

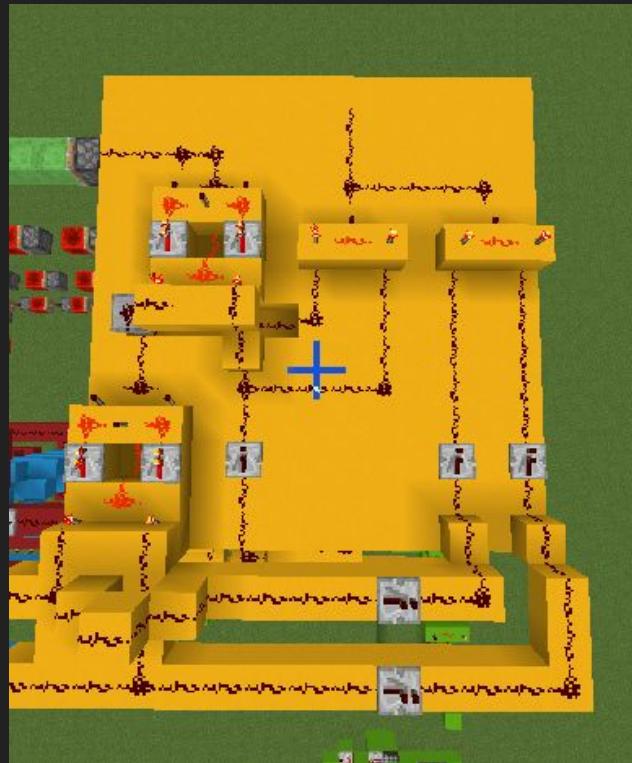
# Mechanical Adder + More

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# Minecraft!



# Mechanical Logic

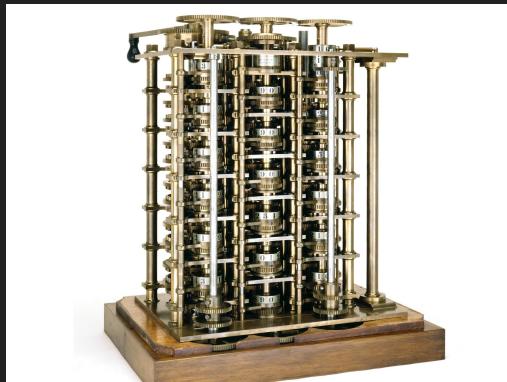
# What physical ways are there to represent logic?



Pascal's calculator (1642)

- The value of a number is added to the accumulator as it is being dialed in
- By moving a display bar, the operator can see either the number stored in the calculator or the complement of its value

Charles Babbage's Analytical Engine (1838)



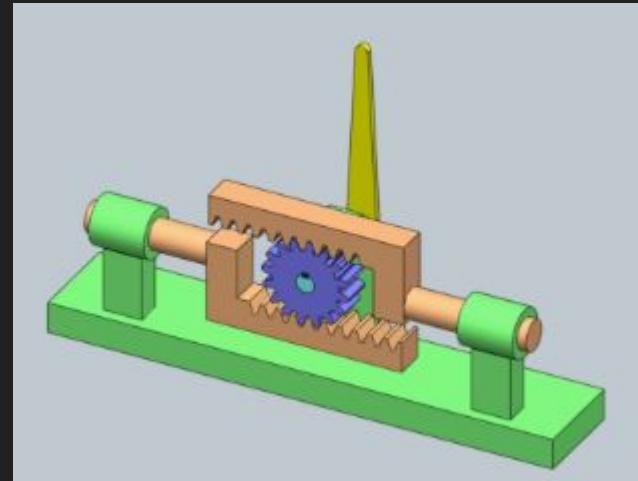
- Turing (haha) complete instruction set.
- Uses wheels, cams, and gears to perform operations.
- Relies on all devices staying in place when not being driven - the device won't work while it's being shaken or moved.

# Things we considered

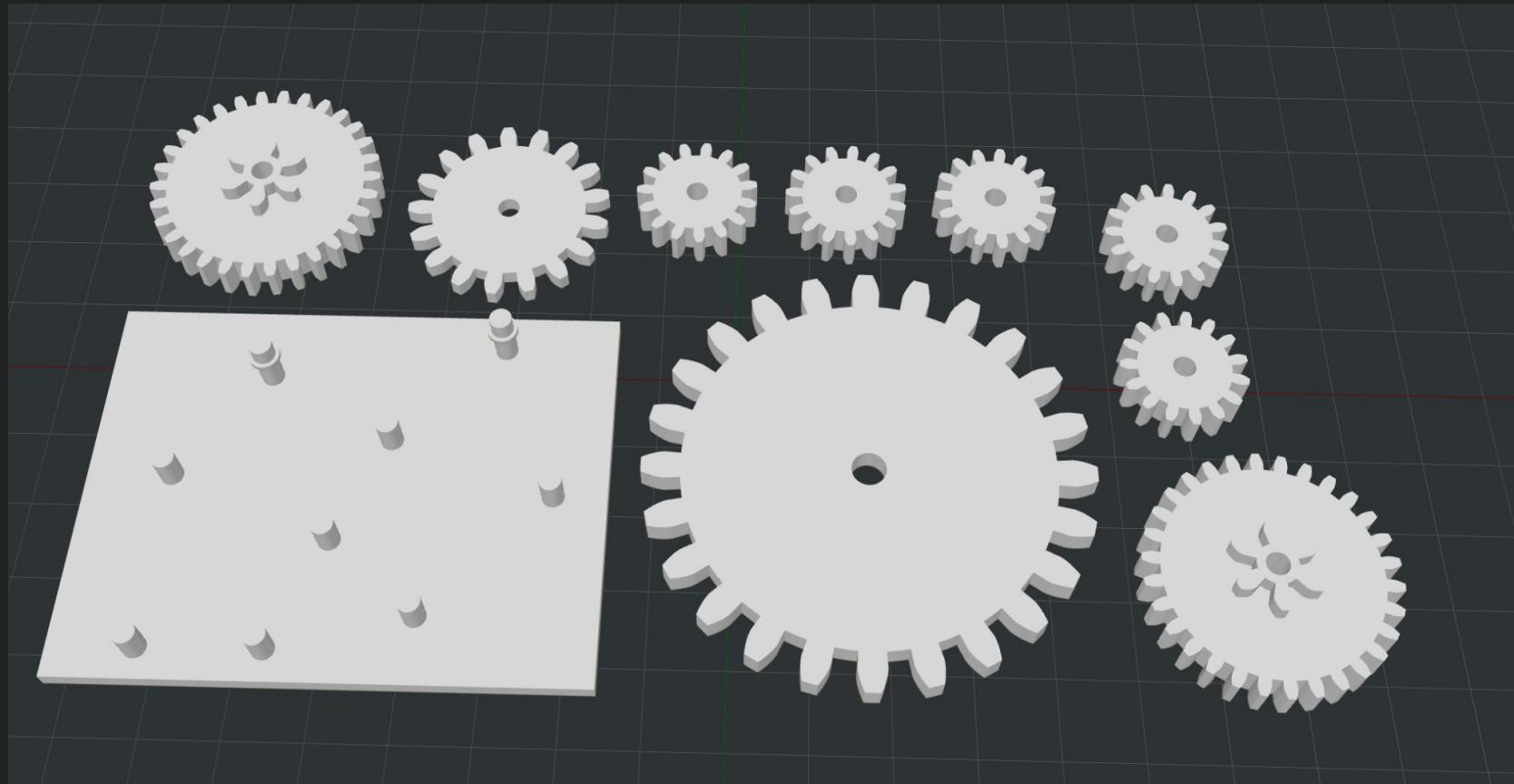
- We were interested in the:
  - Fluidic adder - unfortunately pouring 1 ml and 2 ml of water into a tube and calling it 10 ml of water did not qualify as a final project
  - Analog adder with transistors - we not ECE majors
  - Abacus - we want at least a B
  - Oxygen Adder - ???

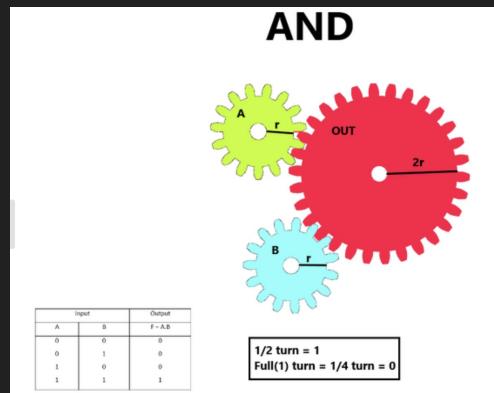
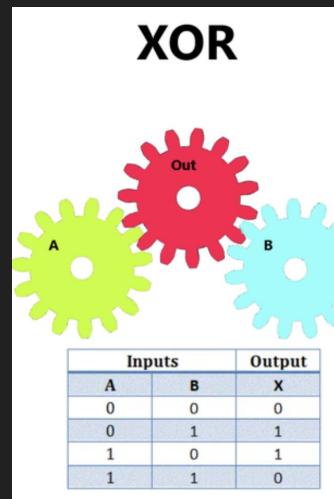
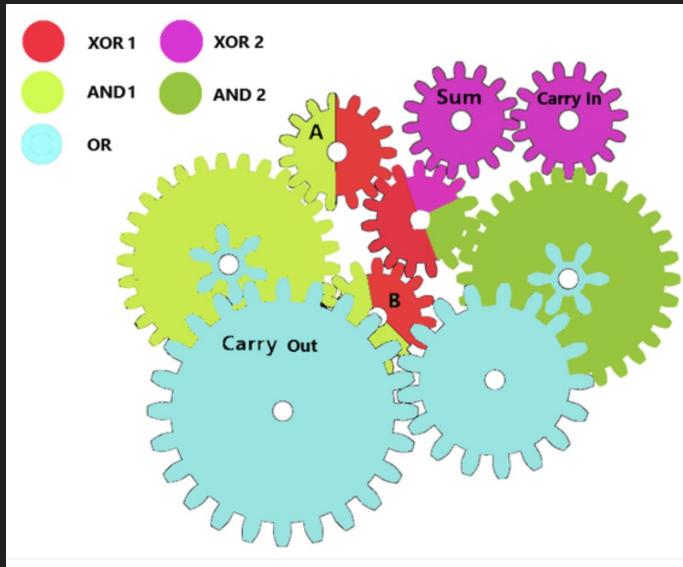
# Mechanical Binary Gates

- But it's possible!
- Mechanical systems exist to represent binary logic.
- OR, AND, XOR, NOR, and NAND gates.
- Use simple machines in series to generate output motion based on two input motions.
- For example, a simple inverter is made by two racks and a gear:



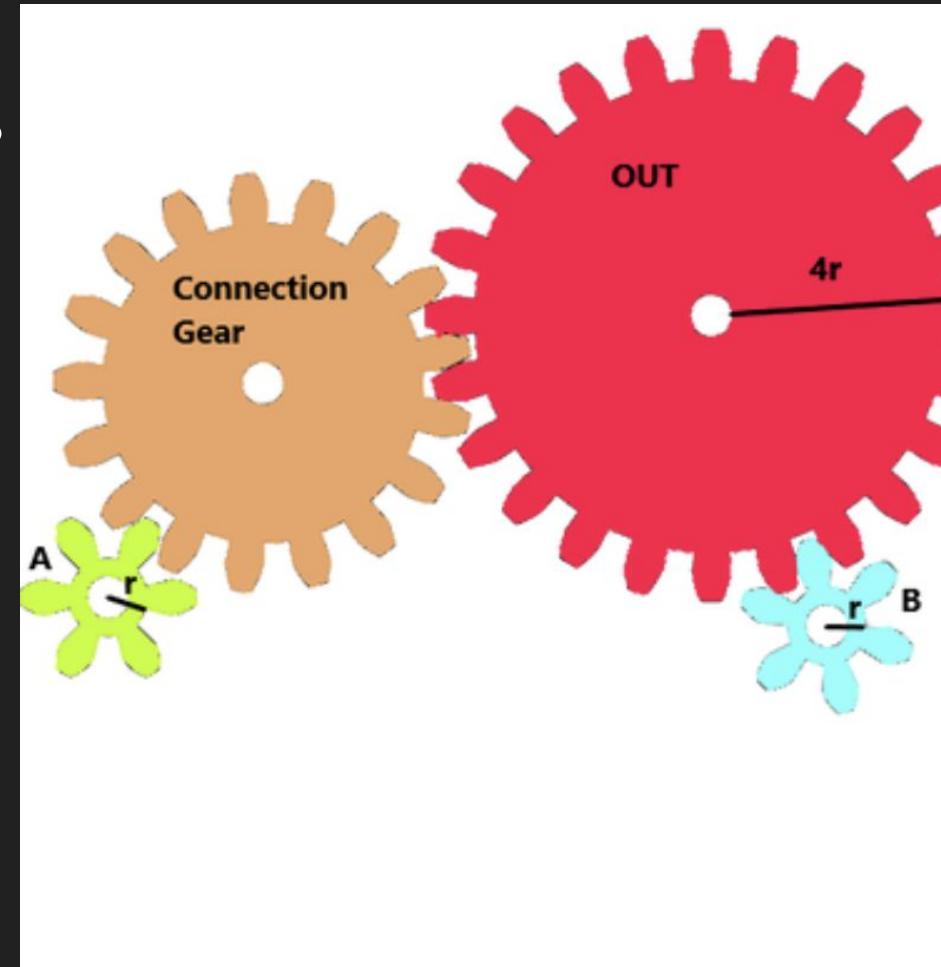
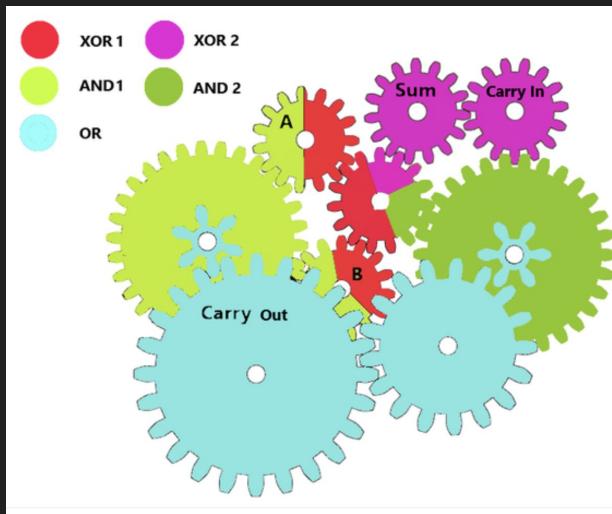
# Gear Adder!





# But we have two problems

Not really an OR gate

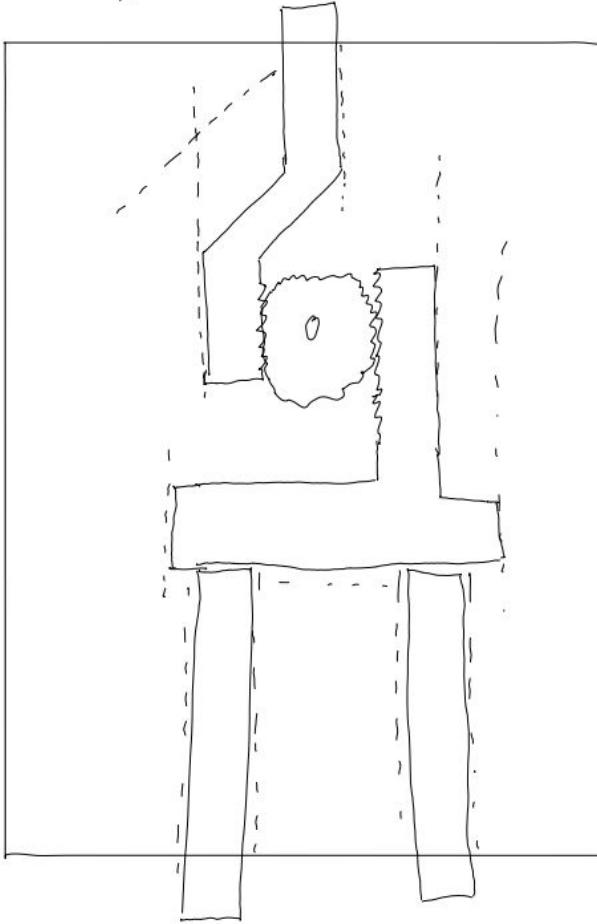


# The Design

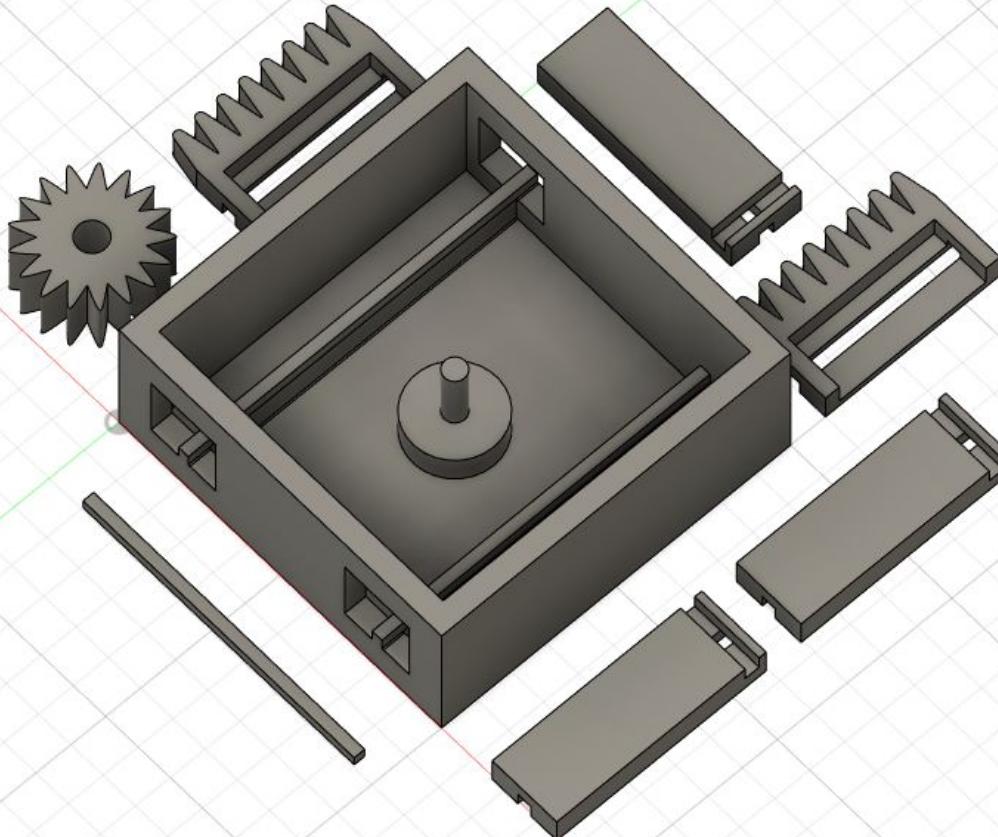
- The simplest physical gate to design is the NOR gate.
- Output is always pushed out, unless either/both inputs are pushed in.
- Two connected input rods feed into a mechanical inverter.
- Output rod will be pushed out when the input rods are not pushed. When either input rod is pushed, output rod retracts.

A	B	Out
0	0	1
1	0	0
0	1	0
1	1	0

Nor

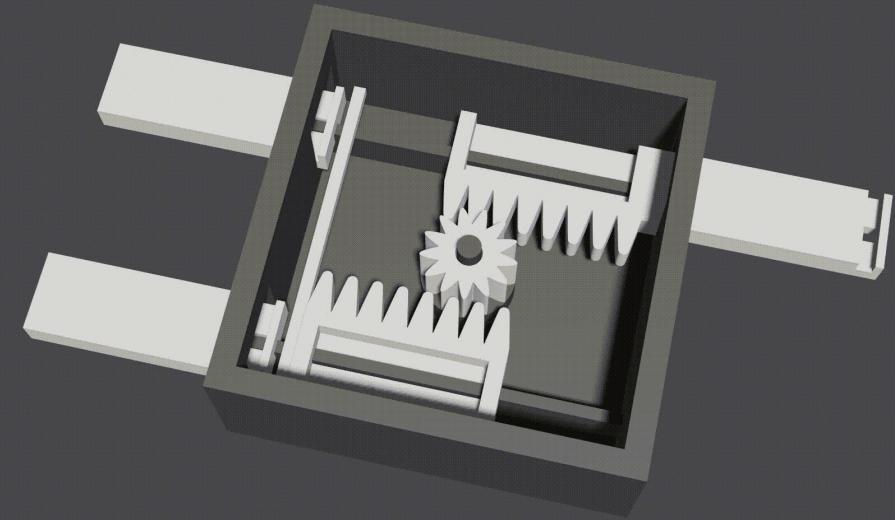


All done with 1 CAD class





This video took 4  
hours - we aren't  
animation majors :(

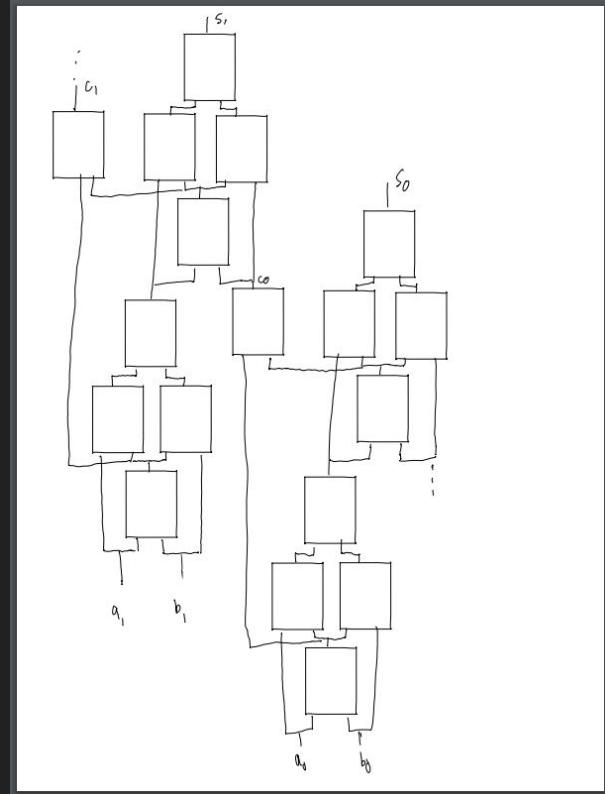


# Full Adder Design

Seen here is our NOR gate based full adder.

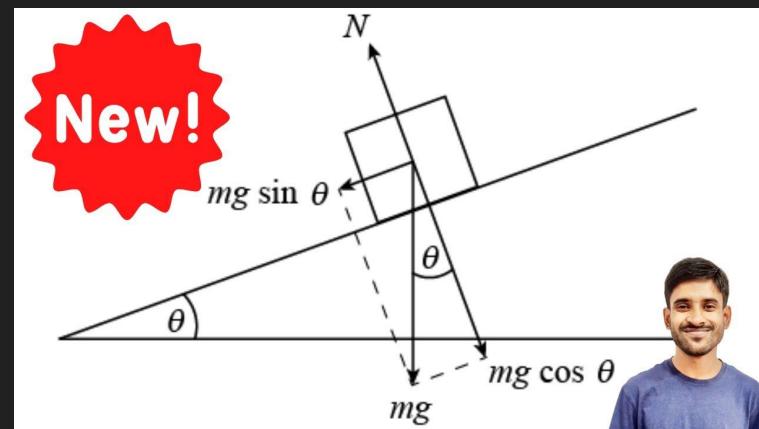
This circuit will add two 2-bit numbers and an optional carry-in.

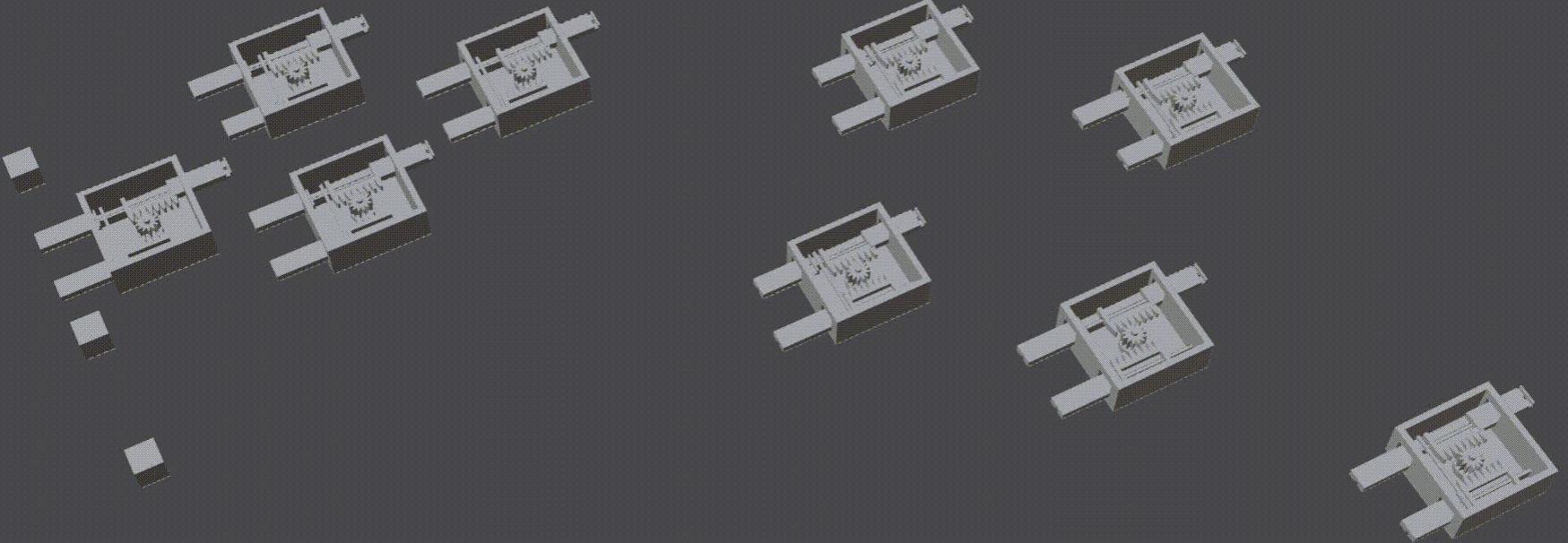
If we can make a mechanical NOR gate, we can mechanically connect the inputs and outputs to replicate this circuit.

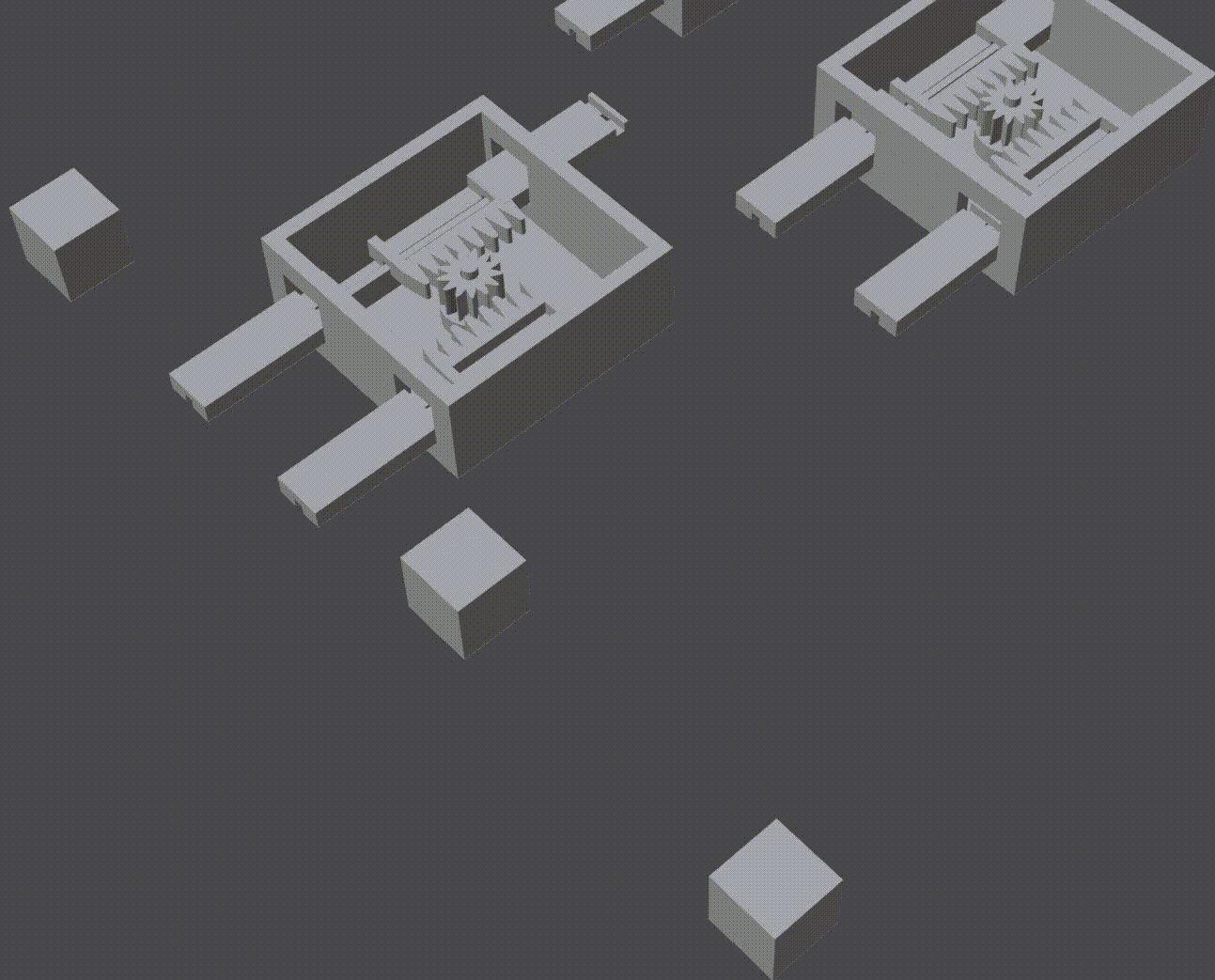


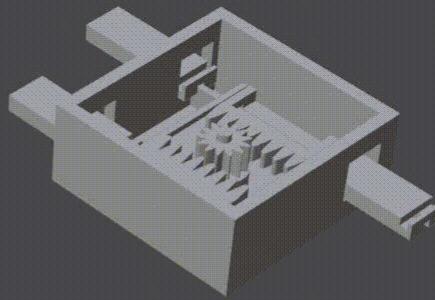
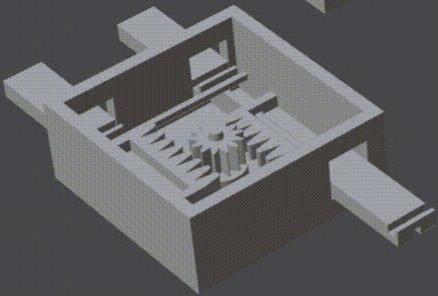
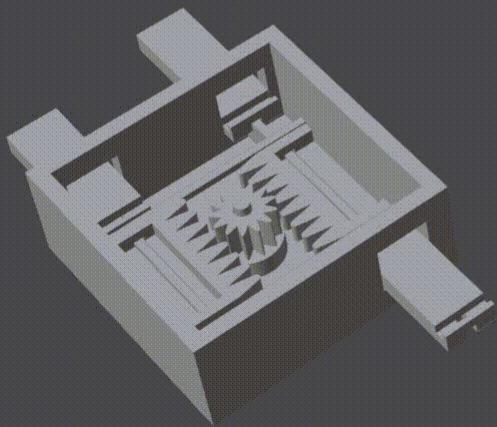
# 4-bit Full Adder

- This could be made as 4 full adder designs chained together.
- However, friction is a key restrictor for mechanical designs.
- Chained designs have scaling friction, and the force required to actuate the inputs increases (we do not hit thumb day).
- While we created a diagram and a simulation for this design, physically replicating this is not feasible.

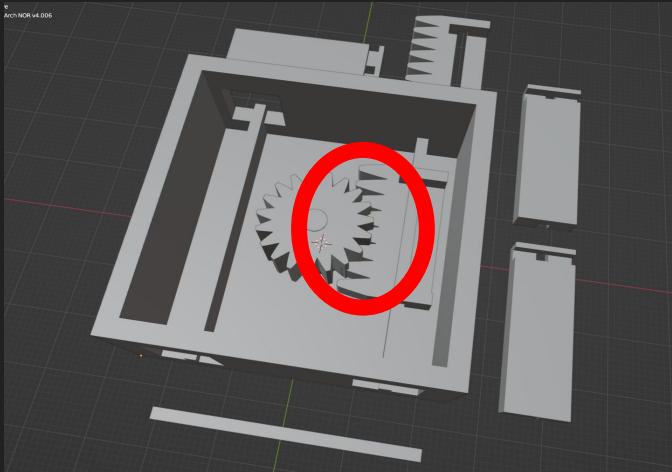








# We are not Mark Rober (I can CAD fr)



# Questions?