



**CALIFORNIA STATE SCIENCE FAIR  
2016 PROJECT SUMMARY**

<b>Name(s)</b> <b>Tommy Hartman; Alfryd van Bruggen</b>	<b>Project Number</b>  36086
<b>Project Title</b> <b>The Curious Motion of Rolling Cylinders</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The purpose of our project was to identify and explain the differences in the rolling behavior between a cylinder half-filled with a granular material (sand) and one that is half-filled with a fluid (water).</p> <p><b>Methods/Materials</b> We half-filled a cylinder with either water or sand and then rolled it down a ramp onto the flat ground to provide a reproducible velocity. Time-lapse photography was used to measure the distance travelled at each interval. Pictures of the rolling cylinder were taken to show the motion of the sand and water. Based on our measurements we derived an equation that described the physical properties of these motions.</p> <p><b>Results</b> At high velocities, the sand was held to the outside of the cylinder by centrifugal force, but at low velocities the sand fell to the bottom due to gravity, making the cylinder stop. From theory and our knowledge of the properties of the cylinder, we calculated that the centrifugal force and gravity would be equal when the velocity of the cylinder with sand was 56 cm/s. From our experiments we determined that the velocity at which rapid deceleration occurred was 58 cm/s, within the experimental error of our theoretical value. The cylinder of water had an initial velocity higher than that of sand, but with rapid deceleration at first then slower. Both of the materials had the same velocity at which the linear deceleration changed, but with opposite directions.</p> <p><b>Conclusions/Discussion</b> Although our theorem accurately predicted the motion of the cylinder half-filled with sand, the cylinder of water did not behave as predicted. The fact that the water had a higher initial velocity was due to the water having less rotational energy because it had less friction with the interior of the cylinder, allowing more potential energy to be converted to translational kinetic energy. The cylinder of water slowed faster at first, because at higher velocities the water was turbulent before settling. Once the water settled on the bottom, the deceleration was reduced.</p>	
<b>Summary Statement</b> The characteristics of a rolling cylinder half-filled with a fluid or granular solid is specific and can be defined mathematically.	
<b>Help Received</b> Designed and implemented the project ourselves but received some help to confirm the accuracy of our math.	