Industrial Placement Report

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with

DCA Design International
Mechanical Engineering
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Summary:

Working as a mechanical engineer in DCA Design International, a leading product design consultancy that specialises in medical, consumer, industrial and transport sectors.

Main roles and responsibilities included device testing, data processing, report drafting, conducting ANSYS and Moldflow FEA, CAD design, rapid prototyping, supplier liaison and market research.

A variety of project work has developed my existing CAD skills, as well as acquiring new skills such as Python and VBA programming.

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List of Symbols & Acronyms

Term or Abbreviation	Definition
DCA	Design Consultancy
CAD	Computer Aided Design
PDM	Product Data Management
VBA	Visual Basic
FEA	Finite Element Analysis
pFMEA	Production Failure Mode Effects Analysis
dFMEA	Design Failure Mode Effects Analysis

Introduction

DCA Design is a Warwick-based product design consultancy, specialising in four market sectors: ‘Medical and Scientific’, ‘Commercial and Industrial’, ‘Consumer’ and ‘Transport’. Founded in 1960, it now employs over 140 designers, engineers, researchers, managers and technicians. DCA works with clients ranging from global multinationals to startups and are proud to boast over ninety international design awards.

Figure 1. The AllStar Pro Reusable Insulin Injection pen, a flagship insulin injection device designed by DCA.

Officially placed as a ‘mechanical engineer’, day to day roles included designing, CAD modelling, drafting drawings and reports, testing and prototyping. However, due to the variety of projects DCA is involved in, the activities of a mechanical engineer vary greatly and may even branch into other disciplines. This is reinforced by the fact that DCA applies a very multidisciplinary philosophy to its workplace, with different disciplines working side by side, often grouped by market sector rather than department.

Projects

Medical Injection Devices *(August – June)*

Involved in the testing and development of an insulin injection device. Various torque, force, drop and creep tests were conducted with the aim to determine a suitable combination of materials for the device's parts. As testing all combinations would not be feasible, a test plan was designed according to the Taguchi Test Method. This would allow testing to use a reduced number of parts and then statistically analyse which parameters had the greatest effect.

Following the various tests, a large amount of data was generated. Python and VBA scripts were written to aid in processing the data and provide an input to the statistical analysis in Minitab. Once the statistical analysis complete, conclusions were drawn and a full report written, reviewed and approved for sending to the client.

In parallel to testing and physical validation, alternate designs were explored and brainstormed. Many of these alternate ideas were compared and validated using ANSYS and Moldflow FEA software. ANSYS was used for structural analysis, giving insight into how components would respond to applied loads during use. Moldflow was used to assess the whether the redesigned feature would mould satisfactorily in pre-existing injection moulding tools.

As the device's design evolved, updating the design and creation of new test fixtures was necessary. The PDM CAD system was especially useful for this task as version control of CAD data was essential. By fully using the PDM's features, the correct changes were made to the components and assemblies and drawings were updated with ease. Once designed, drawings and job orders were drafted and passed on to the machining and additive manufacturing facilities. Part turn-around time was in the order of days due to these facilities being in-house, meaning it was possible to closely oversee production and iterate if necessary.

In parallel to the update of test and assembly fixtures, a tolerance analysis study was conducted on the device's mechanism. An Excel based database created by DCA was used to generate tolerance chains and appropriate dimensions updated from CAD design. The appropriate limits were then selected according to the type of interference that was required, while also considering manufacturing technique, and risk to functionality. Chains with unsatisfactory tolerance limits were highlighted and a change in CAD geometry carried out. A final tolerance analysis document was drafted for the client in preparation for a full industrialisation analysis.

Further to the tolerance analysis, various meetings were organised to carry out a functional and manufacturing risk analysis (dFMEA and pFMEA). These involved meticulous reviewing of any possible failure scenarios of the device in use and any possible failures occurring on an automated assembly line. A severity and likelihood scoring system was used to flag up potential issues to the client and industrialisation partners. While a student's contribution to these meetings was minimal (prior experience in automated assembly lines was a key part of determining pFMEA risk), the meetings proved to be a valuable learning experience for how to methodically produce a risk assessment.

Work was also conducted on a different medical injection device which was in an earlier design phase. Preliminary CAD had been drafted and calculations were now being carried out with FEA and first principle math models. Having been tasked with updating CAD models for injection moulding, I was able to apply the principles of draft angles and tooling shutoffs to a real scenario. In addition, any design changes were to be verified with the math models to ensure they did not negatively affect the functioning of the device.

Sustainable Polymers *(July – March)*

This project was an open ended and year-long internal research assignment, investigating alternative materials to classic petroleum-based polymers. This was part of a larger, overall sustainability focused group at DCA, looking into various ways of improving the company's sustainability knowledge. Running in parallel to my project was a second similar project developing a case study for making previously designed products more sustainable. This was assigned to two summer students and would then be handed over and integrated into the year-long project.

The project began with some overall market research. This involved general online searching and gathering of reference material, starting discussions with more experienced members to gather previous expertise and opening communication with external suppliers.

The magnitude of the 'sustainability problem' proved to be very challenging to narrow down, so clarification and assistance was sought from the project manager. Following some discussion and feedback, the project direction was clarified.

This project in particular has provided a number of interesting opportunities. The first of which is presenting the work in a department wide "Forum" with the aim of spreading awareness and initiating conversation with other mechanical engineers, designers and researchers. It has also given me the opportunity to travel offsite to attend a seminar presented by a company selling sustainable solutions. Similarly, I have been given the opportunity to organise visits from suppliers to present at DCA.

Internal / Casual Work *(Year-long)*

As well as client and internal projects, smaller, casual jobs often arise. One such example was the redesign and building of a new fixture to display a product at a Careers fair. This involved the use of the 3D printers and workshop to quickly (and inexpensively) create the part.

Another afternoon of work was dedicated to brainstorming some ideas to redesign a component to allow people with arthritis to easily operate the device. The week after, a spare moment was dedicated to upgrading the HTC Vive VR set with a wireless module.

I had the opportunity to keep working with this device in a period of light work. I was tasked of exploring the viability of using 'foveated rendering' with the headset. This required a custom build of Unreal Engine and some basic C++ coding, areas which I did not have experience in, although were of particular interest to me and have inspired me to pursue this personally.

Training & Mentorship

Critical training in areas such as Health & Safety, IT and Brand Identity were delivered within first week of arrival. Engineering specific training was provided for the use of force stands, torque stands, optical measuring systems and their accompanying software.

A Solidworks Passport was provided, giving access to the full suite of training courses provided by SolidSolutions, but has yet to be used. As these training courses take place offsite and often span a number of days, time off work is given provided no client-related work is urgent.

Training for other software (including ANSYS, MoldFlow, Keyshot, etc.) is often provided with a pre-prepared PowerPoint presentation. These are often drafted by more senior engineers at DCA, and therefore conveniently only focus on features that will be necessary for work specific to DCA.

Official mentors are not assigned at DCA, and no single person is a direct ‘supervisor’. A ‘buddy’ is assigned to each placement student, although this has proven to be more for non-professional guidance during the disorientating first weeks of placement. Once settled in, placement students often turn to any of the five ‘skill leaders’ for professional guidance or questions. Quarterly meetings are also organised with the assigned ‘buddy’ to discuss progress and any new work that has been carried out.

Quarterly forums are organised by department. These are afternoons in which a department gathers, and presentations are given on any interesting or challenging work that has been carried out. They are a great source of inspiration, helping spread knowledge and information amongst engineers.

Social & Recreational

DCA's offices are based in central Warwick, a small, historic town. Employees generally live in the outskirts of the town or in the neighbouring city of Leamington. Those used to a more exciting city centre and vibrant night life may find Warwick lacking in social and recreational amenities, although the Leamington and the nearby city of Coventry are easy to reach from Warwick and can provide much more variety.

Internally to DCA, there are a large number of activities that are organised. The most regular of which are weekly sports activities that are often subsidised by DCA such that they are near-free for employees. Badminton, squash, climbing and other sports are organised, with new suggestions always welcome. Activities such as board game nights, bowling, or outings are also organised but less regularly. DCA has a number of yearly events which are often tradition such as a (very competitive) karting race, an (equally competitive) baking competition, and a Christmas Meal.

Covid-19

Following the outbreak of the Covid-19 virus and the lockdown order, all DCA's employees were issued with a company desktop PC and peripherals to be able to work from home. DCA's IT team proved to be very effective, setting up all the necessary infrastructure for the company to keep functioning with almost no reduction in productivity.

Not all work was done from home however, as physical validation testing was still required. A core number of staff continued working from the office, and people conducting testing (such as myself) made visits to the office when necessary. Social distancing and a rigorous logging of in person visits to the office were put in place to minimise risk of infection.

Conclusions

From a technical perspective, working in the ‘Medical and Scientific’ market sector has allowed me to apply and refine the technical skills I have gained at university. While manual testing and report writing does become somewhat monotonous, effort is made to give students opportunities to develop new skills within engineering. The nature of the industry means there will be times when little work is available. When this happens, internal projects ensure that students are not left for long periods without work.

I have also vastly grown professionally at DCA, gaining much needed confidence and time management skills. Being part of a live project team has made me appreciate the roles that people play in bringing a project to completion and the importance of clear communication in doing so. The close proximity to senior engineers has provided me with insight into how experienced engineers approach the discipline, strengthening my knowledge in engineering methods and testing best practices.

Unfortunately, the placement did not provide as many opportunities for creative design as I had hoped for, considering this was a design consultancy. This may be owing to the fact I worked in the medical sector where changes are slow, and documentation is very important, but it remains an issue to be highlighted for future placement students. The possibility of working on exciting new projects exists, but it is unlikely for a student to be place on it for a significant amount of time. In addition to this, I was not able to experience working with other disciplines (engineering or otherwise), again due to the nature of medical work.

The placement has had a very positive impact on my personal development. Thanks to the dynamic and positive attitude of my co-workers, I have undertaken a number of personal projects outside of my comfort zone, knowing I can easily ask for advice. In addition to this, weekly sports activities and the occasional company outing ensured the social aspect of the placement was adequate.

Acknowledgements

I extend my gratitude first and foremost to James Senior, who went out of his way since the day I arrived at the company to make sure I fit in and was comfortable with the work I was given. I also thank my project team and namely Rob Veasey for their trust and patience, making it a pleasure to work with them. Last but not least, I thank Blake, Dwane, Dan and Mark for great conversations and all of DCA for making the office a friendly place.