INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
8 & 9 SEPTEMBER 2011, CITY UNIVERSITY, LONDON, UK

PRACTICE BASED LEARNING FOR AUTOMOTIVE ENGINEERING DESIGN STUDENTS

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ABSTRACT
The automotive industry combines a multitude of professionals to develop a modern car successfully. Within the design and development teams the collaboration and interface between Engineers and Designers is critical to ensure design intent is communicated and maintained throughout the development process. This study highlights recent industry practice with the emergence of Concept Engineers in design teams at Jaguar Land Rover Automotive group. The role of the Concept Engineer emphasises the importance of the Engineering and Design/Styling interface with the Concept engineer able to interact and understand the challenges and specific languages of each specialist area, hence improving efficiency and communication within the design team.
Automotive education tends to approach design from two distinct directions, that of engineering design through BSc courses or a more styling design approach through BA and BDes routes. The educational challenge for both types of course is to develop engineers and stylist's who have greater understanding and experience of each other's specialist perspective of design and development.
The study gives examples of two such courses in the UK who are developing programmes to help students widen their understanding of the engineering and design spectrum. Initial results suggest the practical approach has been well received by students and encouraged by industry as they seek graduates with specialist knowledge but also a wider appreciation of their role within the design process.

Keywords: Design, concept engineer, engineer, practice based learning, automotive design, stylist

1 CONTEXT

Increasingly modern automotive companies are developing more distinct cross-disciplinary roles within their design teams. Jaguar Land Rover Group have developed the new role of a *Concept Engineer* to work alongside the more traditional *Automotive Stylists* and *Production Engineers.* This additional role is an important response to the increasingly demanding design and development process of modern cars.
The design intent of early concepts needs to be protected as the process progresses into pre-production engineering, the transition from stylist concepts into engineering and production needs to guard against stylist's and a dilution of design. This then is why the role of *Concept Engineer* is so crucial to both understanding the various stages of the styling-to-engineering spectrum as well as communicating with all stakeholders during that journey.

2 METHODOLOGY

Examples of best practice from the automotive industry and academia have been used as case studies to compare and contrast approaches with the *Concept Engineer* role as a focus.
The industry cases study highlights the role of *Concept Engineer* at Jaguar Land Rover Design Studios in Gaydon, UK. A position developed to promote faster engineering and design decision making and communication.
The two academic case studies approach the role of the *Concept Engineer* from different ends of the Design-to-Engineering spectrum allowing the two perspectives to be compared as well as the current industry practice to be used as a reference point for best practice.

The two academic case study courses:

- MDes and BA(Hons) Automotive Design, Coventry University. (Styling/Design focus)
- BSc(Hons) Automotive Product Design, Aston University. (Engineering/Design focus)

The two courses selected allowed for a clear comparison of the two different approaches to the design process to be compared across the engineering and design spectrum.

3 INDUSTRY PRACTICE CASE STUDY

A case study with Jaguar Land Rover (JLR) shows how the recently appointed *Concept Engineers* work in the design development process alongside traditional car *stylists* and engineers. This role has been developed to address the need for a coherent conversion between creative styling and creative engineering, each enhancing the other.

The design process used by Jaguar recognises the different technical inputs required for a product to be successfully developed in a competitive market place. The technical engineering considerations are essential, ideally being integrated early with the more subjective emotional aesthetic visions of the stylists. The stylists design vision can often be vulnerable to adjustment and compromise as other stakeholders can push towards different agendas, such as technical production pressures that may not always follow the stylists' pure vision [1].

However a cohesive aesthetic solution is a very valuable outcome in terms of design impact in the market and hence commercial success. JLR recognise this sensitive mixture of the technical as well as stylistic input during the development process.

Having employed a working ethos of understanding and value throughout that spectrum JLR have developed the *Concept Engineer* role to ensure the technical and aesthetic vision is delivered in a coherent way.

JLR have a history of challenging design convention, they have pioneered the manufacture of aluminium body technology for Jaguar cars and introduced many innovations in off road technology into Land Rover vehicles. Attention to design and styling have also been a primary concern and the concurrent approach of placing *Concept Engineers* and *Stylist* in the same location seems to be a determining factor in their ability to continue to produce new vehicles quickly that match consumers expectations.

This collaborative, joint way of working permits challenges proposed by engineering development to provide radical opportunities for new automotive forms. New industrial process developments also impact on form and engineering; introducing curved glass for the 'day light opening' (DLO) has also altered public perception of automotive design.

Other factors will have an increasing influence on the automotive industry in the future; increasing use of telematic devices, that prevent road collisions, could conceivably see the removal of air bags, crumple zones and other safety devices in vehicles. Peck and Verlinden [2] describe the opportunities for dramatic change in automotive design as the complexity of telematics is ordered and incorporated into design first principles rather than conventional thinking. These imminent proposed changes permit designers to take radical approaches to form and appearance. There has long been a dialogue between engineers and stylist's, where a 'best compromise' solution is presented to the buying public. Different requirements for those involved with design can be characterised by the following statement by Roger Watmore, an engineering tutor, when guiding styling students to look for a best compromise solution:

> 'You want your windscreen to have a low angle, I'm telling you it has to be at the correct viewing angle to work – it's your job as an Industrial Designer to make it be as I said but somehow look like you want it to be.'

By changing many different variables in an iterative process, designers from both backgrounds can find successful solutions quickly when they occupy a shared physical space and work concurrently, the Jaguar model highlights the value of bringing design and engineering together both physically but also through a common language through the *Concept Engineer.*

4 ACADEMIC CASE STUDIES

4.1 The Stylist/Designer Approach: Coventry University

The Coventry university course has a long history of producing car designers and stylist. The course focuses on the more creative, conceptual and sculptural aesthetic aspect of the car designer's role, with additional knowledge of the more technical elements of car design supplementing this.

Buying a particular car is now very much dictated by a sense of branding and style; identically performing machines from Volkswagen Audi Group (VAG) are available with only styling changes; a range of prices cover market demand and expectation. At Coventry the course has had an Engineering and Ergonomics requirement (25% for each element) for the past 20 years, reflecting the need for 'styling' designers to be able to speak with authority to other professionals and collaborate with them to provide new and innovative solutions.

This approach produces a range of differing perspectives for students in that the level of commitment from 'stylists' to hard facts and difficult decisions that may be required is variable.

However challenges to engineering conventions, custom and practice can be made with this joint working with good results.

This practiced based learning approach has been used in the more Art and Design focused courses for some time; however the trial also compares the approach with a more traditional engineering style.

As such introducing the approach from the engineering perspective is a new venture for Aston University.

At Coventry much of the three dimensional understanding required for car 'styling' is introduced and fostered in single module called *3D Form Development and Presentation*. The aim is to provide an appreciation of three-dimensional forms related to the sensitivities of automotive and transport design. Appraisal of spatiality, surfacing quality and surface connections and their representation are studied and practiced. Automotive styling clay, high level surfacing software and free form sketching are used to mutually support thinking and understanding.

Part one is a five-week intensive experience of automotive 'hard styling clay', where abstract free-forms are derived from visual examinations of human or animal heads. Formal automotive clay modelling is described in detail by Yamada [3], however here a more free-form approach is used to promote creativity during modelling, Owen [4] (figure 1).

Simultaneously instruction using industry-standard surfacing software (Autodesk Alias Automotive™) begins and culminates in self-selected design work. Sketching, photography and diagrammatic representations support both the physical and digital phases.

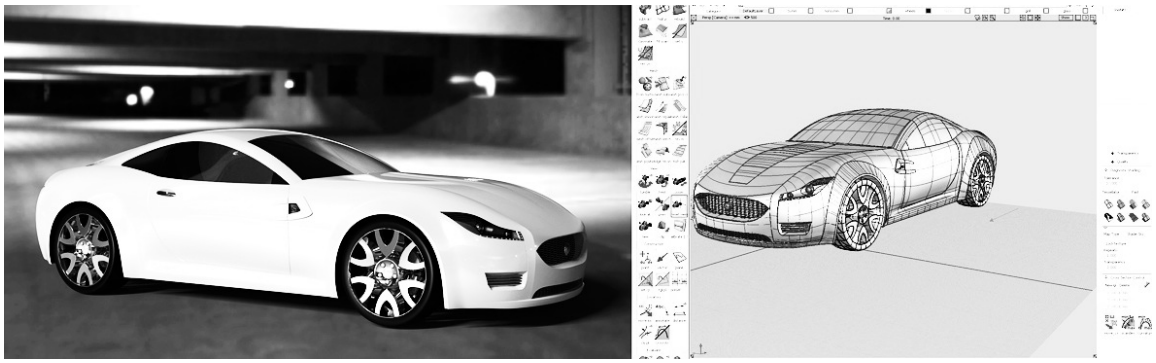

Figure 1. Level 2 Design student CAD modelling at Coventry University

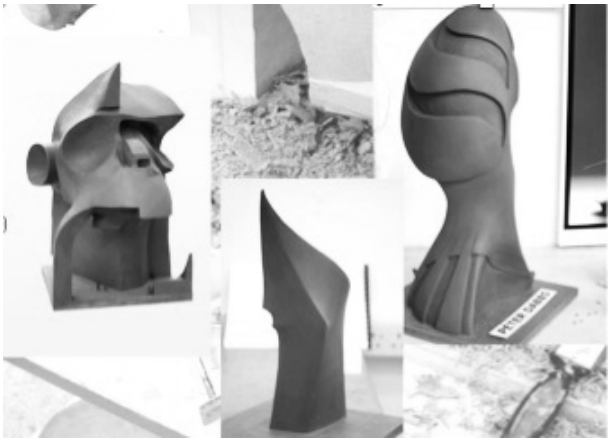

Figure 2. Realisation and sketching of the Clay Heads project at Coventry University

Students and observers see this work as successful in building aesthetic and sculptural understanding (figure 2).
Over 100 students from Product, Automotive and Transport courses work in the same physical space where a sense of belonging to a group is encouraged. The approach is to encourage the conditions where a 'threshold concept' is established that focuses on spatial understanding, permitting further intellectual growth and release form convention. Bull and Tovey [5].
The use of clay to sculpt scale models is a specialist automotive technique, which exposes students to a very immediate and responsive learning experience. Coventry has a focus on the styling end of the design-to-engineering spectrum, but also recognises the need for the Concept Engineer and the role of communicating design intent across that spectrum. As such students are also exposed to and involved in more technical design challenges with ergonomics and vehicle packaging an essential part of the course.

4.2 The Engineer/Designer Approach: Aston University

Aston University has a strong engineering history with the case study programme based within the School of Engineering & Applied Science.
The Aston Design courses are closely aligned to the engineering programmes with much of the curriculum delivered to mixed groups of designers and engineering students. This deliberate mixing seeks to break down the subject boundaries and expose undergraduates to a more rounded and real life experience of engineering and design in practice [6].
The teaching Approach in The Engineering and Design Department at Aston University has embraced the Practice Based Learning approach of CDIO™ since 2010.

CDIO™ – Conceiving. Designing. Implementing. Operating. [7]

The CDIO Initiative is an innovative educational framework designed to bring practice based learning to engineers and designers. The International CDIO group of universities share best practice, supporting each other in developing new teaching approaches to develop the engineers and designers of the future. The practice-based approach of CDIO is ideal in responding to the challenges highlighted by Jaguar Land Rover with the *Concept Engineer* role.
The Aston students are predominantly Automotive Engineers with a strong technical, production focus so the introduction of a more styling/sculptural projects is an ideal opportunity to explore further the design-to-engineering spectrum.
An automotive styling project was set with students more accustomed to designing vehicle suspension, asked to design and develop a concept vehicle with sketches and a scale model.
The basic skills and techniques were shown using specialist automotive clay provided by Jaguar studios and a Master Class session run by a senior Jaguar Designer. The practical design project took the students out of their familiar comfort zone of experience and exposed them to the more creative, sculptural challenges of car design. It should be noted that the input from industry professionals was

an excellent addition and gave the students the opportunity to appreciate the wider design challenges of automotive development.

Figure 3. Engineering Design students learning to use clay in design & realization project alongside a Jaguar Senior Designer at Aston University

The development of the design engineer's experiences of using clay is used to develop greater understanding of the styling and development process. A Jaguar Senior designer worked with the engineering design students at Aston University to help bring some examples of industry best practice to the practical *design and make* clay styling exercise (figure 3).
The majority of Aston graduates who venture into the automotive industry tend towards the design engineer role rather than stylist.
The concept development and sculpting project gave students a greater understanding of the role and issues of the stylist in the automotive field and hence gain a deeper understanding of the *Concept Engineer* role identified by Jaguar.

5 CONCLUSION

The two academic case studies highlighted the different ways of approaching the design-to-engineering spectrum, well recognised in modern industry practice such as Jaguar.
The approach from either engineer or stylist/designer is valid but as Jaguar highlights while specialist focus is important the value of a wider perspective and understanding can prove commercially very effective, and a valuable skill for both engineering and design graduates. The industrial landscape is becoming increasingly complex and an greater awareness of context, beyond a specialist area is an important additional skill for a graduate engineer, highlighted by Spinks *et all* [8] who discuss the increasing complexity and interdisciplinary nature of the industrial work place;

> "One implication of this trend is the need for engineers who can manage complex value chains, involving a wide range of stake holders, both internal and external." Spinks 2007.

The introduction of the automotive clay project seeks to expand the understanding of the wider design process.
One of the most valuable lessons of the practical projects was the greater awareness of the different professional roles along the spectrum, that of engineering or stylist viewpoint, which was best learnt by doing, the practical experience proving very effective (figure 4). *Learning through doing* enabled students to explore and experience the real time challenges of the design process, with the automotive clay an ideal learning medium for technical requirements of packaging and specifications in combination with the more subjective aesthetic sculptural skills.
The teaching approach of *practice based learning* through a CDIO™ approach built on current industry practice, which highlighted some valuable examples of best practice through students showing greater understanding of the critical design to engineering spectrum.

Figure 4. The Design Spectrum required for automotive success

Clearly the automotive industry increasingly recognises the importance of cross-disciplinary working and collaboration with the development of roles such as *Concept Engineers*. The two academic case studies show the potential for practice-based projects to expand students understanding, of not only a specific design skill, but importantly where that may fit into the wider more complex design process. Understanding the academic examples of designers and engineers learning through practice highlights the value of such practical, real world learning.

After the success of this first project at Aston University further design projects are planned. Through the CDIO™ practice based learning approach, with collaborative input from industry, modules will build students awareness of associated roles in design in context to their own specialist area of study.

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