Water Tower Construction:

Subject: AT1 STEM Olympiad

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Introduction:

Water towers are useful structures which are used to store and supply water using gravity. In engineering, designing a stable tower requires an understanding of the forces, materials and construction techniques that you are limited to. This project, though small is a recreation of real-world engineering challenges. And that this project involves building a small-scale water tower, using only what we are allowed to have which are straws.

Topic:

The tower which we create must be strong enough to carry the weight of a golf ball. The challenge is to design and construct a straw-based tower that is both sturdy and efficient.

This projects goals:

- Design and build a water tower using straws that can support weight.
- Testing its ability to hold weight using a golf ball.
- Analyzing any structural weaknesses and suggesting any improvements.

This reports goals:

- Design a Water tower which can support weight.
- To apply any engineering concepts that I have learnt.
- To record everything and you learn from it.

Review previous work/research/products

From previous work such as Challenge 1: The Slender Tower which taught me the strength of a cylinder and in Challenge 2: The Paper Bridge which taught the weakness of a cylinder. These previous works have taught me that a cylinder is strong upright as the weight is spread out evenly across the circle, though once any bend or deform has formed the paper will bend and fall, as the weight wouldn't be even. So after considering this, I realized the importance of keeping the straws not bent and the weight evenly distributed across them. I've also learnt the strength of the triangle and the importance of key joints being secured together.

Method:

The project which is required involves:

Brainstorming: Viewing other designs from around the world and comparing them with your ideas to create a mixture.

Designing: Drawing on an A4 piece of paper to recreate the idea on a blueprint for which the tower will be compared with.

Assembling: Taking precautions with the limited amount of tape and straws to create a tower which can support the most amount of weight.

Testing: Watching carefully as the weight is loaded onto the tower and seeing if the design will hold or not. If something seems unsecure or not stable, adjust and fine tune it until it works.

Adapting: After watching the test, strengthen or change any weak points so that the ball can easily hold the weight.

Main Body Report:

This report shows the design and construction of a straw-based water tower, which should support the weight of a golf ball. This design will be based off real life water towers which are essential structures that utilize gravitation force to store and distribute water efficiently. This project aims to make us explore with stability and material strength while using an engineering approach. The report will show the problem, objects, research findings, design process, construction methodology and the final evaluation.

Statement of the methodology:

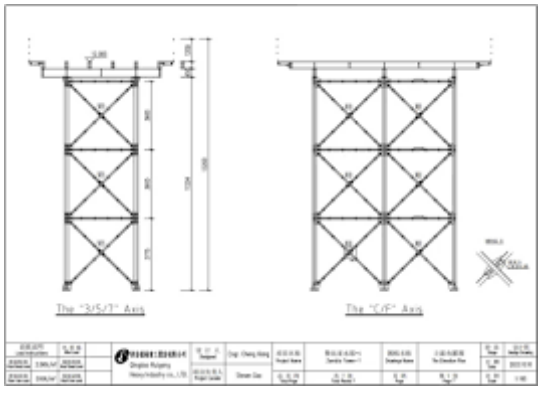
The methodology for this project involved the ISTEM Design Process.

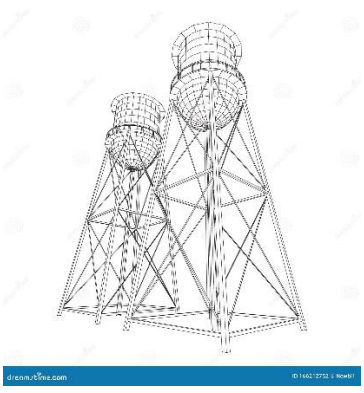
- Define the problems
- Identify the constrains
- Brainstorm multiple solutions
- Design or upgrade the most promising solution
- Prototype the solution
- Evaluate and test your solution
- Iterate to improve your solution
- Communicate and share your solution

Materials List:

- 8x130mm straws
- 20cm of sticky paper tape
- A ruler
- A golf ball

Evidence of research.

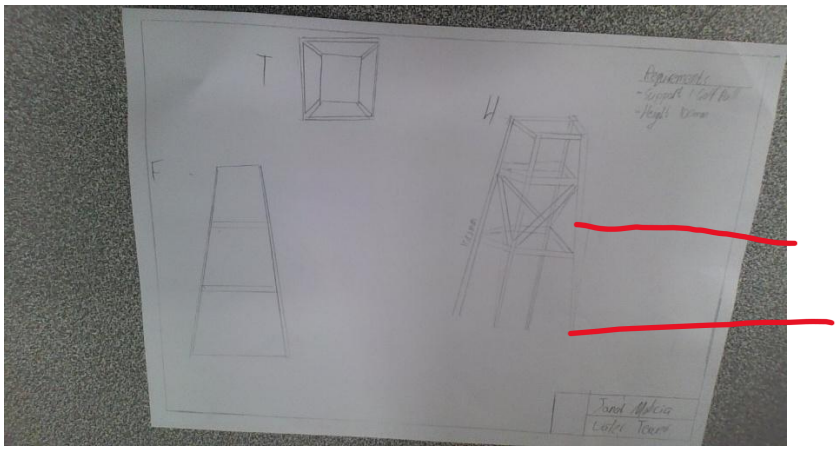




Labelled preliminary sketches of my initial ideas.

Labelled developmental sketches.

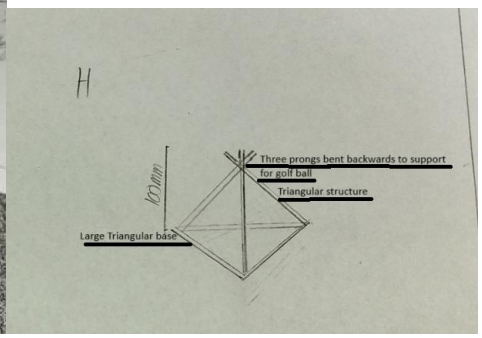
Previous design:

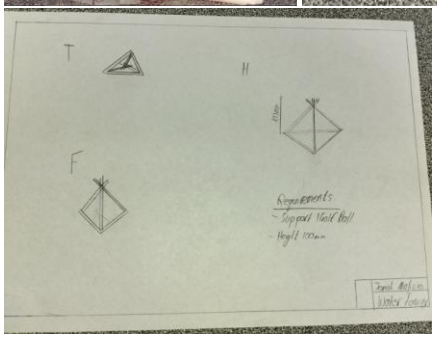


Strong triangular form, allowing minimal movement though keeping it strong together.

Strong rectangular base, allowing more movement.

Structure completed:





Main body:

Procedure account:

Before I began building I needed to follow the ISTEM Designing Process which includes:

- Define the problems – The problem and question I will be solving in this task can include: How can I build a tower that is stable, strong and able to support the weight of a golf ball using minimal materials?
- Identify the constrains – The constraints include using only 8 straws and 20 cm of paper tape. As well as this, the strength of the tape and straws was something to be taken into consideration as it makes supporting the weight of a golf ball more difficult.
- Brainstorm multiple solutions – I brainstormed several ideas and identified many common design flaws in similar builds. In this task I attempted to combine any new ideas into a practical design that could effectively support the weight of the gold ball.
- Design or upgrade the most promising solution – After observing other people's design I developed a structure consisting of two triangular shapes which were connected at the top and middle by two straws. I believed that this structure would securely hold the golf ball.
- Prototype the solution – I built my first design and quickly found that the joints were not strong enough due to the tape limitation. The weak joints would loosen even more to cause the structure to open up, making the gold ball fall and preventing the tower from serving its purpose.
- Evaluate and test your solution – After this failure, I tried spreading the tape more evenly to strengthen the joints. However, when tested again, the ball still fell. Upon further evaluation, I came to the conclusion that incorporating a stronger triangular structure would be a necessary improvement.
- Iterate to improve your solution – After testing my design one final time, I came to the final conclusion that the best approach was to completely redesign it. I concluded that the blueprint needed to incorporate a triangular structure, as triangles are the strongest shape.
- New design implementation – After evaluating the previous prototype and understanding the flaws of the previous design I created a new design. This new design would incorporate a fully triangular structure with additional tape around the joints for better support. The triangle shape provides greater stability, while also allowing the tower to handle the weight of the golf ball more easily.

References:

17 Water Tower ideas | water tower, tank stand, water tank Pinterest images.
24,514 Water Tank Tower Images, Stock Photos, 3D objects, & Vectors | Shutterstock Images of water towers from around the world.
STEMKids Straw Tower - YouTube A video to a simple ISTEM tower design.

Conclusion:

This projects goals:

- Design and build a water tower using straws. – I designed and built two water towers, one that could support the weight and one that couldn't.

- Testing its ability to hold weight using a golf ball. – The weight of the golf ball could be held securely using the materials provided. Rigorous testing was conducted which. The structure held significantly well compared to what I had prepared for.
- Analyzing any structural weaknesses and suggesting any improvements. – I analyzed the previous design for all structural weaknesses and I suggested and implemented improvements such as a triangular structure.

This Reports goals:

- Design a water tower which can support the weight. – In the end the tower supported the wight of the golf ball decently, it was stable and secure.
- To apply any engineering concept that I have learnt. – I used many of the engineering concepts that I learnt such as that the triangle is a strong shape, and that the pylon is a strong shape and should be used though if any deformations appear, the structures resistance to weight will be affected.
- To record everything that I have learnt from it. – I learnt that when designing a project to not be worried if the design fails, because it is from failure that you learn.

The importance from this report is that it teaches us the steps to create a design that holds weight. And that these steps though are for something small can be used on large builds in real life. Some similarities between the Centrelink Tower and the golden gate bridge is that both of them most likely used these processes to create a stable and strong build that will last decades.

The results of this project can be applied to various fields where efficient use of materials is important. The principles of using simple materials such as straws and tape to create a stable structure which can withstand weight can help be applied to simple builds such as small bridges and small water towers. The concept of using triangular shapes, which proved to be the strongest and most stable shape in this project is also used worldwide as in engineering such as bridges and buildings.

Although the tower successfully supported the golf ball, the finding have some limitations. The design was heavily limited by the materials, and that other materials has the chance of not working as well or at all. This project was also restricted by the limited number of straws and tape, which prevented the design from being able to withstand more weight. While the tower met the height requirement of 100 mm, it most likely would fail to hold the weight any higher. And while the tower met the requirement of one golf ball, if the weight was to be heavier, I feel that the design would have crushed as the tape around the base would have snapped or disconnected causing the support arms to fall. I feel that with more tests and stronger materials as well as more materials the design would be able to cover more height and to carry more weight.

The key findings that we have gathered from the project is that the triangular shape when using straws and tape creates the most stable structure under given constraints. Though despite the limitation of only 8 straws and 20 cm of tape, the design was able to support the weight. Though, the limitation impacted the overall strength of the tower.