

Motivation, Goal, Impact

Motivation

The recent storm in January 2026 resulted in trapped cars and the inability to attend work or classes.

Goal

Decrease the effort needed by the user to effectively eliminate layers of frozen snow trapping vehicles.

Impact

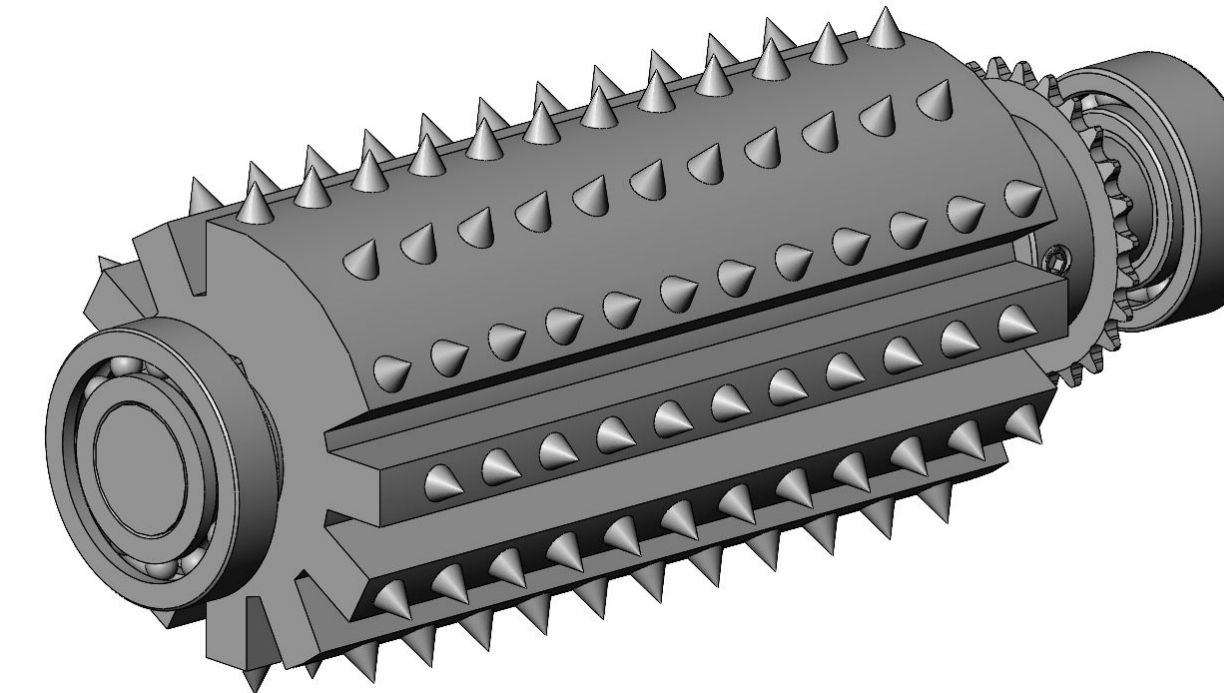
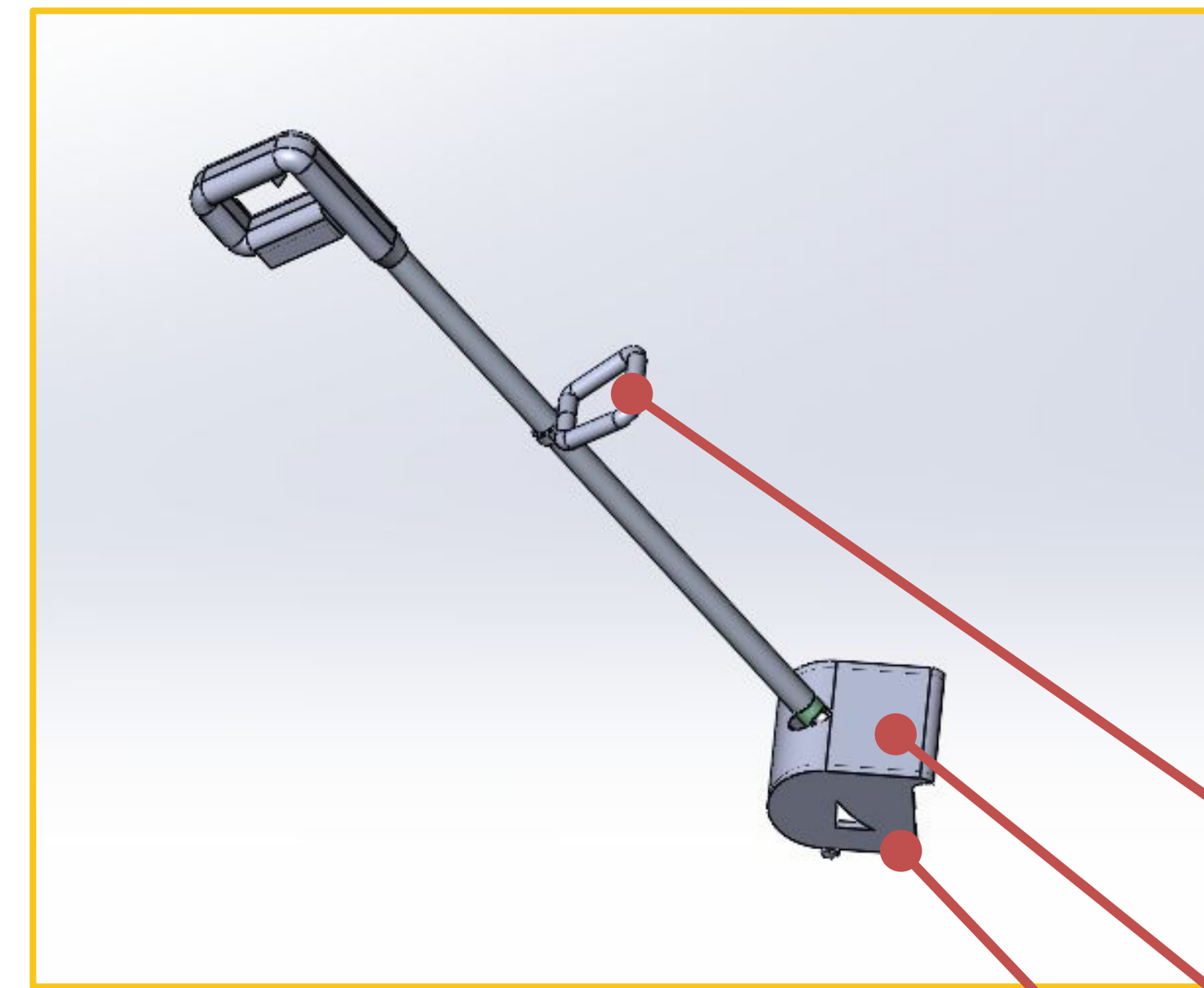
Students, Elderly, Individuals needing accomodations



Cars entrapped by snow, Ella Bruinooge 2026

Requirements

- Break ice around vehicle
- Displace ice from under vehicle
- Restrict damage to vehicles
- Minimize physical exertion
- Complete ice removal in under 15 minutes
- Contact water and ice debris safely (waterproof)
- Maintain affordability
- Remain accessible to all people removing snow
- Fit in a standard vehicle trunk



Final Design

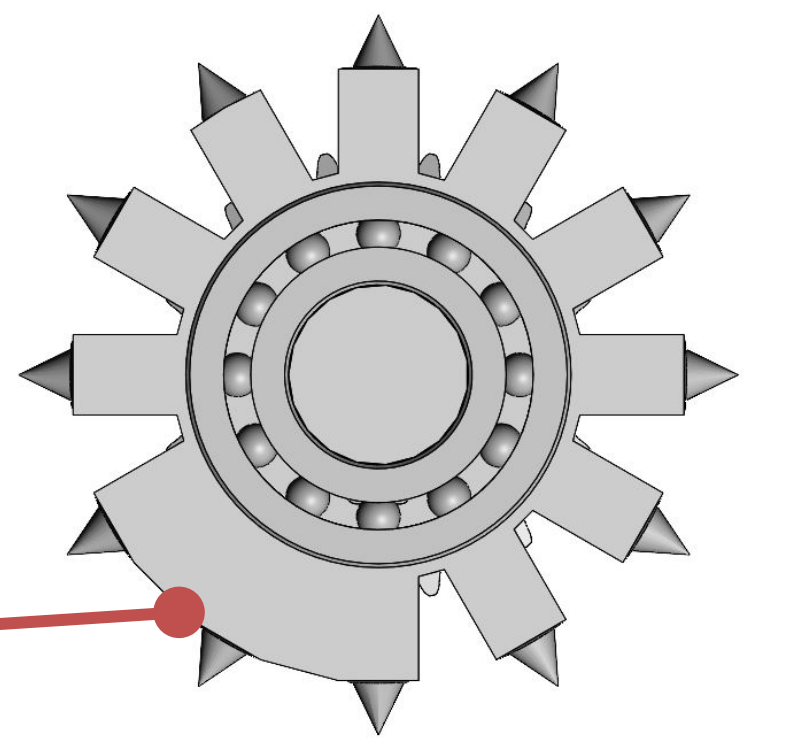
- Operationally similar to a vacuum cleaner
- Rotating metal grinder with tapped-in spikes
- Offset spikes for uniform ice breakage
- Variable speed trigger
- Detachable battery

Push-handle for added force into ice

Cover to restrict damage to vehicles

Clearance under grinder

Asymmetrically weighted grinder for hammering force on ice under housing clearance

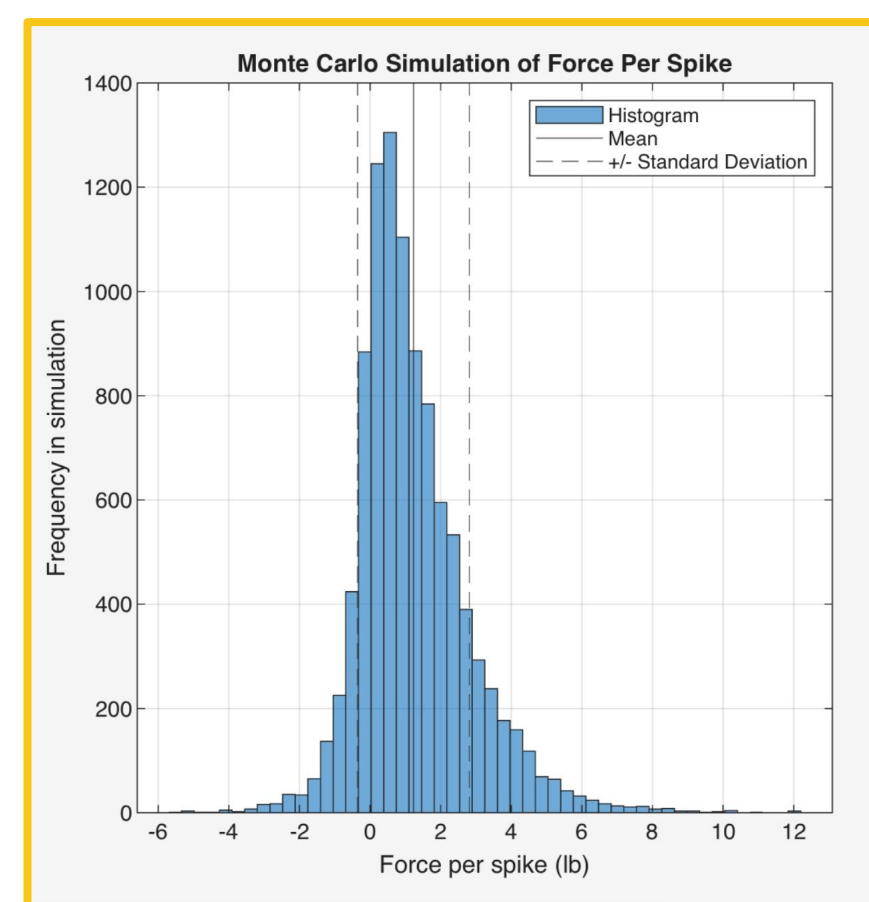


Design Calculations & Decisions

Force Required to Break Ice

Specific cutting force equation: $P = bhE_s = (0.25\text{''})(0.5\text{''})(10\text{ psi}) = 1.25\text{ lb per tooth}$

Monte Carlo analysis provided for uncertainty mitigation



Torque Required for Grinder

$\tau_{grinder} = F \cdot (d_{grinder} / 2)$

Motor Power

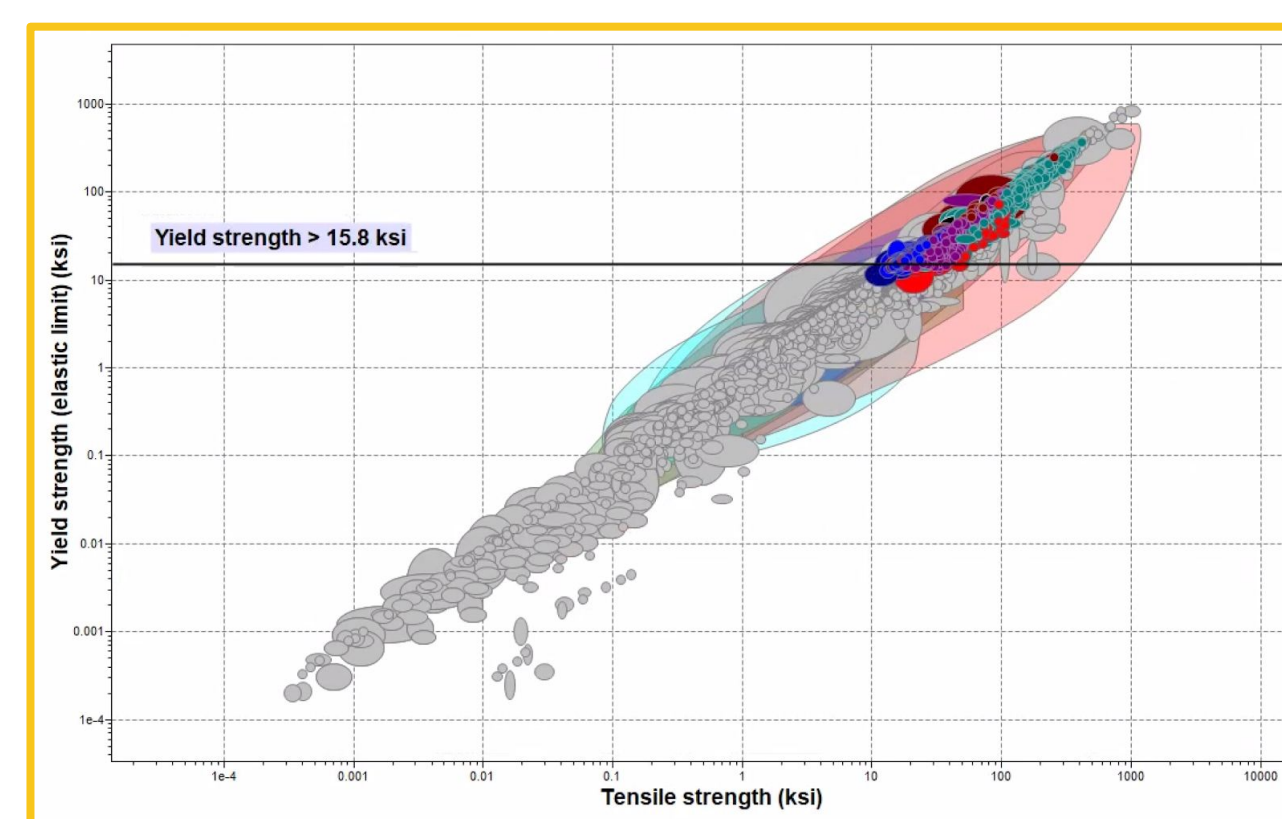
$P_{required} (hp) = (\tau_{grinder} \cdot \omega_{grinder}) / 5252 = 0.603\text{ hp}$

Material Selection

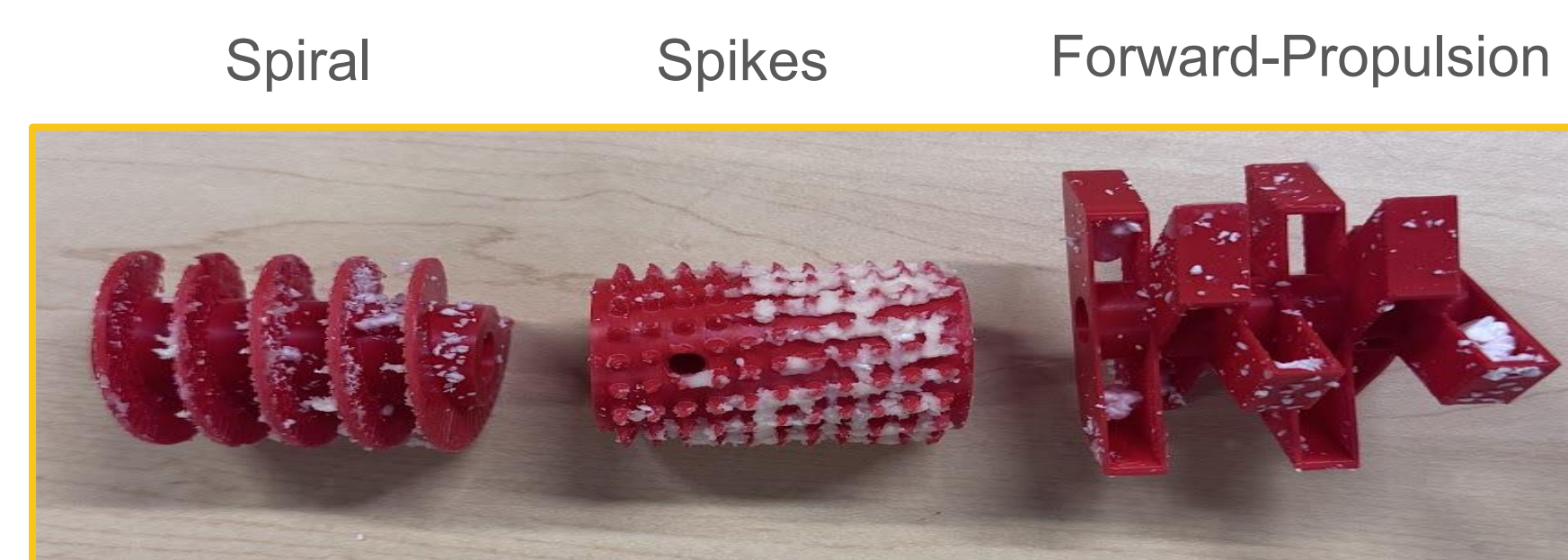
Stainless steel required for end effector

Grinder Selection

Tested polyethylene spiral, spiked, and forward-propulsion grinders on foam and cheddar cheese; spikes were selected.



Source: Granta EduPack



Prototype & Test Results

Method

Purchased garden tiller with replaced end effector to allow focus of testing on efficacy of the grinder

Grinder Prototype

Bored, threaded, and inserted spikes into a 3" diameter cylinder.

Results

Straight cuts in the ice were left, leaving design adjustments to be made to make spike orientation spiral rather than in rows.



Grounded 1.5" thick block in 57 seconds, leaving a grind rate of 1.58"/min



Views of prototype during testing, grinder shown (left) with testing done on ice brick (right)