A Fresh Take on an Old Problem: Using Analytics to Gain New Insights into Ways to Reduce Fatal Motor Vehicle Accidents

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Abstract

Each year 40,000 Americans die in motor vehicle crashes, making these accidents the leading cause of death among Americans 3-36 years old[1]. According to the U.S. Department of Transportation, the total societal cost of these crashes exceeds $200 billion annually [2]. Yet despite these staggering statistics many of the research efforts to date have failed to draw the sort of definitive conclusions that could potentially lead to beneficial policy changes or new regulation. Researchers have attempted to detect trends involving the driver's age or gender, vehicle speed, time of day or month, or the weight of the vehicle. However, the primary shortcoming of these studies is that they all tend to view the vehicle in a vacuum – they either look at vehicle individually, or at singular metrics without accounting for the interactions that occur between vehicles and their attributes.

This paper explores the hypothesis that individual vehicle characteristics are less important than the compatibility of the vehicles involved in the accident. It's not the weight of a vehicle that's most important, but it's the discrepancy in weight and height between the involved motor vehicles. This paper demonstrates how JMP statistical software can be used to create visual aids that provide new and valuable insight into this problem. It also stands as a case study for how analytics can be used across organizations and stakeholders to guide decision-making and regulation in a way that delivers the maximum benefit to society.

1 Introduction

In nearly every field, researchers are continuously embarking on new statistical analyses with the goal of finding the root causes of the many of the problems or trends that exist in our world. Financial analysts search for predictors that can be used to reliably forecast a trend. The intelligence community seeks to isolate patterns that can be used to detect and thwart nefarious plots. Medical researchers are continuously hunting down the triggers that cause various ailments. Usually, when researchers embark on a statistical analysis, it's because there is a problem solve, and the goal is to produce findings that will be useful for devising some solution to solve that problem. The hope is that the analysis will shed some light on the cause of the problem, and that this information can be used to support decision-making activities aimed at solving or alleviating the problem.

It seems that nearly every day the news reports that medical researchers have found a new link between a chemical compound and either a certain type of cancer or a health benefit of some sort. Sometimes, the studies fail to find a link where one was hypothesized to exist. In either case, there seems to be a never ending onslaught of new findings – some that identify a new link between an effect and its possible cause, and some that eliminate metrics as a potential causes.

Despite all of the hard work that goes into these studies, the outcomes are sometimes confusing, or the results are conveyed in a way that doesn't lead to an obvious solution. Different studies sometimes produce conflicting results that only further confuse the issue that the researchers were trying to resolve. Sometimes, results are overstated or misrepresented, leading to misunderstandings and misconceptions. The results of a study may be “valid”, but those results are not always conveyed in the most meaningful possible way. Furthermore, the results of statistical studies are often packaged in a “one size fits all format”. In reality different stakeholders need to see and understand the data in different ways that pinpoint actionable solutions to the problem.

Foremost, this paper intends to demonstrate how visual analytics can be used to portray the same data to different stakeholders in distinct ways that are tailored to their individual needs and objectives. To demonstrate these concepts, this paper uses a problem that is well-understood and easily relatable to most. At the same time, it is a very serious problem, and one that to date has no simple solution. As such, the secondary goal of this paper is to also provide new insights and valuable contributions that could potentially save lives and reduce the nearly 40,000 fatalities that occur annually due to motor vehicle accidents.

2 Good Data and Bad Information

The topic of crash-related injuries and fatalities is a subject that has been studied extensively, but many of these studies yield inconclusive results. Most of these studies focus on the weight of the vehicle as the primary predictor of injury severity. But many of these studies seem to reach contradicting conclusions. Some report that heavier vehicles are safer for their own occupants, while others fail to observe a significant trend. The one thing that is generally agreed upon, however, is that heavier vehicles are more dangerous to the other vehicles with which they collide.

Up to this point, many of the studies that have been done have failed to produce any actionable insights. The World Health Organization has called road traffic injuries “a major but neglected public health challenge that requires concerted efforts for effective and sustainable prevention”[6], and the Public Library of Science has called for “better data to support policy changes that could reduce the global burden of death and injury that results from road traffic crashes”[5].

So why haven't any of the studies produced useful results? Two reasons: First, many of the studies view the vehicle as an individual entity without considering the attributes of the colliding vehicle. Those that do consider vehicle compatibility only do so one-dimensionally – they look solely at weight discrepancy [8], or at height difference [7], but not at these multiple factors simultaneously.

Many of the studies have produced very good data, but have not produced good information. Sometimes, the information is buried in the numbers, and all it takes is a simple visual aid to bring it into light. To demonstrate this point, the following section takes a 'deeper dive' into a study released by the NHTSA. This section demonstrates how relatively simple graphical depictions of the data were used to extract more information from the data than was revealed in the original publication.

2.1 A Fresh Look at an Old Study - Vehicle Compatibility

This paper is not the first to suggest that vehicle compatibility plays a role in the severity of accidents. The NHTSA released a report that explored the role that “vehicle compatibility” plays on fatalities [8]. The primary objective of this NHTSA report was to estimate the effect that 100-pound reductions in passenger vehicle weights would have on fatality risk. The study is based on assumptions that heavier vehicles

Table 1: Original Data from NHTSA Compatibility Study

Crash Mode	Annual Baseline Crash Fatalities	Effect (%) of 100-Pound Reduction		Annual Net Fatality Change	
		Point Estimate	Interval Estimate	Point Estimate	Interval Estimate
LIGHT TRUCKS WEIGHING 3,870 POUNDS OR MORE					
Principal rollover	2,183	2.56	.81 to 3.94	56	18 to 86
Fixed object	2,639	3.06	1.41 to 4.34	81	37 to 115
Ped/bike/motorcycle	2,043	.13	- 1.56 to 1.45	3	- 32 to 30
Heavy truck	860	.62	- 1.61 to 2.48	5	- 14 to 21
Car	5,186	- .68	- 1.79 to .06	- 35	- 93 to 3
Light truck < 3,870	1,010	- 1.50	- 3.20 to - .17	- 15	- 32 to - 2
Light truck 3,870 +*	784	- 3.00	- 6.40 to - .34	- 24	- 50 to - 3
OVERALL	**14,705**	**.48**	**- 1.06 to 1.64**	**71**	**- 156 to 241**

are safer, and the author asserts that “when two vehicles collide, the laws of physics favor the occupants of the heavier vehicle.” The report goes on to show that weight reductions in all types of vehicles (cars, trucks, SUVs) would equate to *higher* net fatality rates.

The results are certainly interesting, because in recent years there has been a strong push to increase fuel efficiency, and one of the easiest ways to meet higher fuel efficiency standards is by decreasing vehicle weight. Yet, this NHTSA study represents a very strong argument against reducing the weight of the fleet.

The report later goes on to show that fatalities can be reduced by changing a small percentage of the on-road fleet from SUVs to cars. Yet, these two messages seem to be contradictory. The first finding seems to be a strong argument against downsizing the fleet, whereas the second seems to favor a downsizing. And despite the early assertion that the laws of physics favor the heavier vehicle, the report also goes on to show that accidents involving vehicles with a “mass mismatch” do not have significantly higher fatality rates that accidents involving two vehicles that weigh the same.

The NHTSA report represents a rigorous and statistically sound investigation of the topic, and although the results are all correct, they come across as non-intuitive and contradictory. The reader is left without a clear understanding of the implications of the findings, and it would be a challenge to derive a set of recommendations using the results from this study.

But why are the results so confusing, and is there a way to derive better information from the data? **Table 1** shows an example of how the data in the original report was presented in tabulated form. As was stated earlier, the primary objective of **Table 1** is to show the effect of decreasing fleet weight on the number of net fatalities. But there is more information hidden in the data that isn't obvious from what's shown in this format.

To uncover this hidden information, this data was used to generate a series of graphs that were not included as part of the original report even though all of the data used to generate these graphs are contained within the original report. **Figure**

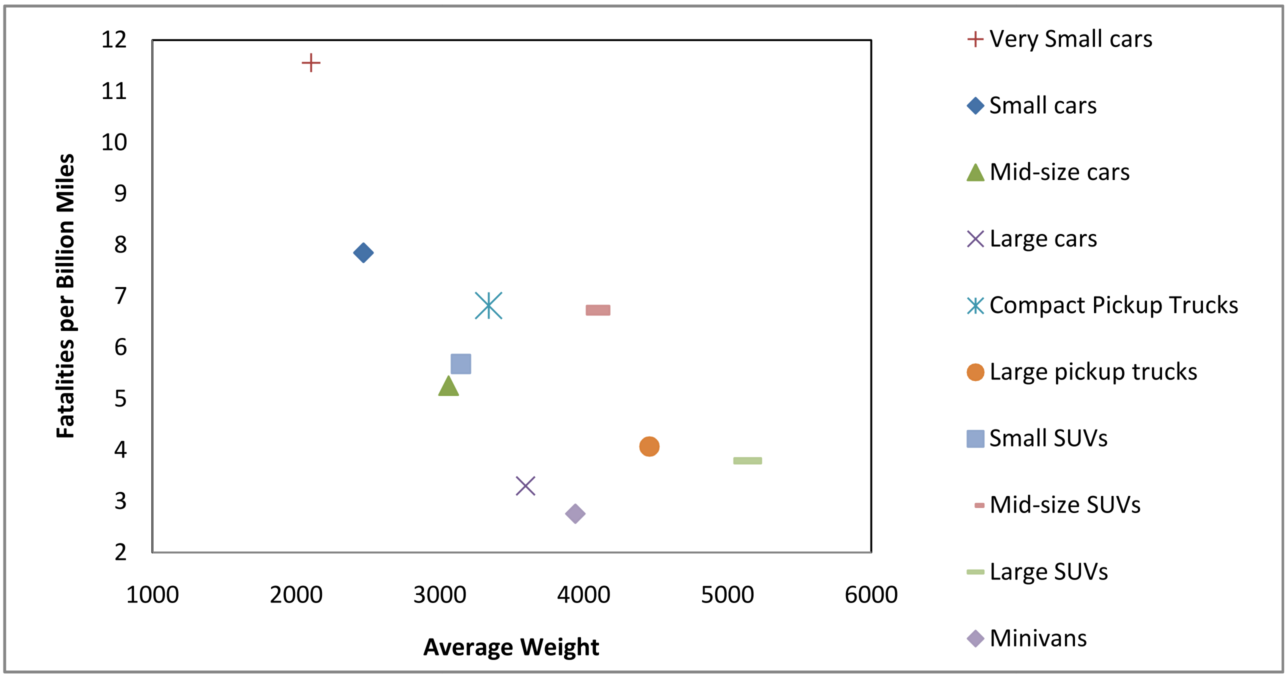

Figure 2: Fatalities as a Function of Vehicle Weight

2 is an attempt to visualize the role that vehicle weight plays in vehicle safety. It plots the average weight of various classes of vehicles against the number of fatalities per billion miles of the occupants of those vehicles. From this graph, one can see why there's so much confusion about this relationship. There does appear to be a slight observable trend indicating that heavier vehicles are generally safer for their occupants, but there are also some definite exceptions to the rule. For instance, mid-sized cars are safer than medium SUVs and compact pickup trucks even though the mid-sized cars are lighter. Minivans are safer than all of the other vehicles types despite being lighter than large SUVs and pickups. So while conventional wisdom says that “the laws of physics favor heavier vehicles”, the data seems to say, “well...it depends”.

Figure 1 takes the previous chart and breaks it up into three separate graphs showing the relationship between vehicle weight and fatalities for cars, trucks, and SUVs. In each graph, the solid blue line represents the number of fatalities per billion miles for the occupants of that vehicle. The dashed red line represents the fatalities per billion miles in accidents involving that vehicle. When viewed separately, the trends become more evident – a noticeable relationship is observed between weight and fatalities for cars and trucks, and that trend indicates that heavier vehicles are safer vehicles. These are the trends that support the commonly-held belief that a heavier vehicle is a safer vehicle. However, the SUVs don't appear to follow the same trend – here the data shows that smaller lighter SUVs are actually safer than their medium-sized

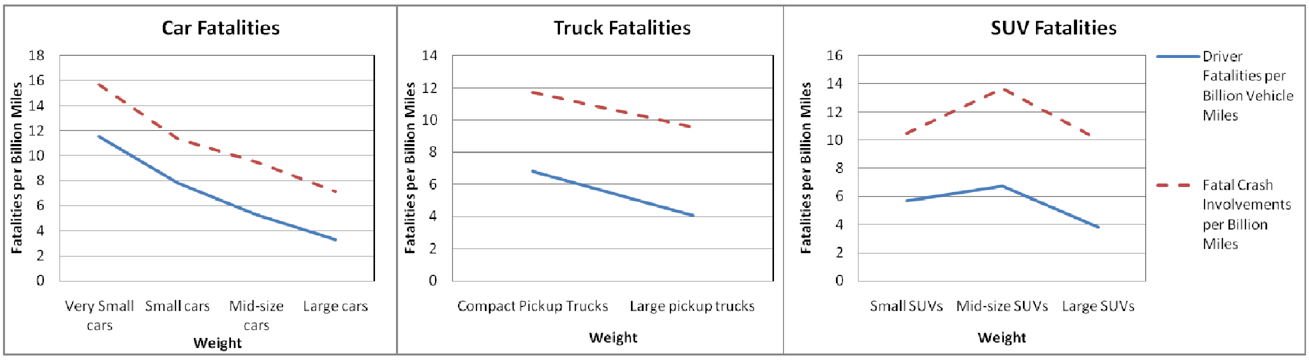

Figure 1: Impact of Weight on Fatality Risk for Different Vehicle Types

counterparts.

Taken together, **Figure 2** and **Figure 1** help to explain the inconsistencies in our understanding about the role that weight plays in risk of fatalities. **Figure 1** shows that for a given body type (car, truck or SUV) the heaviest vehicles in that class fare better in accidents than their lightest counterparts, i.e. a heavy truck is safer than a light truck, a heavy car is safer than a light car, and so on. However, **Figure 2** helps to debunk the common belief that a heavier vehicle equates to a safer vehicle (for its own driver).

At this point, it's obvious that weight isn't the sole factor responsible for predicting the risk of fatality in an accident. In order to try to get to the crux of the issue, **Table 2** shows another (new) table that was generated using data that found in the original report, but was “hidden” inside tables like the one shown in **Table 1**. This table plots all of the fatalities involved in different types of collisions. The y axis contains four different classes of vehicles, and the x-axis lists the things those cars collided with. In each box is the number of deaths that occurred for that type of collision in 1999. The table has been color coded to highlight a trend that might not have otherwise been obvious: crashes between similar vehicles result in fewer deaths than crashes between unlike vehicles. The greatest number of fatalities occur in crashes between the most dissimilar vehicles, with crashes between small cars and large trucks representing the largest number of fatalities. We can also see from this table that the largest heaviest vehicles are more likely to cause rollover-related fatalities.

The observations from Figures **Figure 2**, **Figure 1**, and **Table 2** were used to generate the hypothesis that weight is not the sole predictor of a vehicle's safety, but that safety is a function of the discrepancy between the weight and size of the colliding vehicles. This following section explores this hypothesis.

3 Using Visual Analytics to Gain New Insights

In order to further explore the role that vehicle compatibility plays in accidents, data was collected using the NHTSA's General Estimates System (GES). GES data come from a nationally representative sample of police reported motor vehicle crashes of all types, from minor to fatal. The system was created to identify traffic safety problem areas, provide a basis for regulatory and consumer initiatives, and form the basis for cost and benefit analyses of traffic safety initiatives. The information is typically used to estimate how many crashes of different kinds take place, and what happens when they occur [9].

Table 2: Number of Fatalities in Collisions Between Vehicles

	Rollover	Fixed Object	Car <2950 lbs	Car 2950+ lbs	Light Trucks <3870 lbs	Light Trucks 3870+ lbs
Car weighing < 2950 lbs	995	3357	934	1342	934	3157
Car weighing >= 2950 lbs	715	2822	1342	677	1128	2029
Light Trucks weighing < 3870 lbs	1319	1687	934	1128	247	1010
Light Trucks weighing >= 3870 lbs	2183	2639	3157	2029	1010	784

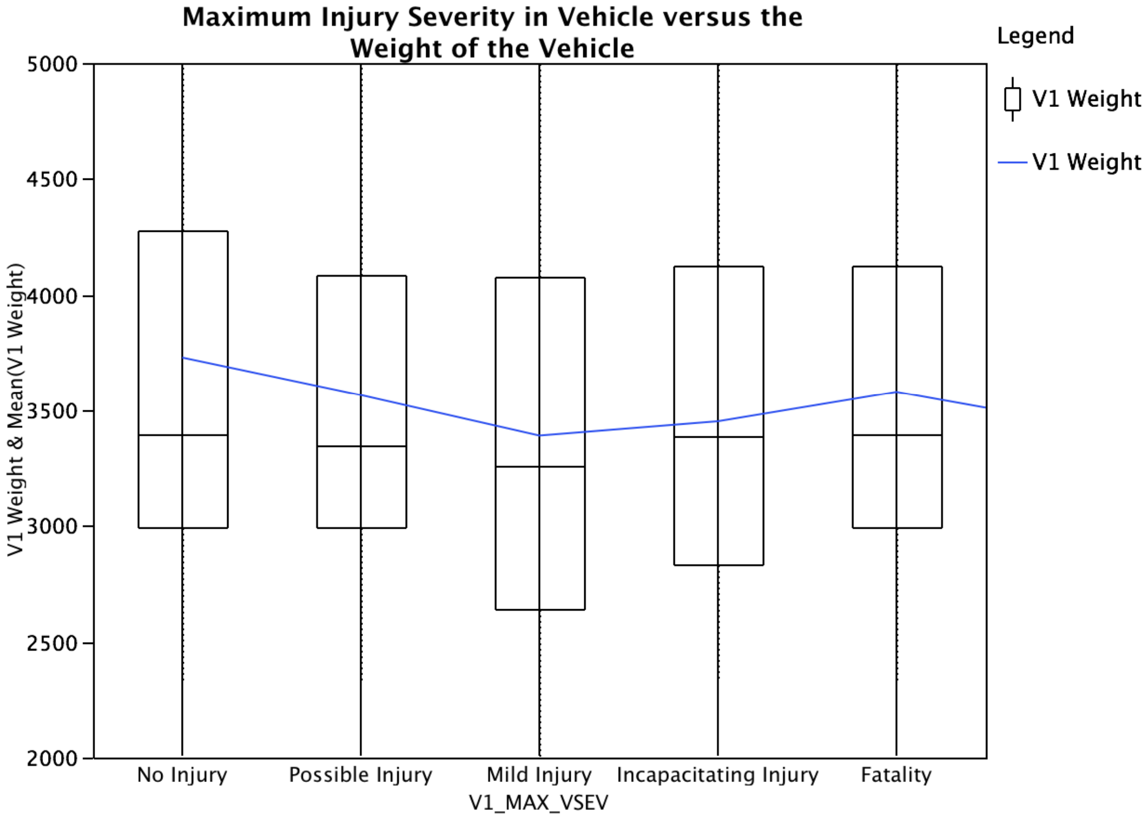

Figure 3: Plot of the Mean and Median Vehicle Weight for Accidents Involving Different Levels of Injury Severity

For this study, the GES data was retrieved for the 2008 calendar year. This dataset included data that had been collected regarding nearly 65,000 traffic accidents ranging from non-injury accidents to fatal accidents. The data contained information about the conditions of the accident, the number of severity of injuries, the people involved, the violations issued, and the make and model of the vehicles involved. Information about the vehicle specifications (weight, ground clearance, width, etc) had to be researched separately by using the make and model information to look up the physical characteristics of each vehicle. This data was then added to the original dataset, and the complete dataset was imported into JMP statistical software for analysis and visualization.

The first task was to investigate whether or not the weight of a vehicle matters as an independent metric. The graph in **Figure 3** was built using JMP's graph builder. All of the accidents in the data set have been grouped according to the most severe injury in the vehicle being studied. The blue line shows the mean vehicle weight for all of the vehicles within each injury classification. The box plot shows the median, lower quartile and upper quartile of the vehicle weights for each severity grouping. It's interesting to note that the mean line seems to show a weak trend of the type that one would expect – vehicles in which no injuries were reported are slightly heavier on average than vehicles in which an injury or fatality was reported. However, the median line in the center of each of the box plots paints a different picture – one with a less pronounced trend. In a nutshell, this figure seems to echo the same inconclusive results found in many other studies that attempted to pinpoint vehicle weight as the "smoking gun" in the cause of fatality rates.

Another common assumption about vehicle safety is that bigger is better. People often say "I feel safer when I'm up high". **Figure 4** tests this theory by plotting the median and mean ground clearance of vehicles involved in accidents ranging from no-injury accidents to fatal. Again, the injury severity on the x-axis only refers to the injuries/fatalities in the vehicle being studied, and does not account for injuries in the colliding vehicle. Similar to the previous plot, this figure supports the notion that on average, vehicles in which no injuries were reported have a slightly higher ground clearance than those with injuries or fatalities. But again, the trend is not significant enough to be a "smoking gun". Furthermore, there appears to be no detectable trend when we look at the median ground clearance in each of the categories, though the distributions appear to be skewed slightly toward vehicles with higher ground clearance in the no-injury category. Together, these two figures potentially indicate that there's a small set of very large and very heavy vehicles in which the occupants are rarely injured in accidents (like large semi trucks), and these few data points are skewing the means.

In order to test the hypothesis that vehicle compatibility matters more than individual vehicle characteristics, we need to view the in data from a new perspective. **Figure 5** is similar to **Figure 3**, except that it shows how the mean and median weight *difference* between two vehicles impacts the severity of the injury in the vehicle. This chart shows that for those accidents in which no injuries were reported in a vehicle, that vehicle was on average about 800 pounds heavier than the vehicle with which it collided. And that in cases in which a fatality occurred in the vehicle, that colliding vehicle was on average about 1200 pounds lighter than the vehicle with which it collided. Again, the median lines show a less pronounced trend, but unlike the previous figures, the mean lines in this

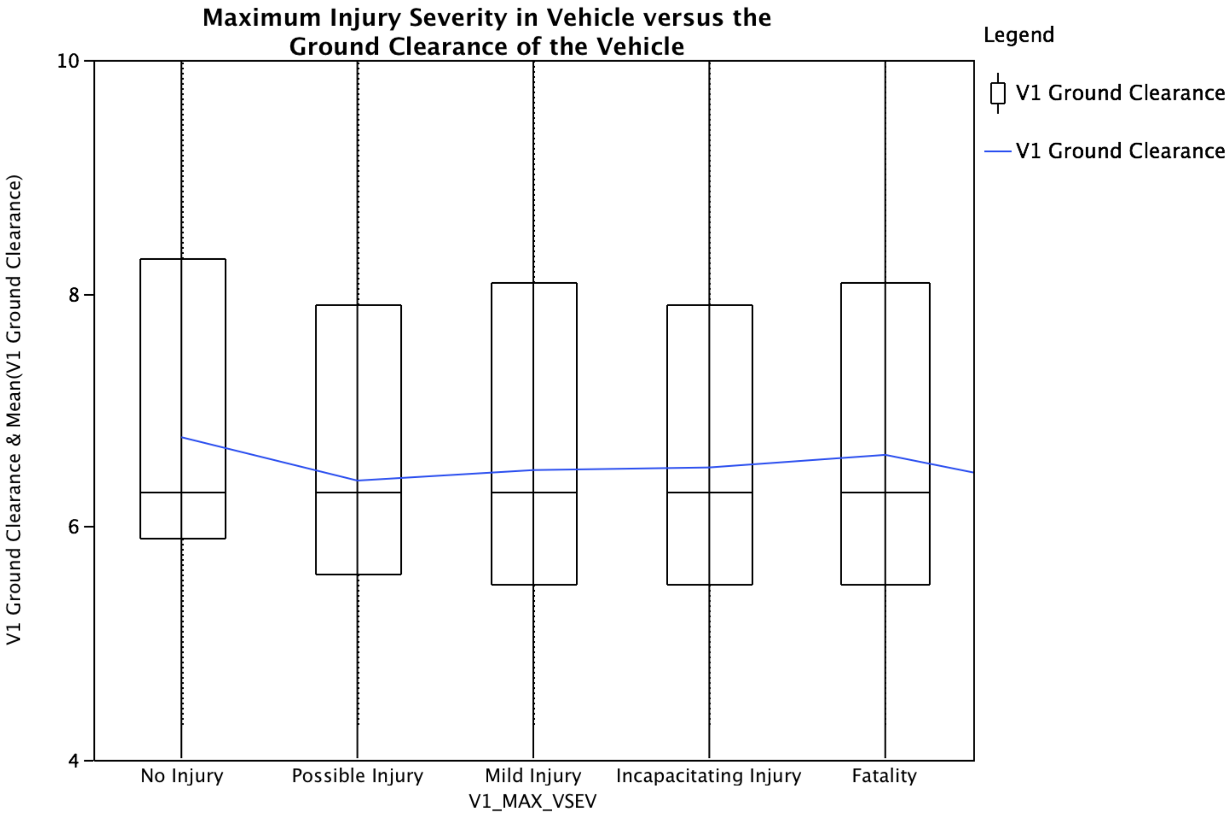

Figure 4: Plot of Mean and Median Ground Clearance in Accidents of Varying Injury Severity

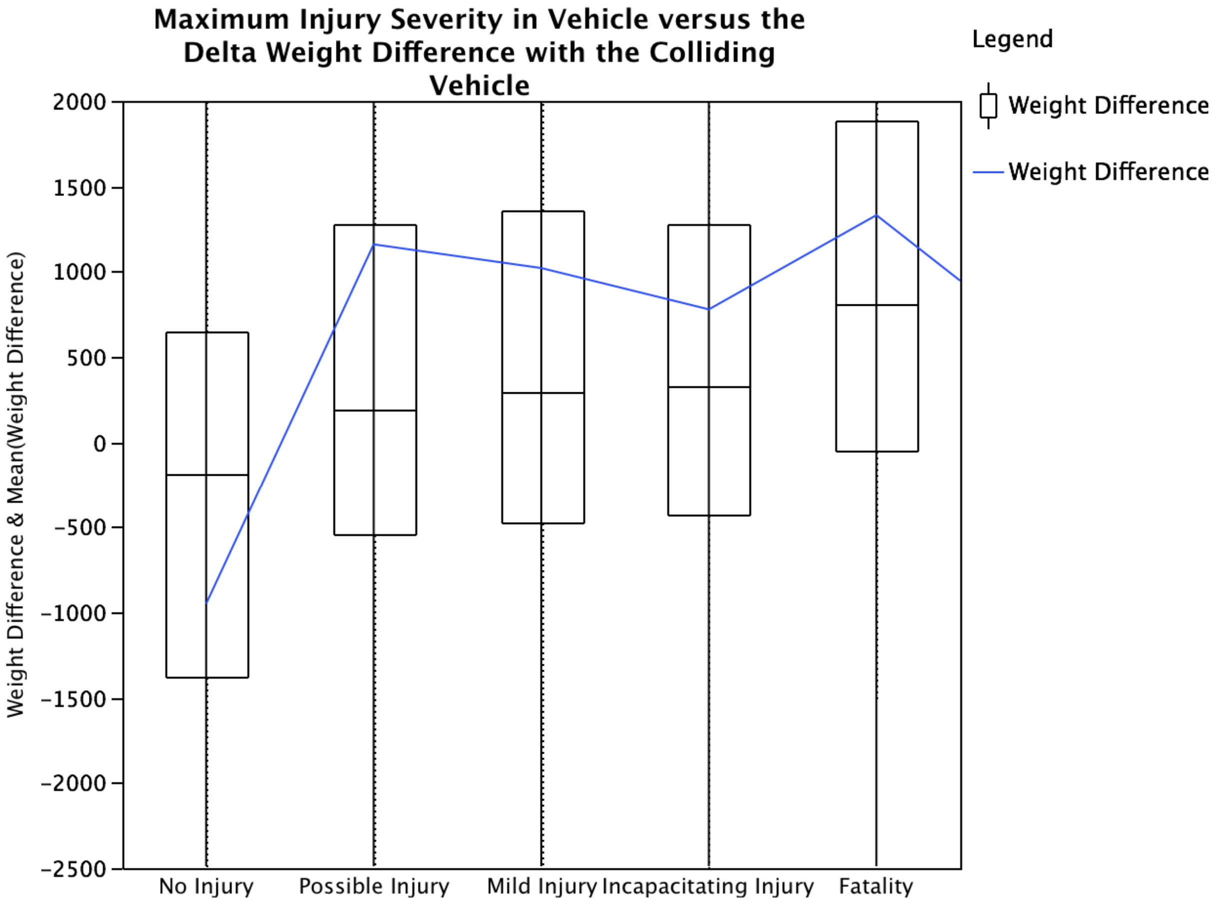

Figure 5: Mean and Median Weight Difference Between Colliding Vehicles for Various Levels of Injury Severity

figure do show a significant trend.

Figure 6 is similar to the previous; this time we are viewing the mean and median difference in ground clearance between two vehicles and the role it plays in the severity of the injury in a vehicle. Again, we see a more significant trend in both mean and median statistics as compared with our initial figures that isolated the physical attributes of the vehicle without accounting for those characteristics in the colliding vehicle.

Note that in this graph, the scale on ground clearance is relatively small, but this also potentially indicates the significance of the role played by the ground clearance of the vehicle. In fatal accidents the ground clearance of the colliding vehicle is, on average, only one inch higher than that of the vehicle in which the fatality occurred. In non fatal accidents, the difference is a mere quarter inch. A vehicle's ground clearance is very closely related to the height of the bumper on that vehicle – as most vehicles have their bumper located near the bottom of the body. Given this finding, it is worth investigating whether small changes in bumper heights could potentially lead to big reductions in fatal accidents.

Up to this point, the charts appear to support the central thesis of this paper by showing that a trend does exist between vehicle compatibility and risk of injury/fatality. While these charts aren't all that useful to the decision-maker, they may be useful in lending credence to a hypothesis even if they don't produce actionable insights. The following sections describe how the same dataset might be visualized in different ways to support four different stakeholders with four different

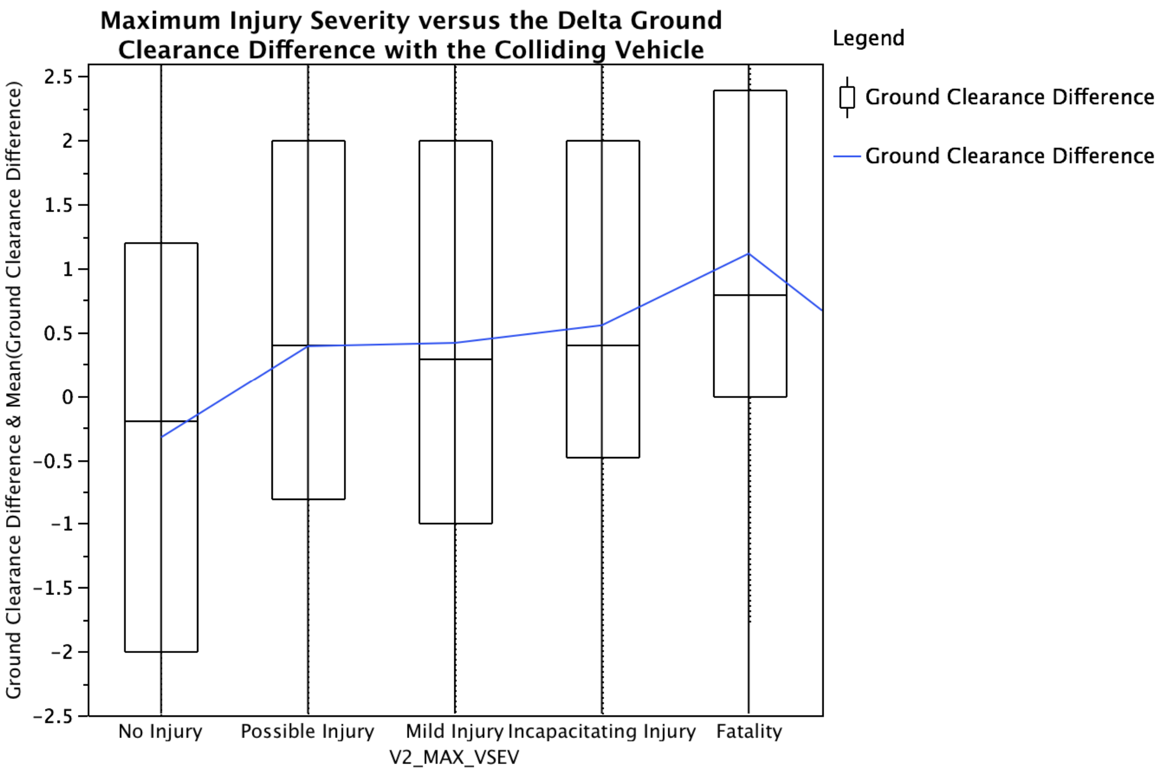

Figure 6: Mean and Median Delta in Ground Clearance for Accidents of Varying Injury Severity

decision-making objectives. For this example, the four hypothetical stakeholders are 1) the policy-maker, 2) the car-buyer, 3) the insurance company, and 4) the manufacturer.

3.1 The Policy-Maker – Exploring the data

The policy-makers' goal is to develop new regulations intended to reduce the net annual fatalities and injuries due to motor vehicle accidents. This is an art because there may be several factors that contribute to the numbers, but not all of those factors can realistically be regulated. Weight and size, for example, are hard to regulate, because society has very diverse needs when it comes to vehicles. Bumper height, however, is a design feature that is a more feasible candidate for regulation. This remedy has been suggested, but reluctance to embrace a bumper-height regulation stems from the fear that "such a massive redesign of the U.S. Fleet could overwhelm automakers"[7]. There's no doubt that imposing regulations on bumper height would be extremely costly. So before the policy-maker would propose such a control, they would first need to know that the potential benefits outweigh the costs.

The exact benefits are nearly impossible to calculate, but they can be estimated in a back-of-the-envelope fashion using the 2008 GES dataset. To do so, a few assumptions are needed. First, it is nearly impossible to track down bumper-height specifications for the many vehicles represented in the dataset. However, most bumpers are situated near the bottom of the body of the vehicle. So for the purpose of a first-order estimate, the vehicle's ground clearance was assumed to be reasonably proportional to the height of the bumper. Also, we must keep in mind that the GES dataset is only a representative sampling of all car accidents.

To estimate the impact of bumper height differences between colliding vehicles, the number of non-fatal and fatal

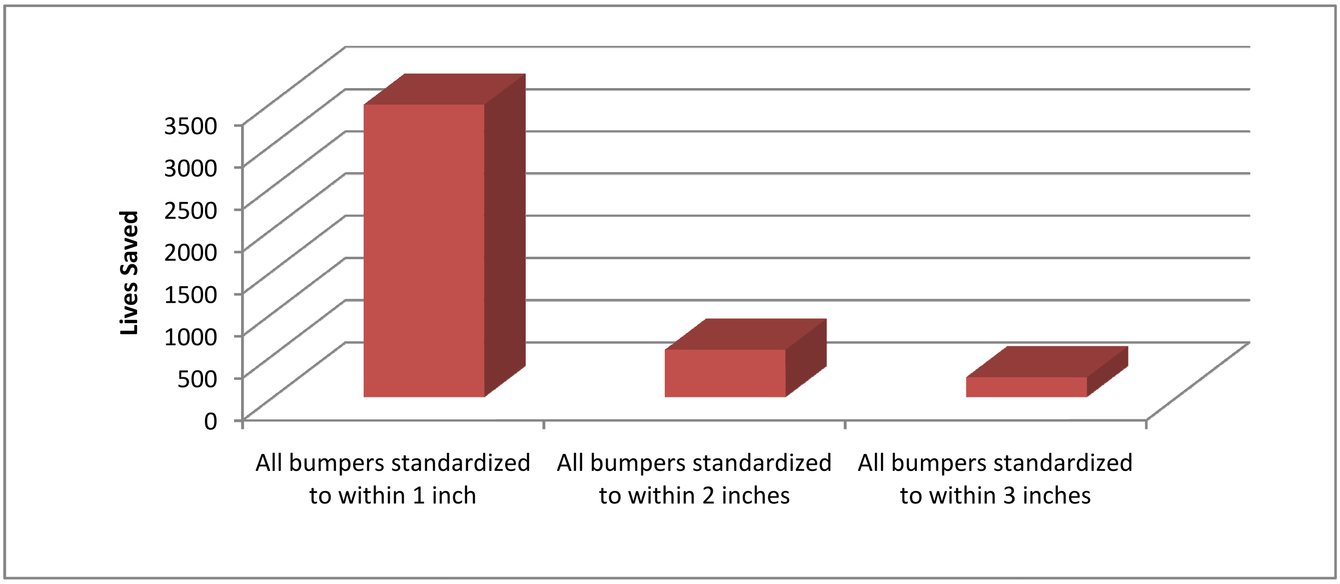

Figure 7: Estimate of the Annual Number of Lives Saved by Imposing Regulations on Bumper Heights

accidents were tallied for every two-vehicle accident and binned according to the delta in ground clearance between the two colliding vehicles. These tallies were used to calculate the probability that an accident with a certain delta in bumper heights would cause a fatality. Then, a "what-if" game was played to estimate the number of fatalities that would have occurred if the fleet makeup were changed. **Figure 7** summarizes the results by showing the estimated number of lives that would be saved annually if different degrees of standardization were imposed on bumper heights. Preliminary estimates showed that over 3500 lives could potentially be saved every year if bumpers were standardized to be within a one inch tolerance of one another.

Calculating the potential cost of imposing such restrictions is beyond the scope of this study. Nevertheless, these initial results show that the topic certainly warrants further consideration.

3.2 The Car-Buyer – Seeing Past the Confusion

The results obtained in the previous section indicate that larger discrepancies in vehicle ground clearance (or bumper height) translate to a higher risk of fatality. In fact, one of the intermediate steps in the calculation produced an estimate indicating that an occupant is nearly 65% more likely to die in a collision if the other vehicle is 3 inches higher (in ground clearance) than if the other vehicle were situated at the same height.

The danger here is that this same information which is of great utility to the policy-maker is very easily misinterpreted by the car-buyer. Upon viewing this data, most car-buyers would conclude that in order to be safe, they should purchase the largest and highest car that money can buy. However, it's important to note that the results that were presented in the previous section do not necessarily indicate that higher is better; they merely indicate that height discrepancies are bad.

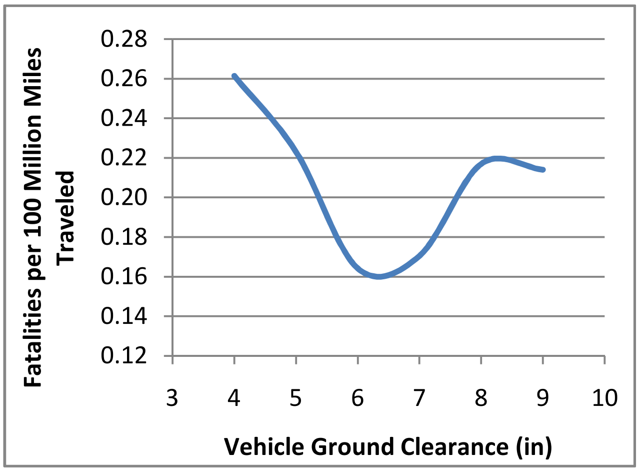

Figure 8: Fatalities as a Function of Ground Clearance

For the safety-minded car buyer, a simple plot can dispel the myth that taller is always better. Figure 8 shows the average number of fatalities per billion miles traveled as a function of the vehicle's ground clearance. This plot shows that there are gains in safety as ground clearance is increased – at least initially – but after the "sweet spot" is reached, those gains taper off again. This "sweet spot" occurs between the 6 and 7 inch mark. Many car buyers may be surprised to learn that the vehicles that fall within this range are mostly mid-sized cars (including the Ford Focus, Honda Accord, and Toyota Camry), and not the SUVs that many assume to be safer.

At first glance, it may seem as though these results contradict those from the previous section. To explain the apparent discrepancy, it helps to recall that the previous section only investigated multi-vehicle accidents, whereas the results in the previous chart hold true for all accidents. About half of all accidents are single-vehicle accidents, and it has been shown that SUVs fare more poorly in single-vehicle accidents[10]. Figure 9 sheds light on a possible explanation. This chart shows that as the ground clearance of the vehicle increases, the vehicle is generally more likely to be involved in a rollover. Furthermore, rollovers account for approximately half of all fatalities in vehicles with a ground clearance greater than 7 inches. Thus, the increased rollover risks associated with larger ground clearance begin to outweigh the safety benefits around the 7 inch mark.

3.3 The Insurance Company – Visualizing the Many Dimensions Involved

Insurance companies must find a way to set fair premiums for all the vehicles on the road. In an accident, the amount of money that the insurance company loses is strongly tied to the damage done to all vehicles involved. Figure 10 shows a bubble plot in which each bubble is a model of a vehicle. The size of the bubble represents the number of those vehicles

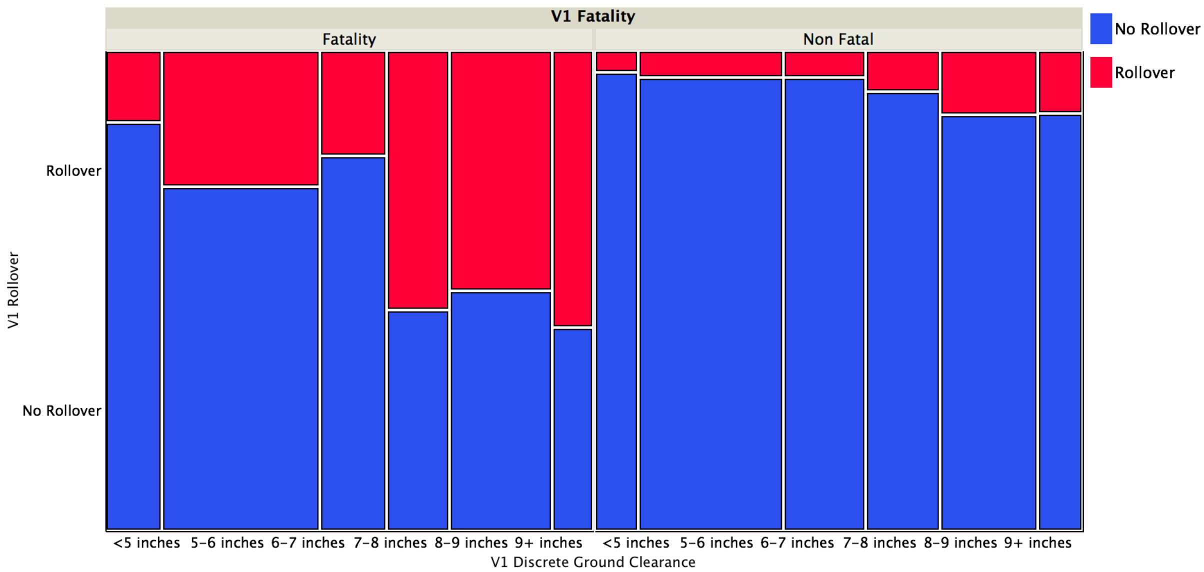

Figure 9: Rollovers versus Vehicle Ground Clearance for Fatal and Non-fatal Accidents

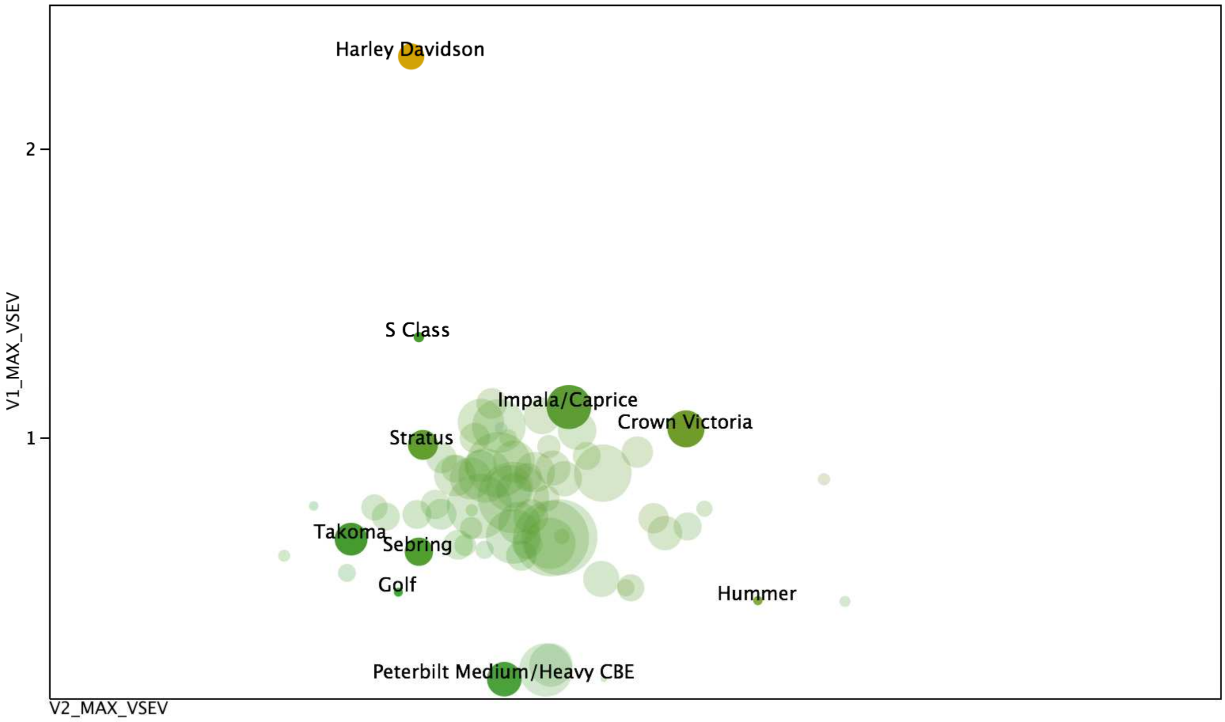

Figure 10: Bubble Plot Showing the Relative Damage Severity Caused to Car Models and to the Colliding Vehicles

involved in accidents. The y-axis is a normalized unit representing the average relative severity of the injury in the labeled vehicle for all accidents involving that vehicle. The x-axis represents the average relative severity of the injury in the colliding vehicle. Basically, this plot can be interpreted by thinking of it in terms of four quadrants: vehicles in the upper left hand corner represent cars that are most dangerous to their own occupants, but impose relatively little threat to other vehicles. The lower right corner represents vehicles that are safe for their drivers but dangerous to others. The lower left corner is the most desirable – representing cars that are safe for their own occupants as well as the occupants of the colliding vehicle. The upper right corner is the least desirable.

Interestingly, the vehicle in the upper-rightmost position is the Crown Victoria, which is often used as a police car. This then leads to an interesting observation that the vehicle's position on the graph may not be solely a function of its crashworthiness – it may also be a function of how that type of vehicle is typically driven. This brings up an important point: when viewing the data, one must remember that metrics are correlated, so one must be cautious about making broad generalizations without considering other factors.

The cost to the insurance company is also a direct function of who received the citation for the accident. An insurance agent would also benefit from the ability to separate the physical attributes of the vehicle from the typical driver of that type of vehicle. So they might also want to view the bubble plot in Figure 11 that shows the average age of the driver in these vehicles on the x-axis, and the likelihood that they were given a citation for the accident on the y-axis. (Again, note that this data is only representative of vehicles that have been involved in an accident in 2008, and may not be representative of all of the vehicles on the road.)

Finally, the insurance agent would likely want to view some charts similar to the one in Figure 12 which shows which type of driver is likely to receive what type of citation.

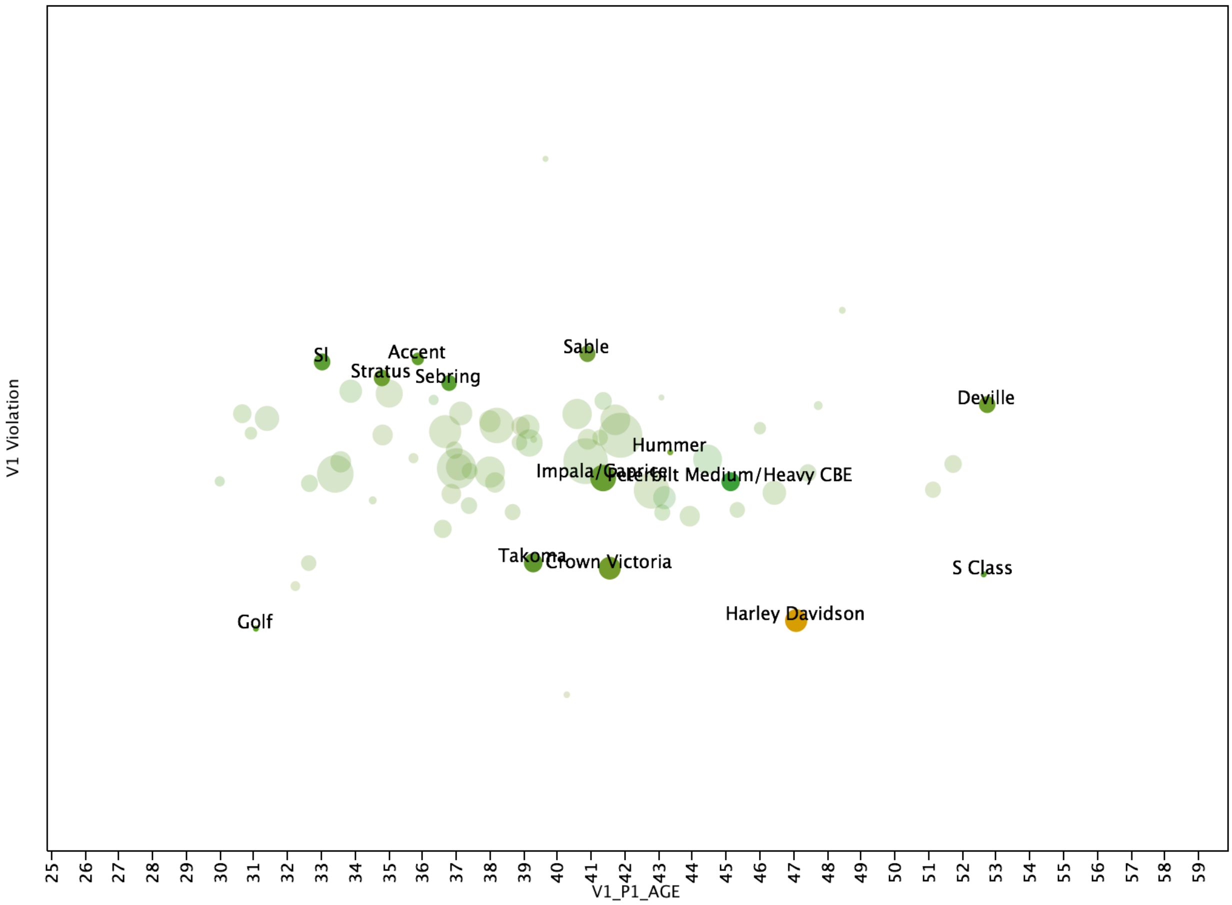

Figure 11: Bubble Plot Depicting the Average Age of the Driver and the Likelihood that the Driver Received a Citation

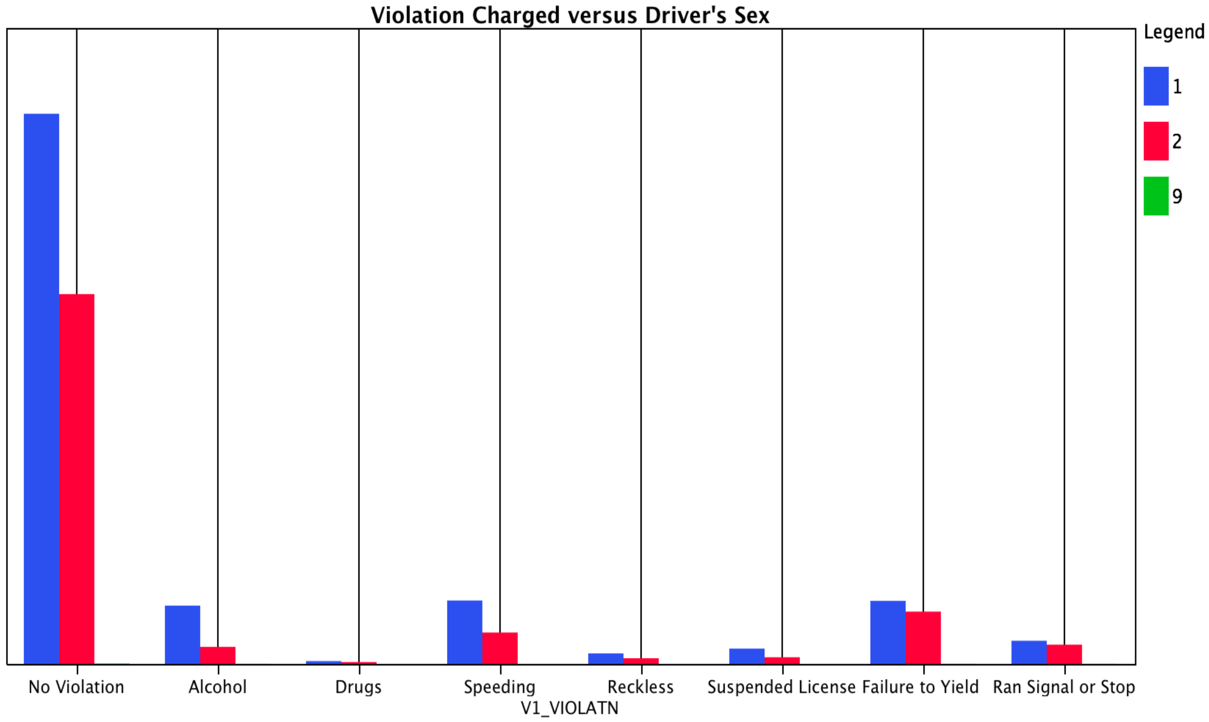

Figure 12: Number of Citations Given to Men (Blue) and Women (Red) for Several Violations

3.4 The Manufacturer – Exploratory Design

The manufacturer's goal is to design a vehicle that balances safety, reliability, and functionality. Design for safety is possibly the most challenging of these three goals, because "safety" is something that's nearly impossible to quantify. Many tests and standards have been created in an attempt to define a measure of safety, but these measures don't always translate to real-world safety.

For example, many of the crash tests are standardized. Manufacturers know exactly how their vehicles will be tested, and so they optimize the vehicles to "beat the test" rather than optimizing for safety on the road. But how could one possibly design for real world safety?

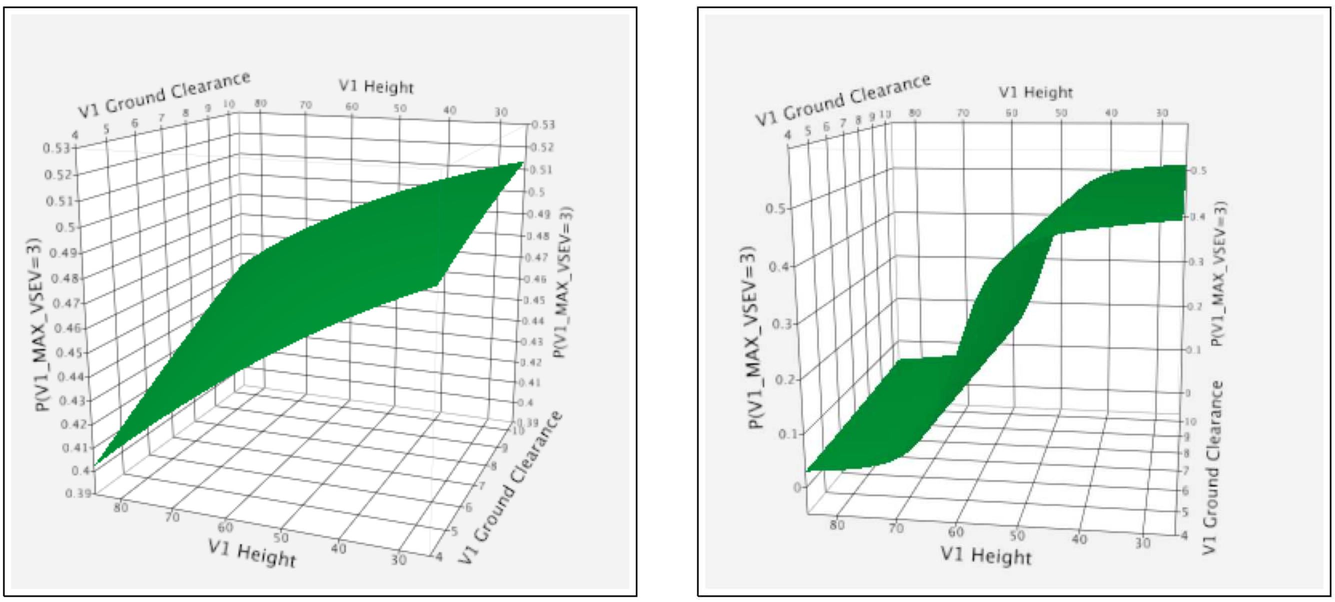

Figure 13: Dynamic Surface Plots Generated by Fitting a Neural Network to the Data

In an attempt to answer this question, the JMP software was used to fit a Neural Network model to the GES 2008 accident data. Figure 13 gives two views of a dynamic surface plot which shows the probability of serious injury on one axis, and the weight and ground clearance on the other axes. The plot itself is a function of the point of impact on the vehicle. Thus, the dynamic nature of this plot allows the designer to “simulate” various types of impacts for various vehicle characteristics in order to identify vulnerable combinations. The designer can then devise solutions that improve upon these vulnerabilities. And unlike the crash-test simulations, these dynamic plots uncover the real world vulnerabilities that cause real life injuries.

5 Conclusions

This paper explores how visual analytics can be used to turn data into information that provides actionable insights. By visually representing the information in custom ways to support specific activities, we can clear the confusion and shed new light on old data.

An analysis effort can produce “good results”, but those results are only useful when conveyed in a way that helps the stakeholder solve their problem. Sometimes, the problem is one of too much information, and the individual stakeholder isn't able to filter out the pieces of information that really matter to their decision. Most often, the problem is that the stakeholder can't visualize what the data means to them – they are handed numbers when what they want to see is trends. Sometimes, all it takes is a very simple visual to convey the implications hidden within the data. The key to success is in the ability to show the right information to the right people at the right time. The visuals should help answer the stakeholders' question(s), keeping in mind that *the right answer to the wrong question is still the wrong answer.*

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