CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
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Project Number
J0826

Project Title
It's a Bird, It's a Plane, It's Gone! How Geometric Shapes Affect Electromagnetic Reflections (Radar)

Abstract

Objectives/Goals
The purpose of my experiment is to measure the radar reflections of two airplanes with very different geometry in order to prove that avoiding some shapes and using others contribute to an airplane's stealthiness. I predict that the F-117 will prove to be stealthier than a typical fighter, such as the F-14, because, according to my research, the flat plane facets of the F-117 will deflect radar while the many other shapes of the F-14 will reflect radar back to its source.

Methods/Materials
I'm only a 7th grade student, and I'm not a pilot, so I did not have a full-size airplane, and did not have access to a real radar. So I created my own formula to predict radar cross section (RCS), and used 1:48 scale models with battery-powered red lasers for alignment and measurements. I created my own units, which I called R.I.C.E., and used Maxwell's equations from my research and a spreadsheet to compute the final RCS. In order to measure the RCS of each aircraft, I did three trials on each and calculated averages. Each trial included 13 different angles of aircraft pitch, and 13 different angles of aircraft roll, with each aircraft mounted to a tripod that had angle measurements (a telescope tripod). I used a reflective tape and metallized paint to reflect the laser in the same way that the aircraft reflects radar.

Results
As I predicted, the F-117 had a smaller radar cross section than the F-14. Using my special measurement system and units, the F-117 had a final score of 41 RICE points, and the F-14 score was 150 points, which is almost four times more visible to radar than the F-117.

Conclusions/Discussion
The shape of the F-117 definitely reduces its radar signature. I found that for the F-117 to be stealthy, it relies on its faceted shape, its hidden inlets, and its internal stores to prevent radar waves from reflecting back to the radar source. The many complicated shapes of the F-14, including corner reflectors, cylinders, and vertical tails, all contributed to its high RCS. Using my formula, I could analyze other vehicles, like boats, cars, and other types of aircraft, even satellites, or the Space Shuttle. With this formula, and the way it calculates how different shapes return radar reflections, my project would be used to help design these other types of vehicles to be stealthy to radar.

Summary Statement
Using what I learned in my research about electromagnetic reflections from simple shapes like planes, corners & cylinders, I measured the radar cross section of two different airplanes to prove that shape affects their visibility to radar.

Help Received
My dad bought supplies at Home Depot and online. He showed me how to solder and use a saw to build my display. He explained some of the radar terms and concepts, and taught me how to create a polar graph in Excel.