

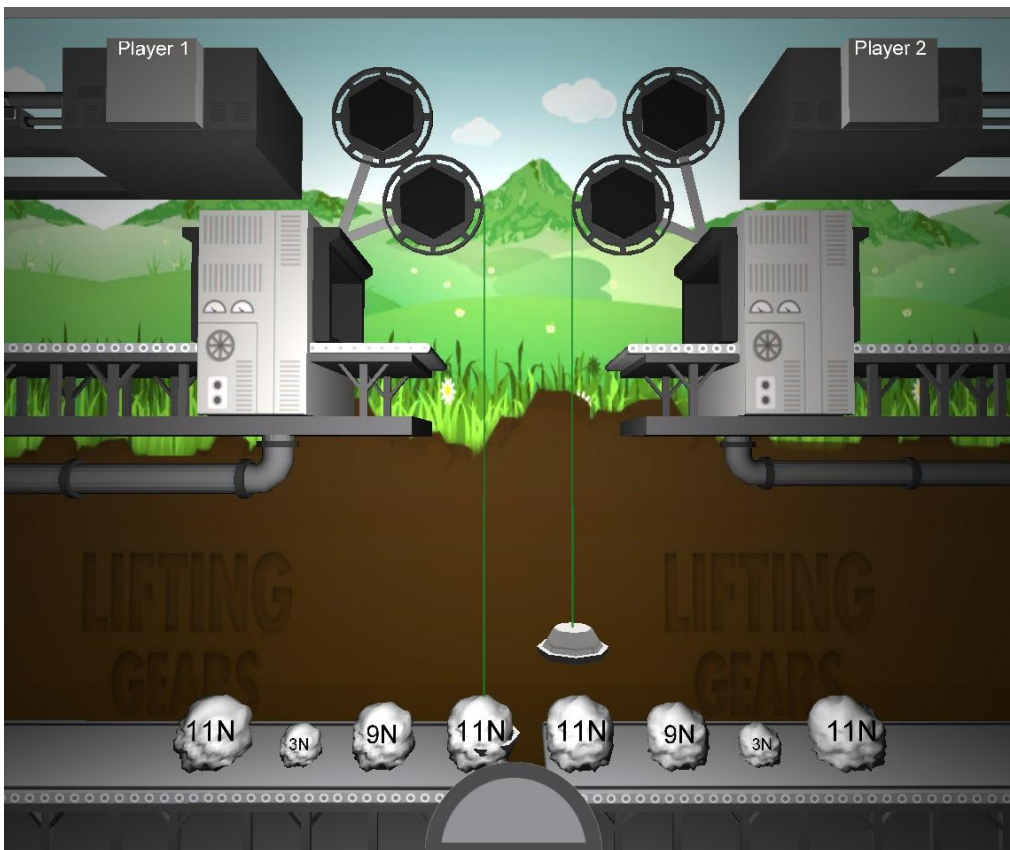


## SETTING UP THE GAME:

We recommend starting simple with only the most relevant components. You have control over which components are visible at each stage.



- Press Ctrl-C to open the configuration panel.
- Click on 'Show Upper Data' to start with 'Weight Lifted' and 'Total Boulders Lifted' on the screen. 'Show Gear Data' will give you the size of the gears.
- Also in the configuration panel you can:
  - Adjust 'Lift Force' for each player
  - Set Round Time
  - Minimum Weight (of boulders)
  - Maximum Weight (of boulders)
  - Save and name custom configurations.



Starting with a basic screen with no components showing allows students to concentrate on the movement rather than wondering what the numbers mean.

### STARTING THE GAME:

- Press the space bar to start the game. Press the space bar again to pause if necessary.
- Press 'R' to reset the game.

The goal is to lift as many boulders as you can in 60 seconds.

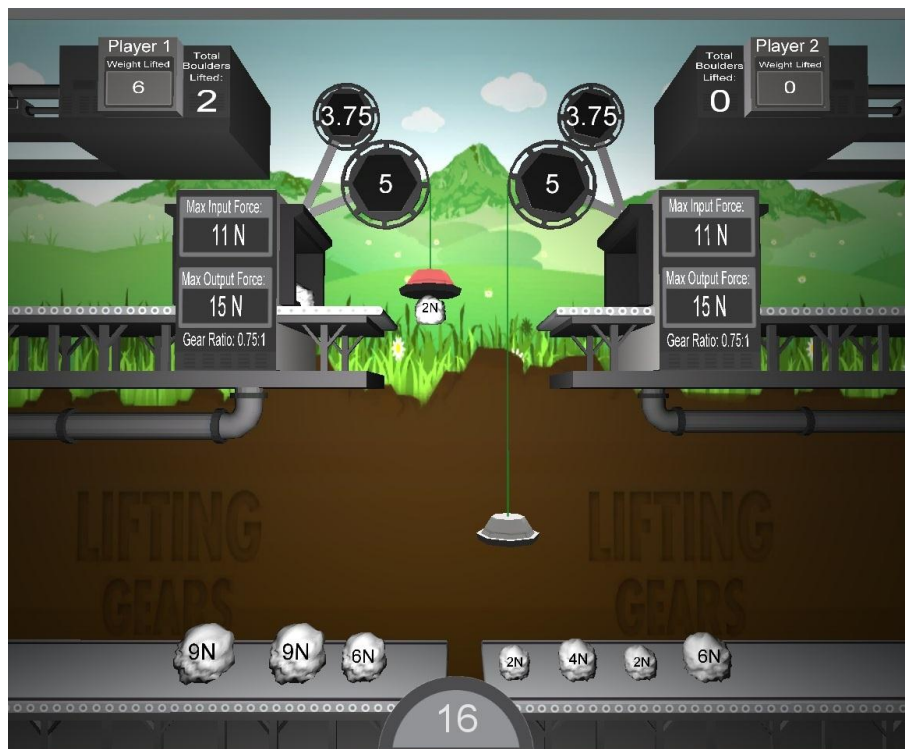
**Student Question** – If you want to bring the magnet down as fast as possible, what would you do with the input gear?

Would you make it smaller or larger?

Do you have to turn it in a specific direction?

Which boulders are harder to lift?

What do you see happening when you try and pick up a larger boulder?



## GEAR RATIO:

As the students play the game, they will see which ratio is optimal for the large boulder.

**Student Question** – What does gear ratio mean? What have we discovered? What is the relationship between the size of the input gear and the weight of the rock you can lift? Why might this be?

- Have students count the number of revolutions on the output gear as it turns.



## INPUT AND OUTPUT FORCE:

- Ctrl-C to open the configuration panel and click on 'Show Force Data' to show 'Max Input Force' and 'Max Output Force' on the screen.

This displays input and output force for the students. A distinction needs to be made between the input and output side of the equation.

**Student Question** – Where is the input? How do we measure force here? How do we measure distance?

The number of times it spins fully around? Now let's look at the output. Which gear is that again? How do we measure force here? How do we measure distance? Will these two be equal or not? Why?

## ***MECHANICAL ADVANTAGE AND WORK:***

The factor by which the input force is multiplied when you use a machine to do work is called mechanical advantage. A machine's mechanical advantage is the ratio of output force to input force.

Since work is the product of force and distance, you would calculate the work done by multiplying the weight lifted (recall that weight is simply a force in the downward direction) by the distance it has been lifted.

The input work would be the force applied by you (the student) as you crank the gear, times the distance (or number of times) that the marker on the outer edge of the gear has been moved.

Input work is the product of input force and input distance. The distance is measured by determining the path length on the outer edge of the gear. The output work is the product of the weight of the boulder (which is a force in the downward direction) and the distance the boulder has been moved.

Or in this case, the height the boulder has been lifted as well.

*Last Modified 8/23/12*