



**CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY**

Name(s) Charlie A. Reid	Project Number 31550
Project Title Simulating Incompressible Fluid Flow with the Navier-Stokes Equation	
Abstract Objectives/Goals The objective was to determine how accurate my fluid simulator was. Methods/Materials The simulation method was a staggered grid finite difference approximation of the two dimensional incompressible Navier Stokes Equations. To test the method's accuracy I simulated fluid flow around circles of varying size. I programmed the whole program in java from scratch. Results The simulation produced results that looked like water in general but did not agree with past experiments numerically. The frequency did decrease with cylinder size as expected but it was almost exactly ten times more than it should be. Also, the frequency decreased about half as much, proportionally, as expected for the higher diameters. All the simulations converged to a stable frequency after less than ten vortices. Conclusions/Discussion This experiment showed definitively that my simulator was too inaccurate for anything but possibly computer graphics. However, the cause of the inaccuracy is still uncertain. A question for future exploration is whether the error approaches zero as the grid resolution approaches infinity and the time step approaches zero. If so, then the approximation method needs to be improved and possibly greater computing power must be used. If not, then there is probably a bug in the program or something fundamentally wrong with the math.	
Summary Statement My project was an attempt to make an incompressible two-dimensional fluid simulator that agreed with the literature.	
Help Received I had some discussions with my science teacher on related subjects such as boundary layers on hypersonic aircraft.	