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# CREATIVITY IN CAR DESIGN – THE BEHAVIOUR AT THE EDGES

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**Abstract:** The paper is developed from a longer evaluation of the history of car design. This larger evaluation used statistical processes for investigating the direction of history. Rather than looking at the way that design thinking and paradigms have become established in car design, the paper takes a sideways look at the variations and quirky cars that have been built, categorising them. The paper ends with a brief look at how and why novelty might become innovation and hence alter the course of the product history. This is where the novelty demonstrates significant advantages for the customer and manufacturer.

***Keywords:*** *Automotive design, Product history, Innovation studies*

## 1. Introduction

Cars have been around us since the latter part of the 19th Century. This paper is a sideways offshoot from a more rational and extensive study into the development of design paradigms in car history. It looks at oddball and off-the-wall thinking in car history and firstly, revels in the variety and secondly, asks more serious questions of how the eccentric might become an accepted innovation.

### 1.1. Being creative doesn't sell cars

People do not love new ideas, particularly when they might be asked to part with money to purchase novelty. They usually purchase a product to fulfil a need or desire. Products have to work reliably and effectively. Novelty doesn't necessarily do that: novel aspects of products need to be tested carefully to ensure they work and they fulfil the expectations. Since Henry Ford's Model T became successful (around 1910), most people wished to buy personal transport rather than, specifically, a car. If best selling cars are investigated, these are seldom at the forefront of change, however determined. However, change in car design does take place – otherwise we would all be driving Ford Model Ts a hundred years after they were first introduced.

### 1.2. Definition of the car

The Oxford Dictionary of English [1] defines a car as *a road vehicle, typically with four wheels, powered by an internal-combustion engine and able to carry a small number of people.* One might add that it is designed to carry people, not luggage or goods, and it is typically owned privately.

It would be worthwhile to investigate the edges of that definition. Firstly, is a car a road vehicle? Yes, generally true, but a significant number are either designed as off-road vehicles or for race tracks or

other non-road courses. Secondly, some have non-typical numbers of wheels – fewer and greater than four. Some cars do not have internal-combustion engines and yet are still cars.

## 2. How to investigate creativity in car design

The method used to investigate car history was to analyse examples of cars from 1878 onwards for layout and form [2]. Nineteen categorical factors were analysed for layout and twenty seven for form using a Categorical Principal Components analysis [3]. Layout variables tend to be categorical in nature, and are related to the position and arrangement of the engine and transmissions, suspension type and body construction. Some form variables are categorical, such as the kind of lighting and front and rear wing forms, but others were obtained by measurement and converted to categorical for analysis. Some were naturally ordered, others ordered by inspecting dates and arranging them into chronological order. This resulted in a number of components for each analysis: the first two components include about 80% of the variation and are therefore the most useful. These four components can be treated as variables and plotted against year of manufacture to allow a line to be plotted along the approximate mean of the data (Figure 1).

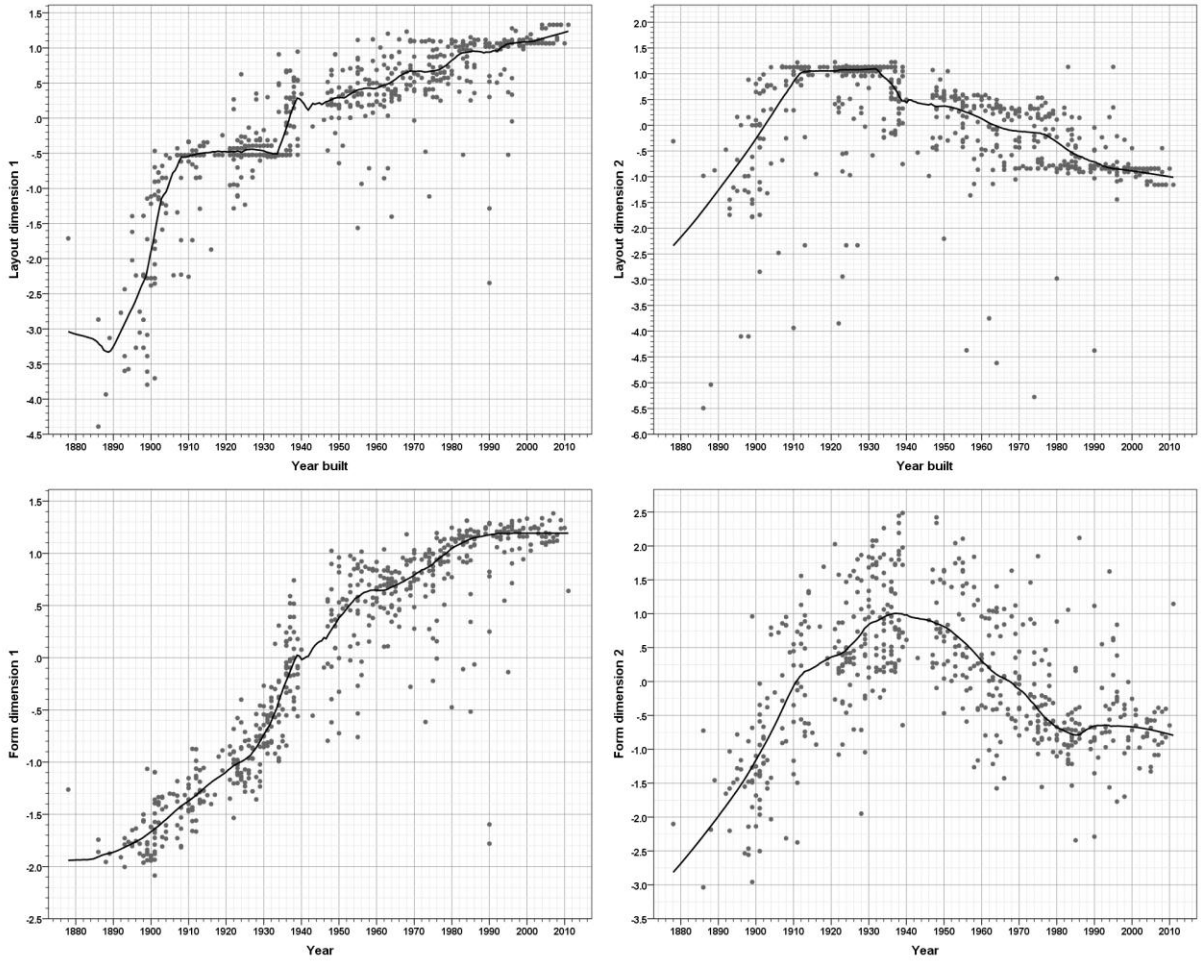


**Figure 1: Categorical Principal Component plots for first (left) and second (right) components for layout (upper) and form (lower) analyses: components plotted against date.**

The investigation of creativity and innovation in car history is the converse of this. Rather than being a coherent statistical investigation that identifies representative cars and seeks to indentify the direction of change from this, this investigation deliberately looks statistical outliers and categorises them. The initial investigation selected cars simply because it was easy to find information. This

resulted in a mixed bag with little coherent reason for selection, on the basis that any car provided useful information. The initial sample included many weird and wonderful examples of creativity, some of which were outside the scope of the car definition such as a non-manufactured design and a disembodied chassis. In the process of obtaining a representative analysis, these find their way to the edges of the statistics and are disregarded. This paper takes these examples and seeks to investigate them in more detail.

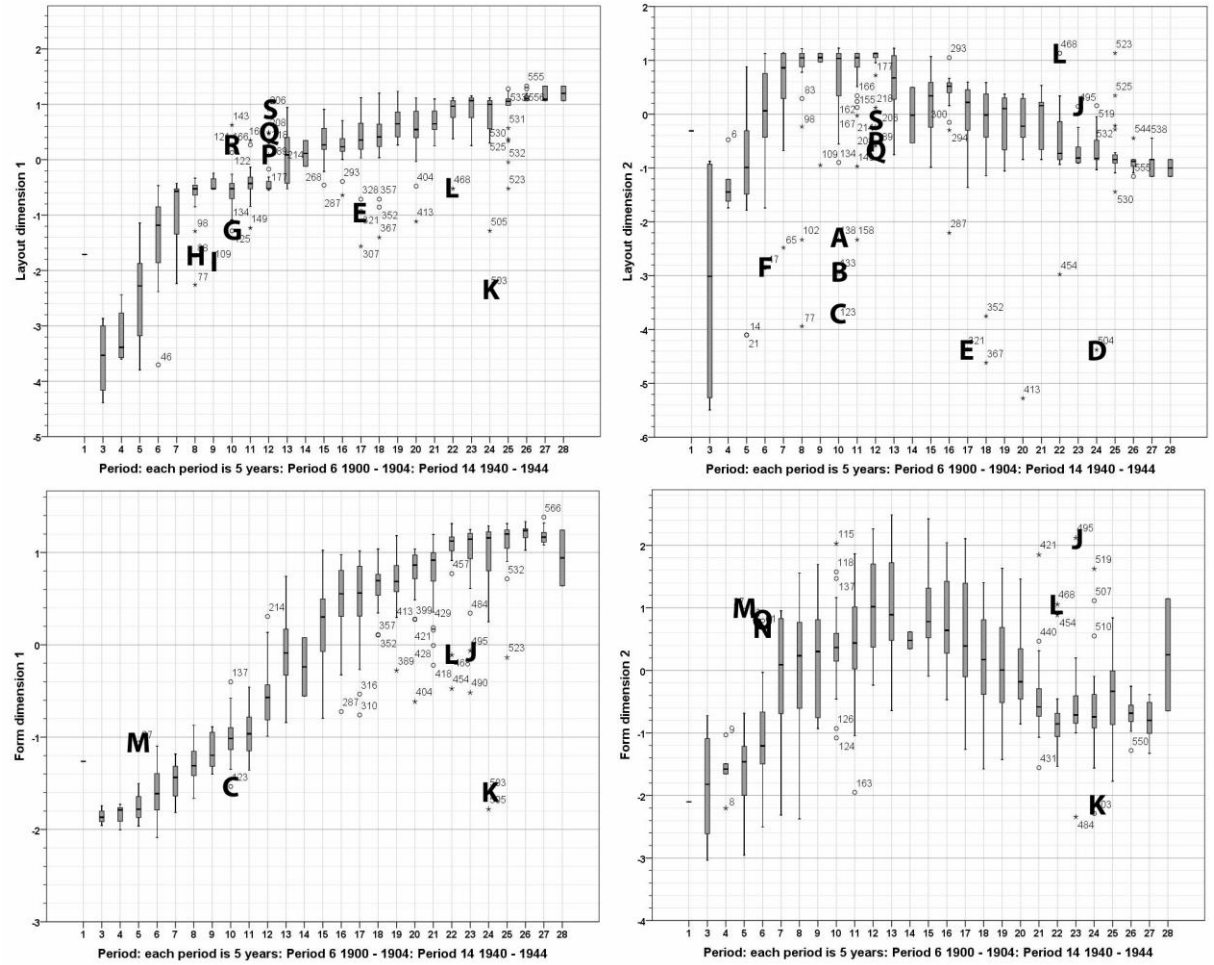


**Figure 2: Categorical Principal Component box plots for first (left) and second (right) components for layout (upper) and form (lower) analyses: components plotted against period, with each period being of five years. The points labelled with letters refer to Figures 3 to 7.**

Figure 1 shows plots from the main analyses: numerical values of variables do not mean much: the form of the graphs is more important and indicates changes and rates of change of the parameters. Each car is represented by a point on the graphs. There are 575 cars in this analysis. Box plots (Figure 2) investigate the outer edges of the four graphs. These identify the outliers and extreme values. Some are outliers for one variable: others for more than one. The meaning of being an outsider may be that the car leads the way: it may be it is behind the times, or it may simply have a different approach from the mainstream. The interpretation depends on how the variable is moving at that time.

Outliers were categorised using an affinity diagram approach. This produced several categories, with some cars in more than one category or linking two categories. Inspection was more useful than plotting layout and form diagrams and using a clustering analysis. Box plots are date-dependent and what is an outlier at one date may not be an outlier for another.

# 3. Creative cars

## 3.1 Eras of car design

Few cars from early eras are deemed extreme. This is because there is a large spread of values for the variables at this point: car designers were not sure how to proceed or what determined a 'car'. By the early years of the 20th century this had been resolved and most cars formed a tightly defined 'paradigm' – described by Sedgwick as a *shibboleth* [4] and by Utterback as a *Dominant Design* [5]. Eccentricities are easier to identify after that. From the early twentieth century up until the mid 1930s there is a period of consolidation, with movement at the edges. This results in designers trying out ideas and seeing how the market takes them, before the shift of the late 1930s where a new direction had been decided. After the Second World War this direction hardened and there were few attempts to change the layout until the 1970s – when there was a dichotomy of directions, producing a bimodal distribution that masks forward thinkers.

## 3.2. Categories of creative cars

The affinity diagram approach indicated three main categories of outliers and cars with extreme values. The difference between categories lies in how they relate to the mean line of the variables. These three categories can be described as a) those outside the mean for all dates after the first paradigm was formed: b) those that would not have been outliers if they had been earlier and c) those that would not have been outliers if they had been later.

Cars in the first of the categories tend to be at odds with the 'car' definition. This splits further into groups. Firstly, cars having the wrong number of wheels or wheels in the wrong places. These three-wheelers are below the mean line of the upper right diagram of Figure 2. Examples of five three-wheeled cars are shown in Figure 3. The sixth car is the 1901 Sunbeam-Mabley – with four wheels in diamond formation. The three-wheeled examples include a Morgan, with the single wheel at the rear, a Messerschmitt, with the same arrangement but thirty years later, a Phänomobil with the single wheel at the front – incidentally, driven with the engine on top – and two cars with one wheel on one side and two on the other: a 1922 Scott Sociable and the 1990 Monash University twin-boomed solar car.

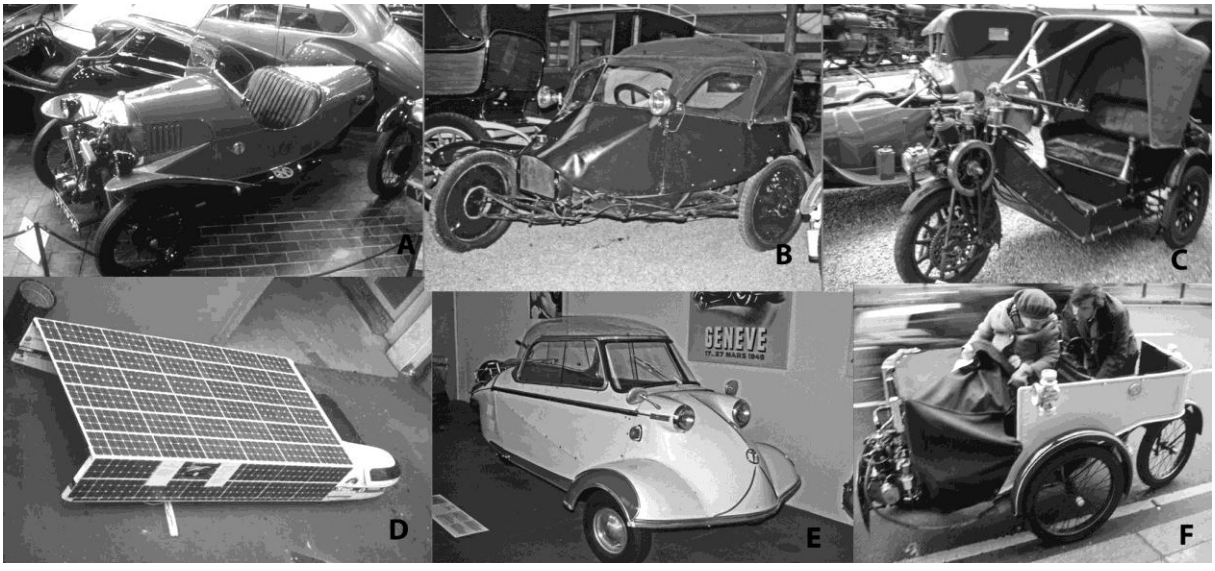


**Figure 3: Odd arrangements of wheels. 1924 Morgan (A), 1922 Scott Sociable (B), 1922 Phänomobil (C): lower row, L to R: 1990 Monash solar car (D), 1956 Messerschmitt (E), 1901 Sunbeam-Mabley (F)**

Cars in a second group in this category do not have internal combustion engines, such as the Monash solar car above. These are slightly below the mean line in the upper left diagram of Figure 2. In early

days internal combustion engines were not the obvious choice, so early electric or steam cars are not extreme and are not outliers. Only a few manufacturers failed to change and steam and electric cars become oddities. These manufacturers are not moving with the rest of the industry, rather than deliberate pushing boundaries.
Cars in this category may have other eccentric features as well. In Figure 3 the Phänomobil and the Sunbeam-Mabley are tiller-steered with no steering wheel: the Detroit Electric also has a tiller and the Messerschmitt handlebars. The Detroit Electric and Sunbeam Mabley also seat the driver at the rear, and the Messerschmitt driver is in the centre.

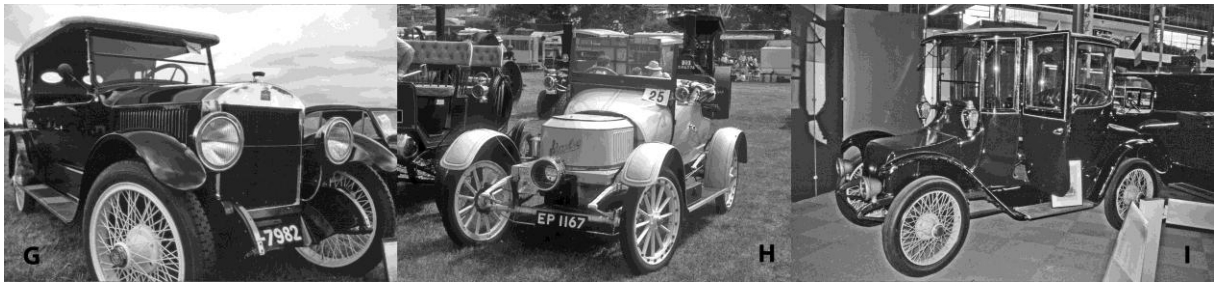


**Figure 4: Steam and electricity: 1922 Stanley (G), 1911 Stanley (H) and 1916 Detroit Electric (I)**

### 3.3. Replicas

The second category of outliers is cars that would not have been outliers if they were earlier. Some of these are deliberately so and are historical replicas. Their design process constitutes deliberate flouting of the status quo of car design: disagreeing with the state of the art when they were built. This category splits up into those which are precise copies of specific cars, and those which are intended to copy the flavour of an era. Figure 5 shows three of these cars.


**Figure 5: 1986 Kougar (J), 1990 Locomobile replica (K), 1989 Bugatti Royale Replica (L)**

Each of these three replica cars takes a different approach and the different dates they are copying mean that they are in different positions on the charts in Figure 2. The Kougar on the left does not copy anything, but picks up the character of an early 1950s open-wheeled sports car. There is no attempt to make the wheels fit the 1950s date – these are from the 1980s. The car on the right is a straight copy of the 1932 Bugatti Royale, using some original parts. In the middle, the Locomobile replica seeks to look and work like the 1900 Locomobile steam car – it has a steam engine – but has enough recent parts (such as front brakes) to make it legal. In all three cases, this aspect of wanting something different has been the spur towards the re-creation. Both the layout and form of these date not from when they were made, but from the date they are copying.

### 3.4. Innovators

More constructive is a study of the third category of cars: those that are the opposite of this: those that would have been outliers if they had been later. Examples of them can be seen in different periods.
In the early years of the twentieth century three cars stand out as being outliers above the mean in the lower right diagram of Figure 2. They are seen in Figure 6. One is Jenatzy's La Jamais Contente. This

car was an electrically powered record car. In terms of its layout, it is not trend setting, but in terms of form it is more integrated (dimension 1) and longer and lower (dimension 2) than other cars. It is cigar-shaped and although trend-setting for form it is outside the mainstream direction. The other two show the direction better, and are a 1904 Mercedes and the 1904 Peerless Green Dragon. These were precursors of a change in (form) design, where cars became longer and lower, with long bonnets at the front with a relatively small passenger area behind. This change was made possible by the (layout) development of the pressed-steel channel-section chassis.


**Figure 6: 1899 La Jamais Contente (M), 1904 Mercedes (N), 1904 Peerless Green Dragon (O)**

The second major period with a number of innovative cars is in the early 1930s, before significant changes took place in the later 1930s. These cars demonstrate developments in layout, and are seen as outliers above the line in the upper left diagram of Figure 2, and just below it in the upper right one. During this period most cars had longitudinal engines in the front, rear wheel drive, rigid front and rear axles and separate pressed-steel chassis. But some designers were pushing boundaries. These may have had independent suspensions; rear engines, transverse engines, or monocoque chassis.

Cars having rear-mounted engines have never really been regarded as mainstream, although there have been quite a few cars with this feature, such as Volkswagen, Skoda, the much later Smart, and a significant number of sports cars.

Figure 7 shows some examples of cars of the 1920s and 1930s with these features. This shows four different directions that cars might have developed. At the top left is the 1931 DKW F1. Its front wheel drive, transverse engine, independent front suspension and unusual structure push it above the mean, but its two-cylinder two-stroke engine pushes it back down a little. It was a German development of the small car, built for the masses in an economical manner and down to a price. Whether the designer was considering it as progressive is not clear. The Wikipedia website (not always the most reliable) simply states that the company was ‘progressive’ [6]. Sedgwick [4] suggests DKW led the use of front-wheel drive in the 1930s and that it was no longer considered a heresy by that time, which suggests the car’s design was outside normally-accepted codes of practice. Although it is not the first recorded use of a transverse engine and front-wheel drive (this honour seems to have gone to an 1895 Graf, one of which is in the Technical Museum in Vienna [7]), it seems to have been the first time this was used in a mass-produced car. Although DKW and its offshoots such as the Trabant continued with this layout, the next serious example of this arrangement was the 1959 BMC Mini. The second example, top right, is a rear-engined Mercedes-Benz. In the early 1930s, several manufacturers played with the idea that the ‘proper’ place for an engine was at the rear and that the driveline between front and rear was misplaced and illogical. Most of this development came from middle Europe, Germany and Czechoslovakia, with examples of the layout from Benz, Rumpler, Hänomag, Mercedes-Benz, Auto Union, Tatra and Volkswagen: of these, the Benz and Auto Union were racing cars and the Rumpler never made it into serious production. Most of these also adopted independent suspension all round, which is probably a more important development. The layout flowered from the mid-1930s. Though it probably had its roots in the German rationality of the Bauhaus, the logicality to placing the engine at the rear did not confer significant advantages over a front-engined arrangement – but in the 1930s it was considered progressive, and managed to flout the accepted codes of practice. The 1934 Citroën (lower right) introduced a combination of front-wheel

drive, independent front suspension and unitary body-chassis construction. The lower left example dates from somewhat earlier, and is a 1925 (designed somewhat earlier) Lancia Lambda. This used sliding-pillar independent front suspension and a unitary-construction body-chassis unit. It is now regarded as one of the most sought-after cars of the 1920s, described in *Classic and Sportscar* magazine as the first production monocoque car; innovative and with excellent handling [8].


**Figure 7: 1931 DKW F1 (P), 1934 Mercedes-Benz 130H (Q), 1925 Lancia Lambda (R), 1934 Citroën 7A (S)**

Another group of innovators on the edge of the box plots is a group of cars from the 1990s and early years of the current century. These are diesel-engined cars, a little in advance of the general market acceptance. This is slightly surprising as the first diesel engined production cars were probably built by Mercedes-Benz as long ago as the 1936 [9]; it has taken from then to the current century for diesel cars to achieve acceptance in the market.

## 4. The anatomy of an innovation

None of these developments in car design have the character of the disruptive innovations described by Christensen [10] and illustrated by the development of the Turbojet in Constant [11] as they do not require significantly different manufacturing technologies to be implemented.

What turns something that is merely outside accepted wisdom into an innovation? And why did technologies such as monocoque body-chassis construction, independent front suspension and front-wheel drive became successful innovations whilst the middle European approach with a rear engine did not? And why did it, in some cases, take so long from the earliest use of a particular arrangement to its being accepted as an innovation?

The difference seems to be that developments become innovations after clear advantages are demonstrated that are then translated into an improved product for the customer. In the case of the use

of independent front suspensions compared to the use of independent rear suspensions the advantages are to do with the car's roll behaviour, where independence allows a step-change in the moment arm resisting the roll moment compared with a non-independent axle. This allows the independently-suspended car to have a softer suspension than a rigid-axled car could have for the same roll stiffness. This improvement in ride quality sold the arrangement to the General Motors management in the early 1930s, and was deemed to be a noticeable advantage for customers. Independence also confers a significant improvement in handling behaviour by reducing oversteering on the limit (resulting in an infinite response to a steering input) and avoids wheel-shimmy. The use of independent front suspensions also allows the car's engine to be moved further forward between the front wheels, giving more space for passengers and luggage. This movement changes the direction of the second form dimension in the lower right diagram in Figure 1. The improvements arising from monocoque structures may be mainly to do with the manufacturing advantages, in that the combination of a mass-produced body with a mass-produced chassis into a single entity is a logical approach that reduces the number of components. In terms of the customer perception, the improvement is likely to come from the improved use of interior space, the improvement of the form of the car into an integrated whole, and more stiffness for the same weight.

## 5. Conclusion

The title for the paper originally came from a discussion where someone stated that the interesting things all happen at the edges. This paper takes a look at what these interesting things might be in car history. It is also perhaps a sideways look at the use of statistical analyses: that of analysing the deviant rather than the norm, devising a process of using the outliers to the norm to do so and then gathering the data using an affinity diagram to identify categories and groupings. This may provide an insight into the way in which developments and ideas turn into either dead ends or innovations.
It also indicates that the statistical or quasi-statistical might lead to possible insights that require other processes to investigate them, and ties the analytical analysis process to that of more conventional historical discussion to explain and make further sense of the findings.

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