Hoisting a Grown Up
Investigation #2

Description
Can you lift a seated adult up? I bet you can!

Materials
- Block-and-tackle pulley system
- Heavy-duty single pulley
- Wooden board, 2 inches thick by 18 inches long by 12 inches wide
- Drill
- Drill bits
- Rope
- Heavy-gauge carabiner
- 2 U-bolts
- Friends
- Snips

Procedure
1. Prepare the wooden seat by drilling four holes, about two inches in from each outer edge, in each corner of the board.
2. Cut two lengths of rope, 8 feet in length.
3. On one 12-inch side, feed a rope through the hole in one corner, under the seat, and up through the second hole.
4. Center the board so there is an equal amount of rope on each side.
5. Repeat on the other side with the second rope length.
6. Bring the 4 rope ends together and tie securely into square knots.
7. Loop the carabiner through the ropes near the knots.
8. Secure the block and tackle to a sturdy structure. A swing-set beam works very well.
9. Hang the single pulley beside the block and tackle on the same structure.
10. Feed a length of rope through the single pulley and tie on a U-bolt.
11. Feed a different length of rope through the block-and-tackle pulley system and secure the U-bolt to the loose end of the rope.
12. Have the adult sit on the floor on the board sling.
13. Attach the carabiner to the single pulley’s U-bolt.
14. Hoist away. Is lifting the adult easy?
15. Try the action a second time while using the block and tackle.
16. Could you move the adult now? Why?
17. Challenge the adult to hoist himself while sitting in the sling.

My Results
Explanation
Pulleys are simple machines that can redirect or magnify an applied force. Using a single fixed pulley doesn’t make lifting an adult easy enough. We would say this pulley gives a mechanical advantage of only 1. The adult’s weight is comparable to the force that must be applied to the rope. With a single pulley, the only advantage is that the rope is pulled down to lift the adult up.

In a multiple-pulley system, the upper pulley also remains fixed, staying in place while the lower pulley moves up with the load. If there are two pulleys with two ropes supporting the load, the pull rope will have to be pulled twice as far to move the load but has a mechanical advantage of 2. The force needed to move the load is half of the weight of the load because each of the two ropes supports half of the weight. So, if the adult weighs 200 pounds, the force needed to move the adult in a two-rope pulley system would be 100 pounds. Raising the adult one meter off the floor would require pulling the rope two meters.

Suppose the block and tackle is made of an upper and lower two-pulley system so there are four rope loops supporting the load. This system would have a mechanical advantage of 4, requiring 50 pounds to lift the adult, and you would need to pull the rope 4 meters for every meter lifted off the floor. A block-and-tackle system uses multiple pulleys to lower the needed force applied to lift a load, but the length of rope that needs to move is longer. This makes it possible to lift an adult.

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