

# Beat Your Wing Force Down Category 'A'

New Mexico High School  
Supercomputing Challenge  
Final Report  
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Team #041  
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## Executive Summary

Upon starting our project we decided to focus on a problem that had to do with aerodynamics, and racing. At our school we often saw spoilers or rear wings mounted on the back of student's cars to make them look like the car was faster. These wings are really not needed on street cars that a student might own, so we decided to focus on the situation where they are needed, on cars that rely on the traction that it provides to the rear tires of the car.

Our initial research was to produce some basic information and ideas to better educate ourselves on the subject. Then we used some web sites we found to produce equations we would be able to use in a C ++ program to produce information we were not able to find on the Internet. We also found information on the Indy car (which has already had the down force tested on it to help us realize if the smaller spoiler were needed.

Various important parts of our project include information that we gathered on the drag coefficients that we used as variables in our C++ equations. We also found a multitude of equations that we used to produce various pieces of information vital to accomplishing our ultimate goal.

## **Introduction**

Down force. These control many of today's traveling and transportation necessities. With this, many of the cars today would not have the sleek design and massive speeds they accomplish today. By using the help of the Internet and computer programming it helped us realize the basic fundamentals of Berilli's Law. Our project was based on the aerodynamics rear wing or spoilers placed on the fast placed Indy cars. We were wondering what was the down force needed to successfully keep the car on the ground. Also by using this information to determine why some new models of cars have small spoilers mounted on the

back. Our project will test these principles, uses equations and all of our programming abilities to successfully fulfill our computational science project.

## Description

The goal of our project, "Beat Your Wing Force Down" was to find the ideal shape for a rear wing spoiler that would provide the perfect amount of down force and the least amount of drag. We accomplished this by using a C++ program to find the amount of drag and the amount of down force each shape produced. The first of our C++ programs was able to produce the drag we needed but we lacked the appropriate equations that we needed to incorporate into our program to produce the down force. After doing extensive research on the Internet we were able to find some equations that gave us what we needed but it was very difficult math that none of our team members understood. But we were able to find long extensive explanations of the equations. These equations were simplified and tested so we were able to understand them better.

## Results

We have found, in the results of our project, that there has to be a perfect median between the down force to drag ratio. Jim Hall, in 1966, mounted a slanted wing on his stock racecar. For many months, he tweaked the rear wing until he achieved the down

force and results he wanted. With this new rear wing design he won nearly every race he entered. He was the inventor of the rear wing. He, as well as us found that when there is too much down force on the rear wing, thus having too much drag, the car cannot achieve very high speeds. If there is too little down force and too little drag, the car will achieve high speeds, but it will not have enough down force to keep the car on the ground. This lack of down force causes a pocket of air to form under the car; pushing the car up and making it flip over backwards. We found that when air hits the streamlined rear wing it creates high pressure on top of the wing and low pressure on the bottom. With this high pressure on top of the wing it creates drag and pushes the car down without fear of leaving the ground. This exact opposite theory is used in airplane wings to create lift or high pressure under the wing.

## Conclusion










We found that the of the correct amount of down force and speed so that the conditions are ideal. With this we used the Indy cars with the abilities to accomplish great amounts speeds and can produce massive amounts of down force. With this we tested out numbers of different shapes and found the drag. with the drag we used the equation of:

$$\text{Drag} = 1/361 * C_d * A * V^2$$

V= velocity

A= Frontal Area

$C_d$  = Drag coefficient (Figure 1 the shapes represent the drag coefficient that is

Shape	Drag Coefficient
Sphere → 	0.47
Half-sphere → 	0.42
Cone → 	0.50
Cube → 	1.05
Angled Cube → 	0.80
Long Cylinder → 	0.82
Short Cylinder → 	1.15
Streamlined Body → 	0.04
Streamlined Half-body → 	0.09

available **Measured Drag Coefficients**

Using these equations we were able to find the Drag which is the key element in finding the down force.

$$C_l = C_{l0} + (C_{la} * \alpha)$$

where:

$C_l$  = coefficient of lift

$C_{l0}$  = coefficient of lift at zero angle of attack

$C_{la}$  = lift curve slope (the slope of  $C_l$  versus  $\alpha$ )

$\alpha$  = angle of attack

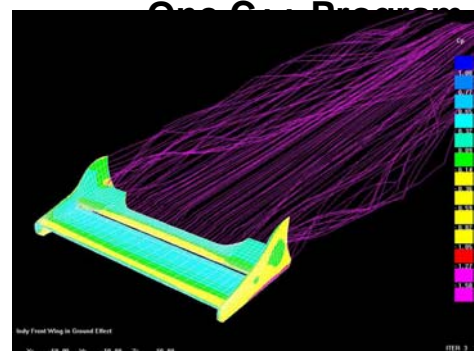
Added to this equation are the factors associated with the object. It was noted in the previous section that the frontal area was important in the amount of drag produced, and this fits into the equation, along with what is termed the 'Drag Coefficient' - a value which says how slippery the shape is. This is the same for down force, only using the 'Coefficient of Lift', which quantifies the objects ability to produce lift or down force (negative lift).

Using these equations in a program would tell you what the speed and angle of attack would tell how fast the car would be going. To be able to use down force.

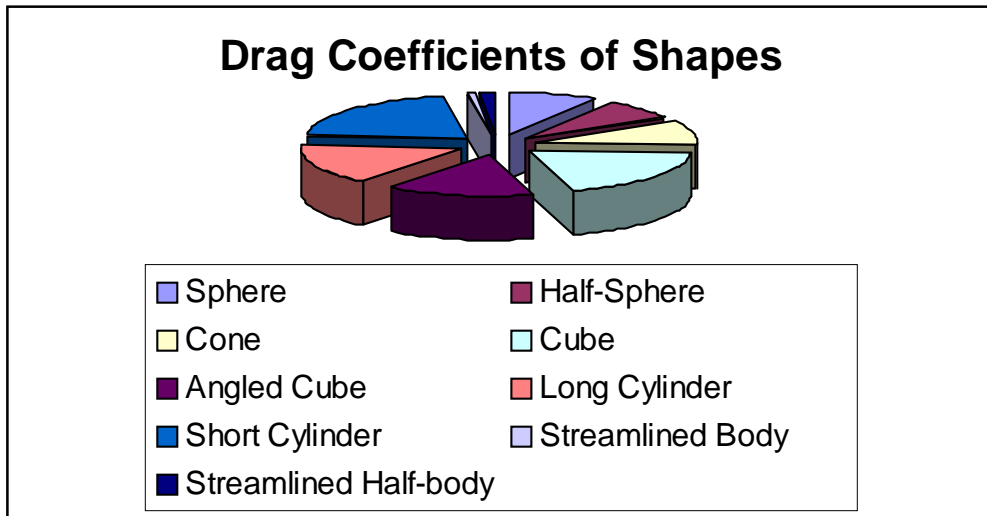
Since most street legal cars on the road can not go to speeds of 225 mph the spoiler is useless and does more harm than good because it creates drag in the frontal area of the car.

Software, references, tables, and other work

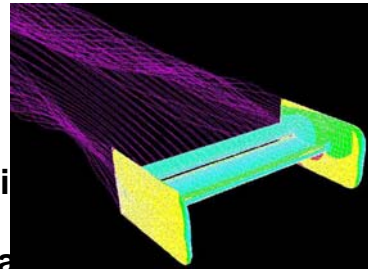
```
#include <iostream.h>
int main()
{
double c,a,v,d,product;
cout << "This is our project3.c program." << endl;
cout << "Please enter the Drag Coefficient" << endl;
cin >> c;
cout << "Now enter the frontal area of the shape" << endl;
cin >> a;
cout << "Now enter the velocity" << endl;
cin >> v;
cout << "Now enter .002557544757033" << endl;
cin >> d;
product = c * a * v * d;
cout << "The drag of " << d << " times " << c << " times " << a << " times " << v << " is " << product << endl;
```



```
return (0);  
}
```



Mo vement



a totally original shape because the racers and designers of the modern day may have unlimited resources and unlimited funds that go directly into finding down force and drag ratios. That's their career, that is what they do for a living and they are very good at it. If we had to choose one achievement, we would choose that we found the perfect median of down force and drag. Although the shape was the same as the shape that is used on all Indy cars, we found it the hard way. We went through all the steps and equations and eventually met our goal.



# Acknowledgments

All Three Members of our group worked on the project. We distributed the work out evenly to all members. When one person didn't know something, the other two would help them to understand what they did not know. We would like to thank our teacher, Larry McBride, for helping us and urging us towards our goal.