.
Whilst manufacturers of heavy goods vehicles have attempted to address this though redesign of the vehicles such as the low-cab refuse vehicles, such innovation is unsuitable for construction related vehicles which require sufficient ground clearance to go off road onto construction and tipping sites. Other measures have been implemented such as additional mirrors (classes IV, V and VI), which are required under the European Directive 2003/97/EC and became law in 2009 (VOSA 2008) and are

shown in figure 1. The Construction Logistics and Community Safety body (CLOC's) also recommend audible sensors and vision cameras to be utilised to eliminate or minimise blind spots as much is practically possible (CLOCS 2015). All these measures are already employed on McGee's fleet and whilst such methods improve visibility there are still limitations, particularly in identifying the blind spot for tipper drivers when turning left.

Figure 1. Image of additional mirrors

McGee sought the assistance of the BSc Product Design course at NTU through their Marketing and Communications manager who was herself a former student of the university, to seek a novel solution to this issue of safely turning left in city traffic around cyclists and pedestrians. A meeting was arranged at the university by McGee with one of the owners in attendance to discuss the proposed collaboration. From this meeting a briefing document was drawn up by the McGee stating what would be delivered when and assigning cash prizes and IP rights between the McGee and the winning students, refining the project over the course of two meetings.

2 DELIVERY OF THE PROJECT

To launch the brief representatives from McGee and the Metropolitan Police delivered presentations outlining the above problem to students as well as the difficulty of developing a solution that is both road and construction site suitable. These presentations were interspersed with videos that demonstrated near miss scenarios and the extent of the blind spots on such vehicles. Following these introductions the brief was delivered. Students were taken outside to a new Volvo XF4 McGee tipper wrapped with vinyl promoting the partnership, see figure 2.

Figure 2. Exchanging Places Exercise

Students were invited to look at, get into, measure and ask questions about the vehicle from the two Police officers and McGee driver present. One of the officers led the students through an 'exchanging places' activity, inviting the students to take the position of the driver in the cab whilst the driver brought a bicycle alongside so students could fully appreciate the difficulty of seeing cyclists and

recognise the blind spots despite the vehicle being fitted with a high level of equipment including the standard 7 mirrors and additional 4 video cameras and ultrasonic sensors.
Following this students were given the key contact details of representatives from McGee and the Police and asked to undertake a week of research and initial idea exploration for the studio session with the tutors the following week. Two weeks into the 5 week project McGee arranged a coach to take the students to one of their sites on the outskirts of London to view the tipper in its off road environment. This visit was particularly beneficial as it gave the students the opportunity to reflect on the brief and their research and then have a second opportunity to ask further questions. It also gave the students another opportunity to see the tipper and spend a lot of time crawling all over the vehicle with tape measures whilst interviewing the driver. This visit demonstrated to the students the importance of ground clearance as the tipper was deliberately stuck in the mud to illustrate the difficulties faced onsite, illustrating to the students the need to consider solutions that didn't impinge on the vehicle's ability to operate effectively off-road, a key reason why existing innovations in coaches and refuse trucks couldn't be transferred to construction vehicles. Students also were taken for a tour of the site in a minibus and taken through the mandatory vehicles washing facility to indicate the water and pressure stress a solution would need to endure. This trip in particular was a turning point for many of the projects, helping the students to identify solutions that would and wouldn't be feasible. Following the trip students had two further weeks to develop their solutions with the studio tutors and make use of their technology laboratory sessions and workshop time to prototype and model their solutions. This was particularly invaluable to the winning team who used their hydraulics and pneumatics laboratory session to mock up their solution.

2.1 Student solutions

At the end of the 5 week project 12 student teams presented to a panel consisting of a Metropolitan Police officer from the cycle safety team and representatives from McGee including their Transport Manager, Marketing and Communications Manager, Health and Safety Director and Head of IT and Communications. These presentations by the students also formed part of their assessment for the project and included Q&A from the representatives. The students' presentations, presentation boards and feasibility reports were collated electronically and sent to McGee so that the owners could review the work and an exhibition of the work was put on for staff at their Headquarters. McGee then held a judging session within the company before deciding the winning teams. Initially McGee were planning to give the wining student team a prize of £2000 to share, however the owners were so impressed with the level of work produced that they decided to award additional cash prizes to the top 5 teams. The 1st prize team were awarded £2000 for their 'Flexi-Flag' concept shown in figure 3. These students also share 50% of the patent and their solution has continued to be developed.

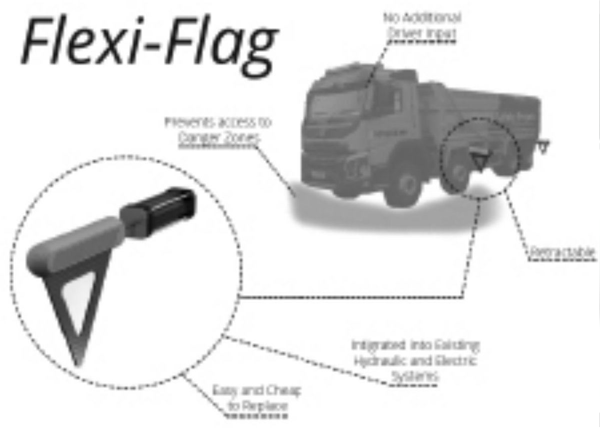

Figure 3. Winning Solution - Flexi-Flag

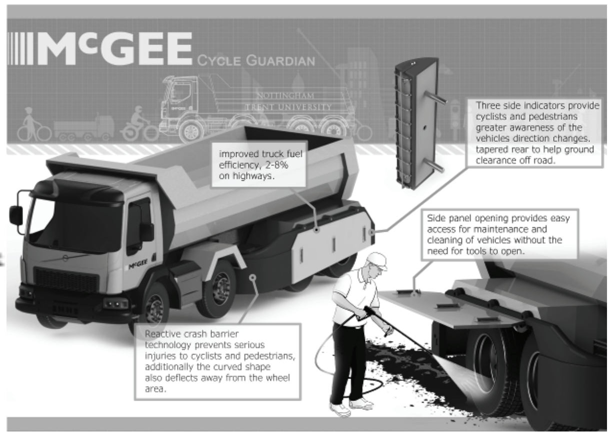

Figure 4. 2nd Place Cycle Guardian

2nd place and prize of £1000 was awarded to the 'Cycle Guardian' team as shown in figure 4 and their concept of a flashing strip indicator down the side of the tipper will be incorporated with the Flexi-flag on a McGee tipper. 3rd place and £500 was awarded to a team of two students and their innovation, the 'Bubble Guard', which was highly praised by the judging panel, for its level of innovation and technicality. However as it was unable to be retrofitted McGee offered the students an introduction to

Volvo trucks UK who invited them to present their concept to them at their HQ. The solution was very well received with Volvo's UK Director for Aftermarket and Customer Support commenting:
"To see the concept that the team have developed with the 'Bubble Guard' is an exciting innovation in continuous improvements towards traffic safety that can only add value to our collective ambition. Another positive for the UK is seeing the talent in design and engineering coming through at Nottingham Trent University" (Attwood 2016).
The concept has since been passed on to Volvo Sweden who are considering the feasibility. 4th and 5th place teams were given £200 respectively. In addition all winners were taken out for a meal by McGee to celebrate following the award ceremony.

2.2 Impact

Shortly after the awards ceremony a Patent was filed on the winning student team submission which was drawn up jointly in the names of McGee Ltd naming the individuals students as inventors granting them a stake of 12.5% each in the invention (McGee Group et al. 2016). Furthermore the collaborative project between McGee and NTU was highly commended in two categories in the Brake fleet safety awards for both innovation and partnership (Brake 2016).
However from an educational perspective the most interesting development was the significant increase in the student attainment on the project. The aggregate mark across the cohort of 42 students who undertook the project in 12 teams was 63%, which is a significant increase when compared to the aggregate marks across the other 6 projects as shown in Table 1 and the overall Studio year aggregate mark.

Table 1. Studio Project Marks 2015-16

	Project 1 Individual	Project 2 Group	Project 3 Individual	McGee Group	Project 5 Group	Project 6 Individual	Aggregate Studio mark
Mean	59.3	57.9	59.5	63.0	58.5	51.7	58.1
Aggregate Deviation	+1.2	-0.2	+1.4	+4.9	+0.4	-6.0	
Median	58	65	62	65	52	52	60.5
Mode	55	65	65	68	52	52	62.7
Standard Deviation	9.9	13.4	10.4	7.5	9.4	13.5	7.6

When considering this upward trend for the McGee project, it is worth noting that the project was double marked and moderated by the two academic tutors, one of whom has taught on the 2nd year Integrated Projects element for the past 3 years therefore ensuring consistency. Furthermore these marks were given and moderated before the feedback from McGee was received so the uplift can't be attributed to a subconscious response to the industry praise. Scrutinising these results further, the McGee project also has a much lower standard deviation in comparison to the other projects undertaken by this cohort of students, suggestive of a smaller grade range with typically higher results across the cohort when compared to other projects. This could be dismissed and attributed to the fact that this was a group project, however the other two group projects 2 and 5 do not show the same trend as care is take on all group projects to ensure transparency and fairness in the marking. This is achieved by asking the students to peer assess their team members and identify in their report each individual's contribution. In addition to this, the tutors request a separate sketch work submission for each student. Therefore the same group mark would not be applied equally across all members but rather adjusted in light of their individual contribution. So it is the author's opinion that the increase in attainment is instead related to the educational experience of the students during the project.

3 REFLECTIONS

It is the opinion of the academic staff that the increase in attainment is largely due to increased engagement and motivation amongst the students, because the level of the work produced was better researched, supported and of higher intensity and development than that which was previously seen in their earlier or even later projects from the cohort. Possible reasons for this increase in motivation are considered below:

3.1 Real World Engagement

The students understood and personally related to the brief; recognising that it had a real life application that could benefit society, key factors in motivation and engagement amongst Net-Generation learners (Watkins 2014). However, whilst this surely has an effect, this cohort of students undertook other live briefs addressing disability and design for the developing world without this level of impact on attainment.

3.2 Financial Reward

It was suggested by the students that the financial incentive played a role in the student's motivation. Whilst monetary prizes from companies had been offered before, they are typically smaller amounts. However, this doesn't fully explain the motivation as initially it was made very clear that the prize was for the winning group only and so it is debatable how much of an effect this would have had as surely mid project some students would have realised that there were teams with more feasible ideas than theirs. However, the financial incentive did bring a new level of competition to the cohort.

3.3 Experiential Learning

The way that the project was supported by McGee and the level of interaction, immersion and dissemination of information was seen by the both the students and tutors to be very beneficial and a number of students commented about how much they had enjoyed it because they felt that they were engaged in a more in-depth project. This was because the information given by the company enabled them to start at a more advanced stage and dismiss unfeasible ideas earlier on in the project than usual.

3.4 Importance

The generous nature of the company and their expectation that the students would be successful also affected the academic staff attitudes, especially due to the external press and marketing involved. Personally as the lead tutor and course leader it created a sense that the project was too big to fail and this importance passed onto the students. As a result of this and the factors mentioned above all the students were actively engaged in ensuring the success of the project and collaboration. This sense of cohesion and purposefulness amongst the student body hadn't been seen before in the cohort even with the two national competitions briefs they had previously undertaken.

In reality it is likely that it is a combination of the all of the factors above that lead to project success.

4 FURTHER WORK

The 'Flexi-Flag' concept has been developed further by a final year student as part of his Major Study Project. This student has developed the existing Flexi-flag concept for manufacture and will produce a fully working prototype for testing on a McGee tipper. The student has sought type and regulatory approval and it is hoped that once prototyped and tested the Flexi-Flag will gain approval to be fitted to the McGee fleet of tippers and be able to be sold to other operators.

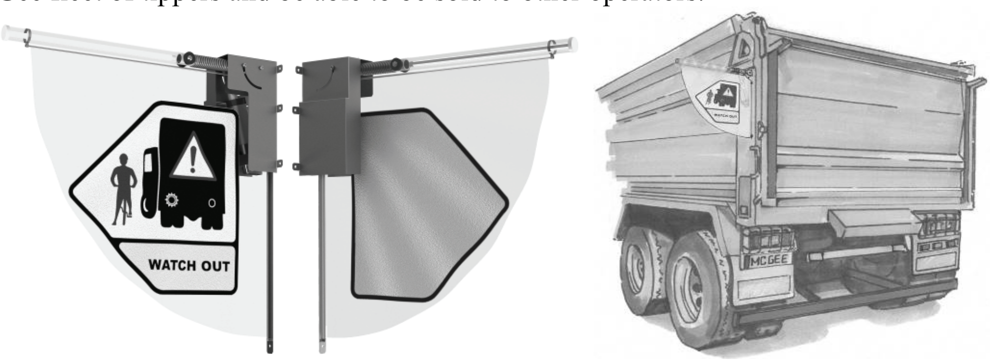

Figure 5. Images of current development of Flexi-Flag by Fraser Ewan

A benefit of this approach is that the differences between the final year work and second year solution can be used in future as a teaching aid to help 2nd year students recognise the difference between the developed concepts they produce and the fully defined manufactured solutions expected in final year.

McGee has also continued to collaborate with the course, with the next cohort of 2nd year students undertaking a project that sought to address Health and Safety in relation to man and machine interactions on building sites in February 2017.

5 CONCLUSIONS

This collaborative project was hugely enjoyable both for the students and staff involved. Whilst the students delivered what we hoped they would, the ongoing impact and interest that this collaboration has had amongst the press, cycling bodies, construction sector and automotive industry was rather unexpected and surprising, but very welcome.

The secret to the success of the project can't be easily described as a single entity nor is it I suspect completely replicable. However, there are a number of factors that have been identified and will impact future collaborations. The benefit of working with a different discipline and seeing their world was hugely inspirational for students and staff alike. Equally the benefits of experiential learning, whether this was being able to explore the inside of the vehicles or observing a construction site, is of immense value to students and whilst we conduct other field trips, having visits so directly related to a project has been invaluable to the students' engagement.

Furthermore, the opportunity to pause and reflect for the students before another opportunity to gather data is incredibly useful in helping them to formulate the right questions and investigations.

One key observation from a tutor involved was the importance McGee placed on the project. The time they invested in visits with numerous senior representatives from a large and successful London based company, not to mention the involvement of Metropolitan Police to a group of 2nd year students in a University in the Midlands, suggests a tremendous amount of value being placed not only on the project but also the students undertaking it. This coupled with the prize money available, must have made the students feel that their potential is valued. Perhaps this was the motivating factor that led to such purposefulness for the cohort.

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