# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Alexander J. Sercel

**Project Number**
**J0224**

**Project Title**
# Effect of Propellant Variation and Aerodynamic Drag on Potato Cannon Performance

**Abstract**

**Objectives/Goals**
This research effort was to gain a better understanding of the physics and engineering principles related to the operation of a potato cannon. Research goals were to find out which common household propellant works best, how much propellant is best, and to learn how air drag effects the trajectory of the potato.

**Methods/Materials**
I made a potato gun and launch stand using PVC and materials available at the hardware store and tested it using a variety of propellant quantities and types. Trajectory performance was recorded on a digital video camera with a calibrated backdrop to capture spud velocity and launch elevation angle. Trajectory range was recorded by flagging ground impact locations then using a tape. Flight distance was predicted using a computer algorithm in a spreadsheet to numerically integrate the equations of motion. By comparing measured spud flight range to predicted range, an indirect measurement of potato drag coefficient was obtained.

**Results**
Spud launch velocities were observed in the range of 20 to 60 m/s. At low fuel amounts, corresponding to 0.5 seconds of spray injection, spud launch speed varied from 30 to 40 m/s. At increasing fuel amounts (up to 2 s of spray), spud launch speed varied from 20 to 60 m/s. Flight ranges of up to 100 m were observed to be less than that which was predicted in the absence of atmospheric drag. Flight range was accurately predicted when drag effects were accounted for in the trajectory integration.

**Conclusions/Discussion**
When there is too much fuel, the gun either works very well or doesn#t have enough oxygen to burn properly. If the fuel mixture is too lean, the gun works predictably but doesn#t have as much launch energy. A medium fuel mixture is ideal for repeatable results because you have higher power than a lean mixture and you don#t run the risk of flooding the chamber. The top three propellants I used all contain denatured ethanol as a main ingredient suggesting that ethanol is an excellent propellant.

My numerical results show that you can't accurately predict how far a potato cannon will shoot unless you include the effects of air drag. It is possible to integrate the equations of motion of a flying potato in a spreadsheet in which the trajectory is broken up into time slices of about 0.01 seconds. This allows accurate prediction of the shape of the potato's trajectory, including the effects of atmospheric drag.

**Summary Statement**
I addressed two questions related to the performance of a potato cannon: What is the best type and quantity of propellant, and how much aerodynamic drag does the potato have in flight?

**Help Received**
My parents took me to the hardware store and bought my materials, my father safety checked everything I did and operated the video camera, my father showed me how to use some features on the computer I had not previously used, and my whole family helped me collect field data on test days.