# Physical Avalanche Simulator

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## BACKGROUND

While teaching avalanche awareness courses, the Utah Avalanche Center (UAC) uses a wooden board, sugar, and flour to model mountain slopes with weak and strong layered snow. The board is sprinkled with layers of sugar and flour, and tilted up to 30 degrees, where an “avalanche” occurs. This is less than ideal as the materials are perishable and the model appears unprofessional. The UAC reached out to us as students to engineer a solution.

## PROJECT DESCRIPTION

In order to solve the UAC’s current problems, we developed an autonomous, portable, and professional model with reusable materials. We began by testing various materials as described in the snowpack layers section. Then, we set to work designing a large portable simulator. We began with a 3D CAD model (an early draft of which can be seen below), and separated the project into 4 different systems: the lifting mechanism, the portability design, the electronics and coding, and the filtering device. It was a challenge getting these systems to work seamlessly in an effective way, but we were able to design an effective tool for the UAC. See details in the key features section.


## THE INGREDIENTS OF AN AVALANCHE

### WEATHER

Weather patterns are what determine the snowpack of any given day. High winds, new snow, and temperatures all contribute significantly to avalanches.

### TERRAIN

Avalanches usually occur on 30-45 degree slopes, peaking around 38 degrees. Slopes below 30 degrees aren’t steep enough for most avalanches.

### SNOWPACK LAYERS

In a slab avalanche, there are at least two layers of snow: a strong, cohesive layer, and a weak, faceted layer. We tested over 50 combinations of materials searching for a set of materials that behaved most closely to these layers. A 420 micron sand was selected for the weak layer, and a 3 micron chalk was selected for the strong layer. Together, these layers behave like snow layers, and create slab avalanches at angles between 30-50 degrees.

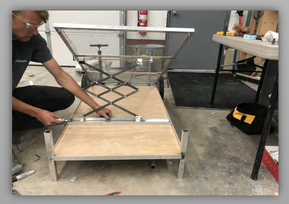
## KEY FEATURES

### INTERACTIVITY

Underneath the HDPE plastic slope is a magnetic steel mesh. This allows users to place obstacles such as trees anywhere on the slope to see how they interact with the avalanche.

### AUTO SLOPE ADJUSTMENT

A scissor lift is used to lift the board to the desired slope angle. The scissor lift is driven by a motor connected to a lead ball screw shaft that actuates the scissor lift to raise and lower.



### PORTABILITY

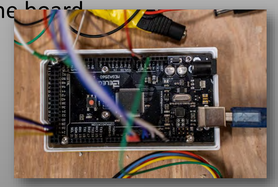
The design is based off a mix of a suitcase and a dolly, both designed to transport heavy/awkward loads.

### Reuseable

After the simulation, we developed a filtering device that separates the weak (sand) and strong (chalk) layers using a 40 mesh sieve and a vibrating mechanism, which allows for recyclability.

## CONTROLS

The board is powered by a 120W power supply. Power is fed to an Arduino Mega, which controls the stepper motor through a motor driver. Slope angle is calculated from the motor rotation, and output to a large display at the top of the board.



The automated system is controlled by a sequence of 4 buttons:

- Raise (+1°)
- Lower (-1°)
- Reset (10°)
- Set (28°)


## FUTURE WORK

The team ran into some unique challenges with our design. These challenges are still currently being worked out, including stability and reliability. One of the major challenges we have had is the stability and robustness of the scissor lift. Our proposed solution is to add struts to the board to add additional points of support to the slope. This will increase its reliability and protect against bumps and other accidents. To further increase reliability, the team is performing further upgrades, such as adding higher quality components, adding strain relief to wiring, and more.

## CONCLUSION

The main issues with the original simulator were professionalism, repeatability, portability, and recyclability. Our final design has solved all of these issues, while adding autonomy and interactivity. The simulator can easily be transported to schools, looks professional, and can be repeated many times with similar results.

## SPONSORS AND TEAM MEMBERS

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