



**CALIFORNIA STATE SCIENCE FAIR  
2005 PROJECT SUMMARY**

<b>Name(s)</b> <b>Elliot R. Kroo</b>	<b>Project Number</b> <b>S1208</b>
<b>Project Title</b> <b>Smart Soaring: Flocks of Autonomous Airplanes</b>	
<b>Abstract</b> <b>Objectives/Goals</b> Thermal updrafts are used by both birds and aircraft to improve flight performance. This project models the actions of a sailplane or soaring bird to enable an autonomous aircraft to improve its performance using thermals. The project also shows how higher performance can be gained through collaboration with other aircraft. <b>Methods/Materials</b> In the computer program used to model flight, all modules were developed by the author -- a three-dimensional flight simulation, thermal model, control laws, genetic optimizer, and graphics package. The 3D simulation uses vector geometry to model an aircraft's flight in a ground-based coordinate system. Object-oriented programming techniques were also implemented, allowing for multiple planes to be easily included in the same simulation. The thermal model was based on a recent NASA paper, together with input from several sailplane pilots. Both single airplane and collaborative control laws, involving communication among several aircraft, were developed and tested in the simulation, and control variables were optimized using a genetic algorithm. The graphics package allowed solutions to be viewed in real time. <b>Results</b> Significant performance improvements were attained by optimizing both the single airplane and the collaborative control laws. Smaller aircraft were found to be able to take greater advantage of thermals and the multiple airplane system demonstrated much better performance than the single airplane heuristic models. <b>Conclusions/Discussion</b> The results suggest several exciting applications in which energy in thermals might be used to dramatically increase the endurance of unmanned civil or military aircraft.	
<b>Summary Statement</b> This project simulates robotic airplanes flying through updrafts. By communicating with each other, they are able to stay in the air for longer periods of time.	
<b>Help Received</b> Dad helped understand mathematics involved.	