Hoist Design Challenge

Deep Science

Sanford Underground Research Facility (SURF), located in the former Homestake Gold Mine in Lead, South Dakota, hosts world-leading research experiments in physics, biology, geology, and engineering.

The main level for science is 4850 feet below the surface. For the science to be successful, equipment, supplies, and of course, researchers need to travel safely to and from the underground on a daily basis.

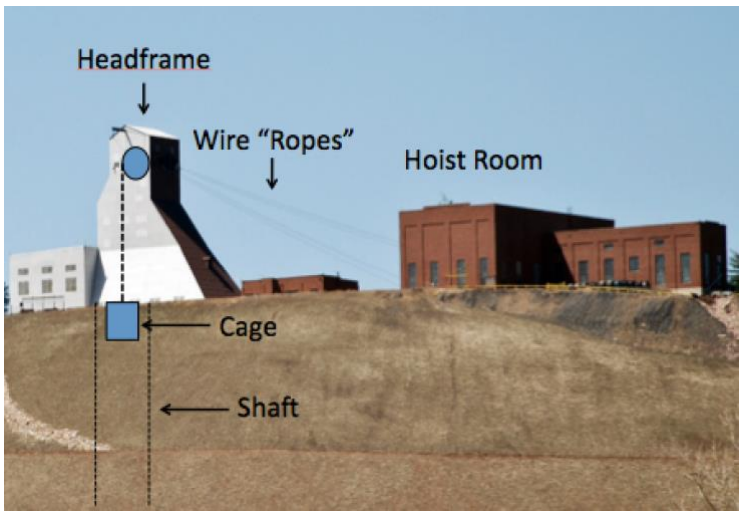
The Yates Shaft is 5,000 feet (1,524 meters) deep. Inside the shaft, the cage transports people and supplies from the surface to the 4850 Level and back. The cage connects to a 6,000-foot (1,829 meter) hemp and twisted steel rope that is part of the hoist system.

SANFORD UNDERGROUND RESEARCH FACILITY

The Hoist

A hoist is an apparatus that can lift or lower a heavy load. At the Sanford Underground Research Facility, the hoists are so big they get their own building! To lift a load the hoist winds up the rope. To lower the load the hoist lets out rope.

The diagram below can help you envision the main components of the hoist system. What do you notice? What do you wonder? What does this system remind you of?



Design and Build

Your challenge is to use your engineering skills to design, test, and build an apparatus that is capable of lifting a load (weight) to the top of a shaft. Your design must also include some sort of brake that will hold the load at the top of the shaft. This would allow for safe unloading of the cage at the top of the shaft (the surface).

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Engineering Design Process

The Cage

The cage is an enclosure, attached to a rope, which is used to transport people and supplies above and below ground. In this design challenge your load will represent the cage.

What can you find that could be used as a load in this challenge? What about something for the rope?

Identify/Imagine/Design

After examining the diagram on page one, you should have an idea of the basic components in a hoist system. Think about how each will be incorporated. Consider the scale of your model. It is not practical to create a shaft that reaches nearly one mile, but it is reasonable to create a structure that is at least 16 inches tall.

Identify materials that you have access to. (The recycling bin is a great place to start.) Brainstorm many possible solutions. Choose your best design option and sketch a detailed diagram of your idea.

Create

Begin constructing your prototype according to your plan. Make sure you can raise AND lower the load. Don't forget that you will need to construct a brake to keep the load stationary at the top of your shaft.

Test/Improve

Test your hoist apparatus. Does it lift and lower a load? Is the design sturdy? (strong enough to support itself) Is it reliable? (will it work more than once?) Has a brake been added? What do you think would happen if this apparatus needed to lift a heavier load? If something isn't working as well as you imagined, this is the time to make improvements.

Share

Which of your designs performed the best? What challenges did you have? How did you resolve them? Now that you have some experience, what might you change to optimize your apparatus?

Now that you have shared your findings with each other might it be possible to select certain aspects from multiple designs and combine them to create a super hoist? What might that look like?