Objective: Part of a Rube Goldberg device needs to have a tennis ball roll down a ramp. This lab will discover what it takes to create a span of 1 meter that will support a tennis ball rolling down it.

Break into ~6 teams, one facility member per team and diversify as much as possible. At least one 8th grade per group.

Hypothesis 1: How much will a single kinx piece flex for a weight of 10g? Write it here

Part 1: Load a single kinx beam as shown in the demo. Write down how much it moved here:

Question: how accurate was your measurement? Is it accurate enough?

Demo: Using a dial indicator, show exactly how much the single beam moves.

Compare how much is measured to how much was estimated. Scatter plot of the results.

Question: How did your hypothesis compare to the results?

Part 2: Load to failure

Hypothesis: How much weight will a single kinx beam support before it just not return to zero when the weights are removed?

Demo: Show how much load a single kinx beam can take. Use a straight edge to show it has permanent deformation.

Each team: do the same and record your results here:

Scatter plot of the entire group.

Part 3: What is the effect of multiple pieces?

Given what was learned in part 1, create two different hypothesis:

Hypothesis 2: Based on what was learned in parts 1 & 2, how many pieces will be needed to support a single tennis ball over a single beam with out permanent deformation?

Hypothesis 2: Will the shape of the assembly of multiple pieces have any impact on how much it will move under load?

Demo: Using the dial indicator, show how much deformation for a 4 piece beam in two different shapes.

Each team: Create beam assemblies that you think will do the job. Bring the beams for load measurement.

Group exercise: Plot the results.

Question: Does the data support your hypotheses? Each team to present why or why not?

Beam equations

For a simple supported beam, the deflection is given by:

$$\delta=\frac{FL^3}{48EI}$$

Where:

F: The force applied
L: The length of the beam
E: Modulus of Elasticity of the material
I: Moment of Inertia

The moment of inertia depends on the shape.

For a round cross section:

$$I=\frac{\pi d^4}{64}$$

Where d is the diameter of the cross section

For a rectangular cross section:

$$I=\frac{w h^3}{12}$$

Where w is the width and h is the height

Work: take the deflection from part 1 and calculate the modulus of elasticity assuming a round cross section.

Work: for a 1 meter beam using a rectangular cross section, calculate the deflection. Question: Will this be acceptable to hold the tennis ball for a Rube Goldberg machine?

Next week: Build the 1 meter beam and test if it works.