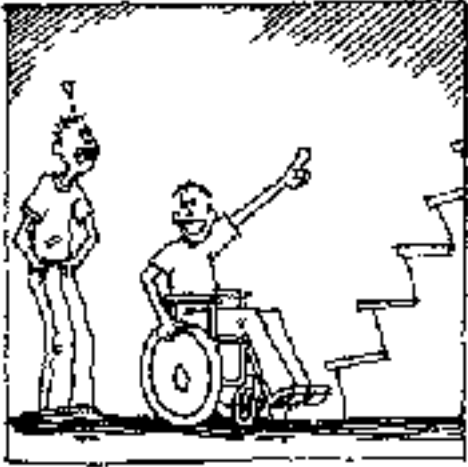


Design Challenge: Helping our Friends



People in wheelchairs sometimes need to get from one level to another.

Design a machine that will help lift and move a wheelchair between two levels.

Consider:

- The platform has to stay level (horizontal) or the chair - and person! - may slide off.
- **Hanging** baskets are good, but they can be unstable. Can you make a platform that will lift but is also stable?

Design Challenge: Park it!



Parking vehicles in some cities is a problem - to take advantage of space, cars are stacked on top of each other.

Design a machine that will lift and move a car so more can be parked in the same place.

Consider:

- The platform has to stay level (horizontal) or the car may slide off
- **Cars are heavy** - while your machine won't lift a real car, it has to be stable!

Design Challenge: Make a Lifternator!



People need to get lifted - for many reasons, from changing a light bulb - to saving a cat in a tree (really, they still do that?)

Design a machine that will help lift a person so s/he can work at a height.

Consider:

- Your machine should stay as level as possible.
- Can you make it turn or rotate so it is more versatile?

Design Challenge: Grab and Lift



Machines are used to lift and transfer things, from robotic arms on assembly lines, to garbage trucks lifting bins.

Design a machine that will grab, and/or lift, and move an item from one place to another.

Consider:

- Machines that do this often use two levers for more movement.
- When grabbing and lifting, the push of the syringe is stronger!

Design Challenge: Hurling with Hydraulics



Machines can accelerate speed by placing the force on a lever close to the fulcrum, - a small movement on one side will create a much faster movement on the other longer side of the lever. Using a double lever really helps!

Design a machine that will throw a piece of plasticene.

Consider:

- Attaching the syringe close to the fulcrum.
- Connecting two levers with string or a pipe cleaner to help acceleration.

Design Challenge: Lift that house!



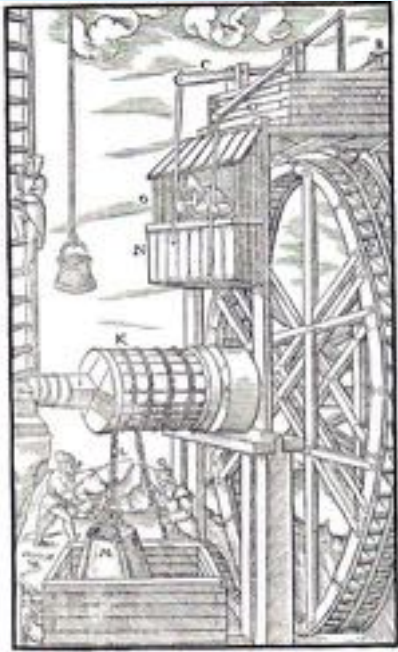
With climate change there may be floods in areas that would usually be nice to live in, but once in a while may get flooded.

Design a machine that will lift a house, and then return it to the ground when the water recedes.

Consider:

- The platform has to stay level (horizontal) or your breakfast may slide off the table.
- **Houses are heavy** - while your machine won't lift a real house, it has to be stable!

Design Challenge: Complex Machine



One complex machine!

Simple machines might use a single lever, gear or pulley mechanism. When you combine elements of simple machines, you get a complex machine (like a bicycle or car).

Design a complex machine that uses both a lever and a pulley in some way.

Consider:

- Using a lever to lift or turn, then a pulley to wind something up
- Combining your machine with other students to create a series of actions!

Design Challenge: Adjusting for Size



People are different sizes and we often need a mechanism to solve the problem of keeping a computer screen - or keyboard, oriented so it faces you, but can be moved up or down.

Design a mechanism that will keep a screen facing you, but still able to move.

Consider:

- Researching and using a parallel linkage.
- Having it hold and move a cell phone! (Use tape!)

Design Challenge: Stand up - Get up!



People are different heights, and to keep good posture while using a computer it needs to be at the correct height. Also it is good for your body to stand up at least every hour!

Design a platform that can be adjusted in height and stay horizontal.

Consider:

- parallel linkages are often used for something like this.
- to make it wider, try using two bases!

Design Challenge: Growing Up ↑



As seedlings and plants grow they get closer to the light. Too close and they burn with the heat. Too far away and the plants are all stringy.

Design a mechanism that can be adjusted as a plant grows.

Consider:

- How can you make it stay the same angle as it rises?
- Use a cell phone as the light, or draw lights on some cardboard.

Design Challenge: Make a Face!

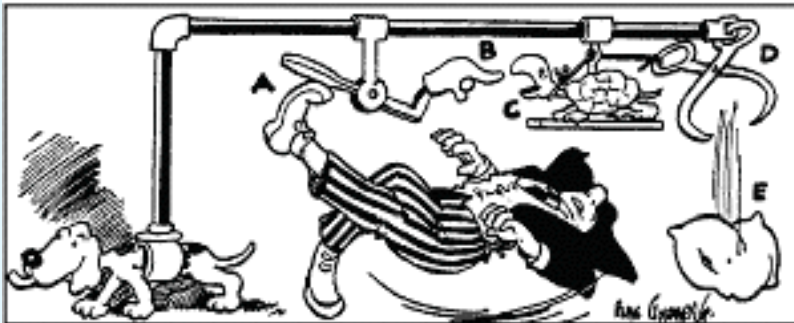


In movies, robotic animation uses levers to make models come to life, from a mouth opening to a walking dinosaur.

Design a mechanism that will make a facial movement

- Consider:**
- Eyes can blink or move, mouths can open!
 - Use cardboard and paper to cover the hydraulics mechanism (well, I guess we don't need to tell you that!)

Design Challenge: Rube Goldberg machine



Rube Goldberg was an artist/inventor who designed crazy machines that did fun, yet goofy things.

Design a simple Rube Goldberg machine (that doesn't involve a toaster)

- Consider:**
- Making two or more machines link together with some action (swinging action is fun!).
 - Involving something that you can push that will roll down with gravity and then bump into something else.

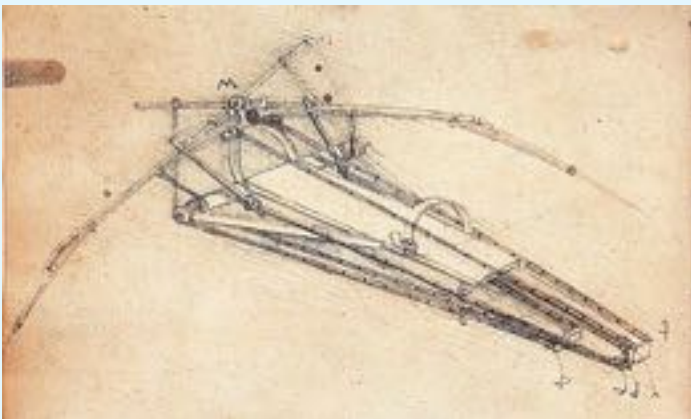
Design Challenge: Make a moving machine

Design a machine that can move itself across a surface.

Consider:

- Not using a base!
- You can push the machine forward, or pull the machine!
- Make a machine that walks!

Design Challenge: Make a winged machine



Leonardo da Vinci made many drawings of flying machines.

Design a machine that can make a movement like a bird's wing

- Consider:***
- Making a high platform so the wings can move down
 - Use cardboard or paper to cover the hydraulics mechanism - so it looks like a wing!

Design Challenge: Make a Moving Bridge

Swing Bridges are common moving bridges where there is little room on the banks of the river.



Design a bridge that can swing open.

- Consider:**
- Make an approach structure with extra bases
 - Use cardboard to cover the road

Design Challenge: Make a Moving Bridge



Lift Bridges are useful when a waterway is used often by boats.

Design a bridge that can lift.

- Consider:**
- Using a winder to lift the bridge? (or hydraulics!)
 - Use cardboard to cover the road

Design Challenge: Make a Moving Bridge

Bascule bridges are the most common moving bridges in the world.



Design a bridge that can tilt back and open.

- Consider:**
- Use two syringes - one for each side!
 - Use cardboard to cover the road

Design Challenge: Steady Cam!

In movies the camera has to be steady as it is lifted up and down.



Make a machine where you can place a cell phone and keep it steady while recording a video.

Consider:

- Use a cell phone with a strong cover in case it falls! (use tape)
- use a counterweight so it is balanced and the hydraulics doesn't have to do too much work - especially if you make the lever long!

Mars Challenge: Moving Solar Panels



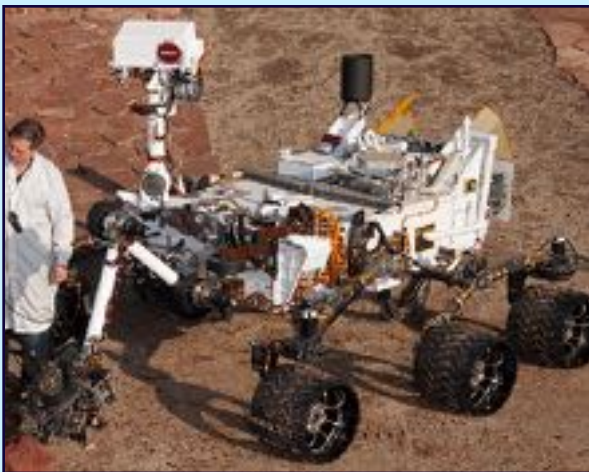
Visitors to Mars will need to use power from the sun to generate electricity.

Design a mechanism that can track the sun as the planet rotates.

Consider:

- using a cell phone as the solar panel
- you will need to change the angle **and** have it rotate!

Design Challenge: Mars Rover



The Mars Rover (Curiosity) has a camera on the top that rotates.

Design a machine where you can place a cell phone and rotate it while recording a video.

Consider:

- Securing the cell phone with tape so it doesn't fall off!
- Using a string and pulley to rotate a camera tower over a wider (360 ° ?) range.

Mars Challenge: Retrieving soil samples



Soil sampler for Mars Rover

Collecting soil samples remotely by a machine is important to understand the chemical makeup of the soil on planets.



Morpheus Rover
arm end effector

Design a mechanism that can reach out and collect a small sample of soil

- Consider:**
- using some cardboard to make a scoop
 - can it collect and place material in a second container?

Mars Challenge: Ship Landing Structure



Space ships need to have a stable platform, and be above the ground.

Design a machine that will support a space ship above the dust storms on the surface of Mars

- Consider:**
- using a square base as the space ship bottom
 - making your structure right side up - then turn it upside down for use!

Mars Challenge: Reusing rockets



As it lands, a stable structure extends out.

Space X has designed a rocket thruster that can land standing up so is easily reused.

Design a mechanism that can extend out and hold up a structure.

- Consider:**
- making a central tower
 - try using 3 pods? - this can be easier to balance!

Mars Challenge: Unfolding Solar arrays



Space ships need to pack solar arrays in a small space for launch, then fold them in space to collect the sun's energy.

Design a mechanism that can open up and create a large surface area.

Consider:

- solar panels can be thin - use unfolding paper!
- do an internet search to see the huge variety of designs!

Design Challenge: Launch an ROV



The Nautilus Research Vessel launches and retrieves the Hercules and Argus ROVs in and out of the ocean.

Design a machine that will lift and move an item like the Nautilus Hydraulic arm does.

Consider:

- The platform it is on has to rotate - so it swings overboard
- Can you use the circle pieces as winders as well as the hydraulic action of the syringes?
- Look up some pictures of how the crane works first!

Design Challenge: Grab an item



The Hercules ROV has a manipulator arm that can pick up items to take to the ship.

Design an arm with a gripper mechanism or platform that can pick up and retrieve an item.

Consider:

- While you may not be able to rotate the gripper - can you bring an item close to the base?
- You could also make a platform that can slide under an item on the bottom of the ocean - what problems might arise with a design like that? Can you solve them? (use cardboard if needed!)