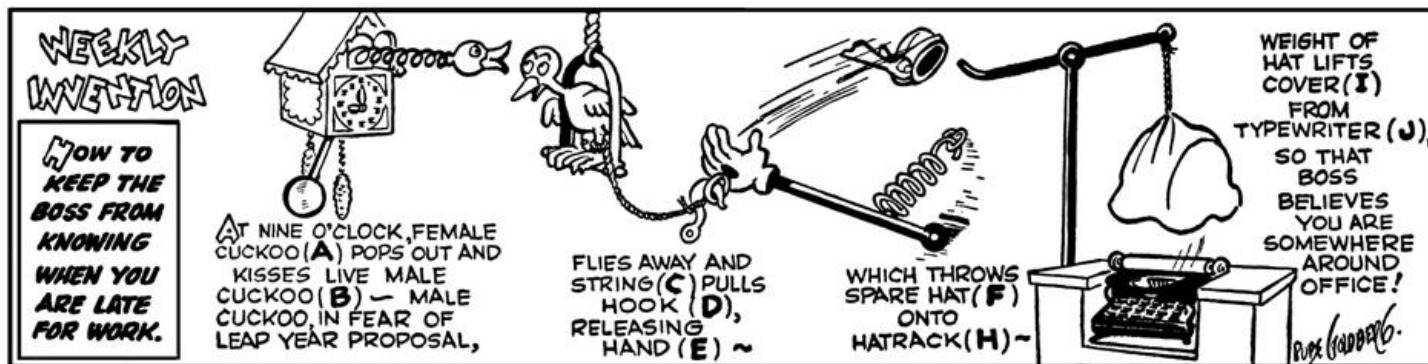Name _____ Date_____

# Rube Goldberg Machines

**There are 5 simple phases to build a machine:**

1. **Concept Phase – Forming the vision for the machine**
2. **Step Building Phase – Designing the main steps of the machine**
3. **Linking Phase – Linking the main steps together**
4. **Test Phase – Testing the entire machine**
5. **Performance Phase – Running the machine for all to see**



# The Concept Phase:

- Gather your team- You can get help from anyone in your home that wants to be creative and try this with you!!!

- Read the rules:

- Identify and research the theme

- Brainstorm ideas!  Create a diagram of your plan!

# The Step Building Phase:

- Collect materials- Be creative as you look around your house! You may use old toys, recycled materials, etc.


- Look around for building materials

     * Have all materials visible when building
     * You will find solutions just by looking around the room
     * You can either build the step from scratch, using wood or plastic OR you can use something that is already built to make the step.


- There are many different options for quick and easy fastening

     * Duct tape is good for light loads
     * Rubber bands are good for medium loads
     * Zip ties are good for heavy loads
     * Screws and bolts are more permanent but provide good support for lg. loads


- Fail Fast

     * Try to build the initial design fast to see if it is going to work, if it doesn't, try another design quickly rather than spending more time getting the original design to work
     * Only 20% of the original designs work
     * Typically it take 2 to 3 designs to the find the one that will work
     * If the current design isn't repeatable 2 out of 3 times, change it


- Don't worry about the step being perfect right now.  We do that in the future phases.


- Start with temporary designs but then go to more permanent designs. Sometimes a complete rebuild is necessary.


- Goals

     * 1st – try to get the step to work 1 time.  This is just to test the design feasibility.  Determine whether it's worthwhile proceeding with the design.  It doesn't have to be built perfect, just build the skeleton (no more than 30 minutes to  build it.)
     * 2nd – try to get the step to work 5 times – run it until you get 5.

This is to test its repeatability.  At this point, a more permanent structure is needed. The step should run without you helping it.  It should stand-alone.  If you can't get it to run successfully 5 in an hour, change the design.
* 3rd – try to get the step to work out 3 out of 4 times.  This is to test reliability.  The best steps are the ones that are reliable and will work consistently.  You should have a high level of confidence that this step will work on run day.

- Look at the step from different angles when you are trying to design it or make it work.
- 
- Look for ways to slow steps down
    * longer strings, shallow ramps, longer ramps, falling sand, slow turning motors

- Use easy structures that can be modified fast

- Simplify
    * Design the step 3 ways, choose the simplest one
    * A simple string will connect two steps easily

- Make steps musical
    * look for items that will make noise
    * try to creatively make noise

- Dream up really cool steps
    * Pick 1 of your favorite steps and spend lots of time on it
    * This will be your pride and joy

- Respect Physics

    * Friction plays a big part in steps – use slick materials (shiny paper, plastic)
    * Gravity can be your enemy – use it to your advantage (weights power steps very well)
    * levers are useful – they connect steps easily (there are endless ways to build levers)
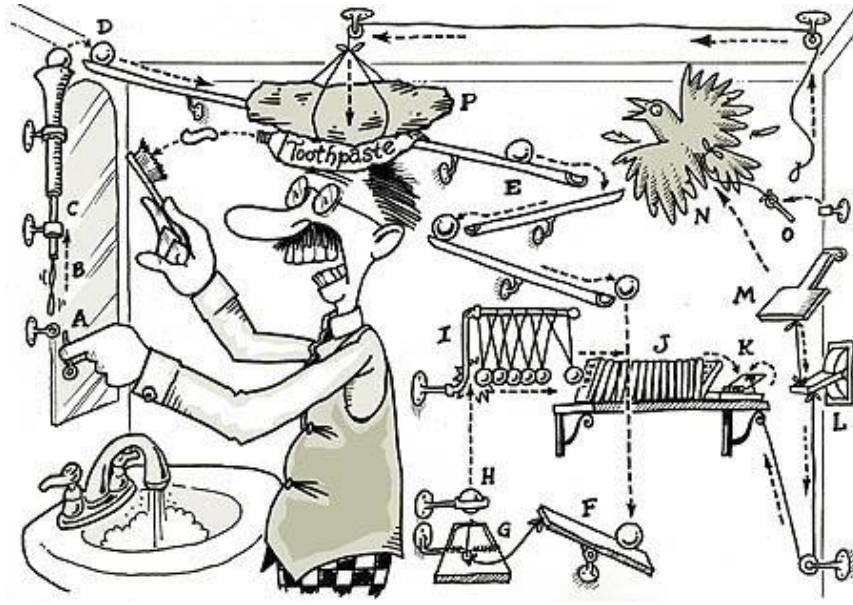
## The Linking Phase

- Simple Links
  - *Levers
  - * String
  - * Weights falling
  - * Mousetraps
  - * Ball rolling down ramp

- Set up machine so it can easily be followed

- Try not to have 2 steps going at the same time
  - * Sometimes it's necessary, but many times another configuration will work
  - * Makes it easier for the audience to follow

- Keep the machine and the steps fully adjustable
  - * This will help with fine-tuning the performance quickly
  - * Troubleshooting is faster when you can quickly change the set-up
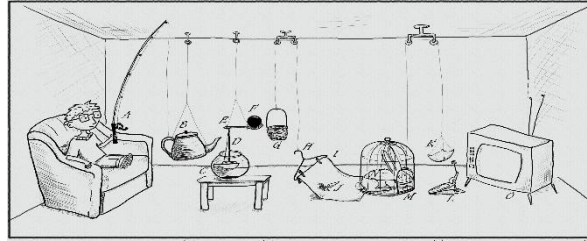
## The Testing Phase

- Give yourself plenty of time for testing
- Make a list of everything that failed and mark off those things as you fix them
- The more times you test, the more you will "know" your machine!  It will run more consistently.  You will be able to set it up faster.  You will uncover all the potential failures.
- Video the runs so that you can see the failures better.
- Time how long the machine runs so you can hit a specific time goal.

## The Performance Phase

- Go above and beyond when displaying your machine.  Do something that is original and the audience will be pleasantly surprised.
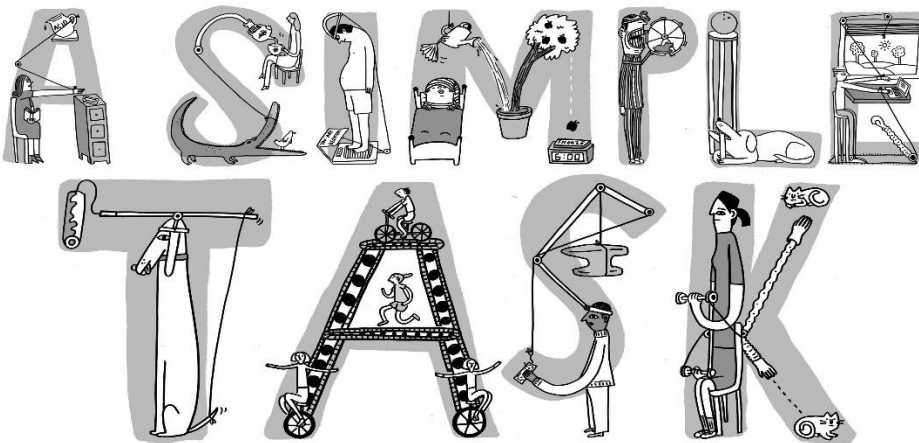
# Machine Specifications & Rules

| Specification | Minimum | Maximum |
|---|---|---|
| Steps | 10 steps | 50 steps |
| Machine Volume (Footprint Area x Height of highest point on the machine) | None | Be Creative! |
| Single run time | None | 5 minutes |
| Hazardous materials, explosives, or flames | Not Allowed | Not Allowed |
| Live Animals | Not Allowed | Not Allowed |
| Use of profane, indecent, or lewd expressions | Not Allowed | Not Allowed |
| Safe for participants and observers | Required | Required |