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ABSTRACT

The purpose of this research was to examine how manipulation of the aesthetic appeal of a motorcycle's image on a web page might elucidate trends in consumer preference. To this end, website visitors were encouraged to reconfigure a blueprint of motorcycle to make it more appealing. These alterations to its confirmation were analyzed to identify patterns of preference that were then compared to the marketplace in general. It was observed that aesthetic preferences recognized by the design method were similar to trends within the motorcycle building/buying public.

Keywords (Required)

User-Centered Design, Aesthetic, Interface

INTRODUCTION

The purpose of this research was to examine how manipulation of the aesthetic appeal of a motorcycle's image on a web page might elucidate trends in consumer preference. The proposed role of the website visitor was to dynamically manipulate the aesthetic appeal of the image in an interactive fashion in order to induce a favorable response. To achieve this, a web applet was developed that allowed people to directly interact with graphical objects visualizing the image of motorcycle (See Figure 1). Users were tasked to redraw the motorcycle by moving its parts (Figure 2), if desired, to make it more appealing. These alterations to its confirmation were analyzed using descriptive statistics, frequency histograms, and K-means cluster analysis. Ultimately, a pattern was considered a preference if the three methods of analysis seemed to be mutually supportive. It was observed that preferences identified by the design method were similar to buying/customizing patterns of the general public

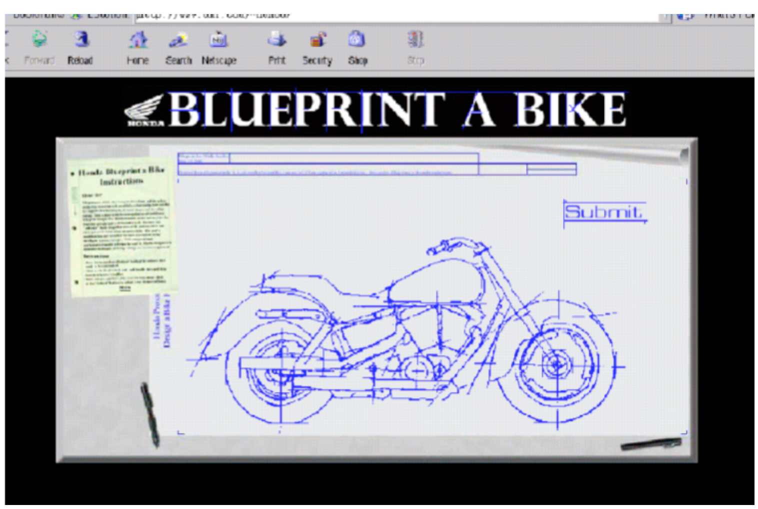

Figure 1. The Research Website (http://web.mst.edu/~honda)/

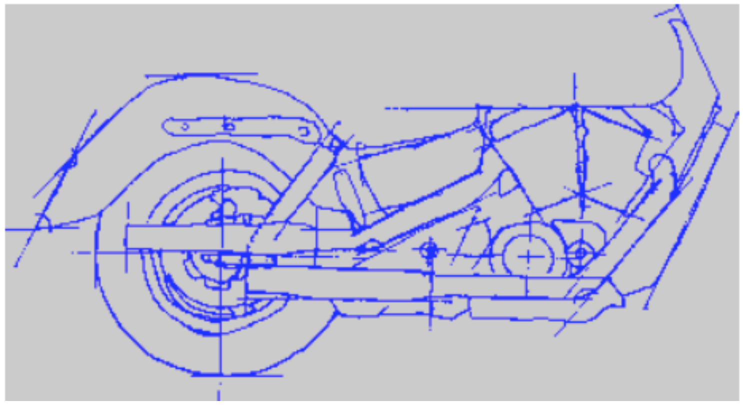

Figure 2. A Graphical Interfacial Object

suggesting preliminary validation of this approach.

LITERATURE REVIEW

In this research, the term “aesthetics” was used in two different senses. The website visitor controlled the look of the elements of the interface. This meant a web page, open in a web browser, was dynamically modified until a virtual object achieved the highest aesthetic value in the opinion of the viewer. Hence, the first level of aesthetics involved the question of what makes the elements on a web interface aesthetically pleasing. The next level involved the passing of aesthetics from the virtual web environment to the physical object. Hence, an important supposition was that there was correlation between the virtual and the real in the mind of the viewer. That is, the website visitor needed to believe that an aesthetically pleasing virtual motorcycle was similarly appealing as its physical realization.

It should be noted that aesthetics is more than just beauty and its importance (Tractinsky and Lavie, 2003). It is a process whereby people survey their visual environment and assess their reactions to it (Zettl, 1999). The motorcycle design process discussed herein allowed a website visitor to manipulate a specific visual environment via computer interface in order to improve his or her assessment of the associated internal reaction. Altering visual aesthetics is an act of communication (Hoffman and Krauss, 2004). It involves reforming content to make it as effective as possible in communicating the underlying message. Through the manipulation of visual elements, the perceptions of the user are also manipulated (Hoffman and Krauss, 2004). Ultimately, the goal of aesthetics control is to unknowingly involve the viewer in the communication of the message (Hoffman and Krauss, 2004). This is facilitated by the observation that aesthetics can lead people into being inquisitive about an object (Klett, 2002). Curiosity is a first step toward an extended relationship with the object. Hence, the need to influence the message sent by an object drives manufacturers to use aesthetics to influence every product made (Haig and Whitefield, 2001). Whether the effort spent to design a product with imagination and flair results in increased sales is a classic marketing question (Lavidge and Steiner, 1961).

A critical factor in this research was changing the role the public played in motorcycle design. User-centered design (UCD) is a process in which the user of a product is actively involved in setting clear design requirements (Vrendenburg, Mao, Smith, and Carey, 2002). Originally proposed by Norman and Draper (1986), UCD was met with mixed community response, since many companies believed it to be impractical (Vrendenburg and Bulter, 1996). Since that time, a wider range of techniques and measures have been developed (Vrendenburg et. Al., 2002). The research introduced herein provides another potential tool for UCD and fits into the family of techniques such as role-playing (Seland, 2006) and “magic wands” (Brandt and Grunet, 2000).

As mentioned, this research was concerned with the manipulation of aesthetics on two levels: the aesthetics of motorcycle on the web pages as well as the aesthetics of its physical realization. According to Hoffmann and Krauss, (2004), literature on the aesthetic aspects of web interfaces is slim. One reason for this is that the academic community is suspicious of aesthetics (Karvonen, 2000) believing it to be inversely proportional to usefulness (Mirzoeff, 1999). Even more discouraging, from the perspective of this research, was that there is an effort to separate interface research from advertising and marketing (Tractinsky, 1997). That is, to focus exclusively on user-centered design at the expense of customer-centered design.

Part of the difficulty in accepting the importance of aesthetics was that a proper measure was elusive to find. However, (Tractinsky, 1997) showed that perceived aesthetics were strongly correlated with *a priori* perceptions of usability. Thereby it was suggested that usability is a reasonable measure. More recent research argued that usability should not be the only measure of the value of aesthetics. Ben-Bassat, Meyer, and Tractinsky, (2006) dealt directly with the relative value of different design features by developing an economic measure. This bridged the gap between customer and user perspectives and coped with a relevant issue in this matter.

Judging that a design as attractive does not imply that the viewer would purchase a commercial object (Einhorn and Hogarth, 1981). However, as products become more functional and reliable, consumers were making the decision to purchase more dependent on visual aesthetics (Dumaine, 1991). Understanding consumer response is a goal of marketing. For example, Block (1995) developed a model of the consumer's response to the visual appeal of an object. This research was followed by Block, Brunel, and Arnold (2003) who developed a scale called the Centrality of Visual Product Aesthetics (CVPA) in order to measure the level of significance that visual aesthetics hold for a particular customer. Hence, the marketing community is also looking for means to understand the impact of visual aesthetics on spending habits.

CONCEPTUAL FOUNDATIONS

Dynamic Aesthetics

According to the concept of aesthetics as proposed in (Zettl, 1999), it is a process whereby people survey their visual environment and assess their reactions to it. In many situations, people have no capability to change their visual environment. Hence, the appraisal of the aesthetics becomes static. If the assessment is not favorable, then it is unlikely that they will prefer the object as compared to others of similar type. But what if people are allowed to adjust the object on the basis of their reaction to it? It seemed plausible that if they can change what aspect they failed to react to favorable, they can affect how they prefer the object. This leads to the conceptual foundation of user-controlled aesthetics.

Controlling the aesthetics of an object must focus on altering the visual environment. Using the concepts of Bloch et al (2003), each individual has an innate response to visual appeal. To get a different user response, the visual appeal must be different. Of course, most of the time, altering the physical appearance of an object is not possible, at least on initial viewing. Given a longer association, the object can be cosmetically modified through means such as painting, dying, and so forth. Given sufficient time, the infrastructure of the object can be changed, creating a new base appearance. This process is viewed as *customization*. People often customize homes, cars, motorcycles, clothes etc. The concept of dynamic aesthetics attempts to bring customization of objects to shorter time periods.

In order to make this more meaningful, the controlled alterations to aesthetics should happen during the design phase of an object. In general, the visual environment presented by an object has many factors or dimensions: size, shape, color, performance, etc. The control of the aesthetics as part of a design process required a relatively small number of factors be open for modification. This kept the process manageable and tractable for analysis. During the act of personally improving the aesthetics, the alterations of the object are captured and recorded. The designers are then faced with the problem of identifying commonality in the preferred aesthetics. This suggested the use of cluster analysis, which is a way to group object so that the characteristics of objects in the same cluster have similar traits and the profiles of objects in different clusters are quite distinct. This was required because there may have been many opinions of what was attractive.

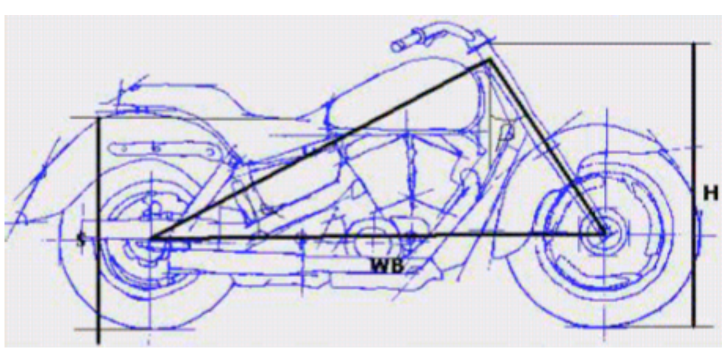

Figure 3. Elements contributing to the visual environment

Example of Dynamic Aesthetics Design

The foundational prototype that was considered in this research was that of motorcycle. This object has a complex aesthetic. The image of the motorcycle is the collection of attributes that in unison create the mental perception generated. Central to this image is the core structure of the motorcycle such as the height of the seat, the wheelbase, and the rake of the front forks. Superficial to the elemental configuration, the motorcycle has painted surfaces, chrome, seats, and saddlebags, for example. These attributes are easily changed; yet they can contribute significantly to the image. The list of elements that forms the visual environment the motorcycle presents is potentially endless. In order to do this study, the cosmetic elements, such as paint and chrome, were both minimized in the presentation and held constant. As can be seen in Figure 1, the interface presents the website visitor with a blueprint. This removes reactions to elements of the environment such as attraction to color and so forth. The visual environment also included more primitive elements that define the basic conformation of the motorcycle. There were geometric factors that formed the frame, forks, and handlebars (See Figure 3).

While these geometric factors seemed like a reasonable basis with which to characterize the confirmation of the motorcycle, they cannot be arbitrarily changed. This introduced a complexity in giving the user control over elements that form the visual environment. That is, there were physical constraints on the visual interfacial elements that must be obeyed. For example, the angle in the lower left corner of the triangle in Figure 3 is fixed. This had implications with regards to the wheelbase. The net effect of this analysis was to determine a reduced set of geometric factors that had to be considered.

Using these considerations the number of geometric factors was reduced to three: the seat height, the handlebar height, and the rake angle. From these, it was possible to reconfigure the entire motorcycle introducing major change in its environmental visual appeal. Furthermore, these three quantities were geometrically independent. This means that it was possible to change the seat height, for example, without causing a physical change in the handlebar height or the rake angle.

RESEARCH METHOD

Research design

An experiment was designed and conducted via the worldwide web to test preference based on controlled aesthetics. In order to operationalize viewer preference of a design, a motorcycle alteration scenario was used. To this end, the user was tasked with creating a blueprint of a motorcycle that was most appealing to him or her. This was an interface-based interactive process. The user "drew" the new blueprint by dragging elements on the original blueprint. The new blue print resulted in three numbers corresponding to lengths of line segments within the figure of a hand-drafted motorcycle (See Figure 3). The means of gathering this information was a button click. The user selected the drawing that was most appealing to him or her then clicked a SUBMIT button and the data was captured.

Data Collection

Forming the platform for the user-controlled aesthetics, a Honda Shadow was used as the motorcycle displayed on the interface. In order to hold certain aesthetic elements constant throughout this survey of user preference, a blueprint was used with traditional foreground and background colors. This eliminated bias caused by the emotions evoked by the color of paint or the amount of chrome. The motorcycle was drawn without windshield or saddlebags to eliminate those who favored touring designs. The drawing was vague on other aesthetic attributes such as pipes and type of tire and wheel. Hence, the blueprint approach was implemented in order to encourage users to focus on the geometric factors of the design.

The web interface presented the user with a task to perform. They were instructed to redraw the motorcycle as desired and to submit their favorite design. At this phase of the research, there was no time limit, password protection, or limit to the number of times the results of the task could be submitted. There was no demographical information collected about the user, and participation was anonymous.

The user was allowed to adjust three geometric factors: wheel base, seat height and handlebar height (See Figure 3). These modifications could be done in any order and there was no commitment to the configuration until a button was clicked. The data collected began as pixel locations. Before uploading the result of the interface interaction, the pixel locations were converted to inches and/or angles measured in degrees.

	Mean (inches)	Standard Dev
Wheelbase	6.8475	3.9762
Seat Height	-1.2662	1.3499
Handlebar Height	2.5538	1.0852

Table 1. Means and Standard Deviations for Differential Length

	Wheelbase	Seat Height	Handlebar Height
Wheelbase	1.000	0.0937**	0.5868**
Seat Height	0.0937**	1.000	0.1150**
Handlebar Height	0.5868**	0.1150**	1.000

Table 2. Correlation of the Geometric Factors

* = p < 0.05 & ** = p < 0.0.1

Participants

The site went online during a fall semester. Initially, it received very little traffic. Then the first of a series of articles concerning this Honda-sponsored research appeared in newspapers. That weekend the site was accessed 300 times. In the weeks that followed, variations on the original article appeared in newspapers around America. The last news article was in *Design News* in February. By then about 1100 people had visited the site.

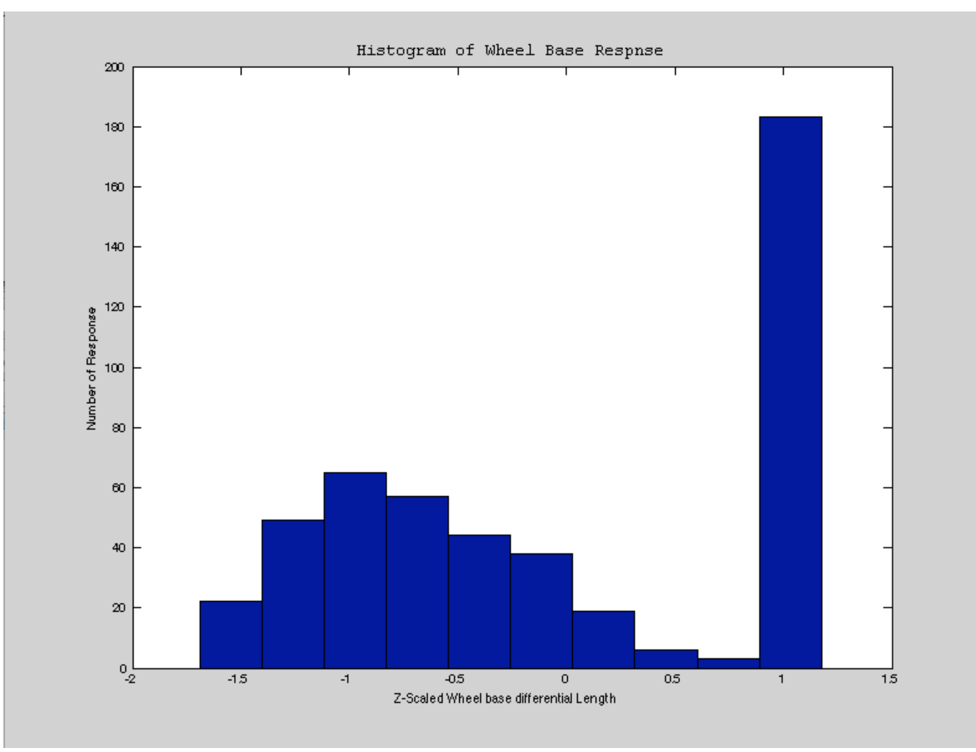

Figure 4. Histogram showing the frequency of Wheelbase responses

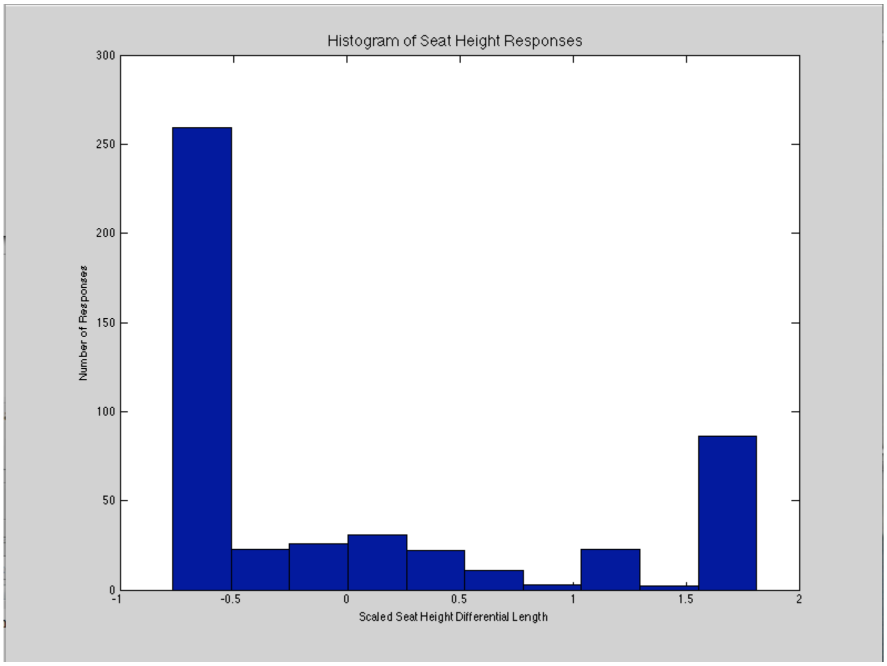

Figure 5. Histogram showing the frequency of Seat Height Responses

Data Analysis

The data analysis of the responses from the experiment began with preprocessing. The first step was to transform the data into differential lengths as opposed to absolute lengths. That is, the geometric parameters of the initial configuration were subtracted from the lengths produced by the user manipulations at the interface. A change of zero meant that the geometry was unmodified. Whether or not a survey result was zero was seen as a measure of engagement. Given the hypothesis depended upon a user controlling the aesthetics, a sincere and engaged user was desired. Therefore, in this initial investigation the focus of the analysis was survey responses that had nonzero differential lengths in all three components.

The means and standard deviations of the differential lengths are displayed in Table 1, and the correlations among the lengths are displayed in Table 2. In order to reduce bias in the cluster analysis, raw scores were converted to z-scores. When the P-values were examined, they were seen to be significant. This meant that the movement of the components was uncorrelated to each other.

GRAPHICAL ANALYSIS

In order to judge popularity of individual geometric factors histograms were examined first. It was reasonable to do this since the component movements were uncorrelated. That is, it was possible to look at the histogram of a component's final location without considering the location of the other components.

Consider Figures 4, 5 & 6. In these graphs, there were two features. Each histogram has a spike. This indicates that there was a concentration of responses over a small range. The spikes occur at the maximum and/or minimum value for the component. However, the data was more complicated than the spikes. It was bimodal. All three histogram demonstrated a region over which the behavior was nearly normal. The spikes could be viewed as normal distributions with very small variances and while the second mode had a wide variance. At the least, the data was clearly non-normal

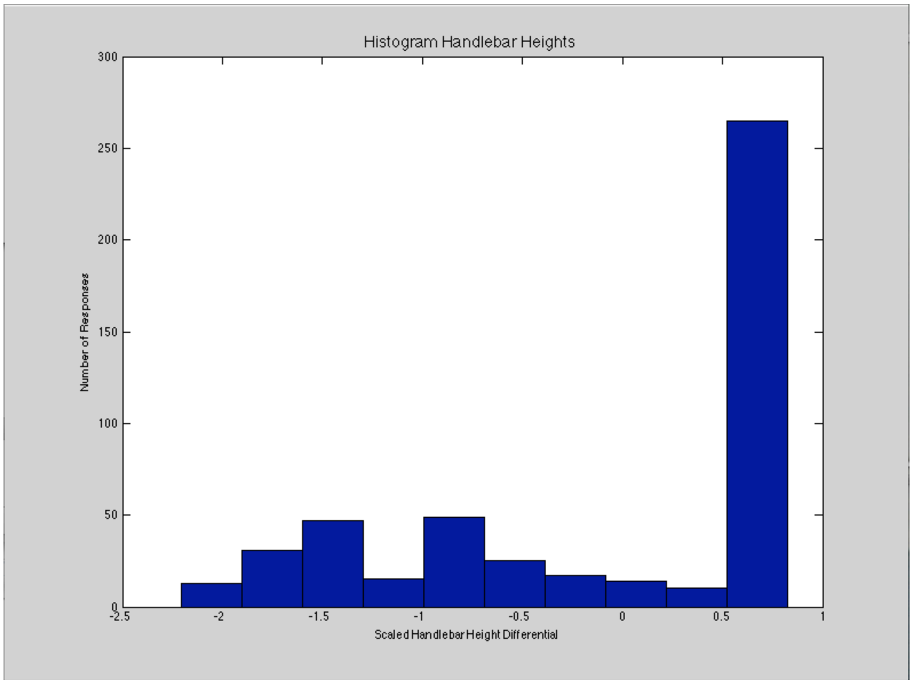

Figure 6. Histogram showing the frequency of Handlebar responses

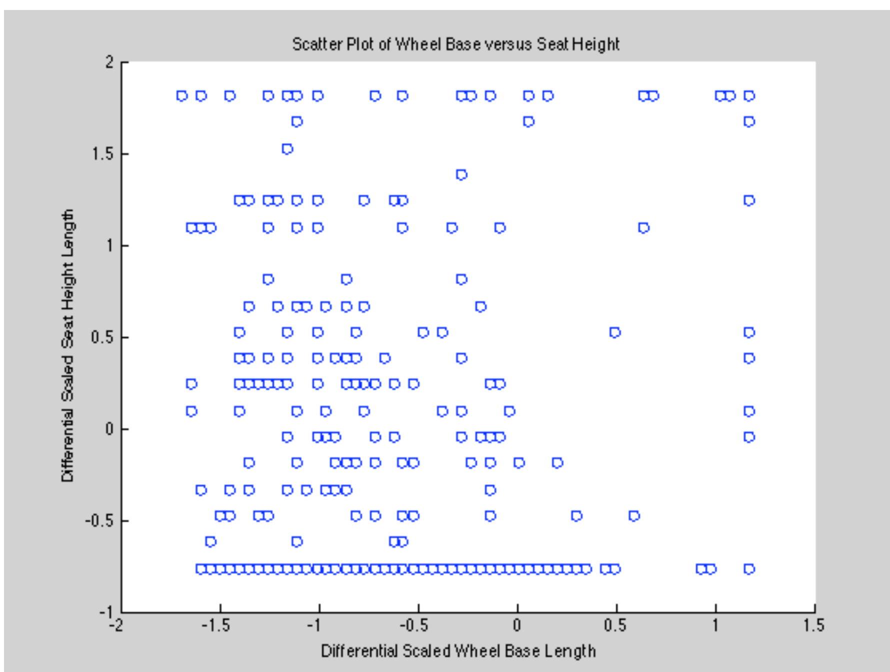

Figure 7. Scatter plot showing the distribution of Wheelbase versus Seat Height

The scatter plots of Figures 7, 8, 9 & 10 demonstrated that there was essentially no correlation between the geometric factor lengths chosen by the users. In particular, these plots show that many of the respondents where strongly engaged in the experiment as they carefully placed the parts. Another element of interest was the observation that there were roughly two clusters of data. One cluster involved the points scattered along the boundaries. There was a cluster of responses in the lower left corner. This type of observation suggested that cluster analysis would be appropriate.

Cluster Analysis

The K-means approach to cluster the data is a partition approach that is particularly well suited for large data sets. It is an iterative process whereby observations are moved into and out of clusters in the goal of minimizing a distance function. At each stage of the iteration, the location of the cluster centroid is estimated. Then the distance from the centroid to each point in the cluster is calculated based on a given metric. These distances are summed, which is the quantity to be minimized. This process is repeated until the minimal sum of distances is found. Associated with this value is a centroid estimate. This process is done on normalized values to remove bias due to differing length scales. In this case, z-scores where used.

Note that this algorithm does not identify the number of clusters. The number of clusters remains fixed through the iterations and must be specified *a priori*. Hence, this type of cluster analysis must be repeated during which the number of clusters is varied each time. Methods such as silhouette graphs can be used to determine if more clusters are required. For this data set, it was found that 2 clusters seemed the most reasonable from a numeric stand point. In examining the frequency histograms, two clusters was also a reasonable conclusion. To see how the clusters are separated and the location of the centroid, See Figure 10.

The centroid of each cluster was found. Recall the centroid is the location in space that has the minimal distance to each point in the cluster and serves as the estimate produced by the cluster. The results are reported in Table 3, after converting back to the non-normalize differential lengths. The motorcycles corresponding to the estimates produced in Table 3 are shown in Figures 12 & 13. Those familiar with motorcycle designs will recognize Figure 12 as a so-called chopper; this cluster will be called the Chopper cluster. In a similar way, the motorcycle corresponding to Cluster 2 is shown in Figure 13. In terms of its type based on the shape, it is somewhat in-between the default state shown in Figure 11 and the chopper in Figure 11. This type of configuration is called a cruiser. In terms of styling, it is slightly more aggressive than the default state.

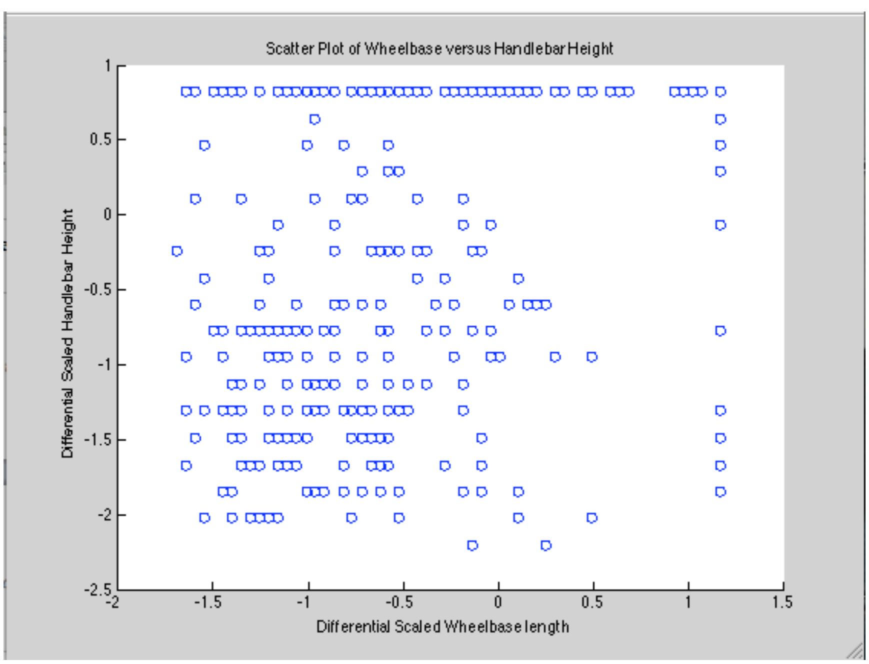

Figure 8. Scatter plot showing the distribution of Wheelbase versus Handlebar Height

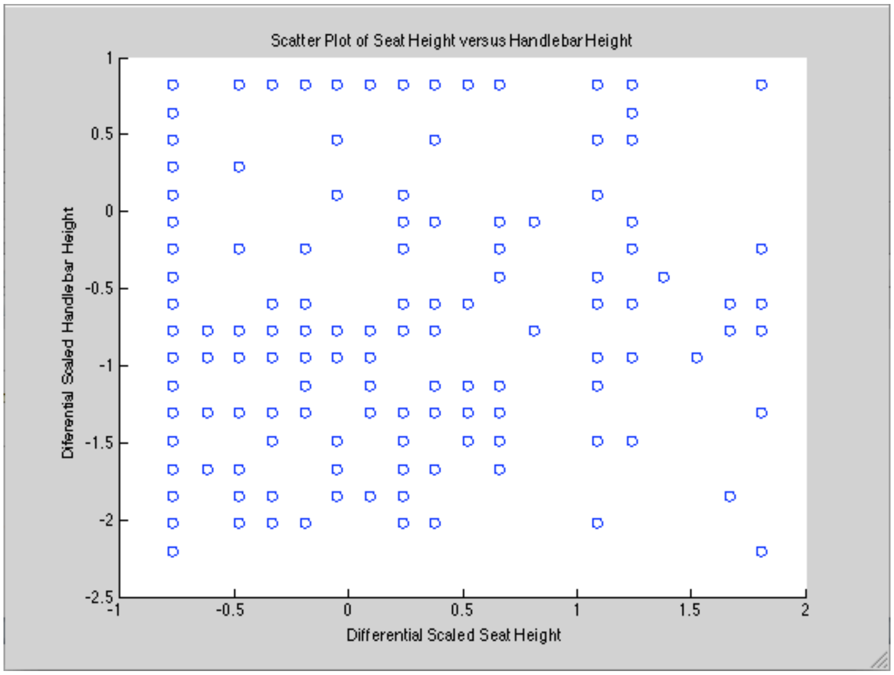

Figure 9. Scatter plot showing the distribution of Seat Height versus Handlebar Height

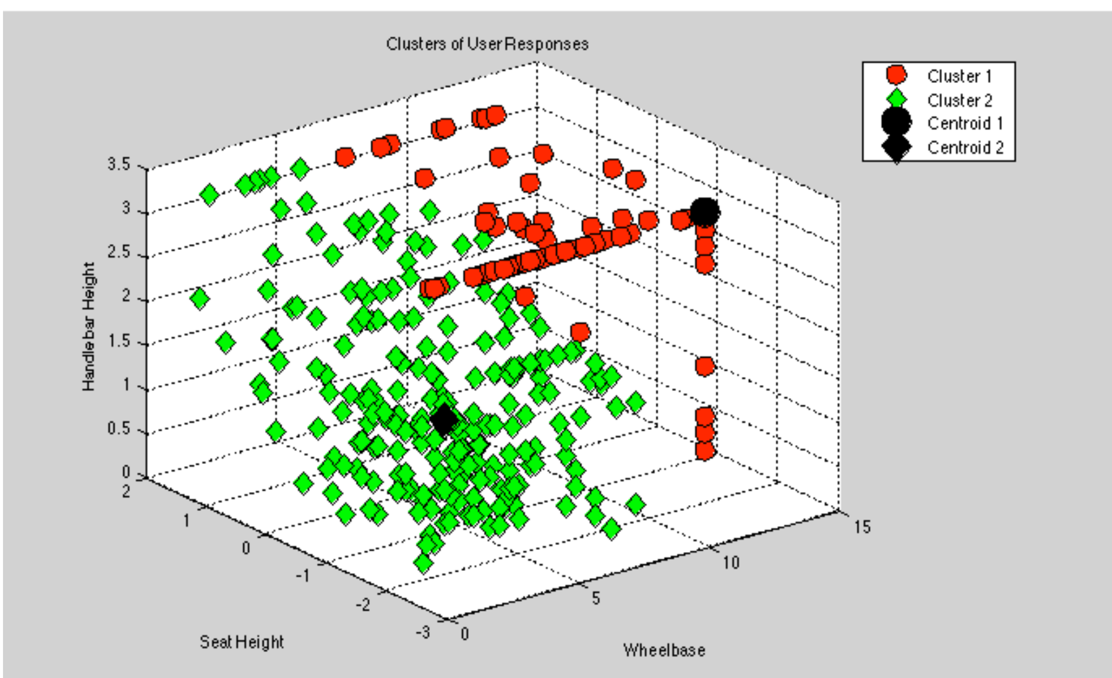

Figure 10. The Cluster Centroids among the User Responses

	Wheelbase	Seat Height	Handlebar Height
Cluster 1	11.5200	-2.3000	3.4500
Cluster 2	3.3200	-1.5200	1.5200

Table 3. Centroid of the Cluster

POPULATION ANALYSIS

In order to validate this UCD process based on interface interactions, it is necessary to have some intuition of the preferred configuration of motorcycles purchased in the United States. The point of this discussion is to identify a few motorcycle types that have consistently been among the most highly preferred in the nation. The sources that were used in this section are somewhat less than authoritative, given more to popular media; however, the validation of the method under discussion does not depend on the accuracy of the numbers. Rather it is most important to identify motorcycle types that enjoy commercial and media attention.

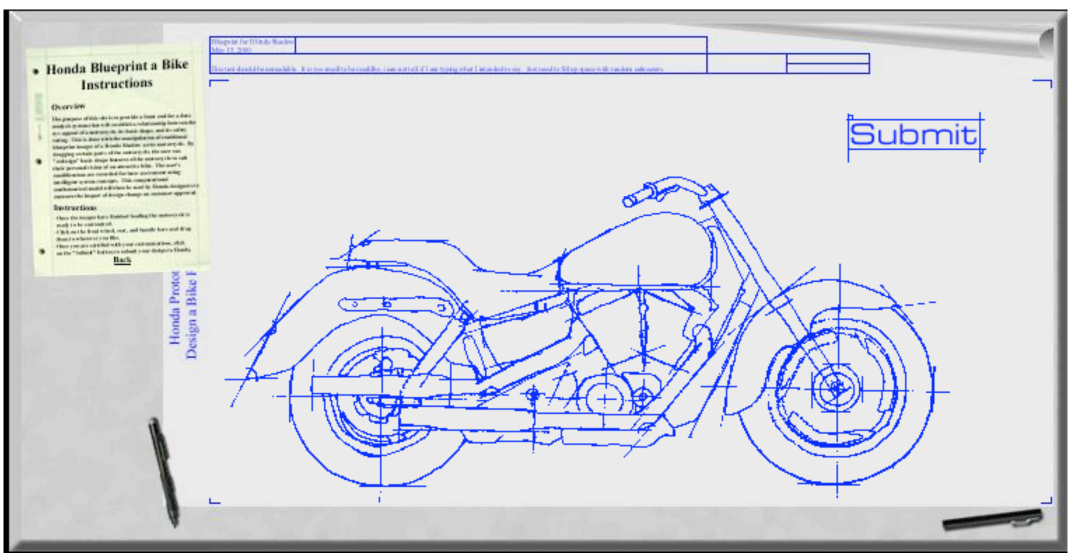

Figure 11. The Motorcycle corresponding to the Default State

The motorcycle market decomposes into four categories, as tracked by the Motorcycle Industrial Council: dual sport, off road, street bike, and scooters (webBikeWorld, 2009). In 2008, 879,910 new motorcycles were sold (webBikeWorld, 2009). Of those, 611,133 of them were street bikes or 69%. Within the class of street bikes available, there are several styles of motorcycles including standard, cruiser, touring, and sport (Honda, 2009; Yamaha, 2009). For Harley Davidson, their entire line is the cruiser, with some accessorized for touring (Harley Davidson, 2009).

The motorcycle associated with one cluster has been classified as a chopper. The characteristics of a chopper include an extended front wheel as well as a low seat and raised handlebars (Wasef, 2007). Choppers are a style of custom motorcycle that has been very popular since the 1970's movies *Easy Riders*. The chopper still enjoys pop culture attention with shows such as *Orange County Choppers* (Orange, 2009), merchandise promoting West Coast Choppers (West, 2009) and the recent movie *Ghost Rider*. In fact, the chopper is about to move from the custom market to the mass-produced commercial world with the release of the Honda Fury in 2010 (Honda Power Sports, 2009).

Figure 14. A Harley Davidson Cruiser with a Custom Paint Job

The cruiser type of motorcycle is associated with the second cluster. Cruisers are characterized by a slight extension of the front wheel and a lower seat and slightly raised handlebars to create a laid back look (Wasef, 2007). Popular Mechanics claims that over 50% of all motorcycles sold in the US are cruisers (Stewart, 2007). Yamaha reports that that cruiser sales account for 63% of their sales (Crowe, 2005). Hence, the cruiser is a significantly preferred motorcycle among the buying public.

DISCUSSION AND IMPLICATIONS

The research question was whether design-oriented user-controlled aesthetics could identify trends in user preference. To achieve this end, there are several important issues that remained to be discussed.

First, the scatter plots (see Figures 7 through 10) and the descriptive statistics (Tables 1 and 2) indicated that the users were reasonably engaged in the task they were given. By this it is meant that a large number of different configurations where submitted. In fact, the difference in the user-submitted observations was so strong that the correlations between factors were zero. This independence between geometric components suggested that users gave the aesthetics of various configuration due consideration before submitting. This indicated engagement.

Second, the frequency histogram showed distributions that were bimodal (Figures 4, 5, & 6). One mode showed a high concentration of configurations near the maximum and/or minimum for that component. The other mode was similar to a normal distribution with mean away from both the default state and extreme limit. This suggested that there were two trends in the appeal of the motorcycle.

Third, the cluster analysis supported the belief there was two trends. One user preference has been identified as a chopper and the other as a cruiser. To what extent do these agree with preference in the user marketplace? Of all of the different types of street motorcycles on the market, the cruiser model accounts for roughly 50% of the total market. It should be noted that about 47% of the total number of observations were in C2 (cruiser). This matched nicely with the buying preference of the public. Furthermore, the motorcycle yielded by C2 (cruiser) has subtle yet significant design changes relative to the base state. It is seen that the front wheel has be extended about 33% of the permissible length (the chopper was stretched as far as it would go). The seat has been lowered by about 50% (the chopper had its seat lowered completely) and the handlebars were raised about 50% (whereas the chopper went to maximum extension). This satisfies the definition by Wasef (2007), which characterizes a cruiser as a scaled back chopper. So this motorcycle was about half way between the default bike and the chopper. As a final note, a visual comparison with the Harley Davidson shown in Figure 14 demonstrates a remarkable amount of similarity as opposed to the default motorcycle shown in Figure 11. It seemed reasonable to conclude that the user-controlled aesthetics method of UCD yielded a preference very similar to a preference in the marketplace.

As discussed above, it is furthermore seen that the chopper is an extremely popular custom motorcycle if not the cultural icon for bike builders. If this exercise in controlled aesthetics had not yielded a chopper, it would likely call the process into question. That it did show the users preferred a chopper is a form of validation.

In summary, this user centered design method was validated for this preliminary study, at least in the sense that a clear preference demonstrated in the controlled experiment produced motorcycles that were highly preferred in the buying public.

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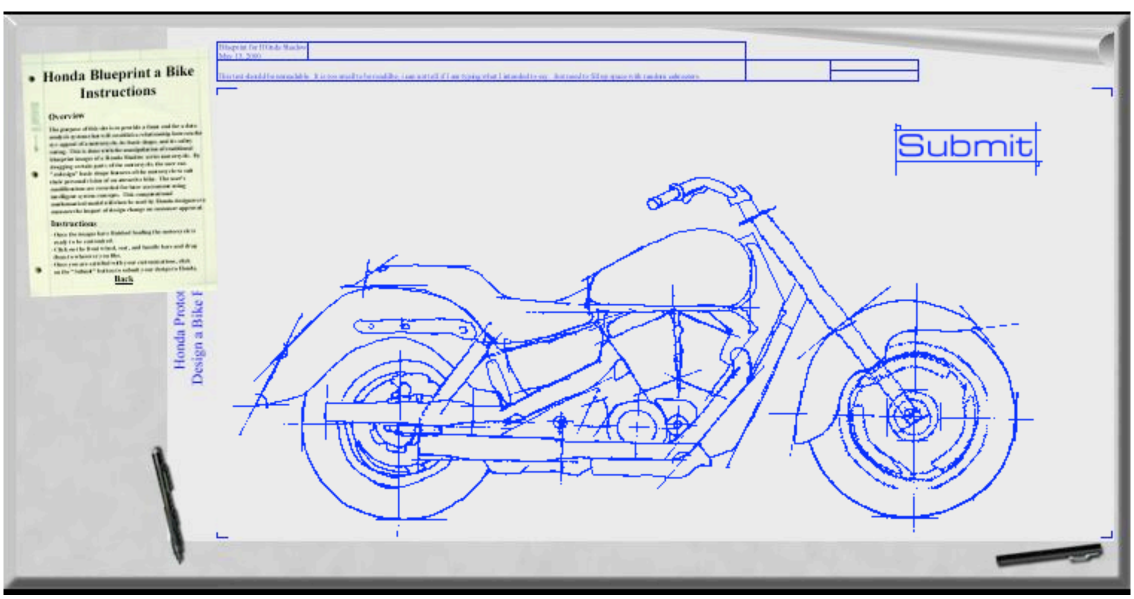

Figure 13 The Motorcycle corresponding to Cluster 2 (Cruiser)

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