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Using Novel 2D Image Manipulation Methods to Aid Initial Concept Generation with Postgraduate Industrial Design Students

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Abstract

The aim of this paper is to provide educators and industrial design professionals with an insight into the development of innovative design ideation images manipulation techniques and, highlight how these techniques could be used to not only improve student ideation skills, but also as design enablers for a broader range of professionals working both inside and outside the creative industries. The review of literature highlights the changing role of the industrial designer through influencing factors such as increased involvement in upstream design activities and the 'maker movement'. The paper documents research conducted with postgraduate industrial design students in a specific year group within Loughborough Design School. The study is a pilot project with a small cohort of 29 industrial design postgraduate students which will form part of the ongoing pedagogic development of the skills required for the ever evolving discipline of industrial design. The study covers one academic semester, where postgraduate industrial design students were asked to use novel ideation methods to produce a range of aesthetic design directions for a communication device. The results of the research showed significant improvements in ideation workflow, the suitability and quality of the student's form generation, as well as the perceived quality of the final design outcomes.

Introduction

Industrial Design (ID) is defined by the Industrial Design Society of America (IDSA) as *"*the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer*"* (Industrial Designers Society of America, 2014). Within this broad definition, Tim Brown's T shaped designers' (Brown, 2009) are evolving in the rapidly changing product development landscape. The many disciplines involved in new product development have seen demarcation between roles blur and a post disciplinary model emerge where industrial designers have been introduced to more upstream activities and design tools have been introduced to "people who may have never thought of themselves as designers" (Brown, 2009 cited in Joore, 2010. p 200).

Review of Literature

Processes recently labelled as "Design Thinking" (Brown, 2009; Cross, 2011) have introduced designers to techniques formerly more common in business, marketing,

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advertising and social science domains (see the cross stroke of Brown's T shaped designer shown in Figure 1).

The opportunity to get involved in design is greater than ever before as design tools become more accessible (Winnan, 2013). With high quality Computer Aided Design (CAD) and tablet computer versions of formerly expensive design software available at low cost, potentially widening design participation (Hurn, 2013).

Manufacturing small components at home has become possible through 3D printing and small scale computer controlled milling machines, giving rise to a new designer maker movement that has a desire to better understand the upstream process of design (Anderson, 2012) and, as Casden puts it, *"is rebuilding American industry, one garage at a time"* (Casden, 2014.

Figure 1. Diagram of the modern industrial designers' skillset based on Tim Brown's "T-shaped designer."

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The changes to the design profession for existing designers, novice designers, hobbyists and stakeholders in the design of new products create new demands on design education (Lawson, 1990). Accommodating the cross stroke of Brown's T shape in an industrial design degree program with finite resources inevitably makes less time available for the development of the more traditional design skills of the vertical stroke. However, to test the outcomes of design research/design thinking processes, rapid solution visualization is still required. Illustration, prototyping, testing and refining of ideas into realistic solutions is still a vital role of the industrial designer (Brown, 2009). ID courses traditionally teach visualization techniques, however, against a background of compressed time to teach and learn these skills a different approach may be required. Initial steps towards this involve novel methods to increase the efficacy of teaching design visualization methods by linking sketching, CAD and physical modelling (Storer & Campbell, 2011).

Product aesthetics are considered a strategic tool in capturing consumer attention (Govers, 2004) and are an aspect of design that traditionally absorbed a significant proportion of an industrial designers' time. Crilly (2009, p. 224) considers the appearance of products to have "*a profound effect upon the way in which they are interpreted, approached and used."* However, it appears that aesthetics have received less attention from the proponents of design thinking. Tonkinwise (2011, p. 536) states that *"all attention being paid to design, whether researched or promotional is nevertheless missing a vital aspect of designing. Aesthetics are downplayed by 'design thinking'."*

The development of aesthetic sensitivity and an ability to create desirable objects is one of our goals in educating industrial designers. However great design is defined, it comes down to desirability, whether this is functionally, aesthetically, or culturally derived. Research into how to encourage and engrain these abilities in student designers has driven a number of educational strategies exploring design inspiration.
The authors noted the changing demands on the design education curriculum and propose a novel method to help develop aesthetic sensitivity and improve the speed and quality of initial concept generation.

Prior Research by the Authors

During the initial ideation phase of the design process, professional industrial designers use a variety of source images as a jump off point to feed the creative process (Hurn, 2011). Concept artist Scott Robertson cities the building of a visual library of resource

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images as an important skill for industrial designers to inspire and inform their form and styling development process (Robertson, 2012). Professional industrial designers might be expected to take this lead, or be provided with source material by Marketers or Brand Managers working for prospective clients. Either way, students are taught to mirror this process of physical mood board or online visual language wall creation to inform their ideation.

However, previous studies have shown that students collect these visual language image resources but that there is a disconnect in their application to the ideation process, meaning that students often do not use this resource and complete the task simply to gain an academic mark (McDonagh & Storer, 2004). Exposing designers to inspiration material has been shown to have both positive and negative results (Cai, Do & Zimring, 2009; Goldschmidt & Sever, 2010) in that it can lead to a wider range of potential solutions and at the same time potentially lead to plagiarising existing work. Research conducted by Cheng, Mugge and Schoormans (2014) on design fixation, suggests that the use of images hinders designers from creating original designs. However, designers continually absorb influences whether conscious or unconsciously and it would be very difficult to design anything without some reference to existing work. In this study, the work is directly created from existing design elements in an overt manner with the source material visible to all parties, however, the idea is that this will in turn be translated, transformed and built upon before the final solution is delivered.

There has been a continuing theme in the authors' teaching within Loughborough Design School to encourage student engagement with visual resource materials during the creative process. A method of understanding and decoding the semantic messages inherent in product form, the Form Analysis Criteria (Lawson & Storer, 2008) were introduced to a number of design practice modules over the last 10 years and used in this 2011 (McCardle et al., 2011) study to good effect. However the authors observed that there was a lack of depth in the students understanding of the semantic messages expressed by the product form.

A 2008 study within Loughborough Design School also found that students' lack of confidence in their sketching ability was creating a barrier to creativity, and hampering their ability to accurately depict form, texture and materials (Storer, 2008).

This new study conducted with postgraduate industrial design students within Loughborough Design School integrates the collection and collation of visual language images into the ideation process by encouraging students to manipulate and combine

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those images using image manipulation software to create high quality conceptual start points directly from those images. Therefore providing the threefold benefits of a) removing the disconnect of visual research and ideation, b) removing the initial sketching barrier to creativity for some students and c) allowing students to manipulate and understand high quality form, texture and materials through the direct use of those images.

To simplify the experiment postgraduate students were chosen as they should fall into the competent category of Dreyfus' five stage model of skill acquisition (Dreyfus,1986), hopefully removing the need to teach the basic techniques. Adobe Photoshop was used to facilitate the primary image manipulation as the students were all familiar with it and it is installed on the institutions design studio computers. In particular, the edit/transform and colour matching features are very powerful in Adobe Photoshop, allowing quick progress with these techniques.

A Mash-Up is defined by the Oxford English Dictionary (2014) as *"A mixture or fusion of disparate elements".* The music industry presents many examples of combinations of disparate elements being combined to explore new directions. In this case we are using it to describe the process of creating images of new objects by combining elements of existing images of objects. In a broader sense than the design industry, the term mash-up has been used for a number of years to describe the method of using image manipulation software such as Photoshop to create often comic combinations of film/TV characters, media celebrities and visual predictions of new automotive models.

The timely relevance of this approach as a design ideation tool is supported by the emergence of "mashed aesthetics" as a legitimate design direction within the design industry itself (Kaleidoscope, 2009). Mashed aesthetics refers to a recognized trend to reuse, combine and reinterpret existing historical designs, following on from, and reacting to "retro" design. Mashed aesthetic design can draw from different eras, product groups and disciplines, with designers "mashing" them together to create new and exciting design directions. Wanderlust, a US design trend forecasting consultancy, recently stated that *"in the post-post-modern design world, all form is fair game"* (Kaleidoscope, 2010.

Method

During an academic exchange to the Middle Eastern Technical University METU, Turkey in 2014, the authors demonstrated their novel mashed aesthetics image manipulation

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techniques to industrial design undergraduates. Figure 2 shows the example used, combining two typical streamlined vehicles to create an alternative universe land speed record vehicle, with the example being completed in 15 minutes. The level of realism achieved was high compared to the time invested; however the source images were in an advantageous orientation.

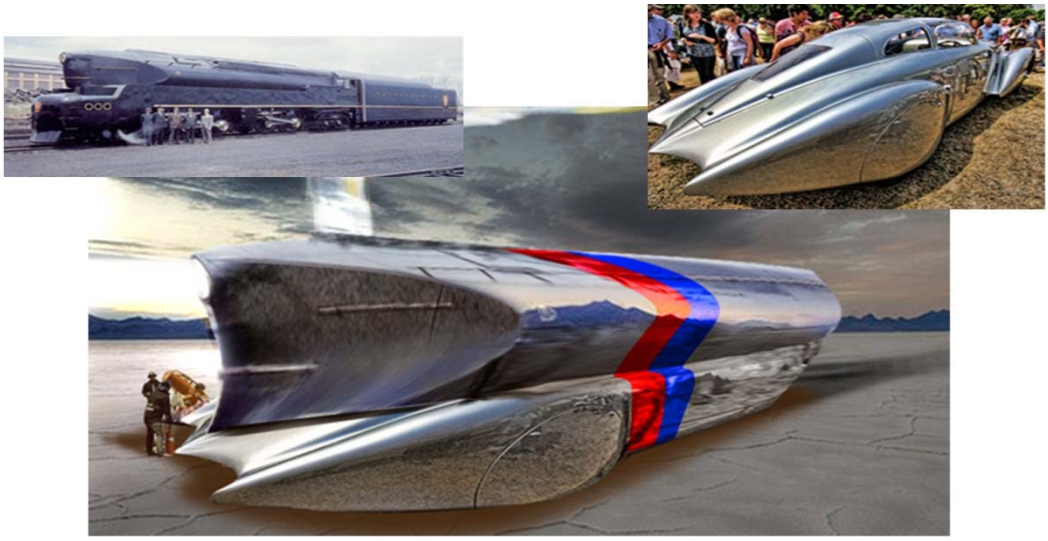

Figure 2. An example of the mashed aesthetic technique demonstrated at the authors' concept art workshop at Middle Eastern Technical University (METU) in 2014

Visualizing the same complex object using traditional sketching (shown in Figure 3) to a similar level of detail took forty minutes without any representation of material finish or environment. This technique, although purely two dimensional has the potential to expedite visual brainstorming prior to sketching or concurrently alongside sketching during the exploratory phase of form generation.

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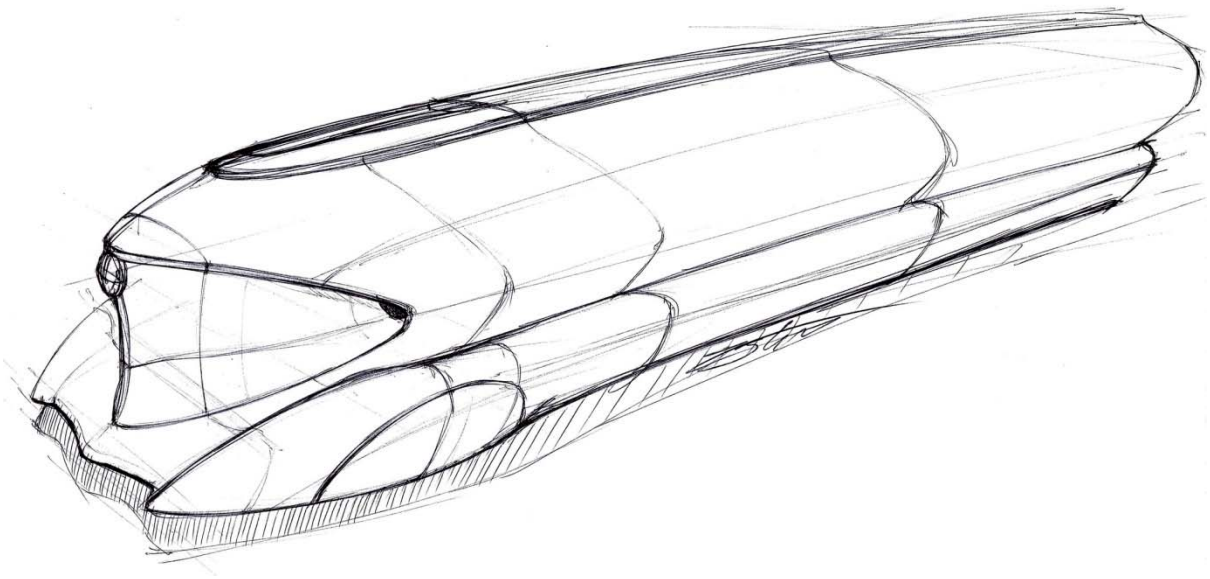

Figure 3. An example by the author of the same form as the METU mash-up example sketched over a 40 minute period

At Loughborough Design School, the Industrial Design Skills (IDS) module within the Master's in Industrial Design program was introduced to facilitate the development of core skills such as design research, ideation, conceptual development, 2D visualization and 3D CAD modeling. The relatively small student cohort of 29 consists largely of international students from China with smaller numbers of students from Europe and the United Kingdom. Due to the small number of students participating, the project would be used as a pilot study to inform the author's ongoing pedagogic research. The students were asked to create concepts for a communication device for a specific user of their choice. This involved defining the user, task, and environment (UTE) initially by conducting visual design research using the image gathering website Pinterest. Online versions of traditional mood boards were produced including images of likely scenarios, products, transport, architecture, etc. The students were also encouraged to choose unusual or challenging users and environments as a vehicle to provoke innovation. The students then received instruction on how to create mash-up visualizations' in Adobe Photoshop as shown in Figure 4.

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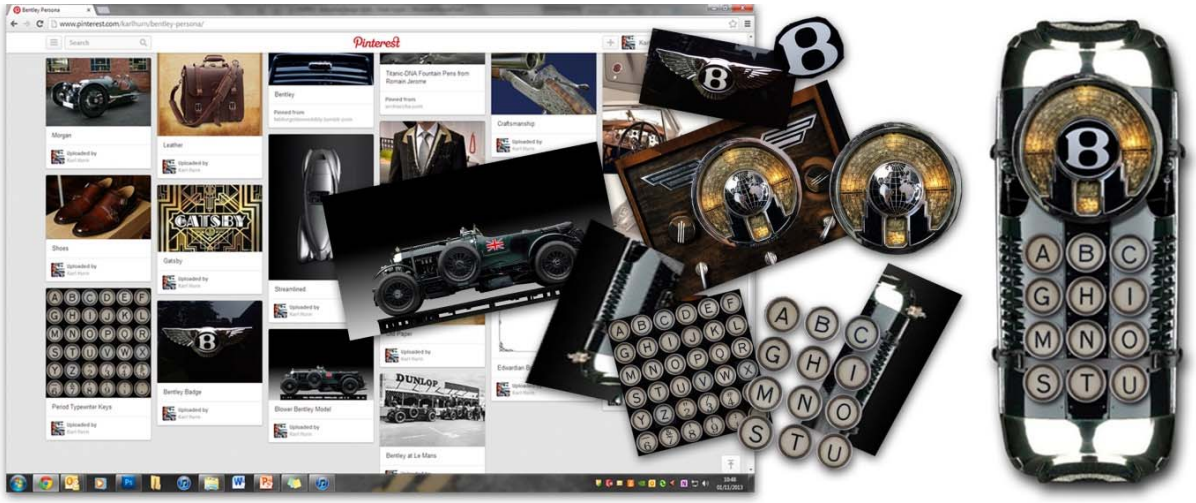

Figure 4. Example by the author of extracting form and visual language detail from Pinterest resource to create a novel product.

To gauge the impact of the initial mash-up process, after a 20 minute demonstration by the authors the master's students were asked to create a mash-up of a communication device from the same image resources used by the author in Figure 4. The authors were greatly encouraged by the examples produced by the students as shown in Figure 5. In the authors view; they show a high level of industrial design form giving, diversity, and design detailing.

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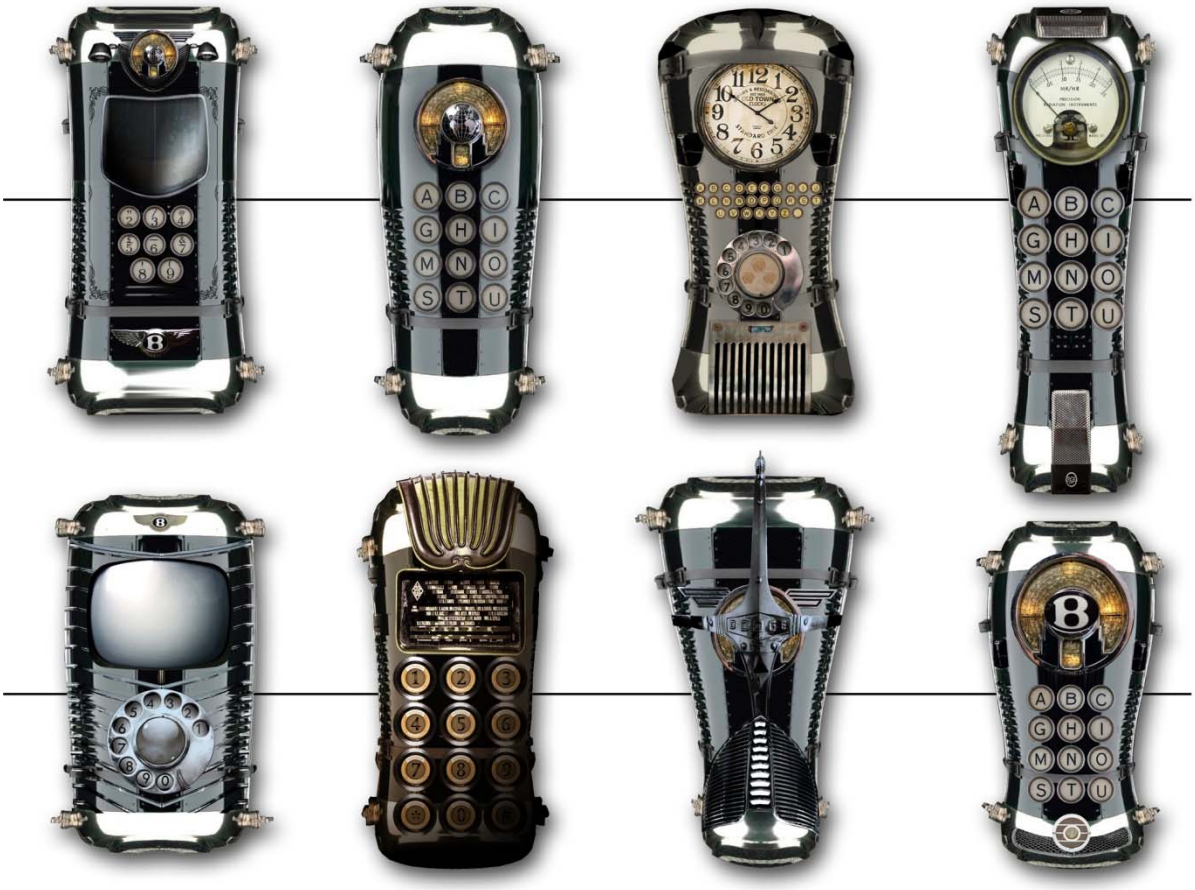

Figure 5. Examples produced by the students from the same image resource as Figure 4 showing the quality and diversity of form and design detailing

The students were then shown how to use traditional sketching methods to develop the largely 2D representations by using elevations, sketching planes, crating, cross-sections, and projected geometry to describe the form in three dimensions (Storer & Campbell, 2012). The authors made a conscious decision not to use 2D sketching software such as Sketchbook Pro for the sketching element of this study to allow a clearer focus on the mash-up approach prior to sketching. The sketching was used to refine and blend the “borrowed” elements and details more effectively into their unique refined designs. The students were encouraged to use the mash-ups to initiate a wide variety of possible design directions; however, the more traditional method of sketching was still encouraged to add clarity and coherency to the concepts, or where the source material didn’t lend itself to the intended product view.

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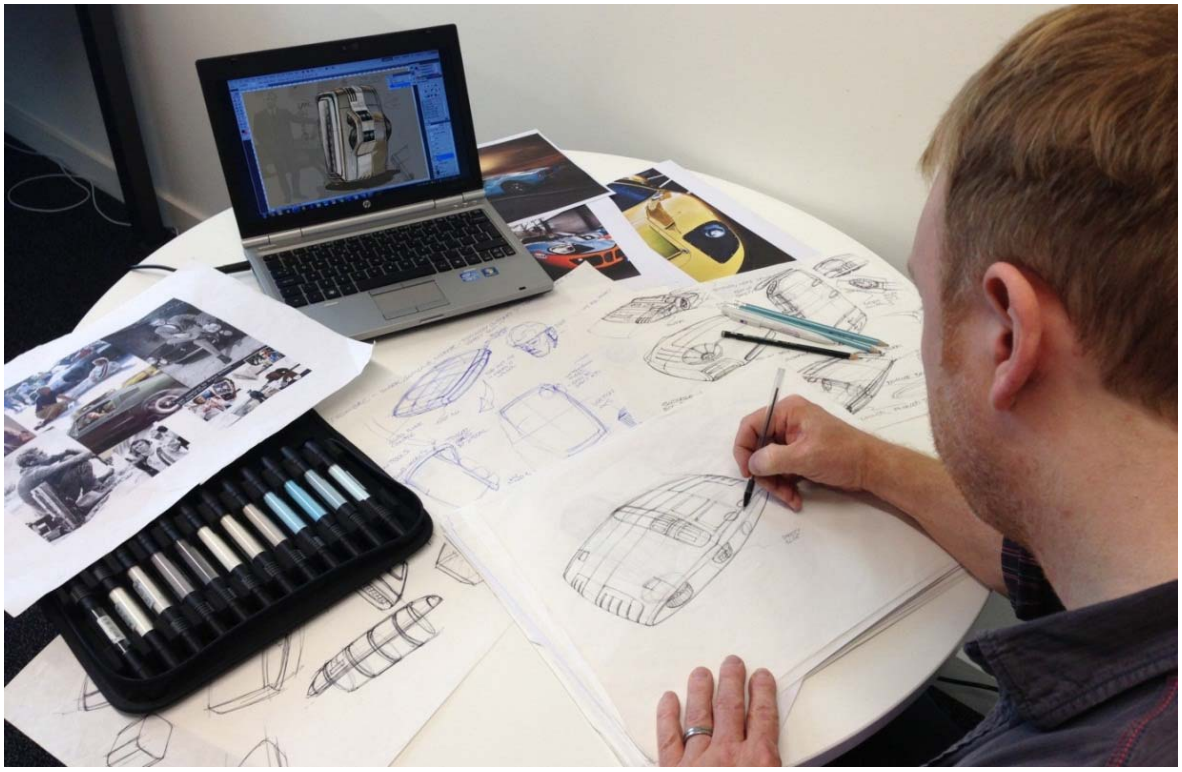

Figure 6. Using image resources and a 2D “mashed aesthetic” visualization to aid sketched development of 3D form and design detailing.

Results

The expected outcome was that students would be able to engage with the front end of the ideation process more quickly and effectively. Producing visual conceptual ideas that contained a level of form, texture and use of colour that was of a higher standard than had previously been possible through sketching alone. In order to assess the effectiveness of the approach, the authors inspected the 2D mash-ups and sketched development concepts of all the students to identify the advantages of the process when compared to more traditional sketch ideation methods.

The entire cohort of the students had engaged fully with the use of 2D mash-ups as their initial starting point, with 21 of the 29 students producing three or more substantially different design directions for their communication device. The authors noted that, drawing on their combined 28 years of experience of teaching industrial

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design sketching and visualization, that the entire cohort had made significant progress in the project in a substantially truncated timeframe when compared to traditional sketching alone. The level of design detail, subtlety of form and product semantics had also made the leap that the authors had hoped for.

Figure 7. Example of an industrial design master's student's design development using the mashed aesthetics process showing clear links to visual resource material

Further to this, the authors found that 23 of the 29 students had used the combination of 2D mash-ups and hand sketching in the way that the authors had envisaged and used the source images to "clothe" sketches in the intended materials. However, mash-ups were used more to support the sketching process rather than replacing it. Designs were still developed on paper, particularly with consideration to how the forms provided by the mash-up would work effectively in three dimensions, with the students then using CAD systems such as Solidworks to combine and refine their sketches and mash-ups into design development 3D models that could be taken to a presentation stage. For

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example, Figure 7 shows one student's successful combination of the methods previously cited, with initial resource material being combined effectively into a design direction mash-up which was subsequently refined through traditional sketching techniques with impressive visual fluidity from resource material through to final concept.

Discussion and Conclusions

This study offers some opinions on a novel way to approach the initial ideation phase of an industrial design project. It is clear that the use of mashed aesthetics offers the opportunity for students to create high quality ideation concepts early on in the design process by removing some barriers to creativity which stem from a lack of sketching ability.

It is also clear that students can create initial ideas more quickly, with a greater understanding and subtlety to their application of form and product semantics, not only by using forms that already have inherent beauty, complexity or historical and emotional significance, but also in that the sourcing of images is now enhanced by applications such as Pinterest, because design students can access image libraries created by professional designers who collectively have countless years of experience that shapes and informs the selection of this raw visual research resource. The process of forced interaction with the source material reduces some of the issues highlighted by McDonnagh (2004), although there can be a little too much, "borrowing" from existing designs and not enough original intellectual property generation. Nevertheless, as a means of getting started, immersion in the appropriate stylistic genres and overcoming the fear of the blank page this approach appears successful.

Industrial designers' sketching behaviour is dramatically different from that of other disciplines (Lau, Oehlberg, & Agogino, 2009), and therefore it should come as no surprise that their use and application of image manipulation software can, and arguably should differ to that of other disciplines. Industrial designers are innovators by their very nature, therefore how they use software should be open to innovation and reinterpretation. However it is the authors' and a more widely held view that sketching should always play an accompanying role in this.

The methods discussed in this paper not only have the potential to aid fast and coherent ideation for industrial designers, but also these methods could be used to aid communication between disciplines if taught to brand managers and marketing professions, feeding the co-creation process. The authors intend to experiment with teaching these techniques to students from the engineering and business schools to

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explore the potential for widening participation in design thinking activity in new product development.

This study will be followed-up by the examination of the use of hand drawn sketching within CAD systems by industrial design master's students as drivers for 3D surface creation, to ascertain what advantages there are in blurring the disconnect that exists between hand drawn sketching and 3D CAD modelling further down the design process.

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