Banana Split!

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SCAN THIS FOR PROOF OF DIMENSIONS, WEIGHTS, AND LOAD TESTING:

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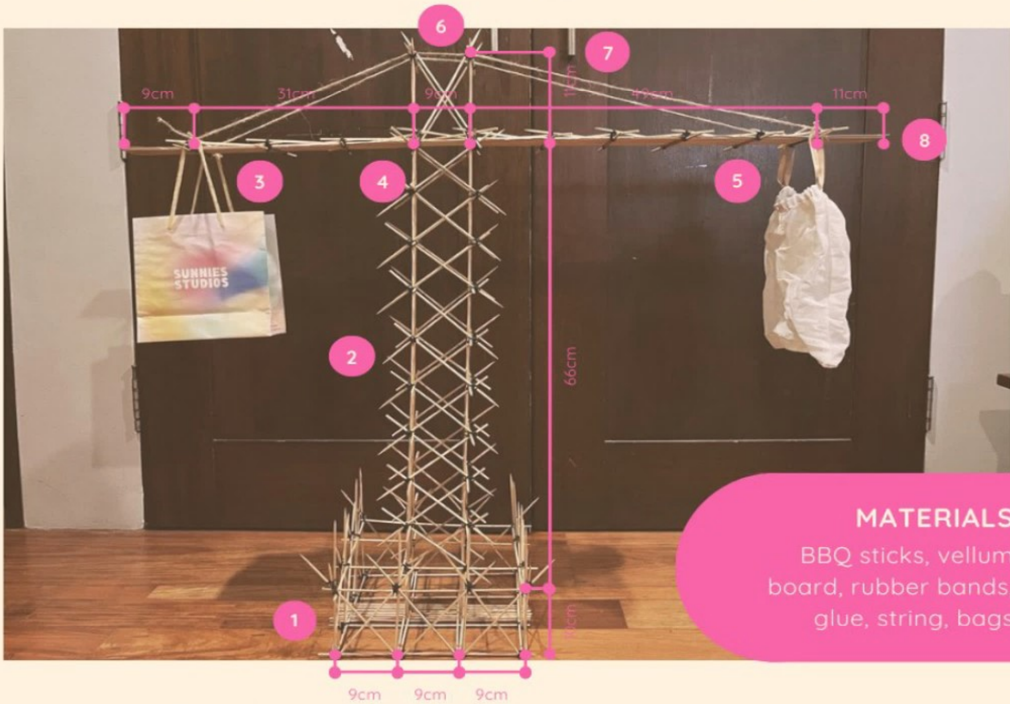
THE CONCEPT

Inspired by the "anti-gravity" look of the "impossible chair", a series of mini-prototypes was held with the intention of incorporating a **tensile string member** into the design. Further developing the model led to a look that highly resembled **tower cranes** used in construction today, hence the decision to push forward with this as the main design concept. This has been proven to work in the industry for years, and so was projected to work just fine on a couple of bananas!



MATERIALS

BBQ sticks, vellum board, rubber bands, glue, string, bags

DESIGN FEATURES

1 The **base** inspired by footings in construction: thick, "eating up" a part of the vertical supports[2] for increased stability and balance

2 The **vertical supports** comprised of 2 BBQ stick "planks" on vellum board planes, connected through crisscrossed sticks on the sides

3 The **counterweight** area of the beam comprised of a small cantilever (that is connected/monolithic to the main cantilever[5]) holding a bag that is increased in load as the main load increases

4 The **junction** between the vertical supports[2] and the beam[3+5], connected in an interlocking manner with sticks and rubber bands "sandwich"-ing these connections to prevent moment

5 The main **cantilever** of the beam (that is connected/monolithic to the counterweight area[3]) with a bag by its end that holds the main load

6 The **joint** of the strings[7] placed at a higher level than the beam[3+5], to allow the strings to lift up the tips of the counterweight area[3] and the main cantilever[5]

7 The **strings** connecting the sticks that hold the 2 bags, adding tension to resist the downward pull of the weights

8 Additional detail on the beam[3+5] and vertical supports[2] : BBQ sticks connected in a **"running bond" pattern** to account for the vulnerable points in which the BBQ sticks are connected

LOAD TESTING

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EFFICIENCY

$$\frac{\text{Weight of 5 bananas}}{\text{Weight of prototype + counterweight}} = \frac{624\text{g}}{687\text{g} + 855\text{g}} = 0.4047 \times 100 = 40.47\%$$

MINIMUM LOAD CAPACITY (1 HAND OF BANANAS)

The prototype was indeed able to support at least 5 bananas as shown, with 5 other bananas and 1 umbrella acting as counterweight. A video of the loading process can be found in the QR code at the upper right corner of this board.

LOAD LIMIT

SIGN OF DEFLECTION & INSTABILITY
at 902 G LOAD and 1133 G COUNTERWEIGHT

Once an apple was added in each bag, the prototype began to lean towards the main cantilever and the beam began to deflect. The imbalance would often correct itself later on when more load was added to the counterweight, but the deflection in the beam continued to worsen over time.

*note: the bags were changed during this test to accommodate more load

SLIGHT RUPTURE
at 2329 G LOAD and 3911 G COUNTERWEIGHT

Increasing the load in both bags led to a rupture in the stick carrying the counterweight, which is also attached to the string that connects the counterweight to the main load. The shape of the bend most likely indicates that it ruptured due to the tension in the pull of the strings.

COMPLETE COLLAPSE
at 2731 G LOAD and 4313 G COUNTERWEIGHT

Raising the structure and further increasing the load led to the prototype's collapse due to instability. The beam remained intact, but the entire prototype tilted towards the main cantilever until it fully fell off from the ground in which it was standing. It is possible that the prototype could have carried a larger amount if there was more balance in the counterweight vs. the main load, which in this case the prototype would be more likely to fail due to the deflection in the beam over the instability in its stance.

WEAKNESSES AND POINTS OF IMPROVEMENT

WEAKNESS	IMPROVEMENT
~40% efficiency in the use of materials	Less materials could be used particularly in the vertical supports that made use of quite a large amount of sticks stuck together, as well as in the counterweight which could possibly be lighter if more (lightweight) bracing were to be added.
Instability/tilting of the prototype	The base could most likely pin the prototype down in a more effective manner if it were heavier. If limitations permit, widening the base would most probably help counter tilting as well.
Deflection in the beam	The beam could most likely resist deflection better if it were "thicker" or just generally had more members. This would require more force to bend.
Weakness at the points of load application	Connecting the hanging bag and the strings to the beam itself as opposed to a stick connected to the beam would most probably prevent concentrating all the load and tensile forces at small points, preventing the rupture that occurred during load testing.

Alongside these weaknesses, the prototype was notably strong on its vertical supports and on the junction between these supports and the beam. The planks with crisscross connections were strong against buckling, and the interlocking nature of the junction with sandwich-ing sticks was firm in keeping the beam in place. This prototyping was surely a learning experience and could most definitely be useful for the construction and/or improvement of real-life tower cranes!