



CALIFORNIA STATE SCIENCE FAIR 2005 PROJECT SUMMARY

Name(s) Christian H. Selby	Project Number J0121
Project Title The Importance of Angle of Attack to Flight	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals This experiment shows Bernoulli's Principle is too simple an explanation and doesn't consider Newton's Laws of Motion or the Coanda Effect, nor does it give enough credit to the angle of attack of the wing.</p> <p>Methods/Materials I built a wind tunnel. A balsa wood wing with an upper camber 15% longer than the lower camber was made. I attached the wing to the side supports with rear pegs and adjustable front pegs. I drilled 8 holes at 0° through 21°. During the 3 trials I pulled the wing to a level position for each angle-of-attack. Average lifting force was recorded for each. Wind speed & wing shape were kept the same. Calculations of lift were made for a Cessna 150 flying: at a normal airspeed; with an upper wing camber long enough; and airspeed great enough to produce the lifting force to keep the Cessna 150 flying.</p> <p>Results The results showed that the greatest angle-of-attack (21°) produced the greatest amount of lift, at 2.4 Newtons and the smallest angle-of-attack (0°) produced the least, at .1 Newtons. The amount of lift increased proportionally with the angle-of-attack. The calculations showed that Bernoulli's Principle was only 3% responsible for the force needed to keep the Cessna 150 flying at a normal airspeed. Increasing the upper camber 50% longer than the lower camber or increasing the airspeed to 727 ft/sec (350 mph) would produce enough lift.</p> <p>Conclusions/Discussion Lift is not possible unless a force acts on the air and that air reacts by lifting the airplane (Newton's 1st and 3rd Laws). The action on the air bending it downward is a result of the viscosity of the air and its attachment to the upper wing surface. This is called the Coanda Effect. From my calculation of the Cessna 150, Bernoulli's Principle was responsible for less than 3% of the total lift needed to keep the airplane in flight. In my calculated results, I have outlined which changes in wing shape and air speed would create enough lift to keep the Cessna 150 in the air. Neither increasing the upper camber by 50% or flying at over 727 ft/sec (350 mph) would be possible. I think the remaining lift must be a result of the angle of attack. In my study of angle of attack I found that lift increases proportionally as angle of attack increases. Pilots know that if the weight of their airplane increases, they will need to fly faster or fly at a greater angle of attack, and redirect more air downward to counteract the force of gravity.</p>	
Summary Statement My project was to show that the primary cause of aerodynamic lift is the redirection of air over the upper camber (Coanda Effect), as a result of a wing's angle of attack and is not the traditionally accepted Bernoulli's Principle.	
Help Received I received help from my father in building the wind tunnel. My mother helped me with the display board. Mr Dan Halbur (physics teacher at Foothill High School) provided the pulley and spring scale, and helped explain the calculation of lift.	