Visually decomposing vehicle images: Exploring the influence of different aesthetic features on consumer perception of brand

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This paper presents a technique to investigate the influence of aesthetic features and brand recognition of vehicles. Appearance has been shown to impact greatly on consumer perception of products and their branding, yet there exist few tools or methods to support reasoning about their influence. A procedure for visually decomposing designs into constituent aesthetic features is proposed. The strategy is applied to a range of saloon cars, and a consumer survey undertaken to establish the significance and potency of individual aesthetic features. Results both validate the decomposition technique and highlight certain aesthetic features that have the greatest influence on brand recognition.

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Keywords: aesthetics, automotive design, design tools, reasoning, styling

It is known that appearance plays an important role in the successful sale of products (Bloch, 1995; Moulson & Sproles, 2000; Page & Herr, 2002). Audi states that up to 60% of a consumer’s decision to purchase a vehicle is based on styling rather than technical performance (Kreuzbauer & Malter, 2005). In the same way that appearance can influence consumer judgement, so can brand. What is more, perceptions of product brand influence judgements of quality and overall desirability and are primarily derived from the product’s appearance (Bloch, 1995; Page & Herr, 2002). Consequently, visual aesthetics become an important consideration during the design process. In industries such as automotive, where technological advances are becoming less of a differentiator between competing products, the role of visual aesthetics becomes even more crucial to a vehicle’s success in the marketplace (Warell, Stridsman-Dahlström, & Fjellner, 2006). This is not to say that quality and technical performance are no longer important factors in the commercial success of vehicles, or indeed of any product. There are many examples of products failing due to poor quality or performance despite well-executed visual properties. However, the focus of this paper is purely in the consideration of product appearance during the design process.
The complex nature of vehicles compared with other mass produced products (such as household products and consumer electronics), along with lengthy design and development times (3–4 years (Thomke, 2001)), mean they require considerable investment from manufacturers. With this investment comes considerable financial risk relating to the success or failure of vehicles when launched onto the market. Thus, during the design and development process there is great pressure on designers and managers to make correct and well informed judgements. While in many design problems there are methods and strategies that can help designers to evaluate designs and make informed judgements (Lockamy & Khurana, 1995; Ulrich & Eppinger, 2008), assessment of visual impression of a product’s appearance remains highly subjective and ill defined. Designers and managers concerned with this aspect of vehicle design must rely on previous experience and training and the notion of designer’s intuition when considering visual qualities of design proposals, despite the impact these judgements can make on the vehicle’s market success (Moulson & Sproles, 2000).

There is a need to support designers and managers involved in vehicle styling by providing some form of tool to help reasoning about the brand perceived to be associated with a design’s appearance and facilitating an optimal compromise between novel yet recognisable designs. This paper discusses the initial steps towards the creation of such a tool by demonstrating a procedure for visually decomposing designs such that the aesthetic features may be identified and assessed, and their influence on brand recognition explored. Section 1 gives background to the process of vehicle design and the role of aesthetics and branding in a product’s design. Section 2 includes a review of previous work that has used visual decomposition in order to explore constituent parts of visual material. The decomposition strategy adopted for the current study is also set out and discussed in Section 3 and the methodology for implementing and testing the decomposition strategy is described in Section 4. Results are presented and discussed (Section 5) and conclusions drawn in Section 6.

1 Background

This section presents the background to the subject of appearance in vehicle design and considerations of brand management during the design process. In discussing research into the design process and the way designers work, Lawson (2006) states that a better understanding of the nature of design and the characteristics of design problems and their solutions is required. Through the discussion of the background, a clear definition of the research problem and thus the aims of this study and how they will be accomplished is proposed. This section introduces the processes followed to generate the aesthetic aspects of a vehicle’s design and the use of visual aesthetics in product design.
1.1 Design development process
Over the past thirty years the design process has been researched and a number of models have been proposed to characterise the process undertaken by designers to develop and produce products (Clark & Fujimoto, 1991; French, 1985; Pahl & Beitz, 1996; Pugh, 1990; Roozenburg & Eekels, 1995; Ullman, 2003; Ulrich & Eppinger, 2008). These models differ somewhat in terminology and the definition of activities undertaken at different stages. However, they all share an underlying similarity in their basic structure. All of the models proposed present a process which begins with the specification of a problem that is to be solved following an iterative sequence of steps. Progression from one step to the next is governed by evaluation at each step as to how well the problem specified at the beginning has been addressed. Throughout this sequence there may be a number of iterations between steps as designs are developed and converge on a final design.

Evaluation of design proposals is highly influential in the design development process as each evaluation guides a proposal through to completion and then defines the point at which a design is complete or finished.

A series of interviews conducted by the authors with industry professionals and educators corroborated that the same structure applies to the automotive styling design process. Evaluation stages also play an integral role in the development of a vehicle’s styling. At key points of evaluation, designers pitch concepts that are judged based on experience and intuition by managers and more senior designers. As a consequence the outcomes from these evaluation stages are based on almost entirely subjective assessments of designs.

1.2 Product appearance in product design
Holbrook (1986) states that in modern society, aesthetic aspects are relevant to all products regardless of their function. Bloch (1995) acknowledges the influence of product appearance on consumers’ decisions to purchase products, stating that given the choice between two products, equal in price and function, consumers purchase the one they consider to be more attractive. As a consequence, the strategic use of aesthetic aspects of products and the role of appearance in the context of marketing forms a sizeable body of research. This research can be summarised with respect to four key dimensions; distinctiveness and demarcation, expression of functions, fashion and trends, and branding which form the basis for evaluating design proposals. These factors are illustrated in Figure 1.

- Distinctiveness and demarcation — This factor refers to the use of a product’s appearance to differentiate one product from old or competing products (Person, Schoormans, Snelders, & Karjalainen, 2008). Further to this Moulson and Sproles (2000) and Loewy (Lichtenstein 1990)
discuss the degree to which styling should be differentiated to achieve maximum product success.

- Expression of function and properties — This factor concerns consumers’ ability to gauge function of the product (Norman, 2002), its properties (Monò, 1997) and furthermore to identify the product from these attributes (Crilly, Good, Matravers, & Clarkson, 2008).

- Fashion and trends — Fashions are defined as shifts in the social meaning of aesthetic characteristics (Cappetta, Cillo, & Ponti, 2006). Hence this factor considers the current and future meanings which may be associated with visual characteristics of design proposals.

- Branding — It has been shown that perception of visual aesthetics impacts greatly on perception of brand (Bloch, 1995; Karjalainen, 2003; Page & Herr, 2002). Hence, this factor refers to the consideration of perceived brand of a design proposal.

The evaluation of these four dimensions of visual characteristics is highly subjective and multifaceted and as a consequence poses a high area of risk and uncertainty for companies. It follows that there is an inherent requirement to support designers when evaluating the visual aesthetics of design proposals, and in particular, provide more quantitative reasoning on the relationship between brand and visual characteristics. Central to achieving this is the need to establish whether a relationship exists between brand and visual aesthetics, and if so, which features are the most potently representative. This paper starts to address this need by creating a strategy to decompose, identify and isolate constituent geometry of visual aesthetics and to explore potential consumers’ ability to recognise brand.

2 A review of visual decomposition strategies

A number of major studies have been conducted exploring the decomposition and isolation of product images in order to gain a better understanding of the visual material. The approaches are discussed highlighting the merits and drawbacks of different methodologies adopted.
2.1 Isolating geometry in drawings

Biederman (1987) and Biederman and Ju (1988) conducted studies decomposing line drawing representations of products to explore human understanding of images. In his initial study Biederman (1987) decomposed images of products in a variety of ways and showed the decomposed images to participants measuring the length of time it took for them to correctly identify the product. Decompositions of images were based around the removal of parts of line elements that constituted the image. Using this approach it was possible to explore which lines or segments of lines were most important for human recognition and understanding. It was found that the vertices in line representations of products were most influential for human understanding. This was demonstrated in the way that respondents could not identify products when vertices were degraded, yet could identify products where mid-segments were removed. In a second study (Biederman & Ju, 1988), the differences between understanding of line representations of products and representations which include surface details were explored. Participants were shown pictures of products isolating surface and edge parts of the images. This study verified the findings of the initial study as it was found that edge properties have far greater impact on human understanding of objects.

The relevance of these studies to the research discussed in this paper is primarily in the experimental method adopted. They demonstrate that a strategy of decomposing images to varying degrees of detail is a suitable approach for exploring the effects of constituent features of a product on human perceptions.

The work of Prats, Earl, Garner, and Jowers (2006) in exploring designers’ sketches demonstrates a similarly suitable approach to visual decomposition. The aim of this research was to enhance designers’ creativity when sketching by developing a tool to generate shape explorations. In order to develop such a tool, the strokes and transformations made by designers while sketching were decomposed and isolated. This approach to visual decomposition provided further insight into the influence of particular elements of sketches on the generation of product form, for use in the development of generative sketching tools.

Work by Tovey, Porter, and Newman (2003), considered sketching in automotive design and the technique of ‘de-layering’ to visually decompose drawings. The de-layering process consists of decomposing sketches made by students and professionals into ‘form lines’, ‘components’, ‘form shading’ and ‘non-form shading’. The study showed the form lines to be most expressive and carry the intentions of the designer. Where Prats and Biederman present methods to decompose line representations of products, the work of Tovey differs in that it presents a method to visually decompose images including richer detail and more realistic details such as those from shading surfaces.
Cleveland (2010) investigates the role of visual style in graphic design styles. A methodology was proposed to aid designers by reproducing graphic layouts within the same style. In creating this methodology, Cleveland decomposes layouts classed as belonging to a particular style by the geometric relationships between constituent features. Relationships include proximity between features and their placement within a page. Trends identified in geometric relationships form the rules by which layouts may be automatically generated. While this research is not directly applicable to general products due to the two dimensional nature of graphic design, it does illustrate the way in which geometric rules can be used to characterise visual styles.

2.2 Identifying aesthetic features
The FIORES projects aimed to improve the working procedures and computer aided tools for modelling aesthetic shapes (Cheutet et al., 2008) by studying ‘aesthetic key lines’. These were defined as lines on a vehicle surface that were thought to be aesthetically important. The aim was to help preserve the original design intent through the complete vehicle design process. Previous work defined curve geometries in the terminology used by stylists (Podehl, 2002). The decomposition strategy used was based on isolating ‘aesthetic key lines’ from front side and rear views of vehicles. The isolated lines were then reviewed with respect to the terminology and curve geometry. Data was used to create an ontology of curves linking quantitative properties from digital models with aesthetic properties based on stylists’ terminology. The key relevance to this paper, is the identification, extraction and isolation of aesthetic features of vehicles.

In a similar manner, the works of Pugliese and Cagan (2002) and McCormack, Cagem, and Vogel (2004) investigate the use of shape grammars to generate designs for motorcycles and cars that contain brand specific aesthetic features. Shape grammar is a term used to describe a set of geometric rules that can be applied to create geometry in a particular style. In order to create a shape grammar the aesthetic features of existing products had first to be explored. This was done by first simplifying images into two dimensional line representations. Shape grammars were then used to generate a range of alternative concepts experimenting with aesthetic features and recognition of brand. As well as adopting an approach of visual decomposition to explore aesthetic features, this research also shows that simple two dimensional line representations of vehicles can still contain enough visual information to provide some of the aesthetic characteristics when conducting visual decompositions.

Warell (2001) addresses the concept of visual decomposition of products. He explores the nature and workings of visual aesthetics to support development of product form. Within this study Warell visually decomposes images of products, defining constituent aesthetic features as belonging to different categories termed ‘form entities’. These are defined by their ‘visuo-spatial’
configurations (how they appear with respect to other aesthetic features). Having categorized product features as belonging to different form entities, the perceptual effects of aesthetic features (syntactic function) were investigated. Doing this was said to enhance understanding of form, structure, content and composition in the design of products.

Warell’s work demonstrates yet another approach for visually decomposing images to better understand aesthetic features in product designs. Warell verifies this decomposition technique in further studies (Warell, 2004; Warell et al., 2006), where decomposition of products by form entities was used to explore consumer perceptions of alternative product designs.

Karjalainen (2007) also explores the aesthetic properties of vehicles and their branding through visual decomposition. A range of vehicles of a particular brand was visually decomposed in order to identify explicit visual references. These were defined as references embedded within design features, implemented by designers with the intention of being easily recognized and perceived as belonging to a particular brand. The explicit visual references identified were then used as a basis for designing different products but still identifiably of the same brand. Results showed that such analysis of the product range and isolation of features could be used as a basis to design products exhibiting distinct brand features.

Liem, Abidin, and Warell, (2009) present a further study into recognition of aesthetic features of vehicle form. This study aimed to explore how recognition is formed by visual elements in vehicle form. In order to achieve this goal Liem et al. decomposed different views of a vehicle into individual components. Next a group of designers was asked to highlight the components they thought to be most expressive and thus able to trigger recognition. Although this study does not decompose images to the point of isolating components for further investigation, it provides a valuable example of a strategy to identify types of visual features that constitute vehicle form which could be decomposed.

While all of these strategies are relevant to the work of this paper in that they present approaches to visual decomposition of products, no single approach is adopted for the purposes of this investigation. Rather, elements from studies are drawn on in order to form a visual decomposition approach for vehicles.

3 Proposed visual decomposition strategy for vehicle images

The strategy proposed here draws on studies discussed in Section 3, as well as understanding gathered from practicing designers, on the characteristic processes used to create the aesthetic features in designs. This information was gathered through a series of interviews and presentations with practicing
designers from GM Holden Australia, Nissan design Europe, Shado and IAD automotive design consultancies, as well as with automotive design educators and students.

3.1 Categories for decomposition
Interviews revealed that, in order to generate research findings that are relevant and valuable for use in the styling design process, the steps taken by designers need to be considered in the creation of a decomposition strategy. Hence the strategy produced here is based in the sketching activity and steps taken by designers during ideation and realization stages to create overall vehicle form. From interviews the following types of aesthetic features are defined.

3.1.1 Outline
This is the boundary created between the vehicle and space surrounding it. It could also be termed the silhouette. During design the outline defines the vehicle’s general dimensions or ‘volumes’.

3.1.2 Daylight opening (DLO)
This is defined by the front and rear windshields and side windows. The DLO is also referred to as the greenhouse. In terms of constructing the design of a vehicle and its overall appearance, adding the DLO defines the posture or stance.

3.1.3 Muscles
These are treatments given to surfaces or panelling. These are often in the form of creases or curves created by raising or lowering sections of the surface. Such surface treatments are also referred to as character lines or light lines.

3.1.4 Graphics
These are described as markings on the vehicle. These included details such as headlamps, radiator grille and number plate. The addition of graphics to a design is usually the final step in creating a proposal.

3.1.5 Explicit detail
This is a sub category of graphics. It is made up of graphic features which explicitly indicate vehicle brand, such as badges and logos.

Similar definitions are also seen in literature. Cheutet et al. (2008) and Tovey et al. (2003) make reference to muscles as surfacing that determines character lines and their importance to overall appearance. Warell (2001) defines overall outline or silhouette, connecting features manifested in the surface treatment (muscles) and discrete or discerning features (graphics), further reinforcing the suitability of the visual decomposition strategy. Outline, DLO, muscles and graphics form the feature categories used in the decomposition strategy created in this paper.
3.2 Representation of products for visual decomposition

The method of representation of decomposed products is next addressed. For the purposes of this investigation a two dimensional line representation of vehicles will be used. It is acknowledged that this representation of aesthetic features does not communicate in the same way as the complete product in real life. However in light of the studies reviewed in Section 2, two dimensional line representations have been shown to contain enough detail to evoke recognition. Furthermore it is asserted that there are many instances in product advertising where brand can clearly be communicated without complete and realistic product images.

Figure 2 shows the decomposition strategy applied to front side and rear views of a vehicle highlighting the types features that constitute each of the feature categories.

4 Implementing and testing the visual decomposition strategy

The aim of the proposed decomposition strategy was to isolate different categories in order that the influence of different aesthetic features on consumer recognition of brand might be assessed. In order to evaluate the potential of the proposed strategy, and provide an insight into the potency of categories of aesthetic features on brand recognition, a consumer survey was undertaken.

4.1 Approach

A web based survey approach was employed in order to obtain a large participant population (400 plus). It was also easier to distribute and collect data compared with paper surveys. In terms of responses that participants give to questions, a web based survey is far more rigid compared with paper survey or focus groups. Web based surveys offer little opportunity to provide extra information or further thoughts on responses. It is thought that the advantage in the ability to reach a greater sample size outweighs the possibility to capture participant reaction.
4.2 Selected brands and vehicles
Five vehicles were visually decomposed for use in the survey, BMW 3 Series, Audi A4, Mercedes-Benz C-Class, Ford Mondeo, and Honda Accord saloon models all from the same year. These vehicles were chosen because they were found to be in direct competition in terms of size, segment and price (Which? Car, 2010). Furthermore all of the vehicle brands were found to be in the top 100 global brands chart of 2009 (Interbrand, 2009).

4.3 Images
The representation of vehicles shown to participants in the survey is achieved by tracing edges and outlines directly from photographs using chains of cubic B-spline curves. The decomposition strategy was implemented using the following steps.

- High resolution digital photographs of vehicles were taken from front, side and rear views. Photographs were taken in such a way that lens distortion was minimized thus keeping the geometry represented in photographs as close to that which would be seen by the human eye.
- Using Photoshop image editing software, light conditions were accentuated to highlight ‘muscles’ features in the surfacing of the vehicle making them easier to isolate.
- Chains of 3rd degree B-spline curves were used to trace aesthetic features. All features were represented with closed loop curves, with the exception of ‘muscles’ features which were predominantly open curves.
- Isolated features were then layered together to create the combinations of feature categories shown in images used in the survey (Section 4).
- The decomposed images used in the survey were 520 × 367 pixels, approx 140 mm × 80 mm when displayed at 1024 × 768 screen resolution. Isolated features where represented in 2pt thickness lines on a black background in order to maximise detail/clarity.

Figure 3 shows one of the images used in the survey shown as it was presented to participants.

4.4 Survey structure
The structure of the survey was based on displaying decomposed images of front, side and then rear views of vehicles. These formed three sections of the survey. Using five vehicles meant that there were 240 possible decomposition images (sixteen possible combinations of decompositions per vehicle, using five vehicles, in three different views). Including all of the images would result in an exceptionally lengthy and repetitive survey that few participants would take the time to complete. Some combinations of feature categories, especially those containing explicit identifiers, were thought to give away answers to subsequent questions. Other decomposition combinations were
deemed to be so obscure that any correct identification would likely be down to pure chance. As a result, a sequence of 38 decompositions was selected. This showed most of the feature category combinations using a variety of vehicles yet avoiding explicit vehicle identification too early in the survey. The sequence of decomposition images shown to participants is illustrated in Figure 4.

Participants start the survey with the front view containing a single feature category (BMW with only its outline included). Subsequent images show front views with increasing numbers of features. After front views containing all features is shown the sequence is repeated for side and rear views. A number of points should be highlighted when viewing the sequence of images shown to participants. Firstly it can be seen that the same combinations of features on the same vehicles is used in all three sections/views. This was done for the purpose of consistency and comparability of results between the different views. However, it can also be seen that there are instances where the images deviate from this sequence. When visually decomposing the side view of vehicles, there were found to be no ‘explicit identifiers’. Hence, there could be no decompositions that included all five feature categories. Consequently a further decomposition including two feature categories was included (Honda: Outline + Muscles).

4.5 Questions

As the purpose of the survey was to explore the influence of aesthetic feature categories on brand recognition, the primary question posed aims to test participants’ ability to identify vehicle brand. Further insight into what participants recognise from different decompositions is obtained by secondary questions concerning physical and subjective attributes that characterise the product. Three questions were posed to participants in a multiple choice format for each decomposition. Table 1 shows the possible choices given to participants to select an answer from.
The rationale for presenting participants with this range of answers was to include all characteristics that describe the five vehicles used in the survey, while adding additional options to reduce the probability of correct identifications from guesswork. In addition to questions concerning each of the decompositions, a series of profiling questions was posed prior to the start of the survey. These questions concerned information about participants such as age, gender, a self-assessment of their ability to recognize vehicle brand and exposure to vehicles. Thus, participants were asked to record whether or not they held a drivers licence and for how long, how many hours they spent driving per week and their interest in brand and styling of vehicles. Participants were also asked to rate their confidence in their ability to identify the brand of a range of vehicles.

<table>
<thead>
<tr>
<th>No. feature categories in each decomposition</th>
<th>Survey section 1: Front views</th>
<th>Survey section 2: Side views</th>
<th>Survey section 3: Rear views</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>START</td>
<td>BMW: Outline</td>
<td>BMW: Outline</td>
</tr>
<tr>
<td></td>
<td>Audi: Graphics</td>
<td>Audi: Graphics</td>
<td>Audi: Graphics</td>
</tr>
<tr>
<td>2</td>
<td>Mercedes: DLO + Muscles</td>
<td>BMW: Muscles + Graphics</td>
<td>BMW: Muscles + Graphics</td>
</tr>
<tr>
<td>5</td>
<td>Audi: All Feature categories</td>
<td>Honda: All Feature categories</td>
<td>Audi: All Feature categories</td>
</tr>
</tbody>
</table>

Figure 4 Sequence and details of decomposed images shown to participants
5 Results & discussion

The survey was made available online for five days. A total of 420 responses were recorded. Respondents were aged between 17 and 63 years old. 78% of responses were recorded by male participants and 22% by female.

With respect to the exposure of participants to vehicles, 89% of participants held a drivers licence and had had it for an average of 8 years. The average number of hours spent driving per week was 5.7 h with a maximum of 65 h.

The profiling questions revealed that 49% of participants held a car’s styling as being ‘very important’ when considering purchasing a car while 43% responded ‘mildly important’ and 8% responded ‘not important’. It was also found that 36% of participants held vehicle brand as being ‘very important’ when considering purchasing a car, while 50% responded ‘mildly important’ and 14% responded ‘not important’. Finally it was found that from the vehicles included in the survey participants were most confident in their ability to identify BMW, with Mercedes second, Audi third, Ford fourth and Honda last.

### Table 1 Questions posed to participants with respect to decomposition images and multiple choice answers

<table>
<thead>
<tr>
<th>Question Posed</th>
<th>‘Which brand manufactures this car?’</th>
<th>‘In which segment does this vehicle belong?’</th>
<th>‘Which emotions best describe this vehicle’s character?’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible answers</td>
<td>Not sure</td>
<td>Not sure</td>
<td>Not sure</td>
</tr>
<tr>
<td>Audi</td>
<td>City car</td>
<td>Aggressive</td>
<td></td>
</tr>
<tr>
<td>BMW</td>
<td>Small car</td>
<td>Dynamic</td>
<td></td>
</tr>
<tr>
<td>Citroen</td>
<td>Medium/Family car</td>
<td>Elegant</td>
<td></td>
</tr>
<tr>
<td>Fiat</td>
<td>Large/Estate car</td>
<td>Friendly</td>
<td></td>
</tr>
<tr>
<td>Ford</td>
<td>Executive car</td>
<td>Modern</td>
<td></td>
</tr>
<tr>
<td>Honda</td>
<td>Luxury car</td>
<td>Powerful</td>
<td></td>
</tr>
<tr>
<td>Mercedes-Benz</td>
<td>SUV/4X4/Off road vehicle</td>
<td>Sporty</td>
<td></td>
</tr>
<tr>
<td>Nissan</td>
<td>MPV/People carrier</td>
<td>Stable</td>
<td></td>
</tr>
<tr>
<td>Renault</td>
<td>Sports car</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5 Demonstrating the lack of any correlation or trend between percentage of correct identifications of brand and the increasing number of feature categories included in images

Influence of aesthetic features on consumer perception of brand
Key results are shown in Figures 5—9 from which the following primary observations are made. These are discussed in greater detail following sections.

1. Number of correct responses is not proportional to the number of feature categories included in each image.
2. There are more correct responses to questions posed with respect to front views and less correct responses with respect to side and rear views.

![Graph showing percentage of correct responses to image views](image-url)

*Figure 6: Illustrating that more respondents identify brand correctly when shown front views of vehicles*

![Graph showing percentage of correct responses for images containing 'Graphics' feature category](image-url)

*Figure 7: Illustrating images containing 'Graphics' feature category in the front view receive more correct responses*
3. Participants appear to find it harder to recognize vehicle segment and vehicle character compared with their ability to recognize brand.

4. No obvious relation exists between side and rear views of the same vehicle and feature categories.

5. Images which return the greatest number of correct responses to brand are of the front view and include the ‘Graphics’ feature category.

When looking at results, it can be seen that there is no obvious pattern as to which vehicles and combinations of feature categories are consistently recognized by participants (save for those including explicit aesthetic features). On

**Figure 8 Illustrating the range of correct responses with respect to vehicle brand**

**Figure 9 Participants’ confidence in recognising different vehicle brands**

Influence of aesthetic features on consumer perception of brand
the contrary there is significant variation in number of correct responses (3%—90% correct responses to different decompositions). This variety in responses suggests that certain images inspire different levels of recognition in participants indicating that the information communicated through the simplified two dimensional line form is rich enough to elicit correct responses from participants. Thus, although the representations of vehicles suffer from a relatively high level of abstraction, they can still be correctly identified.

5.1 Influence on responses of increasing number of feature categories in decompositions

From the results it can be seen that displaying different combinations of feature categories elicits varying recognition of brand (primary observation 1). Over the course of the survey the number of feature categories that make up an image increases, hence as participants progress through the survey they are given increasing levels of information. However and somewhat surprisingly, the number of correct identifications of brand and vehicle characteristics did not increase proportionally with the increasing level of information (number of feature categories included) in each image. This is demonstrated in Figure 5 where it can be seen that the percentage of correct responses (represented by the dots) does not increase with the number of feature categories included in images (represented by the bars).

Conducting a Chi-test on survey data confirms this observation. The value for $X^2$ tends is close to zero in front, side and rear views showing that the percentage of respondents correctly identifying brand is independent to the number of feature categories included in decompositions.

The brand of decompositions containing all feature categories is correctly identified by a large percentage of participants (Figure 5). This is explained by the presence of ‘explicit detail’ such as logos in decompositions. In all views it can be seen that decompositions containing only one or two feature categories also repeatedly receive a greater percentage of correct responses than decompositions containing three or four feature categories. This pattern suggests that different feature categories have greater influence on participants’ perception of brand than others.

5.2 Significance of views

It is also noticeable that there are more correct identifications of vehicle brand and characteristics in images showing front views of vehicles (primary observation 2). Average correct responses are annotated on data shown in Figure 6. The average percentage of correct responses to front views is 58%, while the average percentage of correct responses to both side and rear views is 41%. These findings are in agreement with literature which states that the front view of vehicles is the most central single element for incorporating brand references (Chen, Hang & Hung, 2007; Karjalainen, 2004). Thus, this experimentation confirms the idea that aesthetic features in the front view have the greatest influence on consumer perception of brand.
5.3 Responses to different types of questions
Throughout the survey, participants achieve less correct responses to questions on vehicle segment and perceived character than to questions on brand. This is demonstrated by the average percentage of correct response to questions relating brand was 50.6%, while average percentages of correct responses to questions on segment and character were 33.0% and 32.5% respectively (Table 2).

It is asserted that the reason for such a low average percentage of correct responses to questions on vehicle character seems to be due to the abstract nature of questions posed. It is thought that verbalizing vehicle’s emotional character was found by participants to be difficult.

The majority of responses to vehicle segment were also incorrect. This was especially surprising for side views as it was thought that the vehicle outline and DLO would clearly indicate segment. It is thought that the explanation for these results is that terminology used to define segment, although technically correct (based on EuroNCAP classification (1999)) was found participants to be somewhat ambiguous. Further experimentation asking participants to identify segment pictorially could be undertaken to remove this ambiguity.

An exception to this is the case in which the side view of the Mercedes (including DLO and muscles feature categories) is correctly identified by substantially more participants than other combinations of feature categories. The existence of this exception suggests that there is some element of this combination of aesthetic features that make it more recognizable and thus worth investigating further.

5.4 Influence of different feature categories
As previously stated, some feature categories have greater influence on ability to identify vehicle brand than others. On closer inspection of decompositions returning greater percentage correct responses, it can be seen that many of the decompositions contain the ‘graphics’ feature category (Figure 7). This suggests that the graphics feature category in the front view is more potent in communicating vehicle brand.

<table>
<thead>
<tr>
<th>View</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>Brand</td>
</tr>
<tr>
<td>Side</td>
<td>Segment</td>
</tr>
<tr>
<td>Rear</td>
<td>Character</td>
</tr>
</tbody>
</table>

Table 2 Summary of the average percentage of correct responses to decompositions with respect to view shown and questions posed

Influence of aesthetic features on consumer perception of brand
5.5 Influence of brand name

When analyzing responses to different feature categories within specific vehicles (e.g. the BMW in isolation), no common pattern can be seen (Figure 8).

In other words, when the number of correct responses at different levels is looked at for specific vehicles, each vehicle exhibits a different trend. This is because none of the vehicles share common feature category combinations, as these were limited by constraints on the time and length of survey. It would hence be worthwhile extending this survey as part of further work to investigate potential patterns in visual breakdown of specific vehicles.

Results from the profiling questions prior to the start of the survey show that participants were the least confident in their ability to identify ‘Honda’ and ‘Ford’ brands. This is reflected when comparing correct responses with respect to the five vehicle brands used. It can be seen that there are less correct identifications of these brands and their characteristics. It is inappropriate to draw further conclusions from this basic observation because, as with looking at trends relating to individual vehicles, these brands made limited appearances during the course of the survey.

5.6 Influence of participants familiarity and exposure to vehicles on responses

A multivariate analysis of results was conducted including information gathered in the profiling stage of the survey. This was done to ascertain whether the effect of a participant’s prior knowledge of, and exposure to vehicles had any effect on that participant’s ability to identify vehicle characteristics. Broadly, of the participants correctly identifying vehicle characteristics, the proportions of age, gender, confidence in identifying brands and interest in styling reflected those of the total participant sample. As would be expected, it was found that participants who could drive and spent longer per week on the road answered a greater proportion (5%) of questions correctly than those who did not.

A further multivariate analysis was conducted in order to investigate the distribution of correct responses on condition that a correct response to another question was achieved. For example, investigating distribution of responses to questions on vehicle segment where participants had correctly answered questions on vehicle brand. This was done to investigate whether participants associated certain vehicle segments or characteristics with brands when attempting to answer questions. The three possible combinations of two feature categories (brand and character, brand and segment, character and segment) were reviewed for each of the five vehicles used in the study. The distribution of correct responses is illustrated in Figure 10.
As different vehicles were shown to participants a different number of times during the surveys, correct responses are shown as a proportion of the total number of responses to each vehicle. Based on Figure 10 it can be seen that there is no clear trend for participants to consistently answer one type of question correctly having answered another type of question correctly. For example, participants do not always identify segment correctly if they guess brand correctly. This is also demonstrated in that the proportion of correct responses is mirrored by the overall percentage of correct responses to segment and character shown in.

The ambiguity in possible answers contended to have affected participants’ responses to questions on segment and character, is also considered in this analysis. It is possible that, due to this ambiguity, participants may have clear ideas of vehicle segment and character however these were not recorded. Thus it is not possible to draw any clear conclusions as to whether participants associate certain types of vehicle segment or emotional characteristic with brand.

6 Conclusions
Appearance is one of the influential factors leading to a successful product. Despite this, evaluating aesthetic features remains one of the most difficult challenges faced by designers and managers in evaluating aesthetic features. In this study vehicles were visually decomposed into constituent aesthetic features. In order to explore and better understand their influence on consumer perception of brand, combinations of features were assessed using a web based survey. From the study a number of implications for designers, the product

![Figure 10 Multivariate analysis on responses to different vehicle characteristics](image-url)
design and development process have been discussed, and a number of conclusions can be drawn.

Firstly the proposed method of visually decomposing images of designs into feature categories was successful in exploring the way different aesthetic features affect recognition of brand. This was demonstrated by the distribution of correct and incorrect responses over the course of the survey. This also indicates that the representation of products adopted for this study contains an appropriate amount of detail for consumers to correctly identify brand.

The second key conclusion is that different combinations of feature categories have different potency in representing brand. The graphics feature category holds the greatest potency in representing brand. This was shown in participants’ responses to images of the front view that included ‘Graphics’ (headlights and grille detail) producing far more correct responses than those without. Due to the varying potency of different geometries it can be further concluded that it is not the sum of information included in feature categories that influence responses but the potency of geometries included.

The decomposition strategy proposed and used here, although useful in highlighting features most potently representing brand (Graphics), does not provide designers and managers with decisive guidance on particular features or when faced with a range of similar design proposals. What is needed are numeric metrics against which decomposed aesthetic features may be individually assessed. These would give designers and managers scales or measures by which to review characteristics aesthetic features within a design in the same way that they may be used to review technical aspects of a design. It is this challenge of applying metrics that is to be addressed by the authors in their future work.

6.1 Implications for product design and development

There are a number of implications derived from this study, which also extends to the product design and development process in general. The application of the visual decomposition process provides designers with a better understanding of the relationship between the visual characteristics of aesthetic features and brand recognition. Thus the primary implication of this is that designers and others involved in the formal evaluation of product appearance are able to reason and make judgements concerning brand recognition from designs less subjectively.

Further to this primary implication, application of the visual decomposition strategy facilitates the achievement the optimum compromise between progressive styling and familiarity in brand recognition to achieve maximum commercial success, highlighted by Loewy (Lichtenstein, 1990) amongst others (Moulson and Sproles, 2000; Person et al., 2008). The ability to achieve
such a compromise has a further implication in that the design and development process is made more efficient as fewer design iterations are required and less time is required for the evaluation of designs.

Another key implication of this work to the designer is that an increased understanding of key products provides freedom to be less conservative in the design proposals with the knowledge that brand recognition will still be maintained.

Finally, knowledge of brand potency and features may inform marketing and product strategy in terms of reviewing coherence among product families and also maintaining distinctiveness from previous products and competing brands. These substantial implications reinforce the importance of this research and the need to extend research in the manner proposed.

Acknowledgements
The work reported in the paper was carried within the Innovative Design and Manufacturing Research Centre at the University of Bath, also gratefully acknowledged for providing studentship funding to the first author. This is funded by the Engineering and Physical Sciences Research Council (EPSRC) (gs1) under Grant number reference GR/R67507/01. This support is gratefully acknowledged.

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