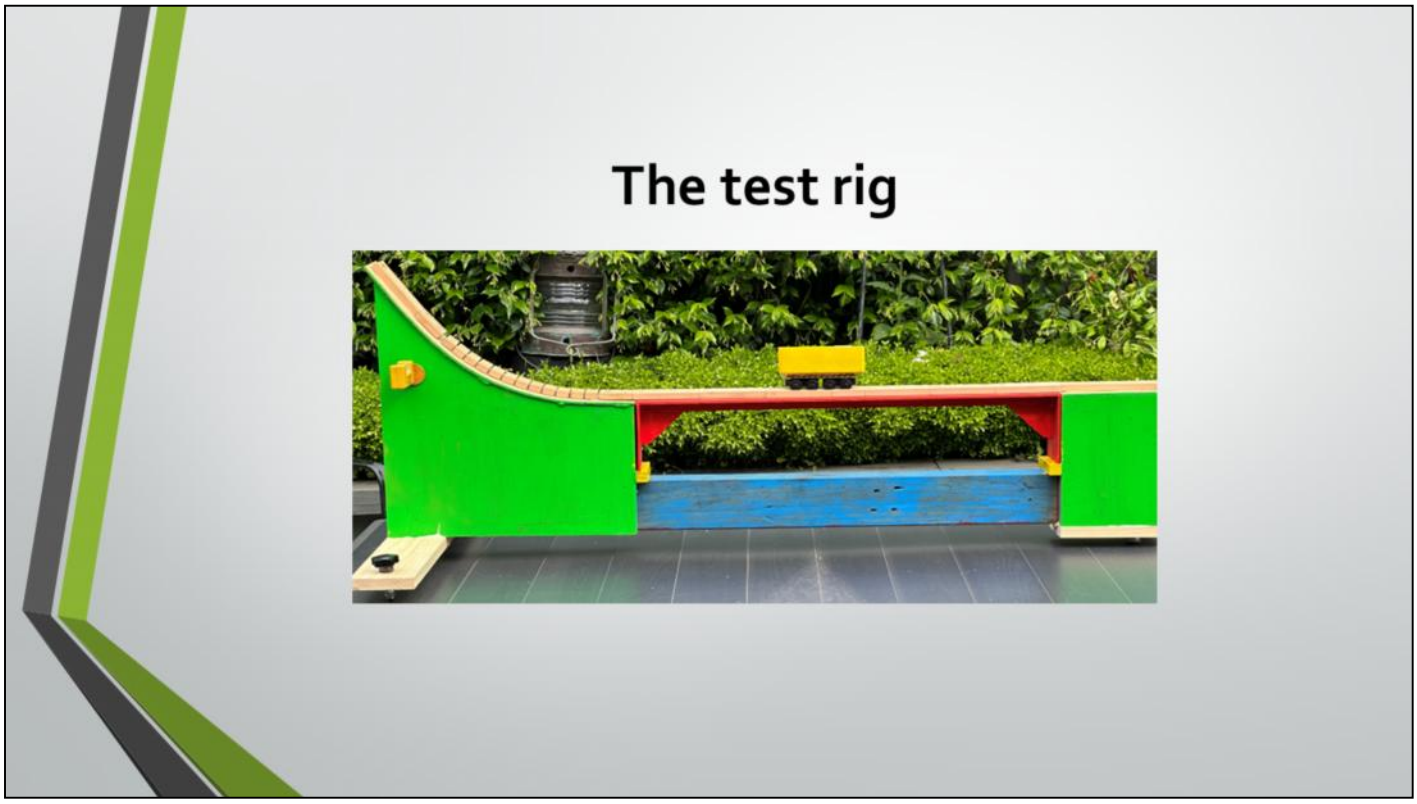
Welcome to the Spaghetti Bridge Challenge

My name is …… I am your presenter for this challenge.

Setup is as follows

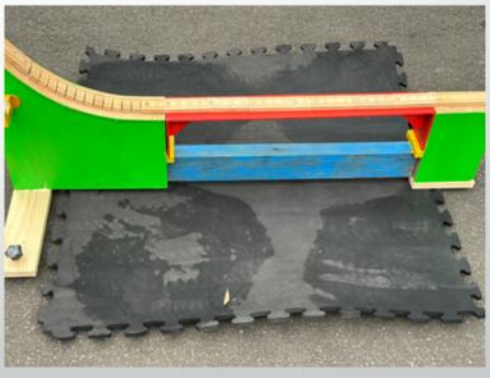


Bridge set Up

Note Bus is 900gm its heavy stand back when operating it.

Safety

- Place a gym (yoga) mat under the bridge as shown. This will help catch the Bus if the bridge fails.



A note about safety

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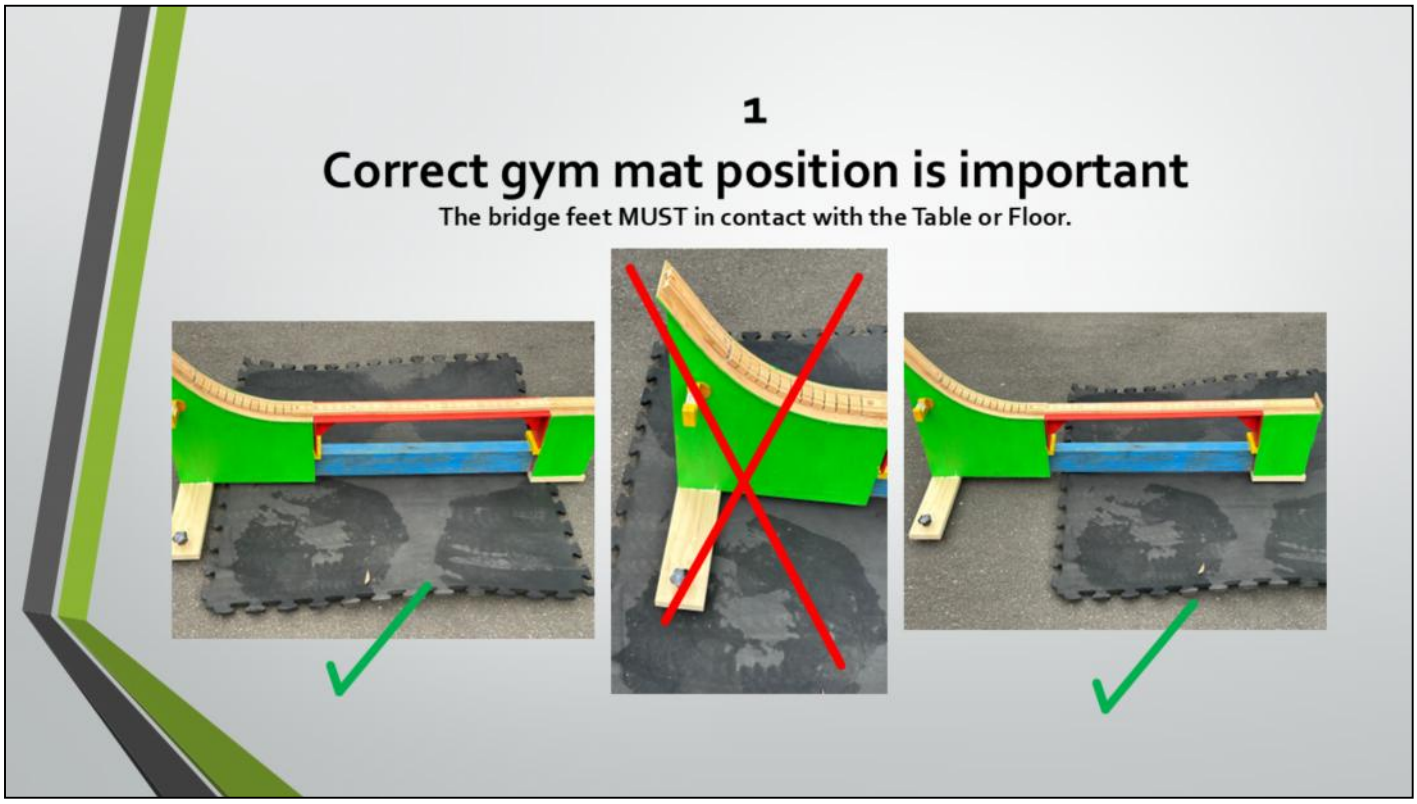
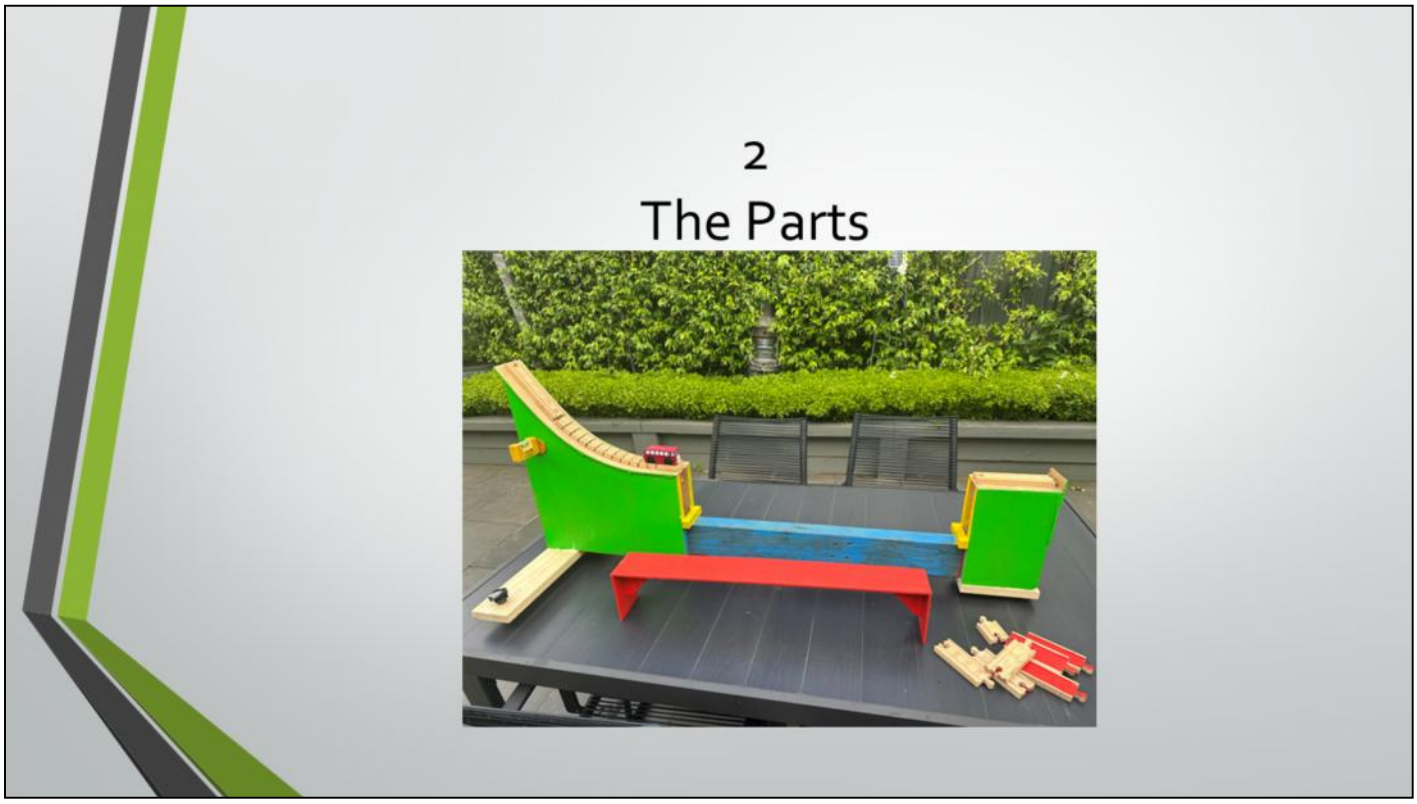


Placement of the rig is important

The three feet must be in contact with the table NOT THE MAT



Make sure you have all the parts

Flexi road 6 full and 1 half

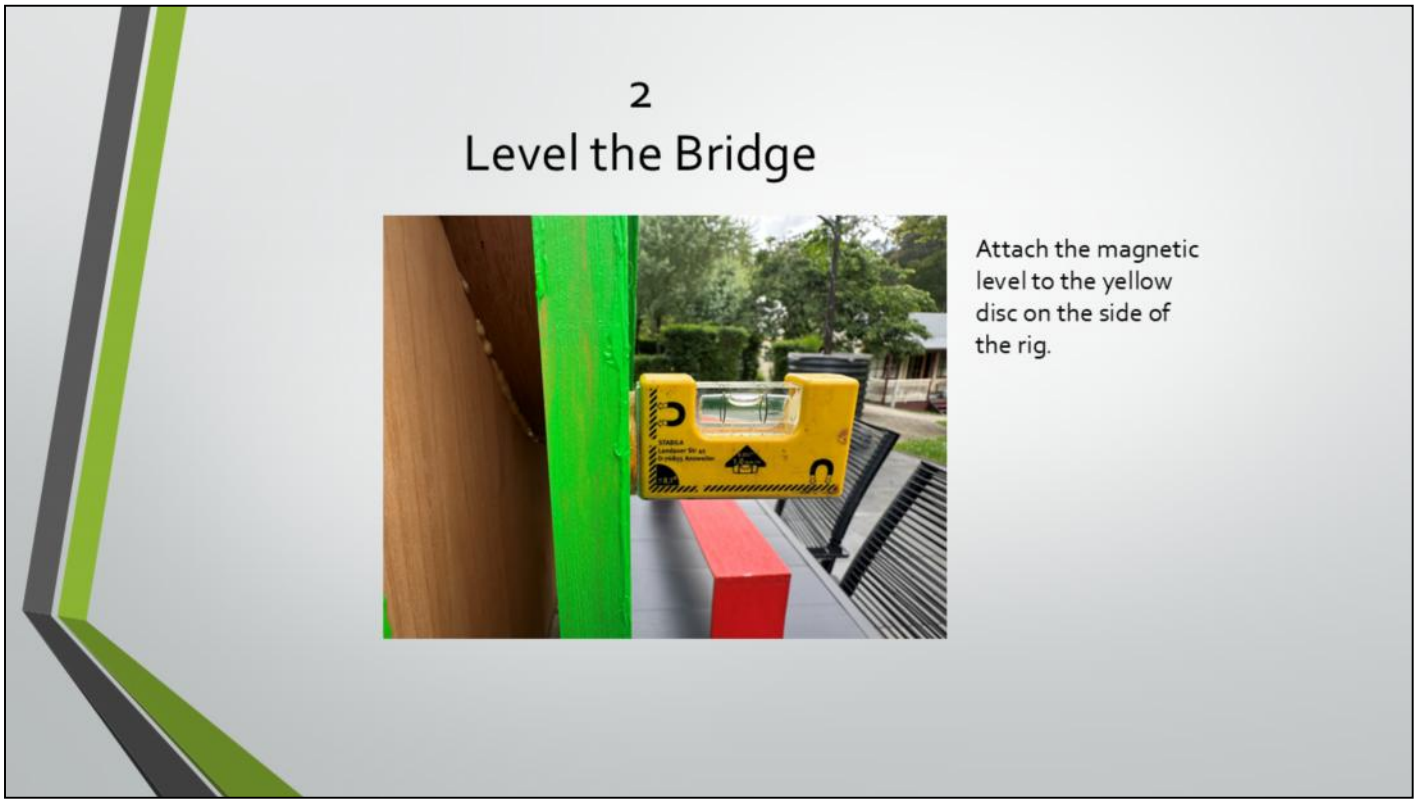
Dummy bridge (red)

Bridge rig (green and blue)

Yellow magnetic level

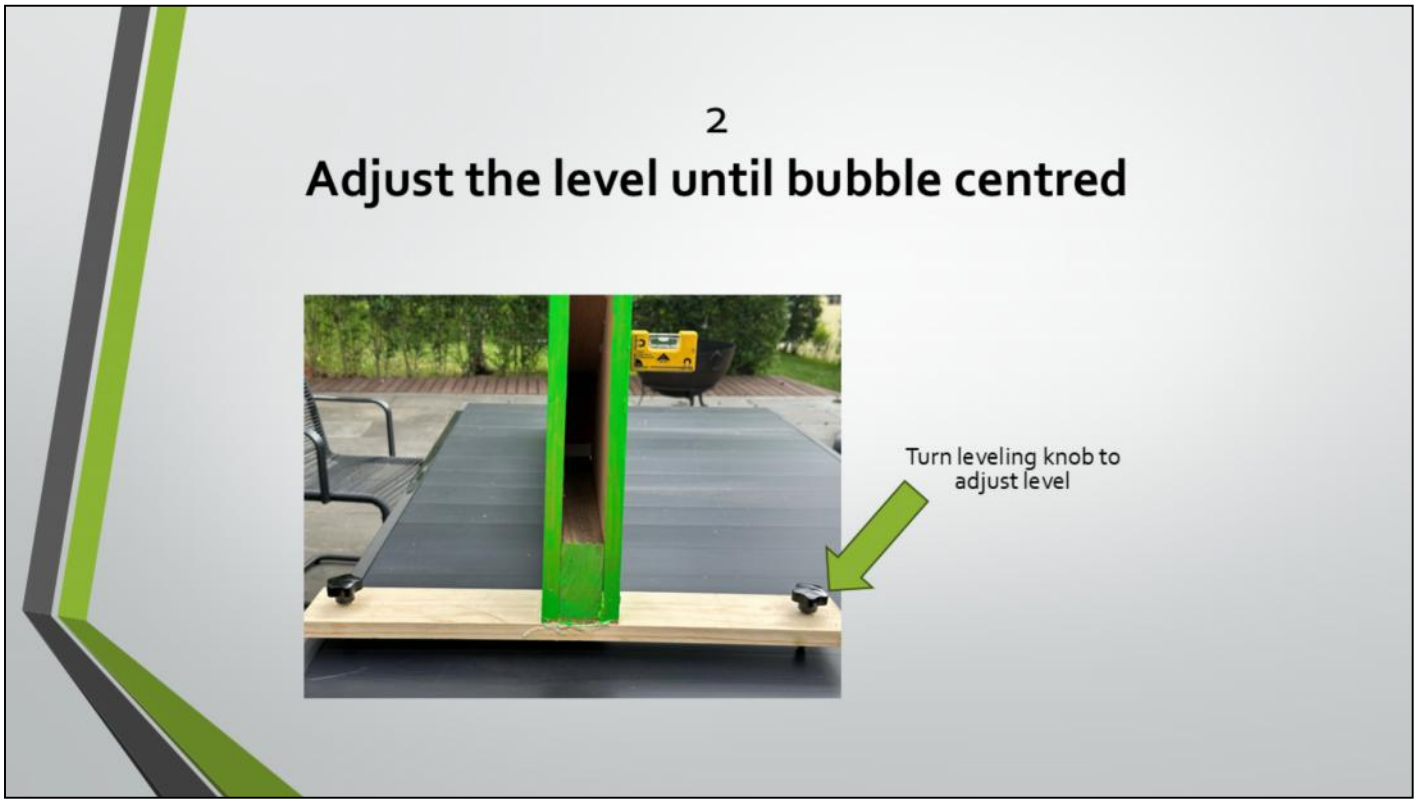
Bus

Assemble the bridge to look like this



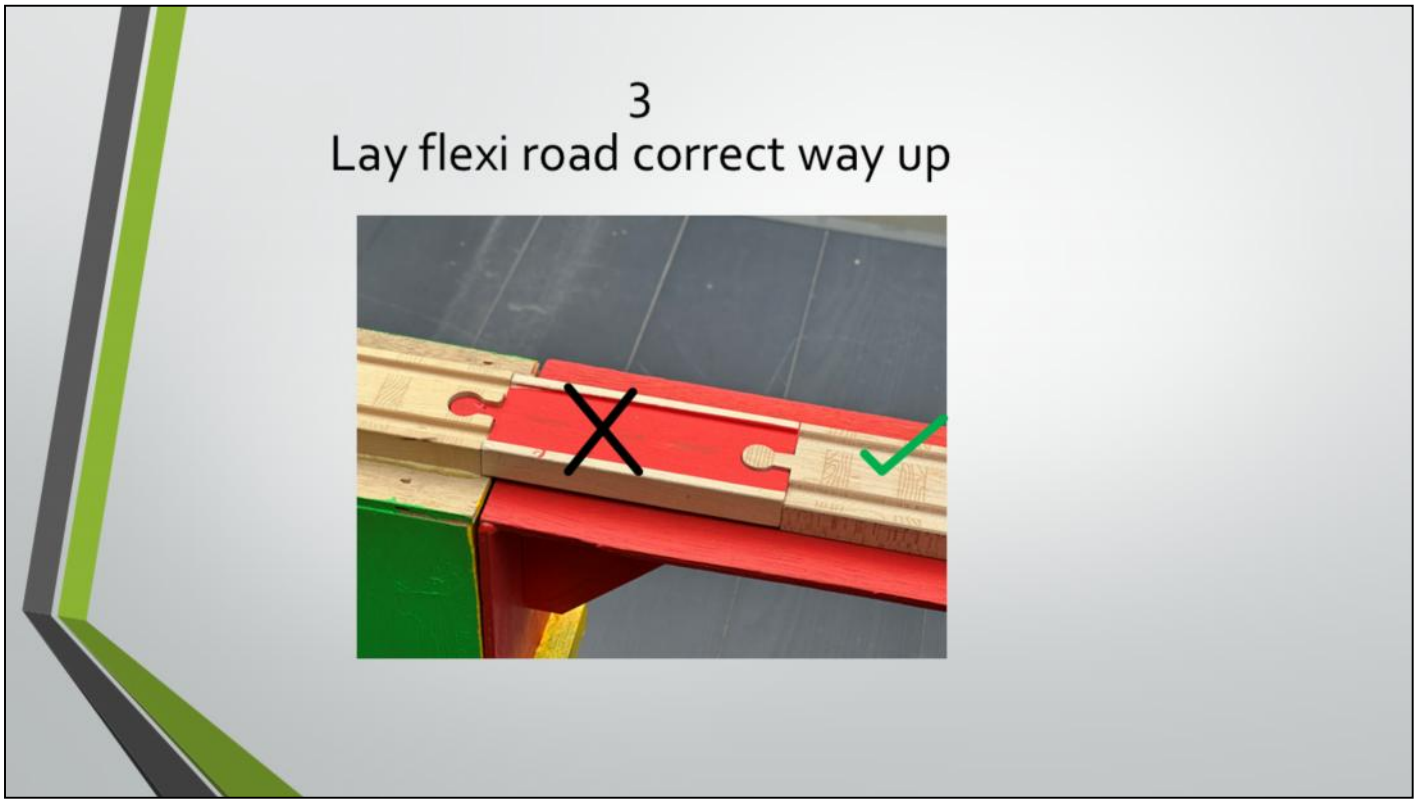
Level the bridge using the Stabilo magnetic level.

On one side is a yellow metal disc to which the level will attach.



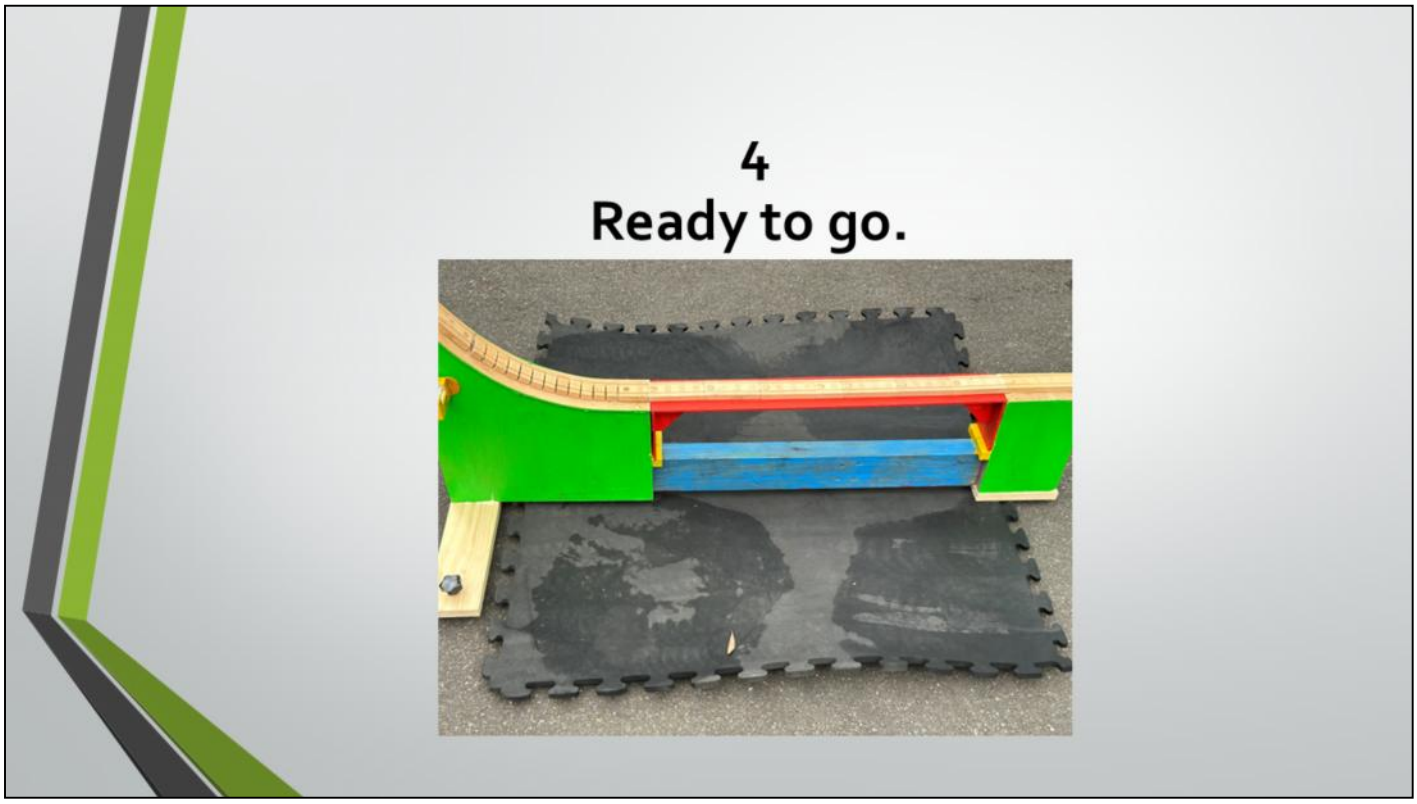
Your team must make sure your bridge fits. So you will need THREE measurements.

1. Road or step width
2. Bridge Span
3. Step distance to bottom of Flexi Road surface.

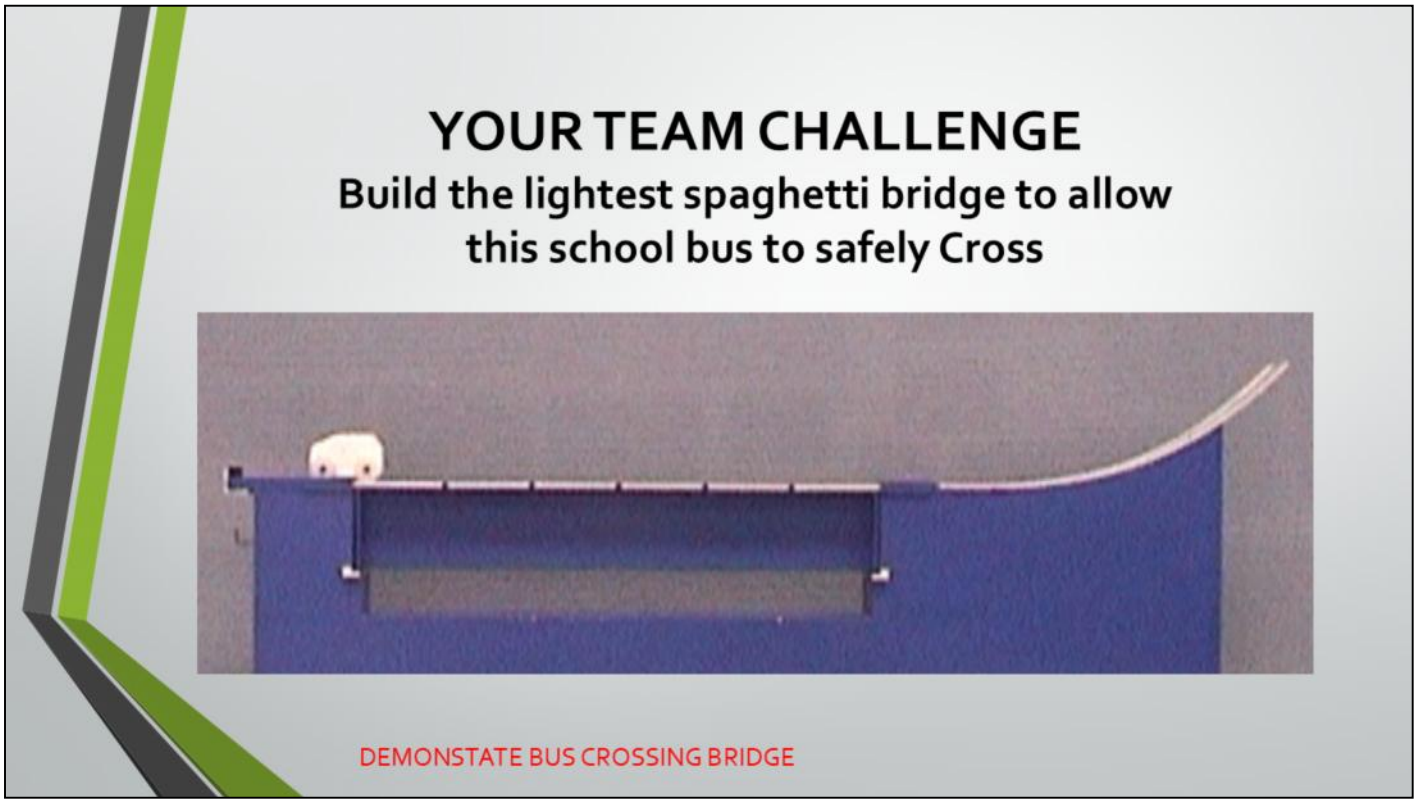


When laying the flexi track it must be red side DOWN

DO NOT OPERATE IF RED SIDE IS UP



A quick inspection for nothing missed and your ready to go



Your Challenge is to design and build a replacement from spaghetti across this gorge.

The bridge has to carry the daily School bus across the river.

The Bus has a mass of 900gm.

Using your knowledge of bridges your Team will Design, Build and Test a successful replacement bridge from Spaghetti and Hot melt glue.

You will need to lay the Flexi road for the Bus to drive over your Bridge.

DEMONSTATE BUS CROSSING BRIDGE

Design Considerations

- Does our bridge fill the gap?
- Is it strong enough?
- How can we be sure of our design?

Today we will Learn how to design a bridge.
To prove we can we will build and test it.

By the way if you thought of a Bus collapsing a bridge is a bit far fetched
Let me show you.

Who said Bridges don't collapse with a bus crossing them.

Would you go to school on a bus across a bridge like that?

Play video

Universities in Australia, USA, Canada and Europe use a spaghetti bridge contest to introduce the principles of bridge design to engineering students.

Like these at John Hopkins University in the USA.

Play video

A note about safety

Wear protective glasses when cutting spaghetti

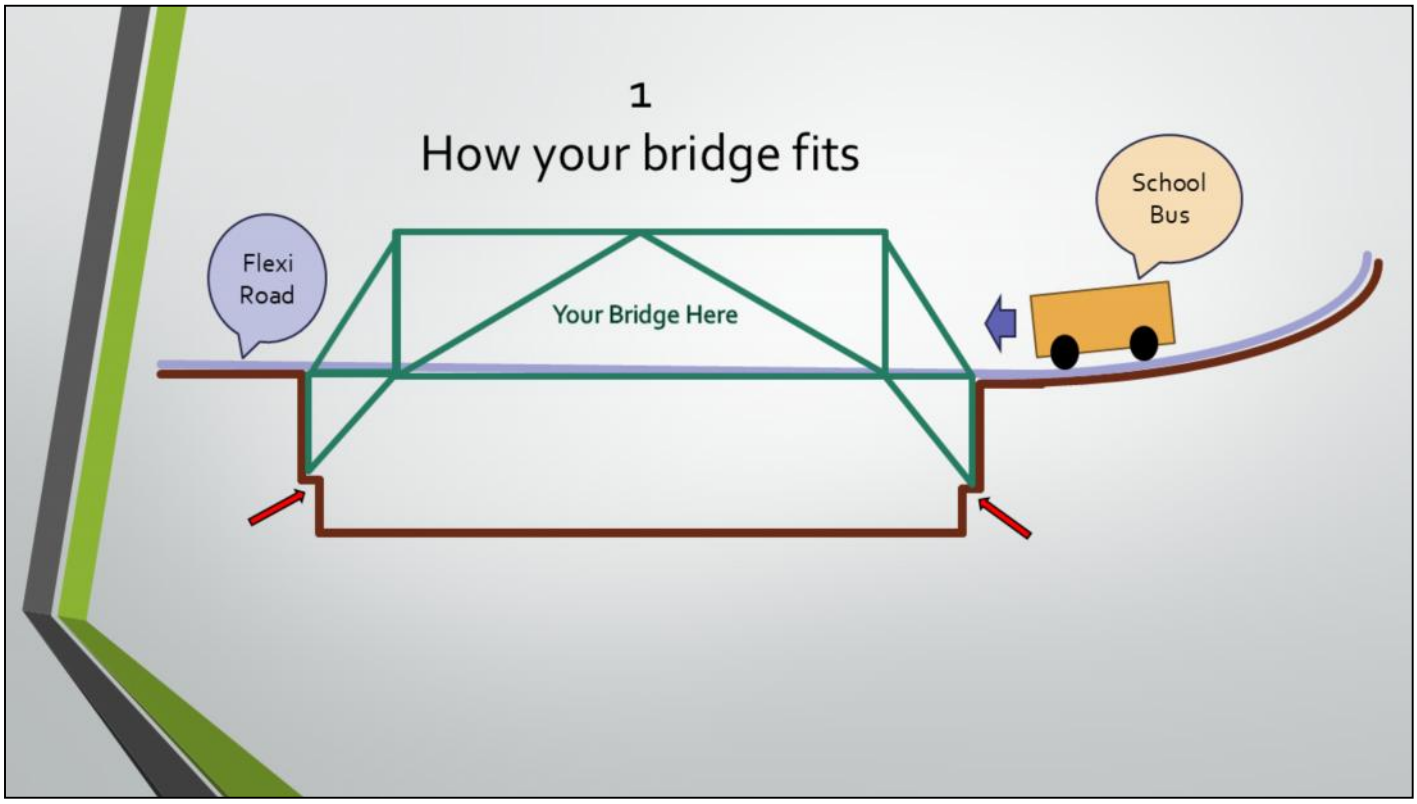
Only cut the spaghetti with the side cutters

Do NOT use a knife to cut spaghetti

Warning Hot Glue Guns Burn please wear gloves

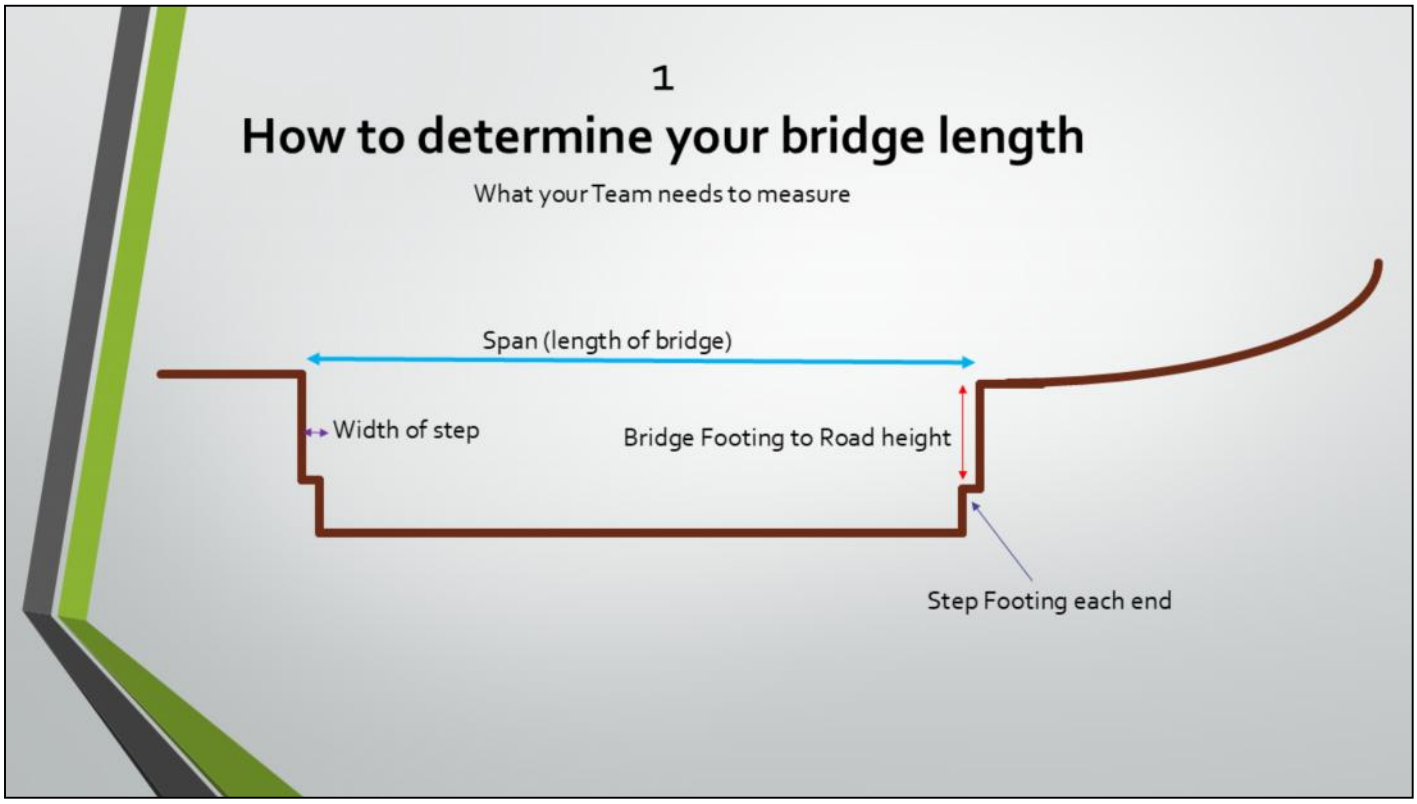
Determine your bridge length. Our replacement bridge will use the existing abutments (the bridge supports at each end). You need to measure the distance between the two sides of the support structure to determine the length that your bridge will need to span.

It's a good idea to start with a short practice distance when building your first spaghetti bridge. Then, increase the length of your bridge to full as you learn how to build.



Your bridge will fit here shown in green.

The abutments (footings) are a step on which the bridge sits shown by the red arrows.



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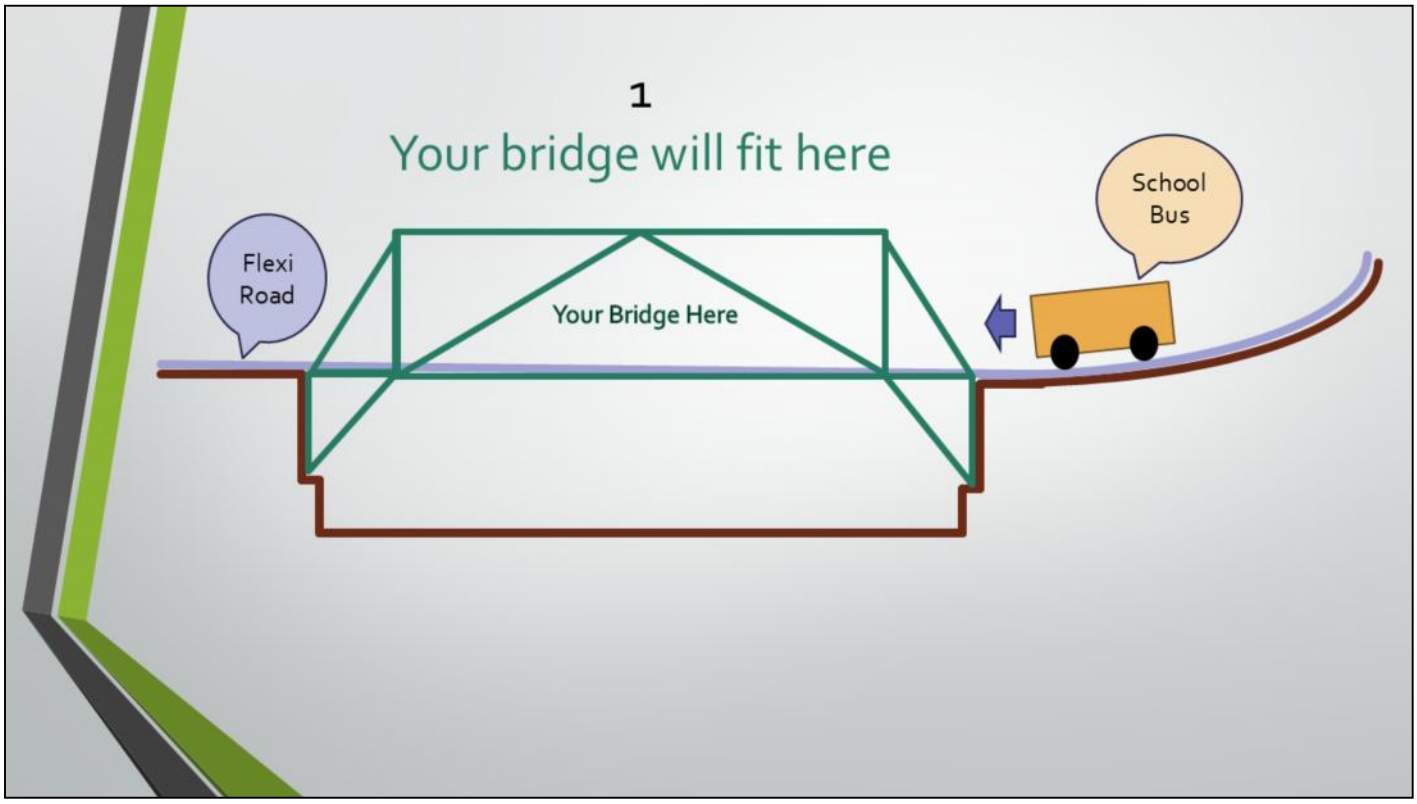
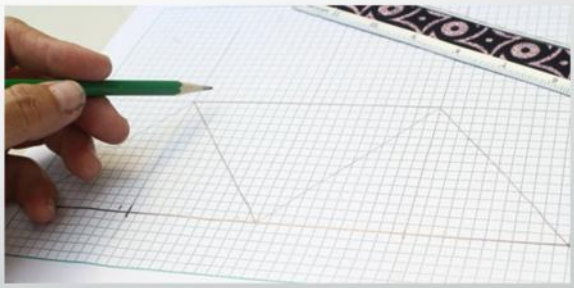


This will allow your bridge to fit perfectly.

Remember you MUST use the Flexi road other wise the Bus will go in any direction.

2
Design a template.

- Having got the measurements draw where your bridge has to fit.
- Design your bridge on a sheet of graph paper first.
- Draw your bridge on the graph paper actual size.
- Then cover your sketch with grease proof paper.
- Then lay your spaghetti over the lines you have drawn on the graph paper and carefully glue the pieces together.



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Hot glue from a glue gun is easy to apply, but is slightly flexible when dry. This is not ideal for reinforcing the joints of your bridge. You may need to use more Spaghetti.

Allow drying time for the Hot glue to cool and harden before use.

Spaghetti is thin and very strong in tension (pulling apart) BUT not very stiff. Why is this a concern?

Take two pieces of spaghetti on 10cm long the other 20cm long. In turn put one point down on the digital scales. Press with your finger downwards from above.

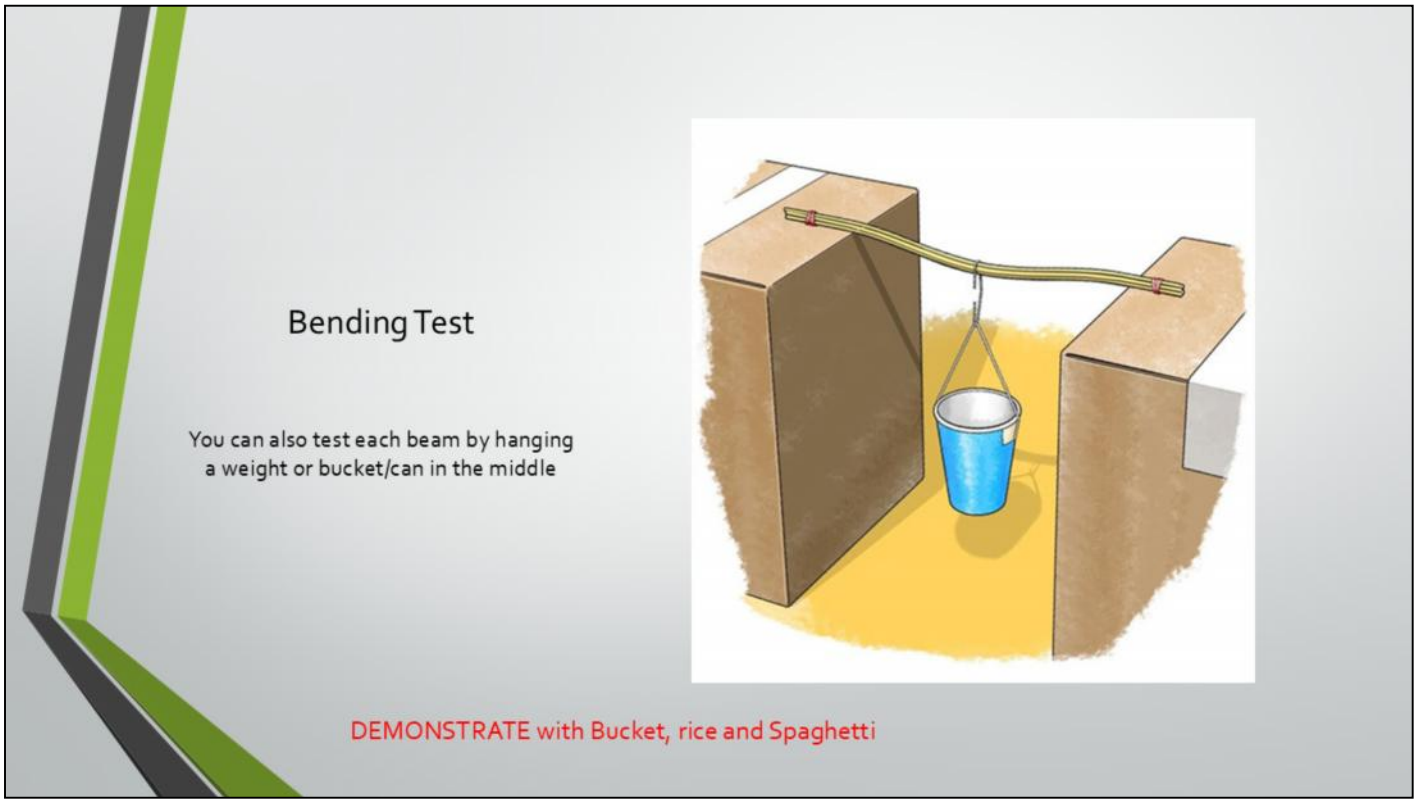
Record the Force at which it bows and breaks.

Now try the other.

Which one can take the higher compression load?

If you glue 4 or more thin pieces side by side to make thicker spaghetti. Will the combined pieces support a higher compression load?

DEMONSTRATE with Scale and Spaghetti



For Bending Test cut 20 cm long sections of Spaghetti.

Place the Spaghetti across two bricks on end or between two desks.

Use the Teams mini-Bucket to load the Spaghetti rod.

Start filling the bucket with DRY Rice when the Spaghetti fails weigh the bucket and Dry Rice to measure the Side Force the Spaghetti failed.

Your digital Scale will give you grams or kilograms, not Force.

But we know

Force = ma = mg

To Get Force for these experiments use an Aerospace Engineers trick.

Instead of using 9.81 for ‘g’.

Instead

Use g = 10

The math is easier.

DEMONSTRATE with Bucket, rice and Spaghetti

4
Record your test Results

Make up a Table like this to record your Bending test and your compression test results.

You can then compare which pieces will suit your bridge.

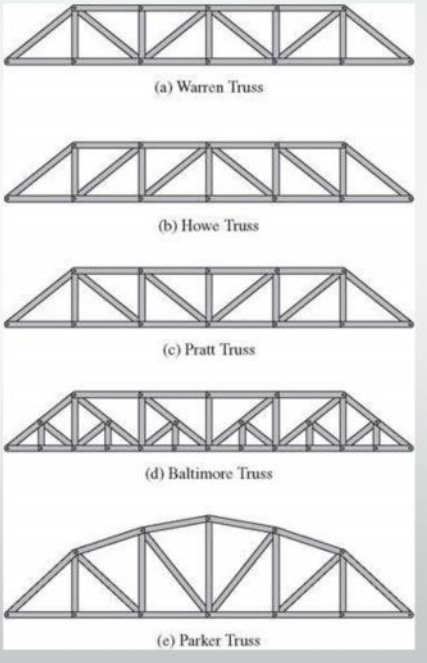
Test Type	Diameter mm	Length mm	Force (mx10) N	Deflection	Choice for build
Bending	2	150	3	20	x
Compression	2	150	1.2	30	x
Bending	6	150	5	4	✓
Bending	8	150			

Here is a helpful hint

Make a table to Record your test results so you can choose the best beams and structs to use.

5
Types of trusses

Here are some types of truss Bridges in common use.

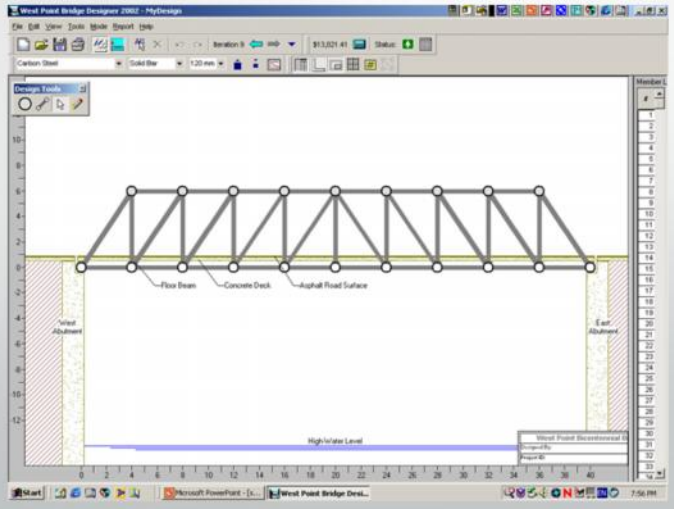


What type of Truss to use?

Here are some common types of truss Bridges.

Simpler is often better but if you need to strengthen a design then (d) the Baltimore Bridge is strengthened by adding extra beams.

Which Truss is best?



Which Truss is best?

How can you quickly Design a Bridge and know it will work?

To help you quickly evaluate different Truss types use this Windows App “West Point Bridge Designer”

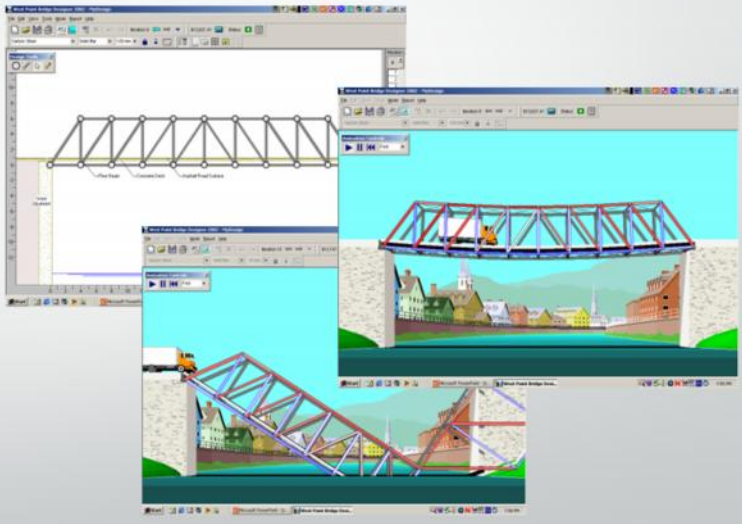
Universities around the world use the West Point Bridge Designer App to introduce bridge design and why things don’t fall down.

West Point Bridge Designer APP

A tool to help work out what sort of truss to use

Quickly trial different truss designs.

Tells you if you left a beam out.

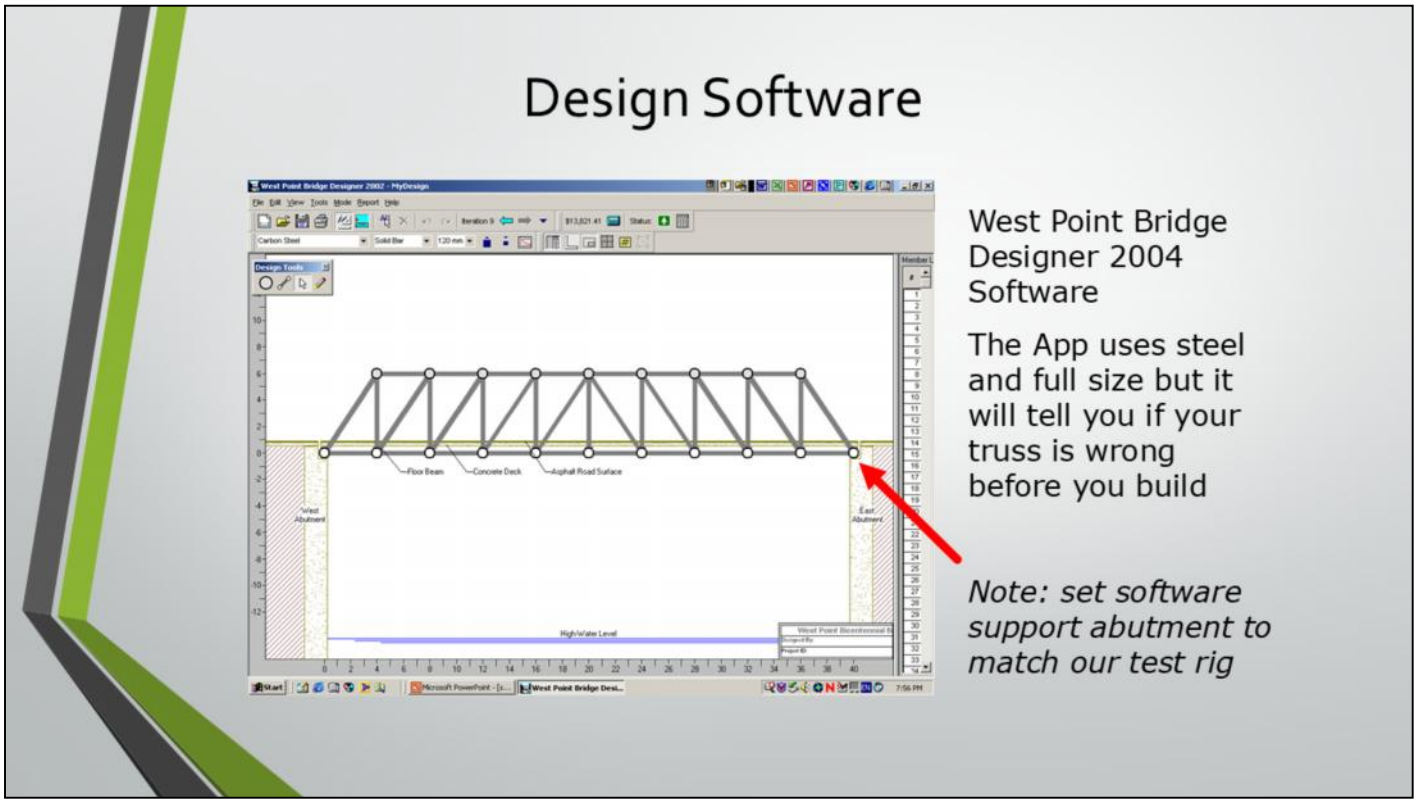


A useful tool to help work out what sort of truss to use is the West Point Bridge Designer App

It will tell you if you left a beam out.

If you have enough triangles.

If your triangles are too big or small.



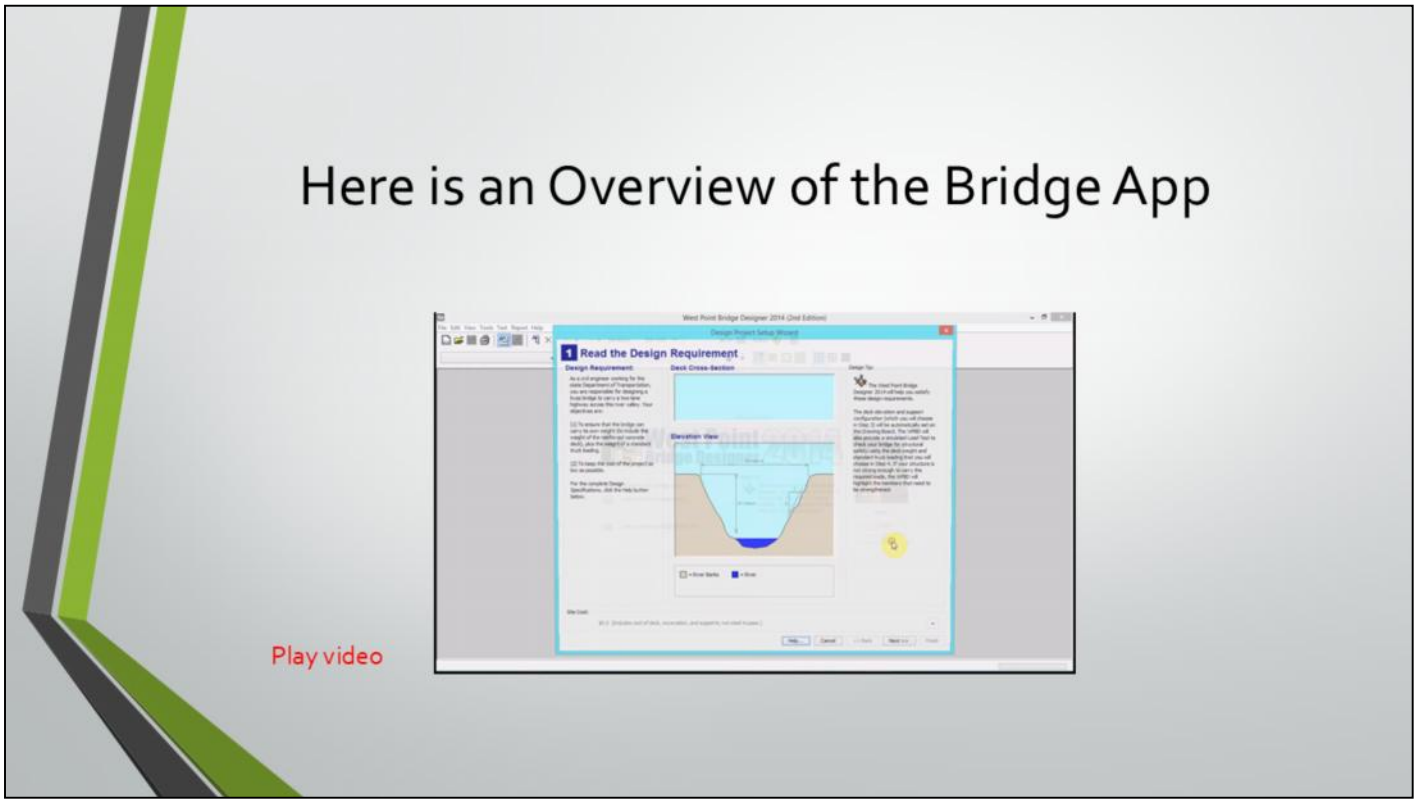
West Point Bridge Designer 2004 Software

The App uses steel instead of spaghetti and its full size.

But it will tell you if your truss is wrong before you build.

You can quickly change the truss arrangement.

Note: select in set up support abutment to match our test rig

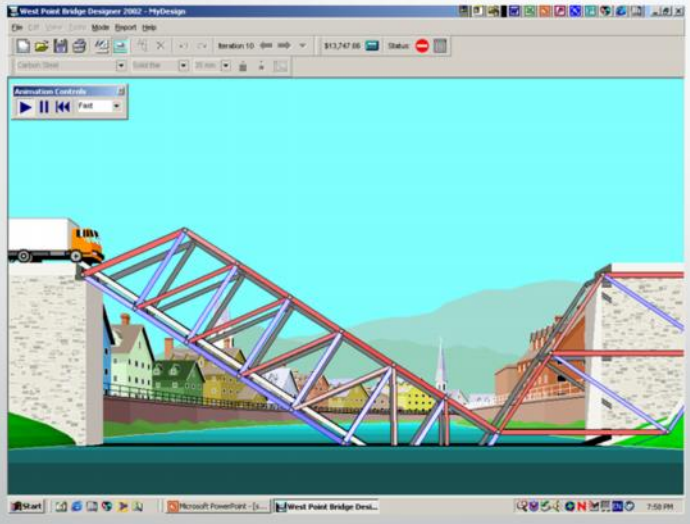


Here is a highlight snapshot of our video tutorial.

The Full video tutorial (11 min) is available for viewing in the Challenge Folder.

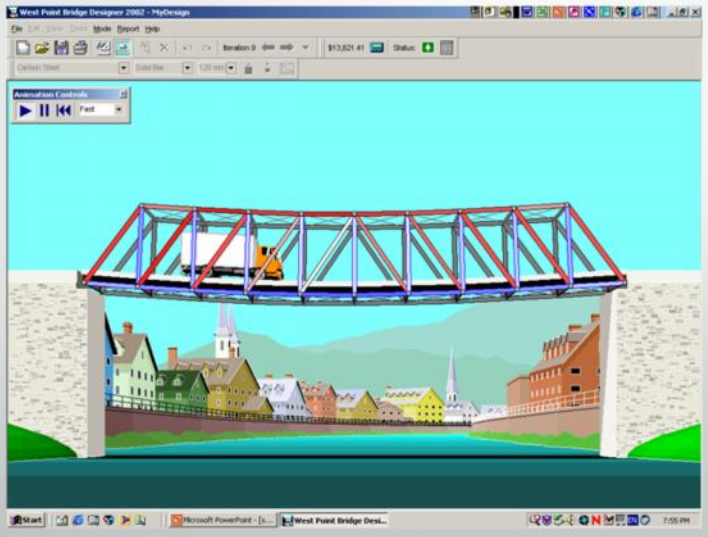
Play video

Evaluate your concepts easily and quickly



The App will tell you if you left something out.

Test for Success



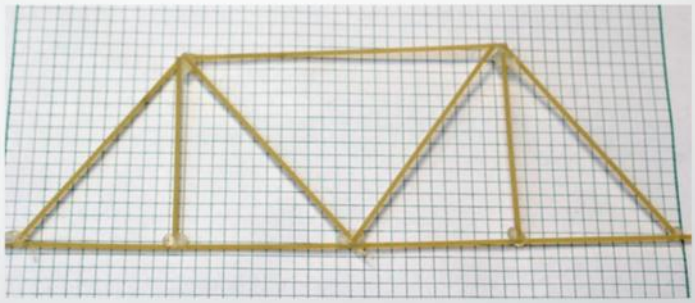
And when you got it right!

5
Build your trusses

Having Chosen your Truss design draw it out on graph paper. Cover the drawing with grease proof paper and cut and glue your truss together.

Trusses are triangle-shaped support beams that attach point-to-point along the bridge on either side.

Trusses distribute the forces of the weight you will add to the bridge.



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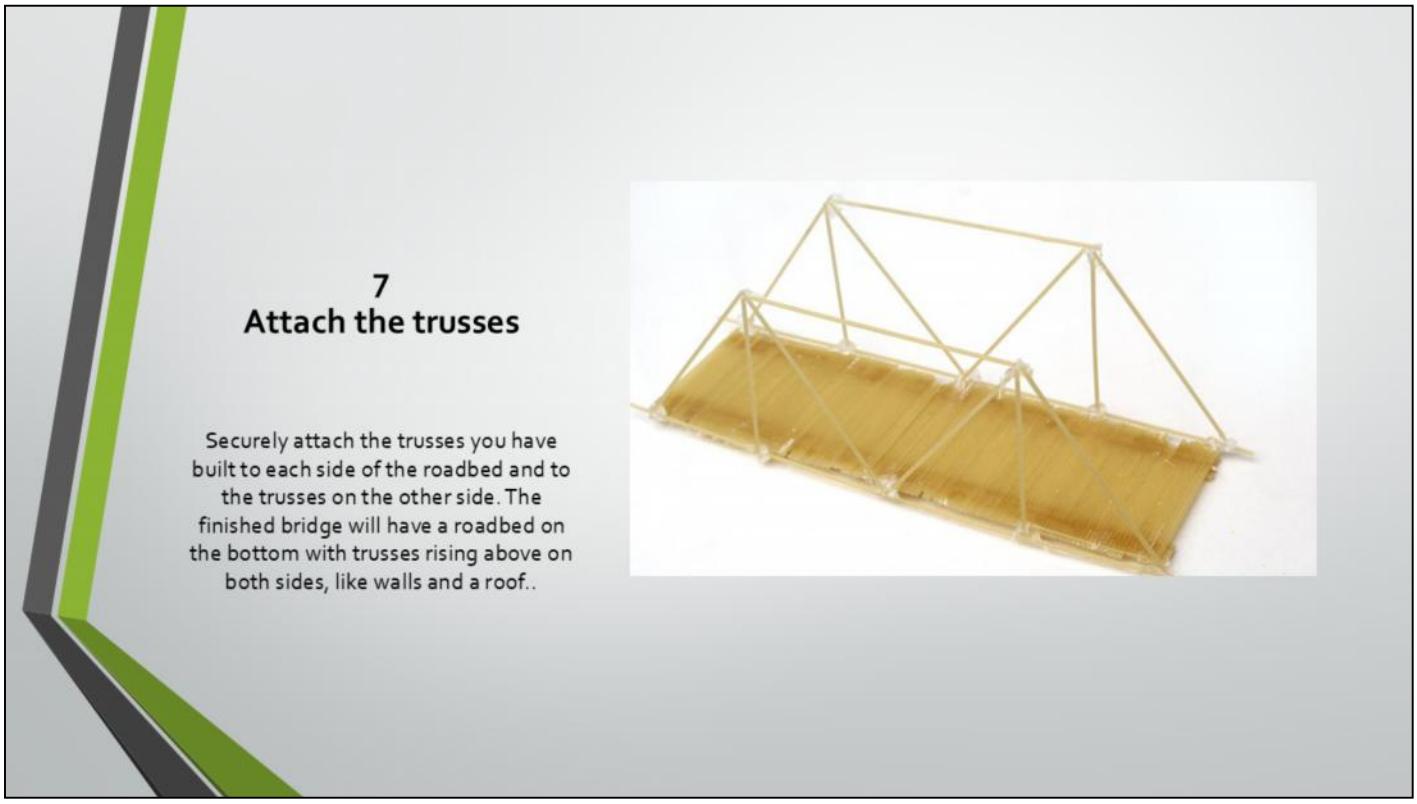
Trusses distribute the forces of the weight you will add to the bridge.

MAKE SURE YOUR Bridge is wide enough for the flexi road and the bus.

Warning the Bus wobbles as it moves.

You can do this by gluing several layers of spaghetti to each other to make a thick, flat roadbed. You may want to leave the strands unglued in some layers so they will naturally move and help redistribute the weight



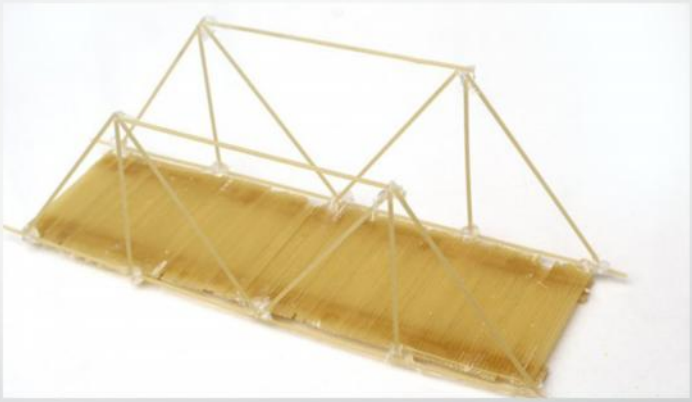
Once you have the Truss sides and the base for the Flexi road you can assemble your bridge by gluing it together.

Add some cross members across the to keep the spacing stable and your done.

Make sure the bus will pass freely under any top cross members

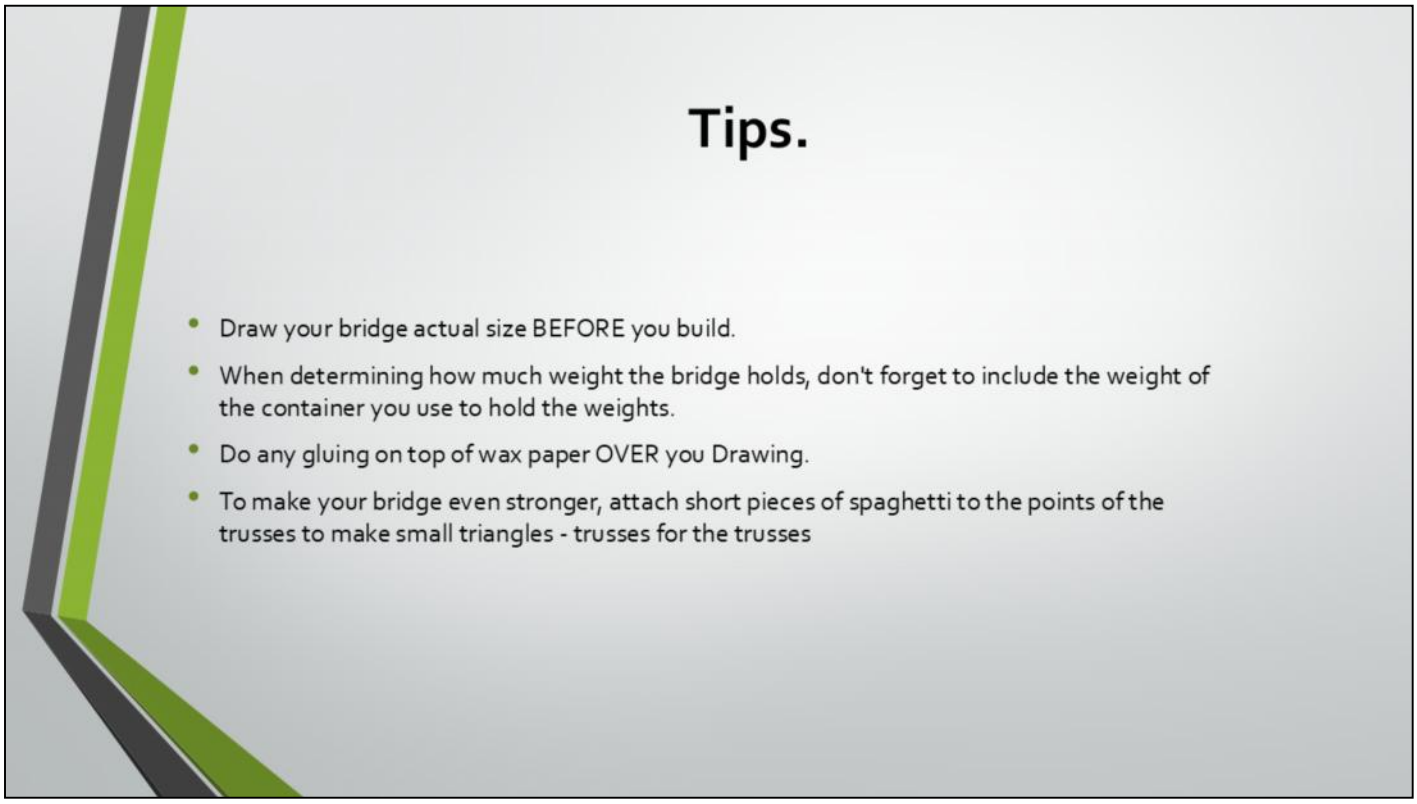
8
Weigh your bridge.

Rather than setting the bridge itself on the scale, set it on something stable like a box and weigh both. Then, subtract the weight of the box. You can also use 2 scales, placing 1 underneath each edge of the bridge, and then add the weights together.



Light test bridge that carries the Bus safely across WINS!

So record your bus weight

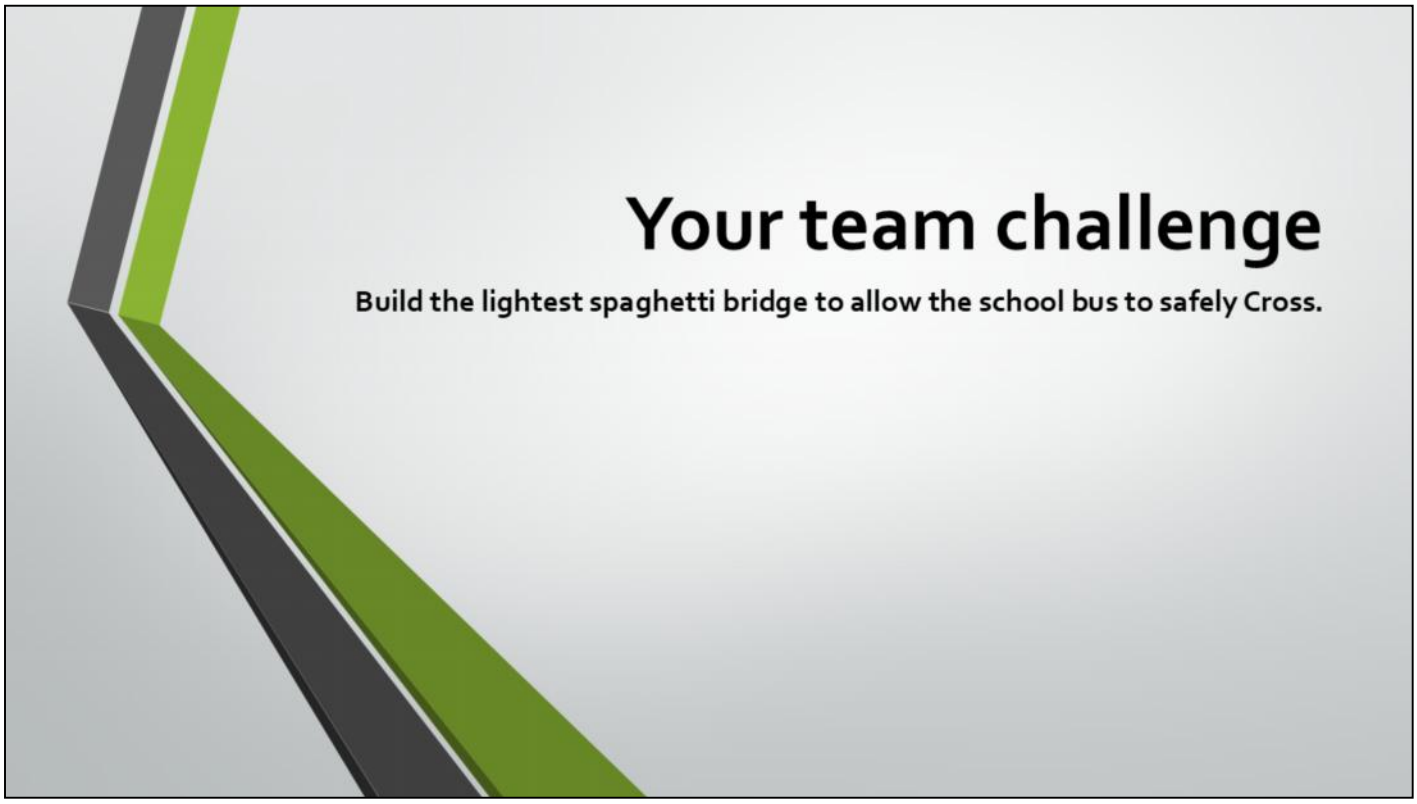


Draw your bridge actual size BEFORE you build. You can use this drawing as a template to build on.

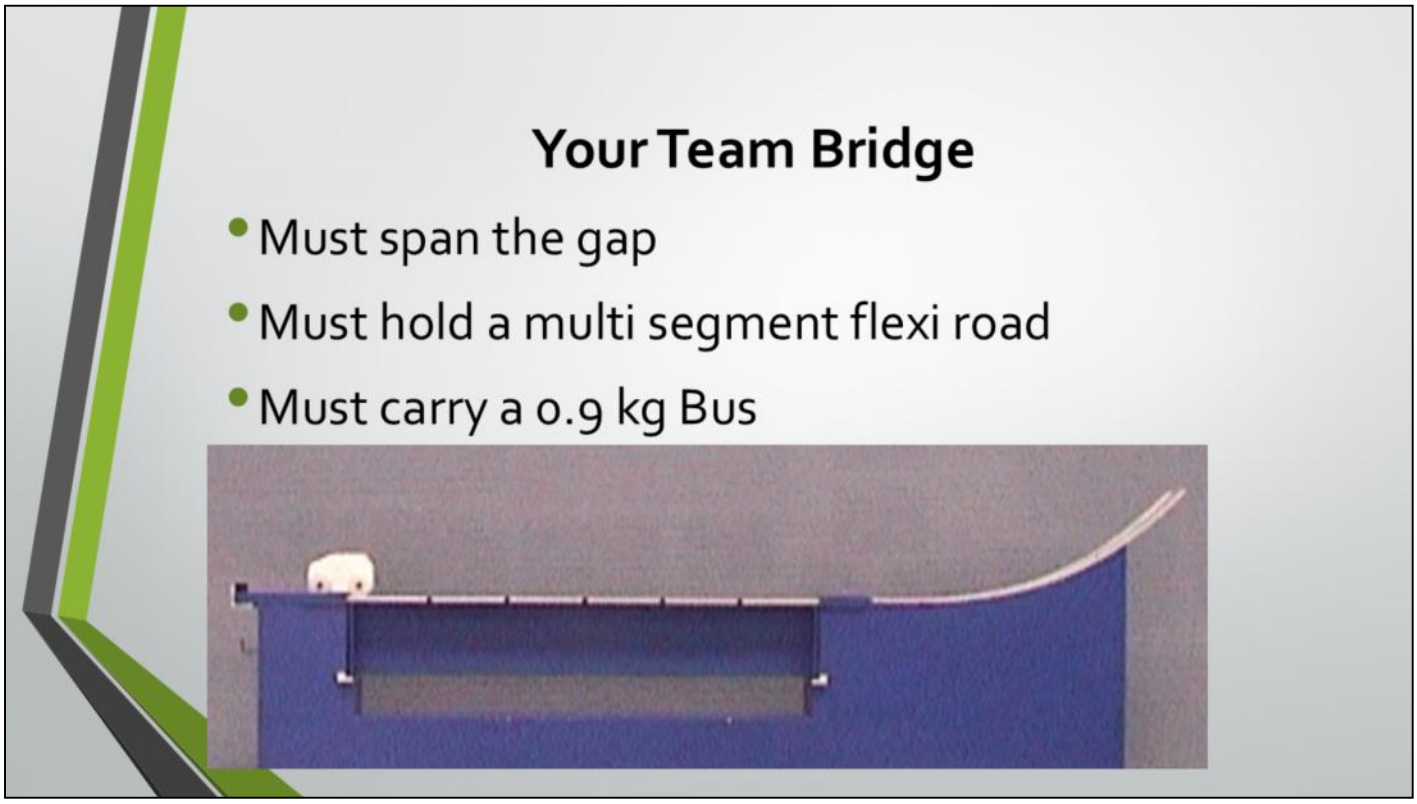
When determining how much weight the bridge holds, don't forget to include the weight of the container you use to hold the weights. For spaghetti bridge-building contests, the weight of the bridge itself matters, and the winner is the bridge with the highest strength to weight ratio.

Do any gluing on top of wax paper. Wax paper can also be positioned over a graph paper drawing, allowing you to see the design. Normally the right and left, front and back are the same. Use strips of duct tape to temporarily hold items drying.

To make your bridge even stronger, attach short pieces of spaghetti to the points of the trusses to make small triangles - trusses for the trusses



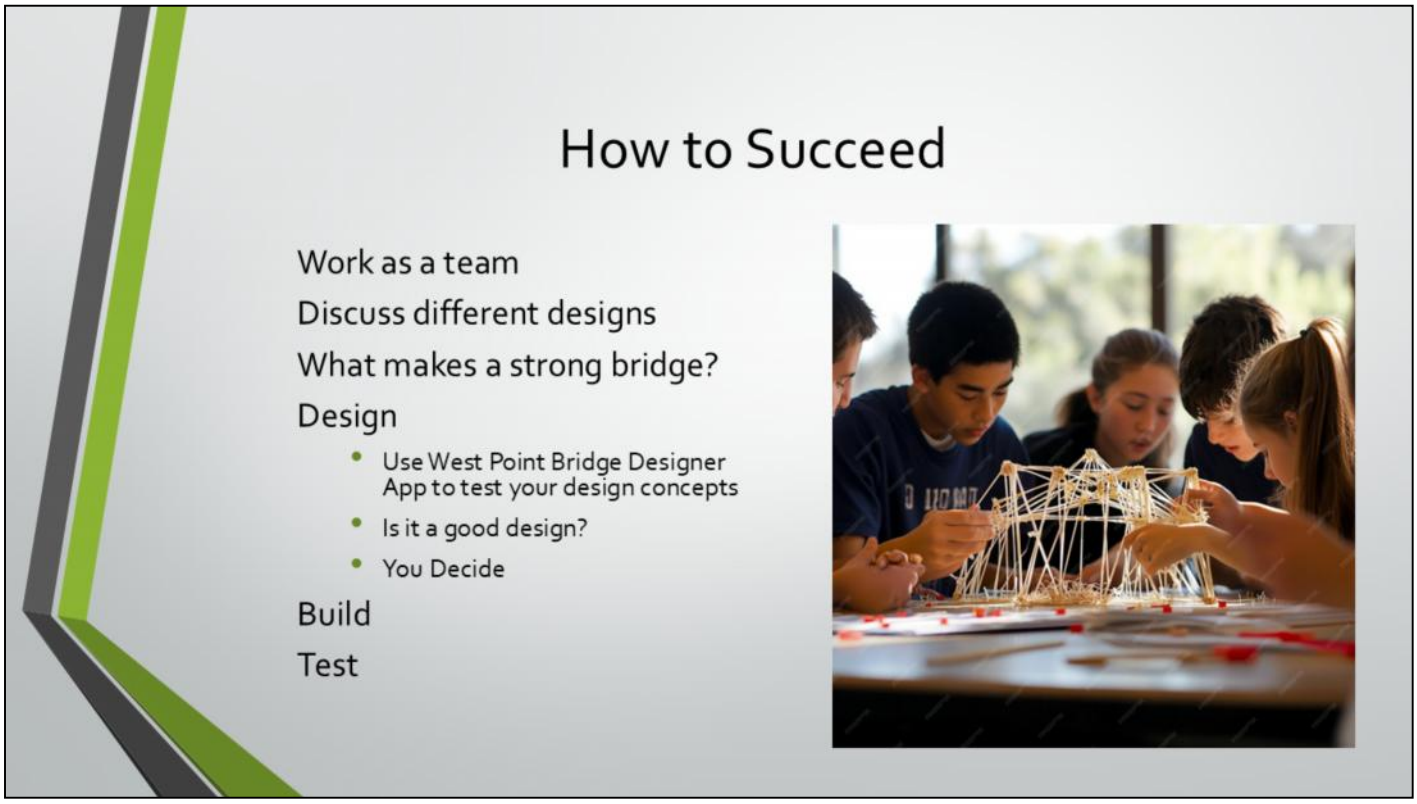
Your Aim is to build the lightest spaghetti bridge to allow the school bus to safely Cross.



Your bridge must span the gap

It has to carry the flexi road and a 900gm Bus

Good Luck your Team can do it.



Work as a team

THINK about the problem and record your results.

Its not the fist built bridge that wins but the LIGHTEST.

Discuss different designs, ask questions.

What makes a strong bridge?

Design

- Use West Point Bridge Designer App to test your design concepts
- Is it a good design?
- You Decide

Build

Test

Spaghetti is awful thin.

How can we make it thicker?

This short video will tell you every thing you need to know to build a Mega Spaghetti Bridge.

Play video

Safety

- Wear protective glasses when cutting spaghetti
- Only cut the spaghetti with the side cutters
- Do NOT use a knife to cut spaghetti
- Warning Hot Glue Guns Burn please wear gloves

A reminder about safety

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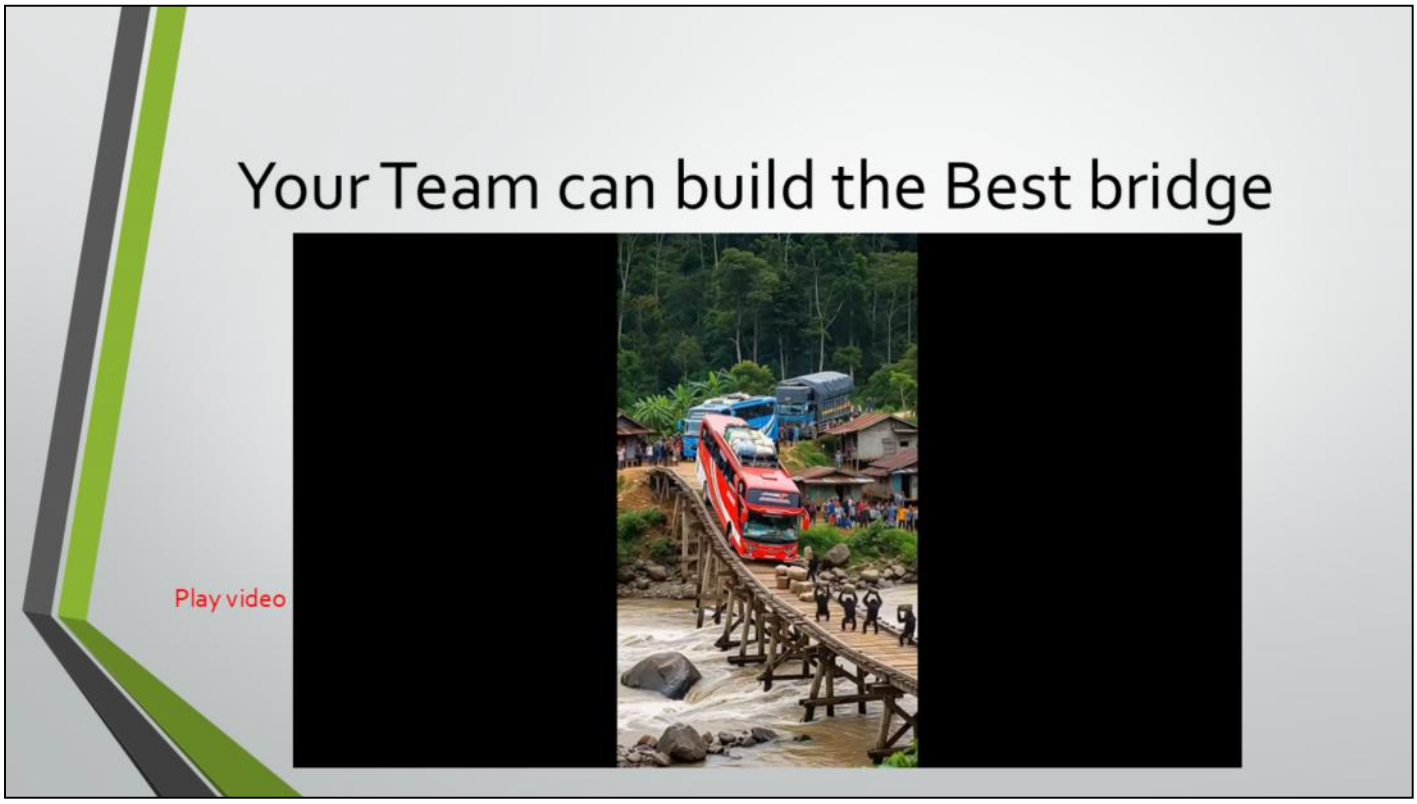

It’s up to your team design a better and safer bridge

Play video