



**CALIFORNIA STATE SCIENCE FAIR  
2004 PROJECT SUMMARY**

<b>Name(s)</b> <b>Elliot R. Kroo</b>	<b>Project Number</b> <b>J1213</b>
<b>Project Title</b> <b>Learning From the Birds: Using Atmospheric Energy to Improve Airplane Performance</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The purpose of this project is to find to what extent it is possible to increase an airplane's performance by using the energy in atmospheric turbulence. I hypothesized that since there is energy in turbulence, there should be a way to use this energy to stay flying without any thrust. If my hypothesis is correct, some kinds of planes could fly for a long time on low power in places where charging batteries is very difficult or impossible.</p> <p><b>Methods/Materials</b> To make the programming aspects of this project easier to work on, I developed them one piece at a time. Using some of the software I developed for my science fair project last year (Artificial Intelligence: Can a computer program learn how to play connect four?), I quickly implemented a Genetic Algorithm, an optimization algorithm that uses natural selection to single out the best answer to a problem. I then combined several laws of physics: Newton's second law of motion, the forces on the plane (in both the upward/downward directions and the forward/backward directions), and some laws of aerodynamics including the relationships governing the values of lift, drag, and air velocity of a moving plane. My simulation integrated these equations in very small time steps, and by controlling the lift coefficient over time with a basic control law, controlled the plane through the simulated air.</p> <p><b>Results</b> When I optimized the control law with my genetic algorithm, it was able to gain ten meters in altitude in 450 meters in a time period of 60 seconds with a maximum gust of 0.7 meters per second. With a gust even greater than 0.7 meters per second, the plane was able to gain even more altitude. This control law was able to turn moving air into energy that the plane could use, and to the point where it could fly without a motor.</p> <p><b>Conclusions/Discussion</b> The data I collected from my simulations show that my hypothesis is correct. The optimizer found that if the optimized airplane surfed the turbulent air, it could gain altitude or speed. If I were to add to this project in the future, I would try different types of gust patterns, or send up a model plane gather data to develop a more accurate representation of the atmospheric turbulence.</p>	
<b>Summary Statement</b> It is possible to get all the energy necessary for a model plane to gain altitude from turbulence the plane encounters in flight.	
<b>Help Received</b> My father helped me to formulate the problem, to understand the aerodynamic concepts, and led me to interesting and useful references.	