



CALIFORNIA STATE SCIENCE FAIR 2013 PROJECT SUMMARY

Name(s) Jonathan M. Wahl	Project Number J0130
Project Title Air Conditioning vs. Windows: How to Cool Down Your Car Fast	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The goal of this project is to find out if opening windows before activating the A/C system helps cool down the automobile's interior faster than a baseline of A/C only. Measurements were obtained at different vehicle speeds to characterize the convective mixing of air inside the vehicle. A simple temperature model was used to optimize the window open time for fastest cool down.</p> <p>Methods/Materials The temperature inside the car was measured simultaneously at four strategic locations to obtain a representative average temperature. The car interior was heated up to about 50C before each test. The temperature was recorded for four sensors at 1 sample/sec as the effect of different operating conditions was explored. The baseline consisted of only using A/C to reach the target temperature (typically 25C). This was compared to using only open windows (A/C off) while varying the vehicle speed (0, 35 and 65 mph). The experimental data was normalized and curve fit to characterize the convective mixing of air inside the car. This was later used in a model for predicting the temperature inside the car. This model was exercised to find the optimal window open time (before switching to A/C) to achieve the shortest overall time for cooling down the car.</p> <p>Results At 0 mph, opening windows does not help the car cool faster than with A/C only. Although the results suggest that the mixing of air at 0 mph is better compared to A/C only, the air from the A/C is so much colder compared to the outside temperature that the A/C cools the car down faster. The situation changes once the windows come down when the vehicle is moving at which point the air mixing overwhelms the A/C's capabilities, provided the outside temperature is not too high.</p> <p>Conclusions/Discussion The key finding of this project is that opening windows at any speed is better as long as the outside temperature is not too high. Reason being the fan rushing the air through the A/C system is not powerful enough to compete with the jet stream coming through the windows. The temperature model established as part of this project can predict the window open time for any given vehicle speed and outside temperature and can be possibly used in a Smartphone application to provide guidance or it could be programmed into the car's computer to do the same thing as the Smartphone but controls the components automatically to achieve the fastest cool-down.</p>	
Summary Statement This project investigates and quantifies which approach cools down the interior of a car the quickest: using only A/C or opening windows first followed by A/C.	
Help Received Father derived advanced mathematical equations and set up the temperature model in an MS Excel spreadsheet. See student notebook for further details.	