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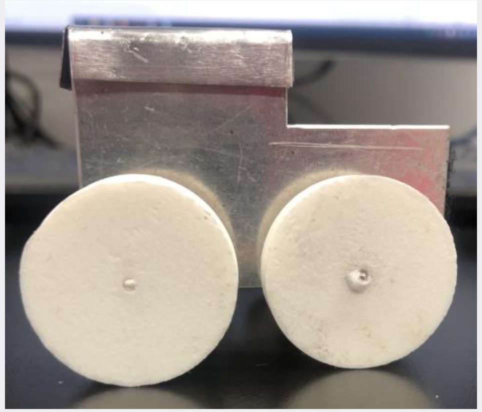
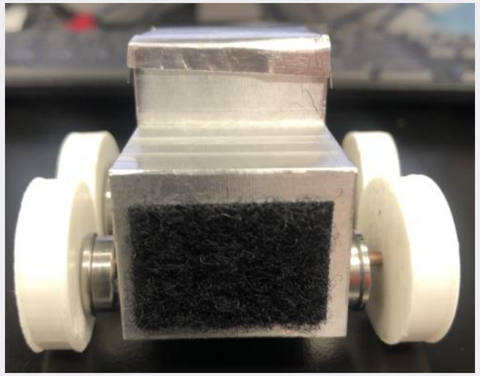
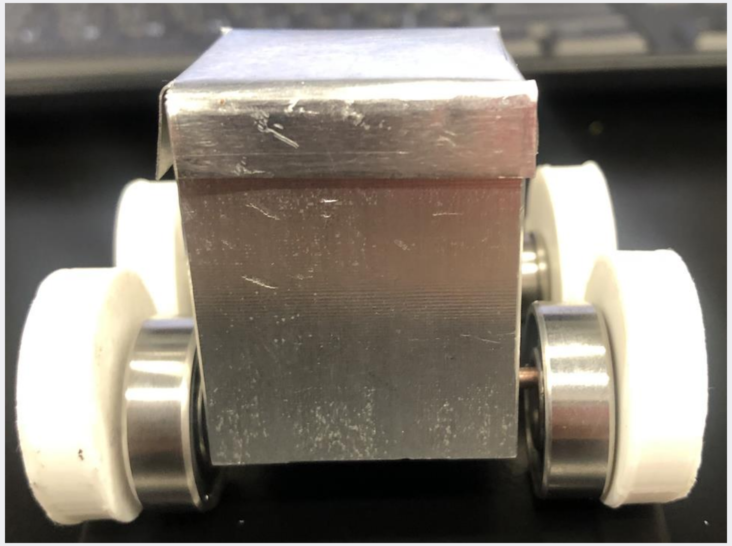
DAP: Catapult Car

Design

- Low build and wide axle for stability
- Bearings for weight and increased stability
- Compact mass for "point-mass" effect
- Press-fitted wheels for directional stability and build quality

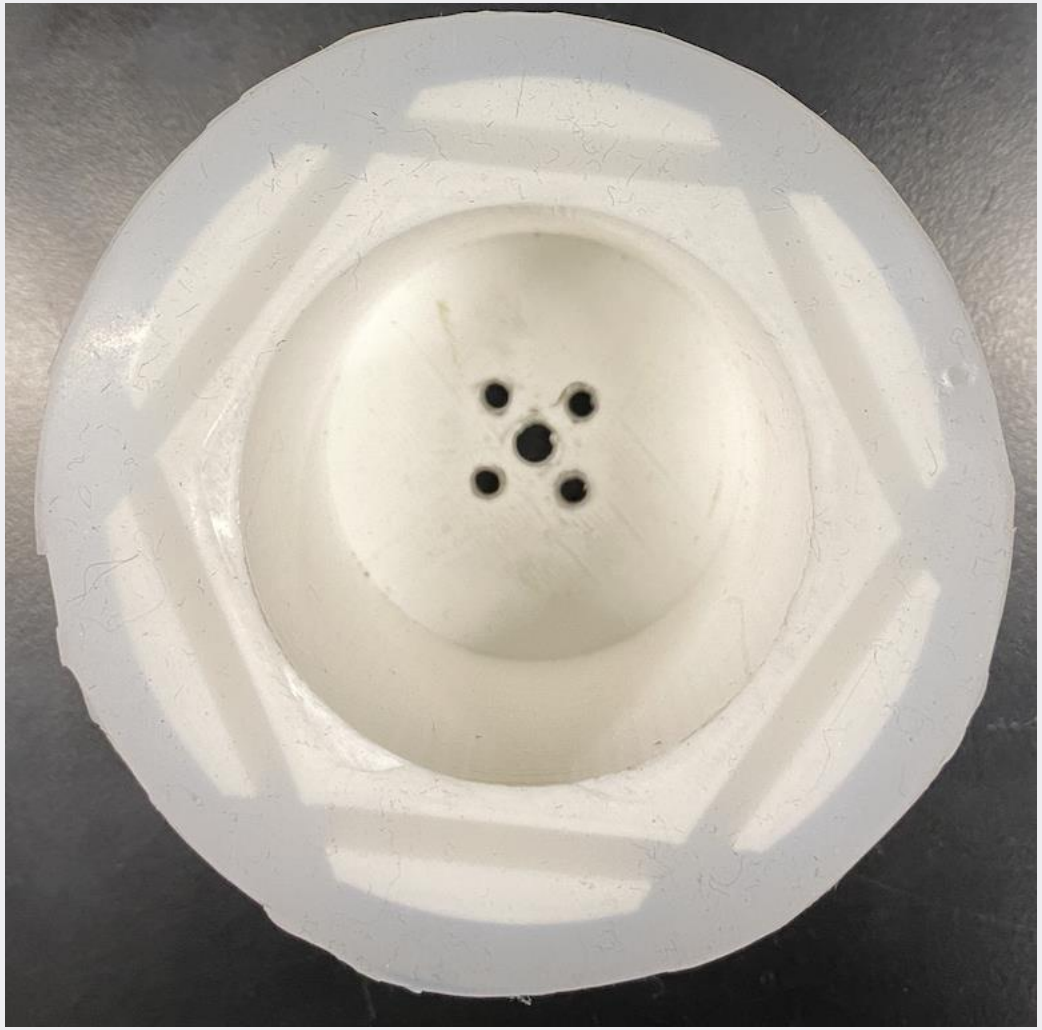






Construction

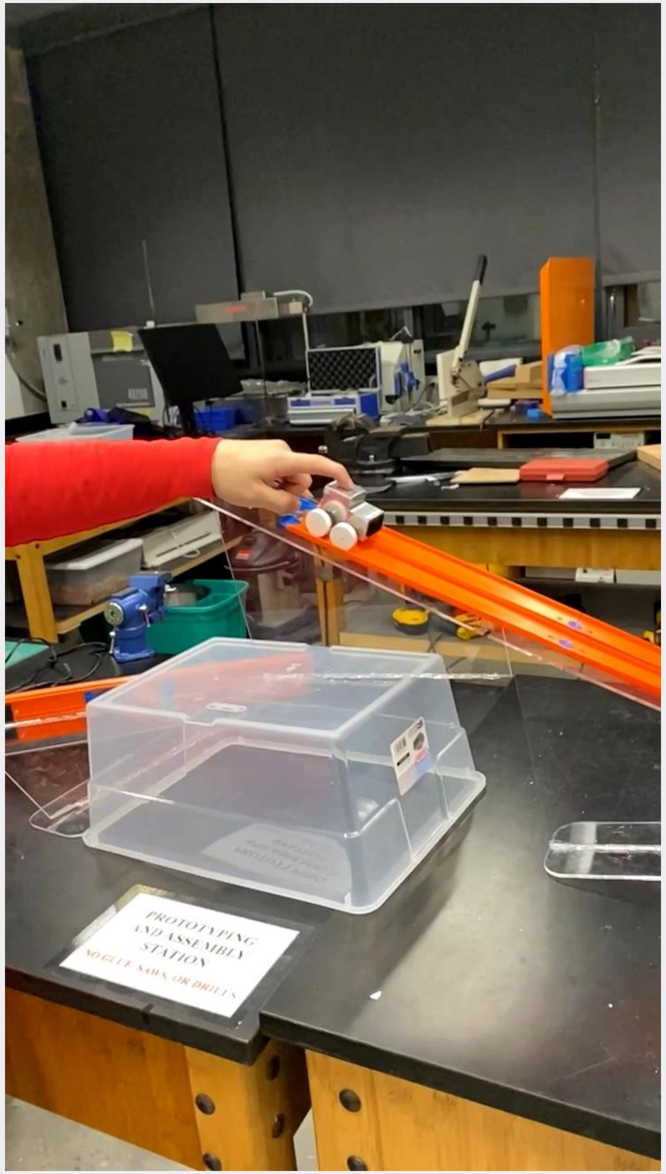
1. Aluminum block machined with Sinisa
2. Axle design review with Brian
3. Wheel design consultation with Jeanette
4. Re-evaluation and testing



Performance and Test Results

- Outperformed expectations
- Able to stay on track without silicone on wheels
- Stable, fast, and attaches well with contact board

Sneak preview



Calculations

STATES

1) CAR'S FINAL SPEED @ CATAPULT
2) CATAPULT ARM'S FINAL ANGULAR SPEED
3) DISTANCE TRAVELLED BY CATAPULTED MASS

DRAWING OF ENTIRE SYSTE

STATE 1 : CONSERVATION OF ENERGY

$M = M_c + M_w + m$

frame, wheels, other components if used.

$GPE = KE_{linear} + KE_{rotational} + W_f$

frictional work, set to zero due to size and mass of car

$Mgh = \frac{Mv_f^2}{2} + \frac{N I w^2}{2}$ #wheels

Assumption that axles will allow 2 pairs of wheels to move

↳ $Mgh = \frac{Mv_f^2}{2} + I w^2$ (1)

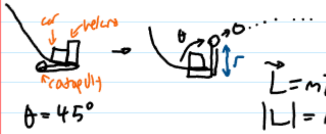
$w = \frac{v_f}{r_{wheel}}$ (2)

(2) in (1): $Mgh = \frac{Mv_f^2}{2} + \frac{I v_f^2}{r^2}$

Finally vf: $Mgh = v_f^2\left(\frac{M}{2} + \frac{I}{r^2}\right)$

$v_f^2 = \frac{Mgh}{\left(\frac{M}{2} + \frac{I}{r^2}\right)}$, $\boxed{v_f = \left(\frac{Mgh}{\frac{M}{2} + \frac{I}{r^2_{wheel}}}\right)^{1/2}}$

STATE 2: CONSERVATION OF ANGULAR MOMENTUM



$L_i = L_f$ Inelastic collision due to velcro

$\vec{L} = m\vec{r} \times \vec{v}$

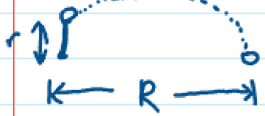
$|L| = m|r||v|$ scalar components

↳ $M r v_i = (M + m)_{catapult} r v_f$

↳ $v_f = \frac{M r v_i}{(M + m_{cat}) r} = \boxed{\frac{M (Mgh)^{1/2}}{\left(\frac{M}{2} + \frac{I}{r^2_{wheel}}\right)^{1/2} (M + m_{cat})}}$

substituting state 1 vf into state 2 vi

STATE 3: PROJECTILE RANGE



Range equation: $R = \frac{v_i^2 \sin(2\theta)}{g}$

vf of STATE 2

$\therefore \boxed{R = \frac{\left[\frac{M (Mgh)^{1/2}}{\left(\frac{M}{2} + \frac{I}{r^2_{wheel}}\right)^{1/2} (M + m_{cat})}\right]^2 \sin(2\theta)}{g}}$